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INTERNATIONAL ECONOMIC CONFERENCE

GENEVA, MAY 1927

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DOCUMENTATION

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THE

CHEMICAL INDUSTRY

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## PREFACE.

At its first session in April 1926, the Preparatory Committee for the International Economic Conference decided that it was necessary to submit to the Conference a series of memoranda describing the present position in certain major industries, among them the chemical industry.

The Committee at the same time outlined the general scheme on which these studies were to be carried out.

The Secretariat was instructed to prepare for the Committee's second session, in November 1926, memoranda on certain key industries. With regard, however, to the other more important industries, among them the chemical industry, it was thought better to obtain memoranda from the competent organisations in certain countries. Consequently, at its second session, the Committee was placed in possession of a memorandum prepared by the Fachgruppe Chemie des Reichsverbandes der Deutschen Industrie and of a statement submitted by M. Duchemin, President of the Union des Industries chimiques (France).

At its November session, the Committee decided that the memorandum from the above-mentioned German Association should be transmitted by the Secretariat through the Members of the Committee to those countries to which a study of it might be of interest and which might desire to offer observations upon it.

Subsequently such observations were received in the form of special monographs and notes submitted by the Association of British Chemical Manufacturers, The Honourable E. Belloni (Italy), the Union des Industries Chimiques (France), the Union of Polish Chemical Industries, Sveriges Kemiska Industrikontor (Sweden) and Dr. F. Hodač, Secretary-General of the Czechoslovak Manufacturers' National Association.

At its meeting in Paris on February 23rd, 1927, the Documentation Committee of the Sub-Committee B of the Preparatory Committee for the International Economic Conference decided that the general Memorandum prepared by the German Association should be published, together with the British Monograph, the notes of M. Duchemin, the Honourable E. Belloni and the Union of Polish Chemical Industries, in one volume.

In accordance with the decision of the Documentation Committee, the other observations submitted have been taken account of in the form of corrections in or footnotes to the German Memorandum.

Geneva, March 1927.

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April 1927.

INTERNATIONAL ECONOMIC CONFERENCE

The Chemical Industry

Among the nine reports on various industries (Iron and steel, Coal, Shipbuilding, Chemical and Potash Industries, Electro-technical Industry, Mechanical Engineering, Cotton, Silk, Artificial Silk) being prepared for the International Economic Conference (Geneva, May 4) is a volume on the Chemical Industry of the world which has just been issued by the Economic and Financial Section of the League Secretariat.

This volume contains a fifty-page monograph by the Chemical Group of the National Union of German Industries, which is divided into a preliminary survey of the essential conditions governing the development of the industry (markets, technical development, raw materials, non-economic factors); capacity and actual output for the industry as a whole and specific branches; employment and unemployment; hours of labour; output per head; wages; raw materials used; customs duties (import and export prohibitions and licences); exports and imports for the industry as a whole and specific branches; consumption per head and by countries; prices; industrial organisation of the industry as well as of buying and selling.

The Association of British Chemical Manufacturers contributes a forty-page monograph covering much the same ground, while a ten-page statement is contributed by the French Union of Chemical Industries on "The Main Aspects of the Chemical Industry throughout the World as seen from a French Standpoint." There is also a statement on "Statistics and other Information regarding the Italian Chemical Industry" by the Hon. Ernesto Belloni; and "Observations on the Chemical Industry in general and on the Rates of Import Duties levied on Chemical Products entering Poland," by M. Trepka, Director of the Union of Polish Chemical Industries.

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**MONOGRAPH ON THE CHEMICAL INDUSTRY.**

**Prepared by DR. C. UNGEWITTER,**

**Secretary-General of the Fachgruppe Chemie des Reichsverbandes der deutschen Industrie,  
September 1926.**

*Communicated by* DR. C. LAMMERS.

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# THE CHEMICAL INDUSTRY.

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## FOREWORD.

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### AIM OF THE PRESENT MONOGRAPH.

The present monograph is intended to serve as a basis for the study of the "situation of the industry and the causes of its difficulties".

### SCOPE OF THE INDUSTRY TO BE DISCUSSED.

The present monograph has been written in reply to the request of Commission B of the Preparatory Committee for the International Economic Conference of the League of Nations to deal with the branch of industry concerned with "chemical products (especially potash)". The monograph should therefore set out the special features of the international situation of the "chemical industry".

### METHOD EMPLOYED.

Commission B of the Preparatory Committee for the International Economic Conference of the League of Nations has proposed that the monograph should be arranged in accordance with the following plan:

1. Preliminary Survey of the Essential Conditions governing the Development of the Industry in Recent Years.
2. Output Capacity.
3. Actual Output.
4. Employment and Unemployment.
5. Hours of Work; Output per Head.
6. Wages.
7. Raw Materials used.
8. Customs Tariffs (Prohibition; Licences).
9. Exports and Imports.
10. Consumption per Head in each Country.
11. Prices.
12. Industrial Organisation; Selling and Buying Organisations.

It is, however, expressly stated that "the plan will have to be adapted to the special conditions in each industry".



### DIFFICULTIES.

In endeavouring to give in the form of a monograph an outline of the chemical industry from the international point of view, two fundamental difficulties are encountered:

- (a) The difficulty of delimiting the chemical industry;
- (b) The difficulty of obtaining the necessary information.

#### Ad (a). *Difficulty of delimiting the Chemical Industry.*

The scope of the term "chemical industry" varies widely in international usage. Even within individual countries it is not always certain which branches of manufacture are counted as chemical industries and which are not.

The predominance of chemical processes in any branch of manufacture is no criterion for classification. For example, the entire metallurgical industry, including the smelting of iron, consists of typically chemical processes. In fact, these processes are described in every manual of chemical technology. Nevertheless, these industries cannot be termed chemical industries, and must undoubtedly be left outside the scope of the present monograph. Other branches of industry, such as the manufacture of soap or the production of rubber goods, are reckoned as chemical industries in some countries and not in others.

It is therefore necessary to make quite clear which branches of manufacture are to be reckoned as chemical industries. The following branches of industry may perhaps be classed as such :

The manufacture of the so-called heavy chemicals:

Sulphuric acid, hydrochloric acid, soda ash, carbide, acetic acid, formic acid, oxalic acid, tartaric acid, etc., including the products of wood distillation;

Artificial fertilisers, whether:

- (a) Nitrogenous or
- (b) Phosphoric.

*Note.* — The extraction of potash is not usually classed as a chemical industry, but is included in the mining industry; it is therefore hardly suitable for treatment in the present monograph, but, as it is expressly included in our task, it is dealt with in a special note, which will be handed in separately.

Aniline dyes and their by-products;  
Mineral dyes, pencils, etc.;  
Varnish;  
Explosives;

Pharmaceutical products;  
Artificial mineral waters;  
Essential oils and perfumes;  
Cosmetics;  
Glue and gelatine;  
Chemicals for photographic purposes;  
Washing, cleaning and scouring materials, disinfectants;  
Artificial plastic materials (celluloid, galalith, artificial resins);  
Artificial silk.

*Note.* — As a special monograph on artificial silk is contemplated we do not propose to deal with this subject in detail in the present monograph, but it is included in the general figures.

*Ad (b). Difficulty of Procuring Data.*

The statistical material available is extraordinarily incomplete. Official figures of production are only obtainable for the United States of America, Canada, Australia, Sweden and partially for Norway and Denmark. Thus, only for one of the producing countries of special importance to the chemical industry — the United States of America — can we base ourselves on official data.

For the rest, we are forced to employ more or less reliable estimates, particularly in Germany, Great Britain and France, which, after the United States, are the chief producers of chemicals. Reliable private publications are also very rare, so that it is not possible to make up for the deficiencies in the official data with their help.

As regards export and import, we have the official foreign trade statistics; these are, however, in so far as the industries under consideration are concerned, classified in such a way that the items headed "Chemical Products" or the like cannot be relied upon, as the term carried very different meanings in the various statistics. From each of these statistics the individual items covered by the definition given above must be extracted and regrouped.

In the general industrial censuses of the different countries we also have figures of the number of workers in the "chemical industry", but for the same reason these data are not comparable, nor can they be corrected like the foreign trade statistics, for the necessary sub-divisions are absent.

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### GENERAL SURVEY.

The general situation (the conditions of its development will be examined below in detail) is as follows: In 1913, chemical products to the value of 10 milliards of gold marks were produced in the whole world, as against a production valued at 18 milliards of gold marks in 1924. Allowing for the depreciation in the value of gold, the total production therefore has risen by 35 to 40 per cent.

The order of participation of the four countries which took the greatest share in this production in 1913 was as follows: United States of America, 34 per cent; Germany, 24 per cent; then come Great Britain and France.

The order remains the same to-day, but America's share has risen to 47 per cent, and Germany's has fallen to 17 per cent.

The total foreign trade in chemical products amounted on the basis of the export figures alone to 3.2 milliards of gold marks in 1913 and to 4 milliards of gold marks in 1925. This rise in value approximately corresponds to the depreciation of gold; the total volume of exports has thus remained unchanged.

The chief exporting countries in 1913 were as follows:

	Per cent.
Germany . . . . .	28
Great Britain . . . . .	16
Chile . . . . .	15
United States of America . . . . .	10
France . . . . .	10

In 1925, this order had changed as follows:

Germany . . . . .	23
United States of America . . . . .	16
Great Britain . . . . .	14
France . . . . .	13
Chile . . . . .	11

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## 1. PRELIMINARY SURVEY OF THE ESSENTIAL CONDITIONS GOVERNING THE DEVELOPMENT OF THE INDUSTRY.

As in the investigations of every other branch of economic production, distinction must be made, in a survey of the conditions of development of the chemical industry, between:

- (a) The conditions of development determined by markets;
- (b) The conditions determined by technical development;
- (c) The supply of raw materials;
- (d) Non-economic factors.

### (a) DEVELOPMENT OF MARKETS.

Like other branches of industry, chemical production can only develop in proportion to the demand which exists or can be created for its products. Considered as a whole, the markets of the chemical industry are, however, extraordinarily varied, as are also the possibilities of development and the actual development of the individual branches of the chemical industry. These branches may conveniently be divided into the following categories corresponding to the demand:

1. *Those branches whose products come directly into the hands of the "ultimate consumer", e.g., medicines and cosmetics.*

The development of these industries depends on the purchasing power of the general public and on the fluctuations in its requirements. The development of the cosmetic industry, for example, is particularly great in countries where the general level of prosperity has risen. For example, in the United States, the value of the goods produced in the group of perfumery, cosmetics and toilet requisites rose from 71 million gold marks in 1914 to 420 million gold marks in 1923.

Allowing for the fall in the value of gold, this branch of industry has therefore been more than quadrupled in the United States. In absolute figures, the value of the output of this group in the United States has increased sixfold.

2. *Those branches whose products are employed in agriculture.*

The chief of these is the artificial fertilising industry. The development of this branch depends on the purchasing power of agriculture and on its appreciation of the increased production obtained by the use of artificial fertilisers. The purchasing power of agriculture in its turn depends on the market for its products.

The development of this industry, as compared with the pre-war period, is greatest in Germany, in so far as nitrogenous fertilisers are concerned. The requisite conditions as to consumption were provided by the fact that Germany had a comparatively large agricultural industry which has specially appreciated the advantages of artificial fertilisers.

Before the war, 121 thousand tons of pure nitrogen (N 100 per cent) were produced in Germany; in 1925, production had already increased to 450 thousand tons.

3. *Those branches which manufacture products for the building trade in the widest sense of the term, i.e., the paint and varnish industries.*

These have developed most in countries in which there has been great building activity, while they have fallen behind in countries such as Germany, where there has been great depression in the building trade. In the United States, the value of the production of these two industries amounted to 611 million gold marks in 1913 and 1,697 million gold marks in 1924. The development of the varnish industry in the United States was also greatly assisted by the boom in the automobile industry in that country.

4. *Those branches which manufacture products for the textile industry.*

These are the industries which produce aniline dyes and auxiliary dye products. As shown in detail below in the section entitled "Output Capacity and Actual Output", the world capacity of producing aniline dyes has nearly doubled since the war. The capacity of absorption of the textile industry, however, has not increased. The consumption of wool and cotton has not increased, but fashion has developed chiefly in the direction of light and vivid colourings, which require less dye than the darker shades. Although the consumption of natural silk and especially of artificial silk has greatly increased, the total consumption of dyes has not been materially affected. This consumption amounted to 160 thousand tons in 1913 and to approximately the same quantity in 1924. As the producing capacity amounts to 285 thousand tons a year, only about 56 per cent is utilised, a state of affairs which, as far as can be seen, is not likely to be altered to any extent for some time to come (*cf.* particulars given in Section 2 below).

5. *Those branches which manufacture products for use in other industries (excluding the textile industry).*

To this group belong in particular numerous inorganic products, such as soda ash, caustic alkalis, sulphuric acid, hydrochloric acid, etc., in so far as these products are employed in industries which are not themselves chemical industries.

Many of these products are of so little value in proportion to their weight that they rarely enter into international trade, and must chiefly be produced in the country in which they are consumed. Their prospects of development therefore depend on the stage of industrialisation reached by the country concerned.

6. *Those branches which manufacture products for use in other branches of the chemical industry.*

Thus the essential oils industry manufactures semi-finished products required by the cosmetics industry. Nitro-cellulose, which is a product of the explosives industry, is a semi-finished product used in the preparation of varnish and celluloid. Many organic chemicals are extensively used in the preparation of aniline dyes, etc. These branches are therefore again dependent on the development of the other chemical industries which use their products. To this extent the development of the individual branches of the chemical industry depends upon the prosperity of the others.

(b) TECHNICAL DEVELOPMENT.

The second important group of factors which exercise a decisive influence on the development of the chemical industry is constituted by the possibilities and limitations which result from the position of chemical technique for the time being.

Originally, the technical processes of the chemical industry, as of all other branches of industry, rested on a purely empirical basis. But in few branches of industry has technique been so revolutionised by modern science as in the chemical industry.

But the extent of this influence on the individual branches of the chemical industry is very different, and there remain spheres of chemical production in which empirical methods still prevail. Nevertheless, it is a sign of progress that the scientific orientation of chemical technique is more and more coming to pervade the whole domain of chemical production.

Two striking examples of the extent to which the development of the chemical industry is influenced by these highly developed scientific methods of work may be quoted: first, the industry of organic chemical products — aniline dyes, pharmaceutical preparations and synthetic perfumes; and second, the manufacture of synthetic nitrogen compounds, particularly for fertilising purposes. The former branch of production could not have developed had it not been for the brilliant achievement of organic chemistry, or the latter without the help of physical chemistry.

The future development of the chemical industry largely depends on how far it proves possible to maintain and develop this scientific character of chemical technique. This again depends upon the progress of chemistry and the other

natural sciences, which in their turn depend upon the development of institutions for scientific research and of scientific teaching.

The promotion of scientific research and scientific teaching is an important duty of the public authorities, and both have developed and will continue to develop in proportion to the importance attached to them by those authorities and the extent to which these are able to provide funds for the purpose out of the public revenue. According to Garvan<sup>1</sup>, for example, the United States, in 1920 to 1924, spent the equivalent of over 420 million gold marks on the equipment of chemical institutes in the universities, and propose to spend another 2,100 million gold marks on such institutes in the next ten years. These figures do not include expenditure on teaching.

On the other hand, these special technical methods involve heavy capital charges on chemical enterprises, a burden which can only be supported if it is spread over a long period, and if the enterprises are not compelled to realise quick profits. Furthermore, even if the methods proved successful, the undertakings must be able to count on a corresponding turnover, as otherwise the overhead costs would show an unsound relation to the current costs of production (expenditure on raw materials, power and wages).

Indeed, private enterprises must themselves supplement the work done by public bodies by scientific research work of their own. They must attach to their works extensive scientific laboratories in which systematic researches must be conducted on a scientific plan in the special and allied branches on which their production is concentrated. If a new product or process is discovered in this way, much scientific and technical skill must be expended and considerable capital must be invested in experimental apparatus for a considerable period before practical factory operation is begun.

A well-known example is provided by the discovery of synthetic indigo.

Moreover, the manufacturing processes themselves must be scientifically controlled in all their various stages. In no branch of industry is the proportion of scientifically trained chemists and engineers to the other workers so great as in the chemical industry. This constitutes an additional financial burden on chemical production.

But it is not enough to discover new chemical products — new dyes, new drugs or new compounds suitable for fertilisers — to find technical methods for their preparation and to supervise their progress scientifically. The best methods of applying the products must also be scientifically investigated and technically developed by the producing firm. For example, before the new aniline dyes could be introduced into the textile industry, the dye-factories had to establish extensive laboratories which assumed almost factory proportions and entailed large capital

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<sup>1</sup> Speech delivered by F. P. Garvan at the annual meeting of the Synthetic Organic Chemical Manufacturers' Association, December 12th, 1924.

expenditure. Pharmaceutic factories have to spend large sums on the clinical testing of new medicines before they can be placed on the market. The chemical-fertiliser industry must study carefully the effect of their new nitrogen and phosphorus compounds on large experimental farms and work out the various methods of applying these fertilisers before their products can be placed on the agricultural market.

The capital expenditure required by activity of this special kind can only be met if the producers in question can reckon on a corresponding return in case of success.

A typical example is the development of the aniline-dye industry. This industry came into existence at the end of the fifties and at the beginning of the sixties of the nineteenth century almost simultaneously in Great Britain, France and Germany. Although several countries had a share in the earlier stages, the leadership soon passed into the hands of Germany. This country brought the aniline-dye industry to the rank of a large-scale industry and, as shown by the figures given in Section 2 under the heading "Output Capacity and Actual Output", supplied 88 per cent of the world consumption before the war.

This concentration in a single country was of decisive importance for the development of this industry into a remunerative large-scale industry. Only the custom of the entire world market or of a very large proportion of it could guarantee the aniline dyes industry sufficient return to render technical work on the scale described above an economic possibility. The total world sales of aniline dyes as shown by the figures given below in Section 2 could hardly have exceeded 160 thousand tons annually before the war, valued at 350 million gold marks. This quantity is divided among 1,500 dyes, if we count only the chemical "individuals" and ignore the fact that many of them are brought on to the market in varying degrees of concentration and in various mixtures. Nor does this figure include those dyes which, although they have been scientifically discovered, are not effectively produced. The number of dyes which are produced on a large scale, such as sulphur black and indigo, is comparatively small. These dyes have borne the brunt of the expenses, and have materially reduced the total amount of general costs to be distributed among the separate dyes. Their production first placed the industry in a position to develop the whole range of 1,500 colours, so that, for each individual application and for each degree of fastness and colour effect desired, the manufacturer has a specially adapted dye-stuff at his disposal. But the market for the great majority of these dyes, even taking world consumption as a whole, was very small, since the total sale of all aniline dyes, including those manufactured on the largest scale, only amounted to 160 thousand tons a year.

While, therefore, before the war, the dominant characteristic of the aniline-dye industry was its concentration in a single country, the process since the war has been reversed. In nearly all the great consuming countries, in proportion



as they are industrially active, there has been a tendency to develop a native aniline dye industry. Industries on a considerable scale have arisen in the United States, Great Britain, France, Italy and Japan. The aniline dye industry of Switzerland, which already existed before the war, has remained on approximately the same footing. The German share of the total production has fallen to 46 per cent.

As already stated above, the world's requirements in aniline dyes have not risen, but have remained at about the same level as before the war. The possible world turnover has therefore remained unchanged, despite the numerous old and new industries in existence. The possible turnover of each individual industry can therefore be only a fraction of the German industry alone before the war. The consequence is that there is now in each of these industries a thoroughly unsound ratio between overhead costs and current costs of production (expenditure on raw materials, power and wages). Consequently, in none of the new producing countries have the younger industries been able to develop and maintain themselves out of their own resources. Not only has it been necessary in many countries to spend public money on their maintenance, but the domestic market has had to be protected by high Customs barriers, and in some cases import prohibitions have been required to regulate and restrict artificially the influx of foreign dye-stuffs.

### (c) SUPPLY OF RAW MATERIALS.

Of course, the development of the chemical industry, like that of all other industries, depends on the supply of raw materials available. A characteristic of the chemical industry is that, as a rule, it employs raw materials of comparatively small value, available in abundance and obtainable everywhere, for the preparation of synthetic products which then replace in other branches of production materials of natural origin the supply of which is limited. For example, the natural supply of nitrogen compounds in the form of Chile saltpetre is strictly limited. The chemical industry has, however, succeeded in producing artificial nitrogen compounds in the form of ammonia or calcium cyanamide, which as raw materials only require atmospheric nitrogen and water or coal and lime, and as sources of energy coal or water power, all these materials and sources of power being much more abundant than Chile saltpetre.

The characteristic feature of chemical production is, therefore, that it is gradually making the human economic system independent of the natural distribution of the supply of raw materials. This independence is of course only relative. The supply of raw materials imposes certain limits on the industry. The inorganic chemical industry, for example, depends on the supply of cheap power and on that of salt, lime and suitable transport facilities for pyrites or uncombined sulphur. For establishments for making synthetic nitrogen cheap power is a pre-requisite. The most favourably placed country in this respect is the United States,

which has nearly all the raw materials required for chemical production in her own territory. As regards the three chief European producing countries, Germany is particularly short of phosphates, and her requirements in pyrites are only partly met by home production. Great Britain has also no phosphates and no sulphur or pyrites. France has at her disposal enormous phosphate deposits in her North African possessions, but has difficulties with regard to her coal supply and has to import pyrites.

The greater the value of a chemical product in proportion to its weight, the more independent is the branch of industry which produces it of the source of raw material. A typical example is provided by the existence of a very remunerative aniline-dye industry in Switzerland, although that country has no coke industry from which to draw its materials.

Some of the most important raw materials for the chemical industry are specially dealt with below in Section 7.

#### (d) NON-ECONOMIC FACTORS.

The factors hitherto described as determining the development of the chemical industry may, from the point of view of present trade conditions and of the world market, be termed "economic factors". Side by side with these factors we must consider another group, that of "non-economic factors". In the last twelve years, these factors have had a great influence on the development of the chemical industry. They chiefly take the form of intervention by national Administrations in economic affairs by means of Customs duties, import prohibitions, subsidies, etc., and also by the conclusion of commercial treaties and other international agreements.

Such intervention may be exercised in two directions, according to the two fundamental tendencies which may be noted in the development of every national economy. Each of these tendencies acts in a contrary direction, as do the Governmental measures which they determine.

On the one hand, there is the ambition to develop as far as possible all the various branches of industry within the national economic system, so as to bring the country to a state of relative independence and self-sufficiency, without in many cases examining whether or not the special circumstances of the case indicate that course.

On the other hand, we have the tendency to organise the national economy so that it should fulfil its task with the smallest possible expenditure of energy. This involves, however, according to circumstances, a greater or less adaptation to foreign trade, *i. e.* to export and import. Preference is given to the production of those goods for which the circumstances of the country are most favourable, and the surplus of production not consumed within the country is exchanged for the goods which are produced under more favourable circumstances in other

countries. The attempt to produce such goods at home is therefore abandoned in a greater or lesser degree. This process leads to the natural specialisation of production known as the "international division of labour".

We cannot in the present monograph go into the pros and cons of these two tendencies. We shall confine ourselves to noting that, since the war, the tendency to ensure the greatest possible independence of the national economic system and to shut it off, to a greater or lesser extent, from the world economic system has gained the upper hand in many countries. These countries endeavour to create extensive chemical industries of their own or to supplement and extend existing branches of chemical production, regardless whether the prerequisite conditions exist in the country and whether it would not be more advantageous to buy the chemical products in question from these countries in which the conditions of manufacture are more favourable.

As the new or enlarged chemical industries cannot subsist on their own resources, the State assists them by means of Customs tariffs, import prohibitions and even money subsidies. A statistical survey of these administrative measures in the domain of the chemical industry will be found below in Section 8, which, in accordance with the plan followed in this monograph, deals with Customs tariffs, etc.

If we compare, as is done below in detail, in Section 9, the total world production of chemical products with the total exports or imports of all countries, we shall find that there has in fact been a considerable dislocation, for, while in 1913 32 per cent of the production was exported, in 1924 it was only possible to export 23 per cent. On the average, imports have therefore fallen, and home requirements have been increasingly met by home production.

With regard to the second tendency, the increased inter-relation between the national economy and world commerce, we find another group of Governmental measures, of which the most important are commercial treaties. Unlike Customs tariffs and import prohibitions, these are intended to promote international trade. They are often accompanied by tariff agreements which either limit certain duties so that they cannot be further increased, or lower specific duties so that the general tariff level is correspondingly reduced. The influence of these tariff agreements, however, has not as yet made itself felt to any considerable extent in the sphere of the chemical industry.

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## 2 and 3. OUTPUT CAPACITY AND ACTUAL OUTPUT.

### A. — The Chemical Industry as a Whole.

It is hardly possible to obtain accurate figures of the total chemical production of the world. The majority of countries do not publish official statistics regarding this production and it is only possible to obtain figures for a very small number

of products from private sources. Official production statistics are only available for the United States, Canada, Sweden, Australia and to a limited extent for Norway and Denmark. For the rest we are obliged to rely on estimates.

To this difficulty in obtaining data must be added another fundamental and practical difficulty. Even if it were possible to collect data regarding all the products of the chemical industry, a simple addition of those data would lead to erroneous conclusions. A quantitative total is impracticable. It is not possible, for example, to add together the quantities of sulphuric acid and of pharmaceutical products manufactured if it is desired to obtain a figure from which any economic conclusions can be drawn, since the value per quantitative unit of sulphuric acid and of pharmaceutical products is too different. And even if we add the values of the substances produced, difficulties arise. The various branches of chemical production are not horizontal, *i.e.*, on the same stage of production, but, as already indicated above, are inextricably mingled at every stage from the raw material to the finished product. The products of one branch serve as principal or subsidiary material for other branches. If, therefore, we add together the values of the different products, many values may be counted two or three times over.

If we recognise this difficulty, and are not afraid of rough estimates, we may perhaps accept the following figures for the total chemical production of the world:

	1913 or 1914		1923 or 1924	
	Value in milliards of gold marks	%	Value in milliards of gold marks	%
United States <sup>1</sup> . . . . .	3.4	34	8.4	47
Germany <sup>2</sup> . . . . .	2.4	24	3.0	17
Canada <sup>3</sup> . . . . .	4.2	42	0.4	2
Sweden <sup>3</sup> . . . . .			0.2	1
Other countries <sup>4</sup> . . . . .			6.0	33
Total . . . . .	10.0	100	18.0	100

*The total production of the chemical industry of the world can therefore be estimated at about 10 milliards of gold marks annually just before the war, and at 18 milliards of gold marks in the years 1923 and 1924 respectively.*

<sup>1</sup> Figures reckoned on the basis of the official census of production for 1914 and 1923. This includes a section entitled "Chemicals and Allied Products". From this section all subheadings which do not correspond with the definition of the chemical industry given above have been eliminated and others contained in the remaining sections of the American census added.

<sup>2</sup> These figures are a purely private estimate, as no official statistics are available. The figures given for Germany are calculated on the same basis as those obtained from the official statistics for the United States.

<sup>3</sup> Calculated on the basis of the census of production for 1924.

<sup>4</sup> Private estimate.

The greatest share in this production is that of the United States of America, which before the war was 34 per cent and in 1923 47 per cent of the whole.

The German share before the war was 24 per cent and fell to 17 per cent in 1923.

The country with the third largest chemical production is probably Great Britain, and that with the fourth greatest production is France. The estimation of the detailed figures of these countries should be attempted by their own experts.

*Naturally, no guarantee can be given of the accuracy of the above estimates.* They have only been attempted in order to make a beginning with the compilation of statistics on this subject.

### B. — Specific Branches of the Chemical Industry.

The above round figures may be supplemented by data regarding a few of the most important branches of the chemical industry, among which special attention should be given to the following:

Sulphuric acid, which is the most important inorganic chemical for technical use;

Fertilisers, *i.e.*, nitrogenous and phosphoric fertilisers;

Aniline dyes, which are the most important representatives in the industry of organic chemistry.

#### (a) SULPHURIC ACID.

The most important inorganic chemical for technical purposes is sulphuric acid. It is used for the manufacture of other inorganic chemicals, such as sodium sulphate: in the chemical fertiliser industry for the manufacture of ammonium sulphate and superphosphates; also in various other industries, *e.g.*, in petroleum refineries, in the iron and steel industry, and in the textile industry; and lastly in numerous other branches of the chemical industry, such as the aniline dyes and explosive industries.

By far the greater part of the sulphuric acid produced is used, however, in the chemical industry, chiefly for the production of fertilisers and other inorganic products.

The figures of the production of sulphuric acid are therefore a useful index of the development of the inorganic chemicals industry in each country.

The following figures are taken from private estimates based on a detailed knowledge of the market conditions of the raw materials for sulphuric acid, such as pyrites, crude sulphur, zinc blend and gas purifiers (spent oxide).

As sulphuric acid is produced in different degrees of concentration, it is necessary to reduce the figures to a uniform standard. We have accordingly taken 50° Baumé as a standard.

*Sulphuric Acid Production.*

(Calculated to Sulphuric Acid of 50° Baumé = 62.5 % H<sub>2</sub>SO<sub>4</sub>.)

	1913 Metric tons (000's)	1925 Metric tons (000's)
Germany . . . . .	2,700	1,800
Great Britain . . . . .	1,800	1,300
United States . . . . .	3,150	6,300
France . . . . .	1,480	1,840
Belgium . . . . .	580	740
Netherlands . . . . .	60	150
Poland and Danzig . . . . .	100	320
Spain . . . . .	?	230
Denmark . . . . .	100	175
Sweden . . . . .	135	140 <sup>1</sup>
Kingdom of the Serbs, Croats and Slovenes . . . . .	620	100
Czechoslovakia . . . . .		210
Hungary . . . . .		80
Austria . . . . .		70
Switzerland . . . . .	50	50
Italy . . . . .	770	1,075
<b>Total . . . . .</b>	<b>11,545</b>	<b>14,580</b>

While, therefore, the total figure has risen by 25 per cent, the production in Germany and Great Britain has fallen. The fall in Germany has been the most marked, amounting to 33 per cent, and is due to the bad position of the German superphosphates industry, which in 1925 only reached about one-third of the production of 1913. Furthermore, the output of ammonia from the coke ovens has decreased, as coke production has suffered severely from the depression in the iron industry. In consequence, the coke ovens consumed less sulphuric acid for the manufacture of ammonia sulphate. Lastly, an important influence has been exercised by the market difficulties encountered by the German heavy chemicals industry and the severe restriction imposed on the explosives industry by the Treaty of Versailles.

In Great Britain, production has decreased by 27 per cent. In her case, too, superphosphates production has considerably declined. In 1924, it was only about one-half what it was in 1913. As in Germany, the depression in the iron and steel industry has unfavourably affected the coking industry.

The production of sulphuric acid has also declined in the territories of the former Austro-Hungarian Monarchy.

<sup>1</sup> The Sveriges Kemiska industrikontor (Stockholm) gives a production figure of 182,000 metric tons.

In all the other producing countries the output of sulphuric acid has increased. The greatest progress has been made by the United States, whose production has risen by over 3 million tons, the total thus being doubled.

(b) NITROGENOUS FERTILISERS.

At the beginning of the twentieth century the principal producer of nitrogen compounds was Chile. Otherwise they were only obtained to any extent as a by-product of coke and gas works.

In 1905, synthetic nitrogen began to be produced in Norway by the voltaic-arc process (Birkeland-Eyde) and in Germany and in Italy by the cyanamide of calcium process (Frank-Caro).

In the following years, other factories employing the cyanamide of calcium process were established in different countries.

A fresh impetus was given to the synthetic nitrogen industry when, in 1913, the method of direct ammonia synthesis (Haber-Bosch) was first introduced into industry in Germany.

In 1913, the world production of nitrogen reckoned in pure nitrogen (N.100%) was 771 thousand tons, of which 56 per cent was provided by Chile saltpetre, 37 per cent by nitrogen compounds obtained as by-products from coke and gas works, and only 7 per cent by synthetic nitrogen.

During and after the war there was an extraordinary development in the manufacture of synthetic nitrogen compounds.

In 1925, the world production of pure nitrogen already amounted to 1,250 thousand tons, constituting an increase of 62 per cent as compared with 1913. Only 30 per cent of the total production consists of Chile saltpetre, this figure being exceeded by synthetic nitrogen, which accounts for 44 per cent.

*World Nitrogen Production in Thousands of Metric Tons (N).*

	1913 <sup>1</sup>		1924 <sup>2</sup>		1925 <sup>3</sup>	
	Metric tons (000's) N.	%	Metric tons (000's) N.	%	Metric tons (000's) N.	%
Synthetic nitrogen . . . . .	55	7.1	410	38.8	550	44
Ammonia by-products . . . . .	283	36.7	280	26.5	325	26
Chile saltpetre . . . . .	433	56.2	367	34.7	375	30
<b>Total . . . . .</b>	<b>771</b>	<b>100</b>	<b>1,057</b>	<b>100</b>	<b>1,250</b>	<b>100</b>

<sup>1</sup> J. M. BRAHAM, Nitrogen Survey. III. United States Department of Commerce, *Trade Inf. Bull.*, No. 240, 1924, p. 41; J. A. HARKER, Nitrogen Products Committee, Department of Scientific and Industrial Research, London, 1921; and other sources.

<sup>2</sup> Half-Yearly Report of Aikman, Ltd., London, December 31st, 1925, and Monthly Report.

<sup>3</sup> J. M. BRAHAM, "Commercial Status of Nitrogen Fixation", *Chemical and Metallurgical Engineering*, 32, No. 17, 1925, p. 862, and *Le Phosphate*, 35, No. 1441, February 15th, 1926, p. 50.

*World Nitrogen Production, classified by Countries as far as ascertainable.*

	1913 Metric tons (000's)	1924 Metric tons (000's)	1925 Metric tons (000's)
	N.	N.	N.
<i>Europe:</i>			
Germany . . . . .	121	360	450
Austria . . . . .	7	0.8	0.8
Czechoslovakia. . . . .		5	6
Hungary . . . . .		0.5	0.5
Belgium. . . . .	10	13	14
Denmark . . . . .	0.5	0.6	0.6
Spain . . . . .	3	2	—
France . . . . .	18	29	33
Great Britain . . . . .	90	86	88
Italy . . . . .	5	13	17
Norway . . . . .	15	20	—
Netherlands . . . . .	1	7	8
Poland . . . . .	—	11	20
Roumania. . . . .	—	—	2
Russia . . . . .	3	—	—
Sweden . . . . .	4	7	7 <sup>1</sup>
Switzerland . . . . .	1	2	5
Kingdom of the Serbs, Croats and Slovenes .	—	6	7
<i>Asia:</i>			
Japan . . . . .	3	27	33
<i>Africa:</i>			
Union of South Africa . . . . .	0.2	0.2	—
<i>America:</i>			
United States . . . . .	36	102	98
Canada . . . . .	5	15	24
Chile . . . . .	430	367	385
<i>Australasia:</i>			
Australia . . . . .	1	2	—

<sup>1</sup> The Sveriges Kemiska Industrikontor (Stockholm) gives this figure as 8.



*Output Capacity and Production of Nitrogen in the World in 1926, calculated in Thousands of Metric Tons of Pure Nitrogen (N).*

	Capacity	Production
Synthetic nitrogen . . . . .	856	682
Ammonia by-products . . . . .	413 <sup>1</sup>	280 <sup>2</sup>
Chile saltpetre . . . . .	465 <sup>3</sup>	399 <sup>4</sup>
	<hr/>	
Total . . . . .	1,734	1,361

(c) SUPERPHOSPHATE

Before the war, the world production of superphosphate was approximately 11.5 million metric tons. The biggest producer was the United States of America, followed by France and then by Germany.

In the first year after the war, production fell by some 8 million metric tons, but in 1924 it had already risen to 10.6 millions, and in 1925 had again reached the pre-war production.

<sup>1</sup> This figure corresponds to the total output in 1920 (J. A. HARKER, Nitrogen Products Committee, Department of Scientific and Industrial Research, London, 1921).

<sup>2</sup> Half-yearly Report of Aikman, Ltd., London, June 30th, 1926.

<sup>3</sup> Maximum production in 1917 (Asociación de Productores de Salitre de Chile, *Bol. Mens.*, No. 67, 1924, p. 713.

<sup>4</sup> Monthly Reports of Aikman, Ltd., London, for the saltpetre year 1925-26.

The following table gives a survey of the situation:

*Production of Superphosphate.*

	1913 Metric tons (000's) <sup>1</sup>	1923 Metric tons (000's)	1924 Metric tons (000's)
<i>Europe:</i>			
Germany . . . . .	1,850	403	500 <sup>1</sup>
Belgium . . . . .	498	491	490
Denmark . . . . .	90 <sup>1</sup>	190	161
Spain . . . . .	460	683	588
France . . . . .	1,980	2,215	2,304
United Kingdom . . . . .	845	517	439 <sup>1</sup>
Italy . . . . .	951	1,109	1,312
Netherlands . . . . .	346 <sup>1</sup>	380 <sup>1</sup>	482 <sup>1</sup>
Poland and Czechoslovakia . . . . .	—	355	430
Portugal . . . . .	100	52	89
Sweden and Norway <sup>3</sup> . . . . .	297	155 <sup>1</sup>	152
Russia . . . . .	158	7 <sup>1</sup>	21 <sup>1</sup>
Roumania and Greece . . . . .	32	18	29
Switzerland . . . . .	32	19	23
Finland . . . . .	—	15	31
<i>America:</i>			
United States . . . . .	3,248 <sup>1</sup>	3,058 <sup>1</sup>	2,835
<i>Africa</i> . . . . .	56	101	133
<i>Asia and Australia:</i>			
Japan and Australia . . . . .	514 <sup>1</sup>	500 <sup>2</sup>	600 <sup>2</sup>
Total . . . . .	11,457	10,268	10,619

(d) ANILINE DYES.

*Production.*

Official figures regarding the production of aniline dyes are only available for the United States of America. For other countries only estimates are available. The figures in the following table are therefore submitted with due reserve. The quantities produced in Czechoslovakia, Poland, Spain, Greece, etc., have been left out of account since they are less than a thousand tons, in each case, and therefore do not appreciably affect the total.

<sup>1</sup> *International Year-Book of Agricultural Statistics*, Rome, 1925. All the other figures for superphosphate are taken from the *Annuaire Lambert*, "Statistique des engrais et produits chimiques destinés à l'agriculture", 1925.

<sup>2</sup> From private publications.

<sup>3</sup> The Sveriges Kemiska Industrikontor (Stockholm) state that the figures for Sweden alone are: 1913, 184; 1923, 155; 1924, 178.

*Production of Aniline Dyes in 1913 and in 1924.\**

	1913 Metric tons (000's)	Perce- tage of world produc- tion	1924 Metric tons (000's)	Perce- tage of world produc- tion
Germany <sup>1</sup> :				
Production in Germany . . . . .	127	82	72	46
Production in branches outside Germany.	10	6	—	—
United States <sup>2</sup> . . . . .	3	2	31	20
Great Britain <sup>3</sup> . . . . .	5	3	19	12
Switzerland <sup>4</sup> . . . . .	10	6	10	6
France <sup>5</sup> . . . . .	2	1	15	9
Italy <sup>3</sup> . . . . .	—	—	5	3
Japan <sup>6</sup> . . . . .	—	—	6	4
Total . . . . .	157	100	158	100

\* M. Gounod, Vice-President delegate of the Union of French Chemical Industries, observes that no account appears to have been taken of the amount which must have been taken from total stocks in Germany for purposes of consumption and export. These quantities probably represent about *one-third* of the output, which, he thinks, should accordingly be very considerably reduced, say from 72,000 to 52,000 tons.

As regards America, our impression is that production has slightly increased on account of the development of certain export markets. In France our output easily reaches 18,000 and not 15,000 tons. The figure of 10,000 tons given for Switzerland is surprising. The amount consumed in that country is fairly small, imports being about 1,000 tons and exports not more than 6,000 to 7,000 tons. The table showing production should be completed by the addition of figures for Czechoslovakia, Spain, Russia, China, Holland, and Brazil. The total production of these countries represents at least another 6,000 to 7,000 tons.

It is particularly difficult in the case of dyes to ascertain the quantities manufactured by different countries, on account of the varying degrees of concentration in which these products are manufactured and sold. In statistics of this kind, therefore, we are obliged to class together highly concentrated dried products and diluted (10 or 20 per cent) products in the form of paste. Hence there may be great difficulty in estimating the exact quantities produced, and a corresponding liability to error.

<sup>1</sup> The German output for 1913 is estimated on the basis of the exports, which amounted to 109 thousand tons. To this must be added the consumption in Germany, which is estimated at 40 million lb. equivalent to 18 thousand metric tons (cf. p. 145, No. 33, of the *Tariff Information Series* of the United States Tariff Commission).

The output figures of branches of German factories situated outside Germany are estimated.

The German output figures for 1924 are obtained from the returns which the German firms have to make to the Reparation Commission, and which are reproduced on p. 145 of the above-mentioned publication of the United States Tariff Commission.

<sup>2</sup> The figures of production of the United States of America are taken from the Annual Census of Dyes.

<sup>3</sup> Estimate.

<sup>4</sup> Estimated on the basis of exports, to which a further figure has been added for home consumption, allowance having been made for imports.

<sup>5</sup> Cf. *L'Industrie chimique* and the above-mentioned publication of the United States Tariff Commission, p. 136.

<sup>6</sup> Estimated on the basis of the data given in No. 217 of the *Trade Information Bulletin* of the United States Department of Commerce.

<sup>7</sup> Cf. *Vierteljahrshefte zur Konjunkturforschung*, Supplement I, p. 58, issued by the Institut für Konjunkturforschung, Berlin, 1926.

The total production of aniline dyes in 1924 is therefore quantitatively about the same as in 1913.

The value of the production of 1913 can be put at about 350 million gold marks, while that of 1924 amounts to about 700 million gold marks.

When it is considered that the value of the world's coal production in 1924 was 21 milliard gold marks, that of cotton 10 milliards, that of wool 5 milliards, that of silk 3 milliards and that of iron 8 milliards<sup>1</sup>, it will be seen that the value of the aniline-dye industry with 0.7 milliard of gold marks is comparatively insignificant.

The value of the production of the textile industry throughout the world in 1913 is estimated at 44 milliards of gold marks<sup>1</sup>. Therefore, even apart from the fact that considerable quantities of aniline dyes are used outside the textile industry, the value of the aniline dyes employed in the industry amount to only 0.8 per cent of this industry's production in 1913. This proportion has probably not materially changed since the war.

#### *Output Capacity.*

In the publications of the United States Tariff Commission quoted above, the conjectural output capacity of the world with regard to aniline dyes is calculated by taking the maximum official or estimated figure for the actual output for any year since 1913 and adding 25 per cent. By this method, we obtain the following table:

#### *Annual Capacity for the Manufacture of Aniline Dyes.*

	Annual Capacity.	Output in 1924.	
	Metric tons (000's)	Metric tons (000's)	% of Capacity
Germany . . . . .	160	72	45
United States . . . . .	54	31	57
Great Britain . . . . .	24	19	79
Switzerland . . . . .	13	10	77
France . . . . .	19	15	78
Italy . . . . .	6	5	80
Japan. . . . .	9	6	67
Total . . . . .	285	158	56

#### 4. NUMBER OF EMPLOYED: NUMBER UNEMPLOYED.

It is difficult to give particulars regarding the number of men employed in the chemical industry throughout the world, as statistics are only available with regard to a small number of countries. Moreover, the conception of the chemical

<sup>1</sup> Cf. A. KERTESZ, *Die Textilindustrie sämtlicher Staaten*, p. XVI.

industry is so different in the various countries that the available statistics are not comparable.

For the United States, the following figures have been calculated on the basis of the official census of production regarding the chemical industry, as defined in the Foreword to the present monograph:

1914 . . . . .	135,000 workers
1923 . . . . .	192,000 workers.

As regards Germany, it is true that figures can be obtained from the statistics of the so-called "Berufsgenossenschaft der chemischen Industrie", a legally constituted organisation for the insurance of workmen and employees in this industry against accidents. These figures cannot be used here, however, because this union includes branches of production which are not reckoned in the chemical industry, such as salt-works, soap production, rubber goods, etc. With regard to the chemical industry as defined in the present monograph, the German industry employed about 250 thousand workmen in 1925. This figure is larger than that of the United States, although the value of the production in the latter country is nearly three times that of Germany; this is due to the fact that in many branches of the chemical industry Germany still has a comparatively large number of small businesses, *e.g.*, for the manufacture of pharmaceutical products, cosmetics, mineral dyes, varnish, etc. The variety of products is also much greater in Germany than in the United States, which has the effect of increasing the number of workers employed in proportion to the output.

*Altogether, the number of workmen employed in the chemical industry of the whole world cannot be very much in excess of 1 million. It may perhaps be estimated at about 1½ million.*

These figures show that the chemical industry is not one involving an intensive use of labour but an intensive use of capital.

As regards the number of *unemployed* in the chemical industry, no definite figures can be given, because this industry employs no specially trained skilled labour. When unemployment begins, these workers come upon the general labour market, and may be absorbed into other branches of production.

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## 5. HOURS OF LABOUR: OUTPUT PER HEAD.

As regards hours of labour in the different countries, no special particulars can be given for the chemical industry. They are determined by the general labour regulations in force in the different countries.

Broadly speaking, figures concerning the output per head in the chemical industry are valueless, as the output of a chemical factory depends above all on its equipment and on the technical processes used.

It is obvious, for example, that it would be useless to compare the output of two nitrogen factories, one of which employed the cyanamide of calcium process and the other the method of ammonia synthesis, by reckoning the quantity of nitrogen compounds produced per head in a given time.

## 6. WAGES.

As already pointed out, the chemical industry employs no specially trained skilled workers, but only ordinary untrained men. Their wages are thus governed by the general conditions of the labour market in the country concerned. Special particulars cannot therefore be given regarding the chemical industry.

## 7. RAW MATERIALS USED.

General observations on the position of the chemical industry with regard to raw materials have already been made in the Sub-section (c) to Section 1 under the heading "Supply of Raw Materials". Data are given below regarding three of the most important raw materials used in the manufacture of chemicals: pyrites and crude sulphur, natural phosphates and sodium chloride (rock salt and pan salt).

The figures are largely based on publications which cannot be verified and should therefore be carefully revised by the experts of the various countries.

### (a) PYRITES AND CRUDE SULPHUR.

#### *World Extraction of Pyrites.*

(In thousands of metric tons.)

	1913	1923	1924
Germany . . . . .	269	193	160
Austria (post-war frontiers) . . . . .	4	15	28
Great Britain . . . . .	12	7	6
France . . . . .	311	202	181
Sweden . . . . .	34	58	66
Norway . . . . .	441	375	403
Spain . . . . .	3,196	2,652	2,212
Portugal . . . . .	391	200 <sup>1</sup>	200 <sup>1</sup>
Italy . . . . .	317	493	516
Roumania. . . . .	—	26	33
Greece . . . . .	129	52	52 <sup>2</sup>
<i>Europe</i> . . . . .	5,104	4,273	3,857

<sup>1</sup> Figures of 1921.

<sup>2</sup> Figures of 1923.

	1913	1923	1924
<i>Europe</i> . . . . .	5,104	4,273	3,857
Algeria . . . . .	—	21	18
United States . . . . .	347	185	163
Canada . . . . .	144	26	26 <sup>1</sup>
Japan . . . . .	115	226	221
Australia . . . . .	10	12	12 <sup>1</sup>
<i>Outside Europe</i> . . . . .	616	470	440
<b>Total</b> . . . . .	<b>5,720</b>	<b>4,743</b>	<b>4,297</b>

*World Production of Crude Sulphur.*

(In thousands of metric tons.)

	1913	1923	1924
Italy . . . . .	386	256	295
Spain . . . . .	8	18	19
United States . . . . .	499	2,069	1,240
Chile . . . . .	7	11	11
Japan . . . . .	59	37	45
Formosa . . . . .	2	3 <sup>2</sup>	3 <sup>2</sup>
<b>Total</b> . . . . .	<b>961</b>	<b>2,394</b>	<b>1,613</b>

If we compare 1924 and 1913, we find that the total output of pyrites has fallen by about 1,400,000 tons, while the output of crude sulphur has risen by about 650,000 tons. In 1923, indeed, about 1,400,000 tons more crude sulphur was extracted than in 1913.

This falling off in the output of pyrites, on the one hand, and the rise in the production of crude sulphur, on the other hand, correspond to the tendency of sulphuric acid producers in the United States, and to a certain extent also in Europe, to use crude sulphur instead of pyrites.

The greater part of the pyrites both in 1913 and in 1923 and 1924 was produced in Europe.

With regard to the production of crude sulphur, the United States already accounted for 52 per cent of the production in 1913. This proportion had increased to 86 per cent in 1923, and was 77 per cent in 1924.

<sup>1</sup> Figures of 1923.

<sup>2</sup> Figures of 1922.

(b) NATURAL PHOSPHATES.

*Extraction of Natural Phosphates.*

(In thousands of metric tons.)

	1913	1923	1924
<i>Europe:</i>			
Germany . . . . .	—	5.3	(5.3) <sup>1</sup>
Norway . . . . .	0.8	0.2	0.3
Russia . . . . .	25.0	21.1	20.0
Belgium . . . . .	219.4	60.0	(60.0)
France . . . . .	298.9	179.5	166.5
Spain . . . . .	3.5	5.4	6.7
<b>Total . . . . .</b>	<b>547.6</b>	<b>271.5</b>	<b>258.8</b>
<i>America:</i>			
United States . . . . .	3,161.0	3,055.0	2,913.8
<i>Africa:</i>			
Algeria . . . . .	377.9	467.4	671.2
Tunis . . . . .	2,170.5	2,357.0	2,862.0
Morocco . . . . .	—	225.4	461.0
Egypt . . . . .	104.5	25.4	87.9
<b>Total . . . . .</b>	<b>2,652.9</b>	<b>3,075.2</b>	<b>4,082.1</b>
<i>Asia:</i>			
Indo-China . . . . .	—	9.8	12.5
Dutch East Indies . . . . .	6.3	85.9	100.5
Japan . . . . .	19.0	33.1	(33.1)
<b>Total . . . . .</b>	<b>25.3</b>	<b>128.8</b>	<b>146.1</b>
<i>Oceania:</i>			
Commonwealth of Australia . . . . .	6.0	1.0	(1.0)
New Zealand . . . . .	11.2	2.4	1.6
New Caledonia . . . . .	2.1	12.9	(12.9)
Nauru and Ocean Island . . . . .	356.0	317	459.0
Christmas Island . . . . .	152.4	71.6	127.2
Makatea . . . . .	82.1	74.2	89.6
Angaur . . . . .	90.0	61.0	(61.0)
<b>Total . . . . .</b>	<b>699.8</b>	<b>540.1</b>	<b>752.3</b>

<sup>1</sup> The figures in parentheses are for the preceding year.



	Summary					
	1913	%	1923	%	1924	%
Europe . . . . .	547.6	7.7	271.5	3.8	258.8	3.2
America . . . . .	3,161.0	44.6	3,055.0	43.2	2,913.8	35.7
Africa . . . . .	2,652.9	37.4	3,075.2	43.5	4,082.1	50.1
Asia . . . . .	25.3	0.4	128.8	1.8	146.1	1.8
Oceania . . . . .	699.8	9.9	540.1	7.7	752.3	9.2
Total . . . . .	7,086.6	100	7,070.6	100	8,153.1	100

The most important deposits of natural phosphates are situated in the United States and in North Africa. The importance of these two areas has materially changed since the war. While, before the war, Northern Africa had 37.4 per cent and America 44.6 per cent of the total production, this proportion has been more than reversed since the war, and in 1924 America had only 35.7 per cent, while Africa had 50.1 per cent of the total supplied. Northern Africa, whose large phosphate supplies have hitherto been exploited only to a relatively small extent, is destined to play an important part in the next few decades as a producer of raw phosphates.

(c) SODIUM CHLORIDE.

*Salt Production.*

(In thousands of metric tons.)

	1913	1923	1924
<i>Europe:</i>			
Germany <sup>1</sup> . . . . .	2,068	1,931	2,004
Austria <sup>2</sup> . . . . .	163	50.4	66.3
Czechoslovakia . . . . .	—	134.1	124.8
Great Britain . . . . .	2,284	1,899	2,060
France <sup>3</sup> . . . . .	1,282	1,526	1,627 <sup>5</sup>
Netherlands . . . . .	—	28.3	32.7
Switzerland . . . . .	73.6	68	74
Spain . . . . .	610	716	968
Italy . . . . .	644	765.1	807.4
Roumania . . . . .	335	307	303
Greece . . . . .	19.2	59.9	(59.9) <sup>6</sup>
Poland <sup>4</sup> . . . . .	189	363	275
Total . . . . .	7,667.8	7,847.8	8,402.1
<i>America:</i>			
Canada . . . . .	91	184	189
United States . . . . .	4,369	6,469	6,172
Peru . . . . .	24	27	(27) <sup>6</sup>
Chile . . . . .	19.6	38.2	(38.2) <sup>6</sup>
Argentine . . . . .	55	(94) <sup>7</sup>	(94) <sup>7</sup>
Total . . . . .	4,558.6	6,812.2	6,520.2
<i>Africa:</i>			
Algeria . . . . .	27	25	(25) <sup>6</sup>
Union of South Africa . . . . .	—	62.2	(62.2) <sup>6</sup>
Total . . . . .	27	87.2	87.2
<i>Asia:</i>			
India . . . . .	1,497	1,810	1,649
Dutch East Indies . . . . .	221	151	132
Dutch West Indies . . . . .	13.4	(25.5) <sup>8</sup>	(25.5) <sup>8</sup>
Japan . . . . .	640	480	637
Total . . . . .	2,371.4	2,466.5	2,443.5
<i>Australasia:</i>			
Commonwealth of Australia . . . . .	66	51.1	(51.1) <sup>6</sup>

<sup>1</sup> 1923 and 1924, excluding Alsace-Lorraine and Posen.  
<sup>2</sup> Calculated for the territory within the new frontiers.  
<sup>3</sup> 1923 and 1924, including Alsace-Lorraine.  
<sup>4</sup> Calculated for the present territory.  
<sup>5</sup> This figure includes 338 tons marine salt from the previous year.  
<sup>6</sup> The figures in parentheses are taken from the previous year.  
<sup>7</sup> These figures are taken from 1922.  
<sup>8</sup> The figures are taken from 1920.

## 8. CUSTOMS DUTIES (IMPORT AND EXPORT PROHIBITIONS AND LICENCES).

### (a) CUSTOMS DUTIES.

As has been already explained in the Sub-section (d) to Section 1, under the heading "Non-Economic Factors", extensive legislation exists in many countries with regard to Customs tariffs affecting the importation of chemical products. In the various tariffs the number of specific duties on chemical products is disproportionately large.

Thus the German tariff contains 178 such rates; the French 563; the Italian 330; the Spanish 203.

These figures only include actual Customs duties and not incidental references to chemical products which are duty-free.

An enumeration of all these individual Customs tariffs in the present monograph would be impossible. Such an enumeration would only be an accumulation of innumerable details, which, as they stood, would not be comparable with one another. Moreover, we should have as many different currencies to consider as there are countries with Customs tariffs. Again, some of the duties are specific and others *ad valorem*, while the units to which the specific duties apply vary enormously. Above all, the plans on which the tariffs are drawn up are so extraordinarily varied that for this reason alone the individual duties cannot be compared with one another as they stand.

The only way of obtaining a general idea of the level of the tariffs of the different countries is to employ the method of index numbers which is in general use among statisticians for comparing the level of prices in different countries and at different times. An attempt must be made to apply this method to Customs tariffs, although it must be clearly understood that its results will inevitably be incomplete and contain numerous sources of error. It may be hoped, however, that, with the assistance of experts in the different countries, this method may be materially improved.

This index number is calculated at the outset only for the three chief categories of the chemical industry — heavy chemicals for technical purposes, fertilisers and aniline dyes, the latter representing the most important branch of organic chemical production.

In each of these categories we have selected a number of typical products. These are, for the group of heavy chemicals: aluminium sulphate, caustic soda, borax, calcium carbide, bleaching powder, potassium nitrate, potassium bichromate, potassium chlorate, copper sulphate, sodium sulphate, sulphuric acid, soda ash, white lead, lithopon, ultramarine, oxalic acid.

For the group of nitrogenous fertilisers: ammonium sulphate and cyanamide of calcium.

For the group of aniline dyes: 20 per cent indigo, direct deep black dry (Schultz No. 462) and sulphur black dry, i. e. one vat dye, one azo dye and one sulphur dye.

For each of these individual products we then calculated the duty in percentage of the value on the basis of the tariffs of 1913 and 1926. In doing this, the following difficulties were encountered:

(a) The question as to which value should be taken as basis. It was endeavoured to select a mean value which could then be generally applied to the Customs tariffs of all the countries under consideration. This value was calculated in gold marks, and the results are given in the first column of the table on the following page for purposes of checking. When the tariffs gave duties by weight, these were also converted into gold marks at the rates of August 14th, 1926, and the percentage relation between the duty and the value was calculated. For lack of space, the details of the calculation are not given, but they are available.

(b) Difficulties were encountered with regard to a number of products in finding the right item under which they are in practice classified by the different Customs administrations. In this respect also, certain points are perhaps open to correction by experts in the different countries.

After the percentage tariff had thus been worked out for the individual products, the arithmetic mean of the different categories was calculated.

For want of data regarding the degree of production of the individual products, it was not possible to weight the items within the categories. As, however, it was endeavoured to choose those products which are typical of their categories, the figures can probably be accepted without such adjustment.

The arithmetic mean of the final figures of the three categories was then calculated, and this was taken as an index for judging the mean tariff rates in the different countries. By this method, weighting may be said to have taken place, at least to the extent that the categories as a whole are represented on an equal footing in the final figures, so that their comparative importance is approximately represented.

The final figures are naturally of no absolute significance. Perhaps, however, they give a sufficiently accurate idea of the *comparative* tariff level of the different countries concerned in the domain of chemical production.

The net results are shown in the following table. The figures for the individual products and groups are attached to the present monograph as an annex.

This table contains no figures for Great Britain. That country has decreed a general import prohibition on aniline dyes and by-products. Duties are imposed on fine chemicals, artificial silk, films, certain ferro-alloys and a number of chemicals used in industry, such as oxalic acid, glacial acetic acid, methanol, etc. Apart from these, Great Britain imposes no duties.

*Comparison of Tariff rates.*

	August 1926		1913	
	Maximum <i>Ad valorem</i> equivalents %	Minimum	Maximum <i>Ad valorem</i> equivalents %	Minimum
Germany . . . . .	5	4.5	3.7	2.8
Netherlands . . . . .	0	0	0	0
Belgium . . . . .	11.5	1	0	0
France <sup>1</sup> . . . . .	80.9	19.3	45.1	24.6
Switzerland . . . . .	6.4	6.4	3.4	1.9
Austria . . . . .	10.9	7.7	16.8	13.1
Poland . . . . .	112.6	112.4 <sup>2</sup>	141.6	123.6
Czechoslovakia . . . . .	33.4	28.2 <sup>3</sup>	16.8	13.1
Russia . . . . .	137.1	137.1	141.6	123.6
Finland . . . . .	8.3	8.3	27.7	27.7
Sweden . . . . .	4.5	4.5	6.4	6.4
Norway . . . . .	1.8	1.8	18.8	2
Denmark . . . . .	2.5	2.5	3	3
Spain . . . . .	158.3	64.3	48.4	30.8
Italy . . . . .	36.6	28.7	5.8	4.9
Hungary . . . . .	9.5	8.6	16.8	13.1
Roumania . . . . .	6.9	6.9	8.4	6.1
Kingdom of the Serbs, Croats and Slovenes . . . . .	65.5	50.3	24.6	19.5
Bulgaria . . . . .	57.4	57.4	20.7	15.2
Greece . . . . .	65.7	45.8	67.5	21.6
Canada . . . . .	3.1	2.9	4.2	3.7
United States . . . . .	40	40	10.5	10.5
Mexico . . . . .	20.6	20.6	35.8	35.8
Argentine . . . . .	70.3	70.3	52.5	52.5
Brazil . . . . .	84.9	84.9	77.8	77.8
Chile . . . . .	87.1	87.1	23.5	23.5
Japan . . . . .	50.6	50.6	10.8	10.8
China . . . . .	7	7	9.8	9.8
Dutch Indies . . . . .	4	4	4.3	4.3
British India . . . . .	20.6	20.6	3.9	3.9
Australia . . . . .	28.2	21.6	2.7	0.7
British South Africa . . . . .	7.3	6.7	8.1	8.1

For the countries with a considerable, well-developed chemical industry, if only the lowest tariff, *i.e.*, the conventional tariff or minimum tariff as the case

<sup>1</sup> See the note on p. 60.

<sup>2</sup> See note on following page.

<sup>3</sup> M. Hodač (on behalf of the Czechoslovak Manufacturers' Federation) observes that the figure of 28.2 appears to be too high; as a result of the commercial treaties concluded in recent years, there has been a reduction of Customs duties, especially on chemicals.

may be, is taken into consideration, the following percentage tariff rates are shown for August 1926:

	Per cent.
United States . . . . .	40
Germany . . . . .	4.5
France <sup>1</sup> . . . . .	19.3
Italy . . . . .	28.7
Poland . . . . .	112.4 <sup>2</sup>
Switzerland . . . . .	6.4
Belgium. . . . .	1.0
Czechoslovakia. . . . .	28.2 <sup>3</sup>
Japan . . . . .	50.6
Spain . . . . .	64.3
Kingdom of the Serbs, Croats and Slovenes . . . . .	50.3
Sweden . . . . .	4.5
Norway . . . . .	1.8

A comparison of the tariff level in 1926 with that of 1913 shows large increases in the following countries, again calculating on the basis of the minimum or conventional tariff.

	Per cent.
United States . . . . .	from 10.5 to 40.0
Italy . . . . .	,, 4.9 ,, 28.7
Japan . . . . .	,, 10.8 ,, 50.6
Kingdom of the Serbs, Croats and Slovenes . . . . .	,, 19.5 ,, 50.3
Chile . . . . .	,, 23.5 ,, 87.1
British India . . . . .	,, 3.9 ,, 20.6
Australia . . . . .	,, 0.7 ,, 21.6
Czechoslovakia. . . . .	,, 13.1 ,, 28.2
Spain . . . . .	,, 30.8 ,, 64.3
Bulgaria . . . . .	,, 15.2 ,, 57.4

The effect of the commercial treaties may also be inferred to a certain extent from the figures in the table. In countries with the double tariff system, a minimum or intermediate tariff is applied instead of the maximum tariff. In countries with a single tariff, the conventional tariff is applied instead of the autonomous tariff.

(b) IMPORT AND EXPORT PROHIBITIONS.

We can leave out of consideration those import prohibitions which are imposed in nearly every country for fiscal reasons or considerations of public safety (security police, health police, etc.). Examples are the prohibitions imposed on matches,

<sup>1</sup> See the note on p. 60.

<sup>2</sup> According to M. Trepka, Director of the Union of Polish Chemical Industries (see observations, page 131), the average minimum *ad valorem* equivalent for Poland in August 1926 was 20 per cent.

<sup>3</sup> See the note on the previous page.

explosives, sweetening substances, etc. To this category also belongs the prohibition imposed on certain narcotics in virtue of international conventions.

In an intermediate category between these import prohibitions or police restrictions and restrictions of an economic character, numerous countries have regulations with regard to the importation of pharmaceutical specialities which, although they are chiefly based on considerations of public health, are materially influenced in their application by economic considerations. Thus, Section 7 of the preliminary draft of the Czechoslovak decree on specialities lays down that permission to import pharmaceutical specialities may be refused on economic grounds.

Among import prohibitions and special import regulations of a purely economic character must be distinguished those based mainly on exchange considerations, those based mainly on commercial considerations, and those based mainly on protectionist considerations.

To the first category belong the import prohibitions imposed in various countries, *e.g.*, in Italy and Poland, on luxuries. As regards chemicals, these prohibitions affect perfumery and cosmetics.

A mainly commercial character must be attributed to those import prohibitions which were decreed in different countries after the war in order to facilitate the transition from war to peace conditions, and which have been maintained in order to provide a basis for bargaining in commercial treaty negotiations. Such import prohibitions, for example, are still numerous in Czechoslovakia<sup>1</sup>.

The German import regulations which were imposed for the period of transition lapsed on October 1st, 1925.

To the class of import prohibitions which have a mainly commercial character also belong the import prohibitions decreed by Poland against Germany, and those decreed as reprisals by Germany against Poland.

The majority of the remaining import prohibitions have a marked protectionist character. In the chemical industry, aniline dyes are the most affected. Great Britain refuses import licenses for aniline dyes and by-products which are produced in her own territory, irrespective of the origin of the goods. Spain has also recently adopted an import prohibition on aniline dyes, although she apparently intends later to exempt products not manufactured in Spain from the system of licenses. Japan has introduced the license system in respect of aniline dyes and by-products which do not come from countries with which she has concluded a commercial treaty. If not in theory, at least in practice these measures are directed almost exclusively against Germany, as France makes the importation of aniline dyes, by-products, pharmaceutical products and certain other chemicals dependent on licenses, only in the case of those of German origin.

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<sup>1</sup> M. Hodač (on behalf of the Czechoslovak Manufacturers' Federation) observes that the system of prohibitions of imports of chemical products has been largely done away with, and is only retained for certain articles which play merely a secondary part in international trade. It seems, therefore, difficult to speak of import prohibitions in Czechoslovakia, especially in comparison with the larger States possessing chemical industries of their own, Germany excepted.

9. EXPORTS AND IMPORTS.

A. — The Chemical Industry as a Whole.

With regard to exports and imports of chemical products, the official foreign trade statistics of the different countries are available. The figures they contain cannot, however, be employed as they stand, for the scope of the term "chemical products" varies considerably. If we take as a basis the definition of the chemical industry given above and classify the individual items of the official trade statistics accordingly when the heading "chemical products" does not correspond to this definition, we obtain the following tables. Conversion into gold marks has been effected on the basis of the average rates for the year.

*Value of Exports of Chemical Products.*

	1913		1924		1925	
	Millions of gold marks	Percentage of total exports	Millions of gold marks	Percentage of total exports	Millions of gold marks	Percentage of total exports
Germany . . . . .	910	28.4	610	17	930	23
United States <sup>1</sup> . . . . .	310	10	570	15.8	650	16
Great Britain . . . . .	500	15.6	530	14.7	550	13.6
France . . . . .	310	9.7	590	16.4	540	13.3
Chile (saltpetre) . . . . .	470	14.6	450	12.5	(450) <sup>2</sup>	11.1
Italy . . . . .	65	2	130	3.6	170	4.2
Belgium . . . . .	180 <sup>3</sup>	5.6	(175) <sup>4</sup>	4.9	175	4.3
Netherlands . . . . .	180 <sup>3</sup>	5.6	125	3.5	140	3.5
Switzerland . . . . .	60	1.9	110	3.1	130	3.2
Austria-Hungary . . . . .	90	2.8	—	—	—	—
Hungary . . . . .	—	—	10	0.3	5	0.1
Czechoslovakia . . . . .	—	—	45	1.25	50	1.3
Austria . . . . .	—	—	40	1.1	40	1
Poland . . . . .	—	—	20	0.5	15	0.4
Sweden . . . . .	30	0.9	70	1.9	70	1.7
Norway . . . . .	40	1.2	45	1.25	(45) <sup>2</sup>	1.1
Japan . . . . .	55	1.7	80	2.2	90	2.2
Total . . . . .	3,200	100	3,600	100	4,050	100

<sup>1</sup> 1913 = financial year 1913-14.  
<sup>2</sup> 1924 figure.  
<sup>3</sup> Including goods in transit.  
<sup>4</sup> 1925 figure inserted owing to complete arrangement of the Belgian statistics on November 9th, 1924.



*Value of Imports of Chemical Products.*

	1913		1924		1925	
	Millions of gold marks	Percentage of total imports	Millions of gold marks	Percentage of total imports	Millions of gold marks	Percentage of total imports
Germany <sup>1</sup> . . . . .	490	17.7	160	5.8	240	7.8
United States <sup>1</sup> . . . . .	520	18.8	580	20.9	700	22.8
Great Britain . . . . .	290	10.5	310	11.2	340	11.1
France . . . . .	250	9.1	290	10.5	270	8.8
Italy . . . . .	130	4.7	120	4.3	140	4.6
Belgium . . . . .	180 <sup>4</sup>	6.5	(140) <sup>5</sup>	5.0	140	4.5
Netherlands . . . . .	250 <sup>4</sup>	9.1	160	5.8	180	5.9
Switzerland . . . . .	50	1.8	90	3.2	90	2.9
Austria-Hungary . . . . .	120	4.3	—	—	—	—
Hungary . . . . .	—	—	30	1.1	25	0.8
Czechoslovakia . . . . .	—	—	90	3.2	100	3.3
Austria . . . . .	—	—	50	1.8	45	1.5
Poland . . . . .	—	—	50	1.8	50	1.6
Russia <sup>2</sup> . . . . .	160	5.8	45	1.6	100	3.2
Sweden . . . . .	35	1.3	65	2.3	70	2.3
Norway . . . . .	20	0.7	25	0.9	(25) <sup>6</sup>	0.8
China . . . . .	100	3.6	210	7.6	(210) <sup>6</sup>	6.8
Japan . . . . .	100	3.6	220	8.0	200	6.5
India <sup>3</sup> . . . . .	70	2.5	140	5.0	150	4.8
Total . . . . .	2,765	100	2,775	100	3,075	100

The total export figures do not correspond to the total import figures because a number of countries are not included in the tables, and, above all, because the method of estimating the value of the goods on which the official figures of the different countries are based varies considerably.

A closer consideration of the export figures shows that, in 1913, chemical products to the value of 3.2 milliards of gold marks crossed the frontiers in 1913, while in 1925 the figure was 4 milliards. This increase more or less corresponds to the depreciation in the value of gold. *The total volume of the international trade in chemical products has therefore not materially changed, although, as will be*

<sup>1</sup> 1913 = financial year 1913-14.

<sup>2</sup> 1913 taken from 1912 statistics; 1924 and 1925 = business year.

<sup>3</sup> 1913, 1924 and 1925 = financial years.

<sup>4</sup> Also includes goods in transit.

<sup>5</sup> 1925 inserted owing to complete rearrangement of the Belgian statistics on November 9th, 1924.

<sup>6</sup> 1924 figure.

seen from the details given above in Section 2 and 3, the increase in the value of the production itself is greater than the depreciation in gold.

If we compare the total export values with the total production values of separate years, we find that, in 1913, out of a production of approximately 10 milliards of gold marks, 3.2 milliards or 32 per cent were exported, while in 1924, out of a production of 18 milliards of gold marks, 3.6 milliards or only 20 per cent was exported. Therefore, in the world as a whole, the home markets have absorbed a greater proportion of the production, while the proportion of exports has fallen — a fact which is in keeping with the tendencies noted in Section 8.

Examination of the import and export returns in detail reveals important changes in the relative importance of individual branches of the chemical industry in different countries.

(a) *Exports.*

*Germany.* — Of the total exports of the countries enumerated in the table given above, Germany possessed before the war, and still possesses, the greatest share, although this share has greatly decreased. In 1913, it amounted to 28 per cent, in 1924 to only 17 per cent, and in 1925 it had risen again to 23 per cent of the total export.

The falling-off in the German aniline dyes export deserves notice. In 1913, 108,900 metric tons were exported, as against 34,400 metric tons in 1925. As regards value, the exports in 1913 were worth 218 million gold marks and, in 1925, 186 million gold marks.

There has also been a marked decline in the German export of superphosphates, which has fallen in value from 21 million gold marks in 1913 to 3 million gold marks in 1925.

The decline in the German export of explosives and munitions is also very considerable. These items amounted in 1913 to 59 million gold marks and in 1925 to only 9.2 million gold marks. The reason is that, in virtue of the Treaty of Versailles, Germany is only permitted to export these products for purely civilian purposes.

The German exportation of nitrogen products has risen owing to the growth in the manufacture of synthetic nitrogen during and since the war. The exports of ammonium sulphate in 1913 amounted to 18.6 million gold marks, but in 1925 to 85.4 million gold marks.

*Great Britain.* — The second place among exporting countries before the war was occupied by Great Britain with 15.6 per cent. This proportion had fallen to 14.7 per cent in 1924 and 13.6 per cent in 1925.

*United States of America.* — Great Britain has now been overtaken by the United States of America, whose share in 1913 amounted to 10 per cent, in 1924 to 15.8 per cent, and in 1925 to 16 per cent.

While before the war no aniline dyes were exported by the United States, in 1925 there was an exportation of the value of 6.7 million dollars.

There has also been a large increase in the exportation of medicinal preparations, from 6.7 million dollars in 1913 to 19.8 million dollars in 1925, and in the exportation of perfumes and cosmetics, from 1.6 million dollars in 1913-14 to 8 million dollars in 1925.

Exports of paints and varnishes have also considerably increased. In 1913, they amounted to 7.3 million dollars and in 1925 to 18.5 million dollars.

*France.* — In 1925, Great Britain had almost been overtaken as an exporting country by France, whose share was 9.7 per cent in 1913 and had risen to 13.3 per cent in 1925.

The export of perfumes has increased from 19.8 million gold francs in 1913 to 101.5 million gold francs in 1925.

Furthermore, there has been an increase in the exportation of medicines, which rose from 33.7 million gold francs in 1913 to 57.5 million gold francs in 1925.

The development of the French aniline dye industry has resulted in a considerable increase in the exportation of these products, *i.e.*, from 1.6 million gold francs in 1913 to 35.3 million gold francs in 1925.

*Italy.* — Italy's exports have also largely increased owing to the extension of the chemical industry in that country. Her share in the total exports of the world amounted to 2 per cent in 1913, and has more than doubled since then, being 4.2 per cent in 1925.

As regards individual branches, there has been a particularly marked increase in the export of artificial silk, which in 1913 amounted to 2 million gold lire and in 1925 to 103 million gold lire.

There has been a notable increase in the exportation of citric acid, from 1 million gold lire in 1913 to 8 million gold lire in 1925.

*Switzerland.* — Switzerland's share in the international export trade has risen from 1.9 per cent. in 1913 to 3.2 per cent in 1925. This rise is chiefly due to the increase in the value of the aniline dye exports. Quantitatively, the exports have fallen from 8,827 metric tons to 7,330 metric tons. The value of the exports, however, has risen from 28.8 million gold francs to 62 million gold francs.

There has been a considerable rise in the export of artificial silk, from 5 million gold francs to 28.8 million gold francs; in that of pharmaceutical products, including alkaloids, from 2.8 million gold francs to 19 million gold francs; and in that of perfumery and cosmetics, from 6.2 million gold francs to 13.8 million gold francs.

There has been a sharp decline in exports of calcium carbide, which fell from 7 million gold francs to 3.3 million gold francs; this decline is due to the creation of calcium carbide industries in other countries which were previously supplied by Switzerland.

*Sweden.* — Sweden's share in the international trade in chemical products has also risen, viz., from 0.9 per cent to 1.7 per cent.

In particular, exports of matches have increased from 16 million crowns to 43 million crowns.

(b) *Imports.*

*United States of America.* — When we come to consider the import figures, we find that, as before, the first place is occupied by the United States. Their share in the total imports for 1913 amounted to 18.8 per cent and in 1925 to 22.8 per cent.

This marked rise in the United States is a consequence of increased industrialisation, which, as was explained in Section 1, is one of the essential conditions for the demand for chemical products.

The increase in the importation of Chile saltpetre has been especially large. This is due to the greater demand for fertilisers in American agriculture and to the fact that it has not yet been found possible to develop the manufacture of synthetic nitrogen on a large scale in the United States. The imports in 1913 were valued at 17.9 million dollars and in 1925 at 52.5 million dollars.

*Germany.* — The second place in 1913 was occupied by Germany, whose imports amounted to 17.7 per cent of world imports. This proportion had fallen in 1924 to 5.8 per cent, but in 1925 it rose again to 7.8 per cent.

The chief cause of this decline has been the reduction in imports of Chile saltpetre, calcium cyanamide, calcium nitrate, and other nitrogen compounds, as a result of the newly created nitrogen industry in Germany.

The imports of Chile saltpetre after subtracting re-exports amounted in 1913 to 166 million gold marks, and in 1925 to only 1.38 million gold marks. The imports of calcium nitrate and calcium cyanamide fell from 9.4 million gold marks in 1913 to 0.6 million gold marks in 1925.

The imports of ammonium sulphate amounted in 1913 to 10 million gold marks and in 1925 had almost ceased.

Mention should also be made of the reduction in imports of crude methyl alcohol from 6.4 million gold marks in 1913 to 1.5 million gold marks in 1925, and in imports of calcium acetate from 5 million gold marks in 1913 to 0.8 million gold marks in 1925, which is largely due to the synthetic production of methanol and other products of wood distillation.

Germany's importation of carbide has also undergone a considerable reduction owing to the fact that a large carbide industry grew up in Germany during the war. In 1913, the imports amounted to 9.3 million and in 1925 to only 0.2 million of gold marks.

There has also been a material decline in the imports of essential oils, from 27.8 million gold marks in 1913 to 18.6 million gold marks in 1925, which is

due to the increased consumption of home products, particularly synthetic products.

On the other hand, there has been an increase in the importation of artificial silk from 19 million gold marks in 1913 to 28 million gold marks in 1925.

*Great Britain.* — Great Britain's share in imports has remained approximately the same. In 1913, it was 10.5 per cent and in 1925 11.1 per cent.

The greatest reduction has been in the importation of aniline dyes, which fell in value from 1.9 million sterling in 1913 to 0.6 million sterling in 1925.

Quantitatively, this reduction has been even greater, the imports amounting to 18,900 tons in 1913 and to only 2,000 tons in 1925.

*France.* — France's share in the international chemical import trade has remained at an approximately constant level. In 1913, it was 9.1 per cent and in 1925 8.8 per cent.

There has been a considerable increase in imports of ammonium sulphate, which rose in value from 7.3 million gold francs in 1913 to 32.6 million gold francs in 1925. The value of the imports of cyanamide of calcium and calcium nitrate, which in 1913 amounted to 2.1 million gold francs, had risen to 6.2 million gold francs in 1925.

There has been a reduction in the imports of phosphate fertilisers, the value of which fell from 20.9 million gold francs in 1913 to only 1.6 million gold francs in 1925.

*Asia.* — The importance of Asia as a market for chemical products has greatly increased. In 1913, the imports of China, Japan and British India together amounted to 9.7 per cent of the world's imports of chemical products. This percentage had risen to 20.6 in 1924 but fell to 18.1 in 1925. Of special note is the increase in Japan of imports of ammonium sulphate and caustic soda and in China of imports of aniline dyes, which more than doubled in value, rising from 46 million gold marks to 110 million gold marks. In British India, there was also a large increase in imports of aniline dyes, which rose in value from 14.9 million gold marks to 38.2 million gold marks. The import of paints also rose from 10 million gold marks to 19 million gold marks.

B. — Specific Branches of the Chemical Industry.

(a) NITROGENOUS FERTILISERS.

	Imports			Exports		
	1913	1924	1925	1913	1924	1925
	(In thousands of metric tons N.)					
<i>Europe:</i>						
Belgium . . . . .	52	31	32	25	2	2
Denmark . . . . .	6	20	25	0.5	—	—
Germany . . . . .	136	—	1	25	35 <sup>1</sup>	112 <sup>1</sup>
Great Britain . . . . .	22	14	13	69	58	54
Estonia . . . . .	—	—	0.2	—	—	—
Finland . . . . .	—	2	2	—	—	—
France . . . . .	55	72	77	1	3	2
Greece . . . . .	—	—	0.8	—	—	—
Netherlands . . . . .	38	31	37	23	—	6
Italy . . . . .	15	16	20	—	—	—
Kingdom of the Serbs, Croats and Slovenes	—	—	—	—	6	7
Latvia . . . . .	—	—	—	—	—	—
Norway . . . . .	0.2	—	—	11	21	25
Austria . . . . .	14	1	1	5	0.4	—
Czechoslovakia . . . . .		12	14		1	—
Hungary . . . . .		—	0.3		—	—
Poland . . . . .	—	7	9	—	—	3
Roumania . . . . .	—	—	—	—	—	2
Russia . . . . .	7	3	1	—	—	—
Sweden . . . . .	5	7	7	3	5	4
Switzerland . . . . .	0.5	1	0.7	—	—	—
Spain . . . . .	19	43	47	—	—	—
<i>Asia:</i>						
British India . . . . .	3	3	3	—	2	—
Japan . . . . .	27	41	55	—	—	—
Java and Madura . . . . .	—	23	19	—	—	—
Philippine Islands . . . . .	—	3	3	—	—	—
China . . . . .	—	—	4	—	—	—
<i>Africa:</i>						
Egypt . . . . .	9	21	31	—	—	—
Union of South Africa	—	0.1	0.2	—	0.1	—
Algeria . . . . .	—	1	—	—	—	—
Mauritius . . . . .	1	—	—	—	—	—
<i>America:</i>						
Cuba . . . . .	—	5	5	—	—	—
United States . . . . .	113	171	200	1	26	25
Canada . . . . .	6	3	4	5	13	19
Brazil . . . . .	—	0.2	1	—	—	—
Chile . . . . .	—	—	—	424	367	382
<i>Australasia:</i>						
Australia . . . . .	0.5	0.6	—	0.5	1	1
New Zealand . . . . .	—	0.3	0.4	—	—	—

<sup>1</sup> Including reparation deliveries.

(b) SUPERPHOSPHATE.

	Imports			Exports		
	1913	1923	1924	1913	1923	1924
	(In thousands of metric tons.)					
<i>Europe:</i>						
Germany . . . . .	53	11	18	283	18	23
Austria . . . . .	75	16	28	4	—	—
Hungary . . . . .		—	2		—	6
Czechoslovakia . . . . .		2	5		10	6
Belgium . . . . .	28	33	52	319	266	270 <sup>1</sup>
France . . . . .	101	67	31	145	130	228
Netherlands . . . . .	270	81	76	353	281	321
Gt. Britain and Ireland	—	107	116	64	12	26
Denmark . . . . .	119	101	122	1	8	15
Norway . . . . .	4	34	29	—	—	—
Sweden . . . . .	3	8	13	36	34	62
Estonia . . . . .	—	3	9	—	14	15
Latvia . . . . .	—	20	28	—	—	—
Poland . . . . .	—	7	4	—	9	13
Roumania . . . . .	—	—	—	1	—	—
Russia . . . . .	197	—	—	—	—	—
Italy . . . . .	21	15	25	—	7	20
Spain . . . . .	50	67	72	—	—	—
<i>America:</i>						
Canada . . . . .	1	26	38	—	—	—
United States . . . . .	—	—	—	—	43	47
<i>Africa:</i>						
Algeria . . . . .	18	16	23	8	18	24
Egypt . . . . .	13	22	43	—	—	—
Tunis . . . . .	3	5	—	1	—	—
Union of South Africa	37	22	39	—	—	—
<i>Australasia:</i>						
Australia . . . . .	27	—	—	13	—	—
New Zealand . . . . .	—	—	—	—	1	1

<sup>1</sup> *Annuaire Lambert*, "Statistique des engrais et produits chimiques destinés à l'agriculture", 1925. All the other figures for superphosphate from the *Annuaire international de Statistique agricole*, Rome, 1925.

(c) ANILINE DYES.

	<i>Imports.</i>					
	1913		1924		1925	
	Metric tons (000's)	Millions of gold marks	Metric tons (000's)	Millions of gold marks	Metric tons (000's)	Millions of gold marks
Germany . . . . .	3.2	7.1	0.4	1.8	1.7	8.1
Switzerland . . . . .	1	2.2	0.9	4.9	0.8	5.1
France . . . . .	2.1	5.6	2.4	23	1.5	12.1
Great Britain . . . . .	18.9	39.7	3.6	25	2	13.2
Italy . . . . .	7.1	15.5	2.7	10.1	2.2	8.4
Spain . . . . .	1	3.4	0.4	2.9	0.5	3.5
Austria-Hungary . . . . .	7.8	15.2	—	—	—	—
Austria . . . . .	—	—	1.2	11.7	0.9	4
Hungary . . . . .	—	—	0.7	7.6	0.7	3.4
Czechoslovakia . . . . .	—	—	4.0	21.2	3.4	17.5
Kingdom of the Serbs, Croats and Slovenes . . . . .	—	—	0.2 <sup>1</sup>	1 <sup>1</sup>	0.2	1
Serbia . . . . .	0.1	0.3	—	—	—	—
Russia . . . . .	1.9 <sup>2</sup>	8.4 <sup>2</sup>	2.6	16.4	3.6	34.4
Poland . . . . .	—	—	0.5	3.3	0.5	2.9
Sweden . . . . .	1	2.8	1.1	6.1	0.8	4.3
Norway . . . . .	0.3	1.1	0.3	2.1	0.2	2
Denmark . . . . .	0.3	0.9	0.4	2	0.3	2
Belgium <sup>3</sup> . . . . .	—	—	2.2 <sup>1</sup>	6.6 <sup>1</sup>	2.2	6.6
Netherlands <sup>3</sup> . . . . .	—	—	2.5	9.2	1.9	8.1
United States . . . . .	20 <sup>4</sup>	40	1.6	19.6	2.6	30.4
Canada . . . . .	0.5 <sup>5</sup>	1 <sup>5</sup>	1.1	6.2	1.2	6.6
China . . . . .	34 <sup>6</sup>	46.3	30 <sup>7</sup>	109.8	30 <sup>8</sup>	110 <sup>8</sup>
Japan . . . . .	5.5	16.3	8	28.5	3.1	14.5
India . . . . .	7.2	14.9	6.4	30.4	8.2	38.2
Dutch Indies . . . . .	1.8	3.8	1.4	6.5	1.4	6.5
<b>Total . . . . .</b>	<b>113.7</b>	<b>224.5</b>	<b>74.6</b>	<b>355.9</b>	<b>69.9</b>	<b>342.8</b>

<sup>1</sup> Belgium and the Kingdom of the Serbs, Croats and Slovenes, 1924: quantities and values of 1925.

<sup>2</sup> Russia 1913: quantities and values taken from the German export statistics.

<sup>3</sup> Belgium and the Netherlands, 1913: figures could not be used as they partly include wood dyes and other dyes as well as goods in transit.

<sup>4</sup> United States: quantity for 1924 from the German export statistics.

<sup>5</sup> Canada 1913: quantities and values from the German export statistics.

<sup>6</sup> China 1913: quantities from the statistics of the exporting countries.

<sup>7</sup> China 1924: quantity estimated.

<sup>8</sup> China 1925: quantity estimated; value of 1924.



*Exports.*

	1913		1924		1925 <sup>1</sup>	
	Metric tons (000's)	Millions of gold marks	Metric tons (000's)	Millions of gold marks	Metric tons (000's)	Millions of gold marks
Germany . . . . .	109	218	28	130	34	186
Switzerland . . . . .	9	23	9	51	7	50
France . . . . .	1	1	6	32	5	31
Great Britain . . . . .	3	4	5	17	5	17
United States . . . . .	—	—	7	24	12	28
Total . . . . .	122	246	55	254	63	312

10. CONSUMPTION PER HEAD, AND BY COUNTRIES.

As will be seen from the details given in Section 1, the uses of chemical products are so manifold that a calculation of the consumption per head for the chemical industry as a whole, in so far as such calculation may be possible, would not give us any figures from which valid economic conclusions could be drawn.

Even for the individual products, a calculation of the consumption per head would be of little value. In the case of nitrogen compounds, for example, the figures showing the consumption per hectare of cultivated land are of much greater significance. In the following table these are, therefore, the only figures that have been given.

With regard to aniline dyes, the figures given above for the production of the individual countries, taken in conjunction with the import and export figures, allow us to calculate the total consumption for industrial purposes in the different countries. No comparable figures can be obtained, however, by endeavouring to determine the consumption per head of the population by dividing the total quantities of aniline dyes used for industrial purposes by the total number of inhabitants, for in some countries considerable quantities of dyed products are exported and in other countries considerable quantities are imported. We have therefore only given the total consumption of aniline dyes for each country.

<sup>1</sup> M. Gounod, Vice-President delegate of the Union of French Chemical Industries puts American exports at 15,000 metric tons, and French exports at 9,000 or 10,000 metric tons in 1925.

## (a) NITROGEN.

	Total consumption in thousands of metric tons. N.		Consumption in Kg. N. per hectare of cultivated land.	
	1913	1925	1913	1925
<i>Europe:</i>				
Belgium . . . . .	36	44	26.8	35.4
Denmark . . . . .	6	26	2.4	9.8
Germany . . . . .	210 <sup>1</sup>	295 <sup>1-2</sup>	8.1	14.6
Great Britain . . . . .	43	46	7.3	8.0
Estonia . . . . .	—	0.2	—	0.2
Finland . . . . .	—	2	—	1.0
France . . . . .	71	108	3.0	4.7
Greece . . . . .	—	0.9	—	—
Netherlands . . . . .	23 <sup>1</sup>	40	26.3	42.9
Italy . . . . .	18 <sup>1</sup>	36	1.3	2.7
Kingdom of the Serbs, Croats and Slovenes . . . . .	—	0.2	—	—
Latvia . . . . .	—	0.1	—	—
Norway . . . . .	1 <sup>1</sup>	3.6	1.2	5.4
Austria . . . . .	17	2	1.6	0.9
Czechoslovakia . . . . .		17 <sup>1</sup>		2.8
Hungary . . . . .		0.5		0.1
Poland . . . . .	—	23 <sup>1</sup>	—	1.3
Roumania . . . . .	—	0.1	—	—
Russia . . . . .	10	1	—	—
Sweden . . . . .	6	10	1.6	2.6
Switzerland . . . . .	2	3 <sup>1</sup>	—	5.2
Spain . . . . .	29 <sup>1</sup>	49.2	1.7	3.1
<i>Asia:</i>				
India . . . . .	3	4	—	—
Japan . . . . .	29	79 <sup>1</sup>	4.1	11.0
Java and Madura . . . . .	—	19	—	—
Philippines . . . . .	—	3	—	—
China . . . . .	—	4	—	—
<i>Africa:</i>				
Egypt . . . . .	9	31	2.8	9.1
Union of South Africa . . . . .	0.2	0.4	—	0.2
Algeria . . . . .	—	—	—	—
Mauritius . . . . .	1	—	—	—
<i>America:</i>				
Cuba . . . . .	— <sup>1</sup>	5 <sup>1</sup>	—	—
United States . . . . .	137 <sup>1</sup>	271 <sup>1</sup>	1.2	2.0
Canada . . . . .	6	9	0.3	0.3
Brazil . . . . .	—	1	—	0.2
Chile . . . . .	—	—	—	—
<i>Australasia:</i>				
Australia . . . . .	1	2	0.2	0.2
New Zealand . . . . .	—	0.5	—	0.7

<sup>1</sup> Consumption returns.<sup>2</sup> For the agricultural year 1925-26 purchases were not made by German agriculture until the spring of 1926.

(b) ANILINE DYES <sup>1</sup> .	Consumption (thousands of metric tons)	
	1913	1924
Germany . . . . .	18	14
United States . . . . .	24	25
Great Britain . . . . .	22	18
France . . . . .	9	12
Italy . . . . .	7	8
China . . . . .	34	30
Japan . . . . .	5	14
India . . . . .	7	8
Austria . . . . .	8	7
Czechoslovakia . . . . .		
Hungary . . . . .	7	5
Poland . . . . .		
Russia . . . . .		
Total . . . . .	141	141

### 11. PRICES.

If it is desired to obtain some idea of the movement of prices in the different chemical industries of the world, the best method which can be employed, owing to the multiplicity of chemical products, is that of index numbers. Index numbers are given for the four countries most important in the chemical industry, the calculation being that of a private German organisation. The method is as follows:

The basis adopted is the movement of prices of caustic soda, caustic potash, calcium chloride, chloride of lime, citric acid, cream of tartar, acetic acid, yellow prussiate of potassium, sodium sulphate, potassium nitrate, copper sulphate, lithopon, sodium bicarbonate, sodium bichromate, oxalic acid, potash, sal-ammoniac, nitric acid, sulphuric acid and tartaric acid.

For Germany, the selling prices of the chief producing firms were taken.

For Great Britain, France and America, the prices given in the trade publications of these countries were taken.

The prices were then converted into dollars at the New York rate, the prices for 1913 put at 100 and a special index number calculated for each product and each of the periods chosen.

The arithmetic mean of these index numbers was then taken for each of the periods and each of the products considered. Fluctuations in the rate of exchange were thus eliminated and all the figures are on a dollar basis. The details of this calculation cannot be given here for lack of space, but are available if desired. The results are shown in the following table:

<sup>1</sup> M. Gounod, Vice-President delegate of the Union of French Chemical Industries gives the following estimates of consumption in 1924 (in thousands of tons): United States, 30; Great Britain, 15; China, 26.

*Price Index Number in Gold for Chemicals.*

Period	Germany	Great Britain	France	United States
1914 . . . . .	100	100	100	100
1924: July . . . . .	124	140	106	134
August . . . . .	120	141	116	133
September . . . . .	118	139	111	133
October. . . . .	117	138	110	132
November. . . . .	118	142	110	132
December . . . . .	118	146	113	134
1925: January . . . . .	119	147	113	135
February . . . . .	121	147	116	135
March . . . . .	122	149	110	135
April . . . . .	122	146	109	135
May . . . . .	122	146	110	135
June . . . . .	122	148	101	135
July . . . . .	123	148	101	135
August . . . . .	122	148	102	134
September . . . . .	122	146	104	134
October. . . . .	123	145	100	134
November. . . . .	123	143	95	134
December . . . . .	122	144	93	134
1926: January . . . . .	120	143	94	134
February . . . . .	120	142	93	133
March . . . . .	121	141	96	133
April . . . . .	121	140	93	132
May . . . . .	121	140	91	132
June . . . . .	121	141	87	132

12. INDUSTRIAL ORGANISATION.

BUYING AND SELLING ORGANISATIONS.

There is no international organisation embracing the entire chemical industry.

In the individual countries, too, there are no associations covering the whole range of the chemical industry, so as to regulate production or sales and purchases. In Germany, the I.G. Farben-Industrie A.G. only represents a fraction of the whole chemical industry, although it includes the entire German aniline-dye production.

The few general associations that exist, *e.g.*, in Germany, the Verein zur Wahrung der Interessen der Chemischen Industrie Deutschlands, and in France, the Union des Industries Chimiques, Paris, deal simply with questions of economic policy, such as Customs duties, taxation, railway freights, commercial treaties, etc.

Only for individual products are there associations which regulate sales, sometimes also influence production and aim at making collective purchases; international agreements already exist with regard to a number of individual products.

**Annex**

**Ad valorem Duties on Chemical Products, directly imposed**

	Average value per 100 kg. (Reichsmark gold)	Germany		Netherlands		Belgium		France <sup>1</sup>		
		Highest duty in % of value	Lowest duty in % of value	Highest duty in % of value	Lowest duty in % of value	Highest duty in % of value	Lowest duty in % of value	Highest duty in % of value	Lowest duty in % of value	
<b>CATEGORY I</b>										
Aluminium sulphate	August 1926	6.50	62	62	0	0	21	6.9	169	42
	1913. . . .	6.25	48	48	0	0	0	0	72	48
Sodium hydrate	August 1926	27.—	17	15	0	0	13	4.2	47	12
	1913. . . .	19.—	18	18	0	0	0	0	34	27
Sodium borate (Borax)	August 1926	48.—	10	6	0	0	30	5	13	3.3
	1913. . . .	35.—	0	0	0	0	0	0	23	18
Calcium carbide	August 1926	25.—	20	17	0	0	6.8	2.3	75	19
	1913. . . .	21.—	19	0	0	0	0	0	34	23
Bleaching powder	August 1926	13.50	15	15	0	0	6.3	2.1	121	30
	1913. . . .	8.—	13	13	0	0	0	0	53	35
Potassium nitrate (Nitre)	August 1926	49.—	0	0	0	0	8.7	2.9	3.2	0.8
	1913. . . .	42.—	0	0	0	0	0	0	6	4
Potassium bichromate	August 1926	77.—	5.2	3.9	0	0	11	3.7	50	2.5
	1913. . . .	60.—	0	0	0	0	0	0	4	2.7
Potassium chlorate	August 1926	35.—	11	11	0	0	15	0	134	34
	1913. . . .	57.—	0	0	0	0	0	0	53	45
Copper sulphate	August 1926	41.—	4.9	3.7	0	0	8.3	2.8	7.6	1.9
	1913. . . .	45.—	4.4	0	0	0	0	0	5.3	2.7
Sodium sulphate	August 1926	6.—	4.2	4.2	0	0	14	4.7	157	39
	1913. . . .	4.—	6.3	0	0	0	0	0	247	165
Sulphuric acid	August 1926	5.—	9.1	0	0	0	16	5.1	64	16
	1913. . . .	4.—	0	0	0	0	0	0	0	0
Sodium carbonate (Soda ash)	August 1926	11.—	18	18	0	0	2.1	0.6	43	11
	1913. . . .	9.—	17	17	0	0	0	0	55	36
Lead carbonate (White lead)	August 1926	88.—	6	6	0	0	7.7	2.6	19	4.7
	1913. . . .	46.—	2.2	0	0	0	0	0	18	12
Lithopon	August 1926	41.—	7.3	6.1	0	0	5	1.7	38	9.5
	1913. . . .	21.—	9.5	0	0	0	0	0	14	9.5
Ultramarine	August 1926	110.—	27	27	0	0	12	4.1	83	21
	1913. . . .	70.—	21	21	0	0	0	0	34	29
Oxalic acid	August 1926	48.—	25	25	0	0	15	0	73	18
	1913. . . .	45.—	18	18	0	0	0	0	34	22
Average for heavy chemicals	August 1926		15.1	13.7	0	0	12	3	68.6	16.5
	1913. . . .		11	8.4	0	0	0	0	42.9	29.9
<b>CATEGORY II</b>										
Indigo 20 %	August 1926	120.—	0	0	0	0	15	0	161	40
	1913. . . .	125.—	0	0	0	0	0	0	64	36
Direct deep black	August 1926	370.—	0	0	0	0	15	0	63	16
	1913. . . .	235.—	0	0	0	0	0	0	68	34
Sulphur black	August 1926	130.—	0	0	0	0	15	0	271	68
	1913. . . .	130.—	0	0	0	0	0	0	123	62
Average for aniline dyes	August 1926		0	0	0	0	15	0	165	41.3
	1913. . . .		0	0	0	0	0	0	85	44
<b>CATEGORY III</b>										
Ammonium sulphate	August 1926	21.—	0	0	0	0	0	0	18	0
	1913. . . .	24.—	0	0	0	0	0	0	15	0
Calcium Cyanamide (Nitro-lime)	August 1926	17.—	0	0	0	0	15	0	0	0
	1913. . . .	23.—	0	0	0	0	0	0	0	0
Average for artificial fertilisers	August 1926		0	0	0	0	7.5	0	9	0
	1913. . . .		0	0	0	0	0	0	7.5	0
Average of the three groups	August 1926		5	4.5	0	0	11.5	1	80.9	19.3
	1913. . . .		3.7	2.8	0	0	0	0	45.1	24.6

<sup>1</sup> See the note on p. 60.

**Annex (cont.)**

**or calculated from Specific Duties (Percentage of Average Value).**

Switzerland		Austria		Poland <sup>1</sup>		Czechoslovakia <sup>2</sup>		Russia		Finland		Sweden	
Highest	Lowest	Highest	Lowest	Highest	Lowest	Highest	Lowest	Highest	Lowest	Highest	Lowest	Highest	Lowest
duty		duty		duty		duty		duty		duty		duty	
in % of value		in % of value		in % of value		in % of value		in % of value		in % of value		in % of value	
12	12	74	68	105	105	207	207	143	143	25	25	17	17
3.8	3.8	46	46	111	111	46	46	111	111	271	271	18	18
7.4	7.4	30	30	33	33	44	44	72	72	31	31	10	10
3.4	3.4	40	30	103	103	40	30	103	103	5.1	5.1	15	15
0.8	0.8	12	12	50	50	47	35	81	81	11	11	0	0
1.2	0.7	17	14	68	68	17	14	68	68	5.5	5.5	0	0
1.6	1.6	64	51	96	96	119	90	216	216	13	13	11	11
19	0	91	91	226	226	91	91	226	226	18	18	27	27
18	18	18	18	83	83	33	33	368	368	31	31	0	0
10	10	36	18	190	190	36	18	190	190	47	47	0	0
3.3	3.3	23	16	20	20	31	31	0	0	6.5	6.5	0	0
1.9	1.9	9.1	9.1	31	31	9.1	9.1	31	31	72	72	0	0
1	1	0	0	34	34	24	24	79	79	4.1	4.1	0	0
1.3	0.4	19	19	87	87	19	19	87	87	28	28	0	0
6.9	6.9	34	23	114	114	85	85	136	136	23	23	0	0
2.8	1.4	34	14	116	93	34	14	116	93	30	30	0	0
16	16	7.8	6.8	39	39	27	27	47	47	3.9	3.9	14	14
0.4	0.4	6.4	6.4	0	0	6.4	6.4	0	0	8.4	8.4	13	13
13	13	24	16	40	40	31	31	108	108	11	11	0	0
10	6	10	10	109	109	10	10	109	109	24	24	0	0
15	15	41	38	18	18	59	41	169	169	38	38	12	12
6	6	40	24	120	120	40	24	120	120	94	94	17	17
7.3	7.3	18	18	36	36	35	27	108	108	10	10	0	0
0	0	21	21	133	133	21	21	133	133	11	11	0	0
9.1	9.1	9.1	9.1	11	11	9.5	9.5	44	44	4.8	4.8	0	0
8.7	7	17	17	40	40	17	17	40	40	14	14	0	0
3.9	3.9	23	0	49	49	146	87	132	132	10	10	0	0
7.6	3.8	91	38	314	314	91	38	314	314	81	81	0	0
7.3	7.3	22	22	63	54	81	56	96	96	3.8	3.8	0	0
11.4	5.7	27	27	124	124	27	27	124	124	46	46	0	0
3.3	3.3	13	13	42	42	78	78	99	99	18	18	16	16
1.8	1.8	21	21	106	106	21	21	106	106	75	75	18	18
7.9	7.9	25.8	21.3	52.1	51.5	66	56.6	118.6	118.6	15.3	15.3	5	5
5.6	3.3	32.8	25.3	117.4	115.9	32.8	25.3	117.4	115.9	51.9	51.9	6.8	6.8
6.7	6.7	0	0	333	333	0.8	0.8	274	274	13	13	0	0
2.6	1.3	5.1	0	57	57	5.1	0	57	57	38	38	0	0
4.3	4.3	0	0	108	108	0	0	160	160	4.3	4.3	0	0
3.4	1.7	15	12	143	118	15	12	143	118	20	20	0	0
12	12	0	0	308	308	15	15	405	405	12	12	0	0
6.2	3.1	15	12	259	213	15	12	259	213	36	36	0	0
7.7	7.7	0	0	249.7	249.7	5.3	5.3	279.7	279.7	9.8	9.8	0	0
4.1	2	11.7	8	153	129.3	11.7	8	153	129.3	31.3	31.3	0	0
3.8	3.8	14	3.8	48	48	43	43	26	26	0	0	0	0
0	0	12	12	22	22	12	12	22	22	0	0	0	0
3.3	3.3	0	0	24	24	15	2.7	0	0	0	0	17	17
1	1	0	0	287	229	0	0	287	229	0	0	25	25
3.6	3.6	7	1.9	36	36	29	22.9	13	13	0	0	16.5	8.5
0.5	0.5	6	6	154.5	125.5	6	6	154.5	125.5	0	0	12.5	12.5
6.4	6.4	10.9	7.7	112.6	112.4	33.4	28.2 <sup>2</sup>	137.1	137.1	8.3	8.3	8.5	4.5
3.4	1.9	16.8	13.1	141.6	123.6	16.8	13.1	141.6	123.6	27.7	27.7	4.5	4.5

<sup>1</sup> See observations submitted by M. Trepka on behalf of the Union of Polish Chemical Industries.  
<sup>2</sup> See the note on p. 33.

## Annex (cont.)

## Ad valorem Duties on Chemical Products, directly imposed

	Average value per 100 kg (Reichsmarke gold)	Norway		Denmark		Spain		Italy		
		Highest duty in % of value	Lowest duty in % of value	Highest duty in % of value	Lowest duty in % of value	Highest duty in % of value	Lowest duty in % of value	Highest duty in % of value	Lowest duty in % of value	
<b>CATEGORY I</b>										
Aluminium sulphate	August 1926	6.50	0	0	0	0	246	99	30	30
	1913. . . .	6.25	90	0	0	0	29	29	13	13
Sodium hydrate	August 1926	27.—	20	20	0	0	53	18	13	13
	1913. . . .	19.—	15	15	0	0	19	19	8.5	8.5
Sodium borate (Borax)	August 1926	48.—	0	0	23	23	42	17	17	17
	1913. . . .	35.—	16	0	32	32	6.9	6.9	11	11
Calcium carbide	August 1926	25.—	20	20	0	0	480	96	38	26
	1913. . . .	21.—	20	15	0	0	114	114	38	15
Bleaching powder	August 1926	13.50	0	0	0	0	124	42	24	24
	1913. . . .	8.—	28	0	0	0	30	30	40	40
Potassium nitrate	August 1926	49.—	0	0	0	0	16	4	4.9	3.3
	1913. . . .	42.—	13	0	0	0	29	29	5.7	5.7
Potassium bichromate	August 1926	77.—	0	0	0	0	42	21	16	16
	1913. . . .	60.—	9.4	0	0	0	20	20	13	5.3
Potassium chlorate	August 1926	35.—	0	0	0	0	411	80	46	46
	1913. . . .	57.—	20	0	0	0	35	35	28	28
Copper sulphate	August 1926	41.—	0	0	0	0	49	20	5	5
	1913. . . .	45.—	13	0	0	0	0.9	0.9	3.6	3.6
Sodium sulphate	August 1926	6.—	0	0	0	0	333	67	13	11
	1913. . . .	4.—	28	0	0	0	15	15	10	10
Sulphuric acid	August 1926	5.—	0	0	20	20	146	58	0	0
	1913. . . .	4.—	0	0	28	28	45	45	10	10
Sodium carbonate (Soda ash)	August 1926	11.—	0	0	0	0	546	109	26	26
	1913. . . .	9.—	12	0	0	0	27	27	4.4	4.4
Lead carbonate (White lead)	August 1926	88.—	12	12	1.3	1.3	46	23	7.3	7.3
	1913. . . .	46.—	25	17	2.5	2.5	16	13	14	14
Lithopon	August 1926	41.—	26	26	2.7	2.7	98	49	31	31
	1913. . . .	21.—	54	38	5.4	5.4	34	29	48	38
Ultramarine	August 1926	110.—	9.6	9.6	3	3	131	66	16	16
	1913. . . .	70.—	16	11	4.8	4.8	10	9	14	11
Oxalic acid	August 1926	48.—	0	0	23	23	117	47	40	17
	1913. . . .	45.—	0	0	25	25	27	27	18	18
Average for heavy chemicals	August 1926		5.5	5.5	4.6	4.6	180	51	20.5	18
	1913. . . .		22.5	6	6.1	6.1	28.6	28.1	17.5	14.7
<b>CATEGORY II</b>										
Indigo 20 %	August 1926	120.—	0	0	7.4	7.4	133	53	100	53
	1913. . . .	125.—	0	0	7.2	7.2	32	9.6	0	0
Direct deep black	August 1926	370.—	0	0	0.3	0.3	173	86	65	65
	1913. . . .	235.—	34	0	0.5	0.5	85	37	0	0
Sulphur black	August 1926	130.—	0	0	0.9	0.9	492	246	59	59
	1913. . . .	130.—	61	0	0.9	0.9	154	68	0	0
Average for aniline dyes	August 1926		0	0	2.9	2.9	266	128.3	74.7	59
	1913. . . .		31.7	0	2.9	2.9	90.3	38.2	0	0
<b>CATEGORY III</b>										
Ammonium sulphate	August 1926	21.—	0	0	0	0	11	3	15	4
	1913. . . .	24.—	2.3	0	0	0	0.3	0.3	0	0
Calcium Cyanamide	August 1926	17.—	0	0	0	0	47	24	14	14
	1913. . . .	23.—	2.4	0	0	0	52	52	0	0
Average for artificial fertilisers	August 1926		0	0	0	0	29	13.5	14.5	9
	1913. . . .		2.3	0	0	0	26.2	26.2	0	0
Average of the three groups	August 1926		1.8	1.8	2.5	2.5	158.3	64.3	36.6	28.7
	1913. . . .		18.8	2	3	3	48.4	30.8	5.8	4.9

Annex (cont.)

or calculated from Specific Duties (Percentage of Average Value).

Hungary		Roumania		Kingdom of the Serbs, Croats and Slovenes		Bulgaria		Greece		Canada		U.S.A.	
Highest duty	Lowest duty	Highest duty	Lowest duty	Highest duty	Lowest duty	Highest duty	Lowest duty	Highest duty	Lowest duty	Highest duty	Lowest duty	Highest duty	Lowest duty
in % of value		in % of value		in % of value		in % of value		in % of value		in % of value		in % of value	
35	35	43	43	148	123	62	62	86	62	10	10	43	43
46	46	19	1.3	32	32	0	0	200	100	10	10	15	15
44	44	10	10	59	44	24	24	7.4	4.4	10	10	17	17
40	30	21	0.4	11	11	0	0	66	33	0	0	12	12
25	25	5	5	17	8.3	25	25	13	8.3	0	0	2.4	2.4
17	14	6.0	0.2	11	7	11	11	36	18	0	0	3.3	3.3
48	38	6.4	6.4	160	128	64	64	96	64	18	16	37	37
91	91	19	19	190	107	57	57	59	30	20	18	0	0
36	36	12	12	36	30	30	30	24	12	10	10	21	21
36	18	15	1	25	10	30	30	0	0	0	0	12	12
0	0	4.1	4.1	65	49	18	18	2.5	1.6	0	0	9.5	9.5
9	9	2.9	2.9	14	8.6	14	14	111	111	0	0	6.8	6.8
0	0	2.1	2.1	13	10	31	31	16	8.3	0	0	27	27
19	19	13	13	13	0	0	0	21	10	0	0	16	16
55	23	31	31	27	23	30	30	18	11	0	0	60	60
34	14	7	7	11	11	14	14	22	11	0	0	8.2	8.2
12	12	3.4	3.4	49	12	39	39	8.6	0	0	0	0	0
6.4	6.4	2.7	2.7	3	3	0	0	0	0	0	0	0	0
11	11	27	27	160	133	27	27	107	80	0	0	14	14
10	10	30	10	10	10	0	0	312	312	0	0	10	10
35	35	51	51	102	87	73	73	44	29	42	38	0	0
40	24	40	40	20	20	60	60	156	0	58	53	0	0
0	0	22	22	36	29	58	58	18	11	25	25	21	21
21	21	27	0.9	9	9	0	0	0	0	0	0	13	13
14	14	1.8	1.8	50	36	27	27	6.4	4.5	30	27	27	27
17	17	8.7	8.7	104	52	17	17	54	0	30	28	25	25
16	16	6.8	6.8	78	59	49	49	49	29	5	5	40	40
91	38	23	23	57	53	38	38	119	0	5	5	15	15
11	11	8.7	8.7	29	22	22	22	36	22	0	0	25	25
27	27	11	4.6	17	16	9.1	9.1	36	0	0	0	15	15
0	0	3.3	3.3	42	33	42	42	13	8.3	0	0	117	117
21	21	18	18	36	0	21	21	14	0	0	0	31	31
21.4	18.8	14.9	14.9	66.9	51.6	38.8	38.8	34	22.2	9.4	8.8	28.8	28.8
32.8	25.3	16.5	9.5	35.2	21.9	16.9	16.9	75.4	39.1	7.7	7.1	11.4	11.4
0	0	8	8	17	13	267	267	267	200	0	0	99	99
5.1	0	6.4	6.4	32	32	64	38	150	5	0	0	0	0
0	0	1.8	1.8	5.4	4.3	35	35	86	65	0	0	63	63
15	12	6.8	6.8	3.4	3.4	26	17	212	53	0	0	30	30
0	0	5.2	5.2	15	12	98	98	123	77	0	0	95	95
15	12	12.3	12.3	31	25	46	31	19	19	0	0	30	30
0	0	5	5	12.5	9.8	133.3	133.3	158.7	114	0	0	85.7	85.7
11.7	8	8.5	8.5	22.1	20.1	45.3	28.7	127	25.7	0	0	20	20
14	14	0.7	0.7	46	38	0	0	3.9	0	0	0	11	11
12	12	0.2	0.2	33	33	0	0	0	0	0	0	0	0
0	0	0.8	0.8	188	141	0	0	4.7	2.3	0	0	0	0
0	0	0.2	0.2	0	0	0	0	0	0	10	8	0	0
7	7	0.8	0.8	117	89.5	0	0	4.3	1.2	0	0	5.5	5.5
6	6	0.2	0.2	16.5	16.5	0	0	0	0	5	4	0	0
9.5	8.6	6.9	6.9	65.5	50.3	57.4	57.4	65.7	45.8	3.1	2.9	40	40
16.8	13.1	8.4	6.1	24.6	19.5	20.7	15.2	67.5	21.6	4.2	3.7	10.5	10.5



Annex (Cont.)

**Ad valorem Duties on Chemical Products, directly imposed**

		Average value per 100 kg. (Reichsmarks gold)	Mexico		Argentina		Brazil		Chile	
			Highest duty in % of value	Lowest duty in % of value	Highest duty in % of value	Lowest duty in % of value	Highest duty in % of value	Lowest duty in % of value	Highest duty in % of value	Lowest duty in % of value
<b>CATEGORY I</b>										
Aluminium sulphate	August 1926	6.50	158	158	42	42	161	161	177	177
	1913. . . .	6.25	249	249	20	20	50	50	147	147
Sodium hydrate	August 1926	27.—	38	38	8.4	8.4	39	39	34	34
	1913. . . .	19.—	18	18	5.3	5.3	49	49	12	12
Sodium borate (Borax)	August 1926	48.—	13	13	63	63	55	55	96	96
	1913. . . .	35.—	177	177	46	46	67	67	53	53
Calcium carbide	August 1926	25.—	41	41	61	61	50	50	9.2	9.2
	1913. . . .	21.—	66	66	29	29	50	50	7.3	7.3
Bleaching powder	August 1926	13.50	46	46	31	31	129	129	17	17
	1913. . . .	8.—	43	43	25	25	98	98	19	19
Potassium nitrate	August 1926	49.—	0	0	14	14	18	18	24	24
	1913. . . .	42.—	0	0	7.2	7.2	19	19	29	29
Potassium bichromate	August 1926	77.—	8	8	40	40	34	34	15	15
	1913. . . .	60.—	104	104	25	25	39	39	26	26
Potassium chlorate	August 1926	35.—	59	59	89	89	150	150	13	13
	1913. . . .	57.—	42	42	27	27	82	82	13	13
Copper sulphate	August 1926	41.—	5	5	17	17	8.5	8.5	45	45
	1913. . . .	45.—	0	0	14	14	0	0	27	27
Sodium sulphate	August 1926	6.—	171	171	38	38	44	44	77	77
	1913. . . .	4.—	388	388	25	25	59	59	58	58
Sulphuric acid	August 1926	5.50	112	112	189	189	286	286	125	125
	1913. . . .	4.—	0	0	127	127	117	117	115	115
Sodium carbonate (Soda ash)	August 1926	11.—	19	19	12	12	48	48	84	84
	1913. . . .	9.—	77	77	7	7	52	52	89	89
Lead carbonate (White lead)	August 1926	88.—	23	23	32	32	20	20	13	13
	1913. . . .	46.—	60	60	8.8	8.8	34	34	20	20
Lithopon	August 1926	41.—	50	50	101	101	50	50	6	6
	1913. . . .	21.—	131	131	96	96	50	50	44	44
Ultramarine	August 1926	110.—	19	19	19	19	40	40	14	14
	1913. . . .	70.—	39	39	15	15	56	56	26	26
Oxalic acid	August 1926	48.—	21	21	86	86	73	73	58	58
	1913. . . .	45.—	31	31	45	45	69	69	41	41
Average for heavy chemicals	August 1926		48.9	48.9	52.7	52.7	75.3	75.3	50.5	50.5
	1913. . . .		89.1	89.1	32.6	32.6	55.7	55.7	45.4	45.4
<b>CATEGORY II</b>										
Indigo 20 %	August 1926	120.—	17	17	259	259	175	175	345	345
	1913. . . .	125.—	22	22	122	122	150	150	5	5
Direct deep black	August 1926	370.—	5.5	5.5	56	56	94	94	75	75
	1913. . . .	235.—	12	12	43	43	133	133	5	5
Sulphur black	August 1926	130.—	16	16	160	160	269	269	212	212
	1913. . . .	130.—	21	21	78	78	240	240	5	5
Average for aniline dyes	August 1926		12.8	12.8	158.3	158.3	179.3	179.3	210.7	210.7
	1913. . . .		18.3	18.3	81	81	177.7	177.7	5	5
<b>CATEGORY III</b>										
Ammonium sulphate	August 1926	21.—	0	0	0	0	0	0	0	0
	1913. . . .	24.—	0	0	63	63	0	0	10	10
Calcium cyanamide	August 1926	17.—	0	0	0	0	0	0	0	0
	1913. . . .	23.—	0	0	25	25	0	0	30	30
Average for artificial fertilisers	August 1926		0	0	0	0	0	0	0	0
	1913. . . .		0	0	44	44	0	0	20	20
Average of the three groups	August 1926		20.6	20.6	70.3	70.3	84.9	84.9	87.1	87.1
	1913. . . .		35.8	35.8	52.5	52.5	77.8	77.8	23.5	23.5

Annex (cont.)

or calculated from Specific Duties (Percentage of Average Value).

Japan		China		Netherlands East Indies		British India		Australia		South Africa	
Highest duty in % of value	Lowest duty in % of value	Highest duty in % of value	Lowest duty in % of value	Highest duty in % of value	Lowest duty in % of value	Highest duty in % of value	Lowest duty in % of value	Highest duty in % of value	Lowest duty in % of value	Highest duty in % of value	Lowest duty in % of value
20	20	5	5	6	6	15	15	166	166	20	20
20	20	5	5	6	6	5	5	0	0	15	15
19	19	7.4	7.4	6	6	26	26	45	35	3	0
13	13	13	13	6	6	5	5	0	0	3	3
0	0	5.5	5.5	6	6	15	15	15	10	0	0
10	10	45	45	15	15	5	5	0	0	0	0
20	20	8.8	8.8	7.7	7.7	33	33	59	59	44	44
20	20	5	5	11	11	5	5	0	0	15	15
20	20	12	12	6	6	37	37	73	58	20	20
20	20	40	40	14	14	5	5	0	0	15	15
21	21	8.2	8.2	6	6	15	15	15	10	3	0
20	20	5	5	6	6	5	5	0	0	0	0
22	22	8.6	8.6	6	6	18	18	15	10	3	0
11	11	5	5	6	6	5	5	0	0	3	3
0	0	5	5	6	6	15	15	0	0	3	0
0	0	5	5	6	6	5	5	0	0	3	3
20	20	7	7	6	6	19	19	48	34	10	10
20	20	5	5	7	7	5.7	5.7	5	0	3	3
0	0	5	5	6	6	15	15	30	25	20	20
39	39	5	5	6	6	5	5	0	0	15	15
20	20	18	18	6	6	15	15	25	20	20	20
20	20	50	50	23	23	5	5	15	15	15	15
11	11	16	16	6	6	25	25	71	54	40	30
14	14	18	18	9	9	5	5	0	0	3	3
11	11	4.1	4.1	6	6	17	17	35	25	18	15
16	16	10	10	4	4	5.9	5.9	8.7	6.6	15	15
19	19	5	5	6	6	18	18	30	20	20	20
35	35	5	5	6	6	5	5	14	14	15	15
36	36	7	7	2.6	2.6	15	15	30	20	20	20
16	16	7	7	3.6	3.6	5	5	5	0	15	15
0	0	5	5	6	6	15	15	15	10	0	0
16	16	5	5	6	6	5	5	0	0	15	15
14.9	14.9	8	8	5.9	5.9	19.6	19.6	42	34.8	15.3	13.7
18.1	18.1	14.3	14.3	8.4	8.4	5.1	5.1	3	2.2	9.4	9.4
112	112	10	10	6	6	74	74	30	20	5	5
20	20	17	17	1.5	1.5	4.5	4.5	5	0	15	15
97	97	5	5	6	6	29	29	30	20	5	5
8.3	8.3	5	5	6	6	5.6	5.6	5	0	15	15
201	201	5	5	6	6	24	24	30	20	5	5
15	15	5	5	6	6	10	10	5	0	15	15
137	137	6.7	6.7	6	6	42.3	42.3	30	20	5	5
14.4	14.4	9	9	4.5	4.5	6.7	6.7	5	0	15	15
0	0	7.4	7.4	0	0	0	0	25	20	0	0
0	0	5	5	0	0	0	0	0	0	0	0
0	0	5	5	0	0	0	0	0	0	3	3
0	0	5	5	0	0	0	0	0	0	0	0
0	0	6.2	6.2	0	0	0	0	12.5	10	1.5	1.5
0	0	5	5	0	0	0	0	0	0	0	0
50.6	50.6	7	7	4	4	20.6	20.6	28.2	21.6	7.3	6.7
10.8	10.8	9.8	9.8	4.3	4.3	3.9	3.9	2.7	0.7	8.1	8.1

NOTE TO THE ANNEX.

M. Gounod, Vice-Chairman, delegate of the Union of Chemical Industries, observes that Table I, which deals with the *ad valorem* protective duty on certain chemical products might give rise to certain misapprehensions. It is very difficult to compare the protection given in the different countries where the number of products under consideration is so small. We cannot, in fact, lay down any criterion by which to compare the degrees of protection necessary where the industrial conditions and needs of the individual countries are entirely different.

It is wrong, therefore, to assume from a hurried perusal of this document that in 1926 the mean minimum protective duty in France was 19.3 per cent, and the maximum 80.9 per cent, while Belgium only had a minimum protective tariff of 1 per cent — as compared with a general tariff of 11.5 per cent — and Germany (to take a single example among many) only imposed a protective duty of 4.5 per cent (minimum tariff) and 5 per cent (general tariff).

Again, we must not conclude from a cursory examination of the table that the average protective duty in the case of our own industries is 19.3 per cent under the minimum tariff; actually, taking our tariff scales as a whole, it hardly exceeds 12 per cent. In other words, it is approximately equal to the pre-war rate. Our minimum protective duty is in some cases less than 2 per cent.

The rates chargeable under our general tariff only constitute a provisional measure of protection, and will be withdrawn as soon as commercial agreements have been concluded granting foreign industries a reduction in the general tariff, and sometimes even the minimum tariff.

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2.

**MONOGRAPH ON THE CHEMICAL INDUSTRY**

**PREPARED BY  
THE ASSOCIATION OF BRITISH CHEMICAL MANUFACTURERS.**

**January 1927.**

*Communicated by Sir Arthur BALFOUR.*

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# MONOGRAPH ON THE CHEMICAL INDUSTRY.

## FOREWORD.

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The present monograph is arranged on the plan suggested by Commission "B" of the Preparatory Committee of the International Economic Conference of the League of Nations. It presents the British point of view of the subject being studied. The difficulties referred to in the German monograph of delimiting chemical industry and obtaining the necessary information are present also in Great Britain. The classification of the Association of British Chemical Manufacturers is as follows:

### GROUP I.

Acids (including Acetic and Oxalic); Carbonic Acid; Hydrogen; Oxygen and Gases; Alum; Chrome; Zinc; Copper and Iron Compounds; Fertilisers (including Super-Phosphates).

### GROUP II.

Alkalies; Cyanides; Chlorine and Compounds; Silicates; Chlorates; Borax; Hydrogen Peroxide; Magnesia Compounds (not Medicinal).

### GROUP III.

Fats; Greases; Waxes; Resins; Glycerine; Soap.

### GROUP IV.

Gelatine; Sizes; Glue; Varnishes; Paints; Polishes; Tanning.

### GROUP V.

Coal Tar Primary Products (excluding Ammonia and Ammonia Products).

### GROUP VI.

Pine Chemicals — Analytical; Pharmaceutical; Photographic; Rare Earths; Synthetic Essences and Perfumes; Alcohol Derivatives; Ethers.

### GROUP VII.

Phosphorus, Manganese; Potassium; Sodium; Barium; Calcium; Cadmium, etc.; Lead; Arsenic; Antimony; Tungsten; Molybdenum, etc.

### GROUP VIII.

Cellulose Products (including Paper); Celluloid; Rubber and Substitutes.

### GROUP IX.

Explosives and dyes and their Intermediates.

**GROUP X.**

Glass; Porcelain; Pottery; Refractory Materials; Lime; Cement; Chemical Resisting Materials.

**GROUP XI. — ALLIED INDUSTRIES.**

(a) Bleachers, Dyers and Textile Printers.

**GROUP XII.**

Distillation of Coal, Shale, Oils and Woods; Alcohol; Acetone; Ammonia and Ammonia Products; Charcoal; Fuels.

From which it will be seen that while soap is included, artificial silk is not included in this classification at the moment, although proposals have been made for its inclusion. Since no one country can provide a classification which is suitable for all other countries it appears to be convenient to accept for the purpose of this monograph the classification adopted in the German monograph, although it omits all reference to tar distillation products, paints and soap; all of which are very important branches of the British Chemical Industry.

On the question of the difficulty of procuring data, agreement must be expressed with the German monograph. The United States of America still remains the only country which can be regarded as possessing adequate statistics of production. With regard to the figures of export and import of chemicals, it is to be regretted that the classification in the various countries differs to such an extent as to make comparisons most unreliable. The same is true when it is desired to compare the number of workers in the industry in the various countries.

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## GENERAL SURVEY.

The figures quoted in the German monograph require careful examination, and it would be an advantage if the method by which they are calculated could be stated. It is not clear how a figure for the total value of the chemical production of the world has been obtained. Moreover, since there is no general agreement as to what is to be included in the term "chemical products," no accurate figures can be presented for the total world production, and only an intelligent guess can be made at the relative positions of some of the countries.

It might also be pointed out in any general survey of the position of chemical industry that its trend is once more changing. In its earlier stages about a century ago it commenced with the production of what are termed "heavy chemicals," they were few in number and were required in quantities which were large. Later came a period when the industry commenced to produce a vast number of new substances in comparatively small quantities. In this category are included all the synthetic organic dyestuffs and the large range of fine chemicals. At the present time development is on other lines. The synthetic production of chemicals required in large quantities is now being seriously undertaken, as for example the production of artificial silk, ammonia from atmospheric nitrogen, urea, methanol, etc.

In the ultimate analysis it will be found that coal is the real final cheap raw material and that the countries possessing ample supplies of the right kind of coal for use in their chemical industries will be in an advantageous position.

For this reason it is perhaps necessary to give some consideration to the branch of the industry which deals with the distillation of coal tar, although in the strictest sense it may not be considered a chemical industry, because its processes are almost entirely confined to separating from one another, in a more or less high degree of purity, constituents which already exist in its raw material.

The essential factor in the tar distillation industry is that being based on a by-product the quantity of raw material available is fixed altogether independently of the needs of commerce. It cannot economically be increased or reduced.

### I. — PRELIMINARY SURVEY OF THE ESSENTIAL CONDITIONS GOVERNING THE DEVELOPMENT OF THE INDUSTRY.

#### (A) DEVELOPMENT OF MARKETS.

Continuing to accept the sub-divisions adopted in the German monograph, but regarding the British Chemical Industry as covering rather more than is included in the German classification, it should be emphasised that Chemical Industry is the key to many other industries. Not only do its products enter into these other

industries but it is the training ground for those scientists who ultimately, as civilisation develops, will become essential in every industry, however small.

1. — *Chemical products going directly into the hands of the "final consumer."*

These articles are for the most part either what are termed "luxuries," and, therefore, are only purchased in large quantities where wealth abounds (for example, the United States of America) or are brought into common use as civilisation advances and hygiene is more extensively practised. In Great Britain there is an additional determining factor which is of importance. The amount of Revenue which has to be raised in taxation annually is approximately £800,000,000, of which a not inconsiderable amount is raised by Spirit Duties. The heavy rate of the Duty has a considerable effect in diminishing the market for perfumes and other products containing spirit. These two factors have diminished the possibility of developing the home market in chemical products which go direct to the consumer. There has, of course, been the inevitable search for substitutes and the production, at great expense, of such substitutes. This is unsatisfactory: it leads to one of two things, either the substitute itself is added to the list of dutiable articles, or the cost of the substitute prevents the full development of the market.

2. — *Products employed in Agriculture.*

The main fact to be borne in mind in considering the present position of the Nitrogen industry in the world is that it is only in its infancy.

While organic forms of nitrogen have been used in agriculture from time immemorial, and while in the earlier part of the nineteenth century the discoveries of Liebig, Lawes and Gilbert gave a great impetus to the increase in production and consumption of nitrogen derived from Chile nitrate of soda and by-product ammonia, it was only towards the end of the nineteenth and at the beginning of the twentieth century that scientific authorities began to appreciate the vital part which nitrogen was destined to play in the economic conditions of the world.

About the same time the technical problem of producing nitrogen from the atmosphere was solved on a commercial scale in Norway and Germany.

It is now generally recognised by scientific authorities that, in view of the imminent cessation of extensive cultivation all over the world and the rapid increase in the total population, a serious shortage in the food supply is bound to occur unless given areas of agricultural land can be made to yield much larger crops than have hitherto been obtained, or unless the nourishment required by man can be supplied by the direct synthesis of his essential foods.

While many different factors enter into the solution of the food problem, it is clear that a more intensive use of fertilisers offers the most immediate prospect of bringing about an increase in crop yields, and it, therefore, seems safe to predict that during the next few years, at any rate, attention will be mainly concentrated on chemical fertilisers.

Now, although agricultural authorities recognise that the present state of knowledge in regard to the use of fertilisers is an elementary one, certain broad principles have emerged as a result of experimentation all over the world.

One of the principles is that, generally speaking, nitrogen is the most important factor among the plant foods in promoting an increase in crop yield. At the same time, nitrogen has been and still is by far the costliest of the plant foods, the ratio per unit of plant food being about 11 for nitrogen; 2.74 for potash; 2.22 for phosphoric acid.

The effect of this price relation has been to limit the use of nitrogen in the form of fertiliser to a comparatively small portion of the cultivated surface of the globe, its use at past and present prices being only economically justifiable on a comparatively small range of high-priced crops.

In spite of this artificial limitation placed on the development of potential markets, the necessity of replacing a portion of the enormous quantity of nitrogen removed from the soil in the crop (estimated by Dr. J. Lipmann, New Jersey, at over 20,000,000 tons of pure nitrogen per annum for the United States of America alone) has been so imperious that the world's output of nitrogen has had to be increased from about 770,000 tons in 1913-14 to 1,245,000 tons for 1925-26. The proportional rate of increase in agricultural consumption during the last few years has been almost double the rate at the beginning of this decade, and is now approaching 10 per cent. per annum.

If this rate of progress is maintained, the demand for nitrogen will have far outstripped the present combined producing capacity of Chilean synthetic and by-product nitrogen works within the next four years. If, therefore, it is urged that, in view of the plans for creating and extending synthetic nitrogen production, which are now in active preparation practically throughout Europe and also in Russia, Japan and the New World, the industry is approaching a condition of over-production, it may with justice be contended that, until the effect on the demand of a substantial reduction in price has been ascertained, it is not permissible to claim that the productive capacity existing and in preparation is even adequate, far less excessive.

The sustained strength of the demand during the last ten years has resulted in selling prices for nitrogen which have borne little or no relation to cost of production either in Chile or at by-product or synthetic works. This state of affairs has had a twofold influence on the manufacturing side of the industry.

On the one hand, it has caused private capital to flow generously into a seemingly attractive proposition, and on the other hand it has stimulated direct or indirect incursion into the industry by the State in several countries (Great Britain *not* being one of these), in the hope of meeting the chronic clamour of the farmers for lower prices of nitrogen and reducing importation of food, and at the same time of providing an insurance against future unpreparedness for war or possibly against the prospect of a more distant world shortage of food. The problem for the States which are suffering from a depreciated currency, and which

are not in a specially favoured economic position for producing synthetic nitrogen, is whether the ultimate capital loss likely to be experienced on the erection and maintenance of the plant can be regarded as profitably offset by the immediate alleviation of budgetary difficulties to be secured by the production of more food at home and importation of less from abroad.

State activity of this kind, especially when bolstered up by a high tariff, is, no doubt, regrettable from a purely economic point of view, but it is impossible not to sympathise with the desire of even small countries to render themselves partially or wholly independent as regards the supply of so vital a necessity as nitrogen.

A further argument advanced against the diffusion of synthetic nitrogen works is the fact that within the limits of present technical achievement production at the lowest cost only appears to be possible if operations are conducted on a gigantic scale; this carries with it the risk of a sudden large shortage of supply in case of accident, and also raises problems in regard to transport and distribution.

A further difficulty arises owing to the fact that only recently have successful attempts been made to supply nitrogen in the form most suitable for the particular type of plant and soil to be manured. It is certain that the industry has as yet only touched the fringe of this problem. Its successful solution will certainly open up new avenues of demand which have been closed to the somewhat Procrustean methods of propaganda hitherto carried on in favour of fertilisers like Chile nitrate and ammonium sulphate.

The desire to protect the enormous capital already sunk in the large synthetic works and the politico-economical reasons for the fostering of smaller works by some States, referred to above, are each of such a cogent nature that nothing short of an actual trial of strength in regard to selling prices is likely to settle the final aspect which the industry is to assume.

Signs are not wanting that this trial of strength cannot now be long delayed. It is at present impossible to say whether an equilibrium between supply and demand will be reached at a level of price which will permit an economic functioning of synthetic plant under the less favourable economic conditions, or whether it will be necessary to seek a level at which only the largest scale synthetic producers can "live."

When this question has been settled, not on paper but in practice, it will be possible to state what special steps (if any) are necessary to ensure adequate supplies of nitrogen to countries which cannot produce it economically.

In the meantime the Economic Conference may be able to prevent much unprofitable expenditure of capital, both private and public, by pointing out that a heavy reduction in the selling price of nitrogen is inevitable in the near future if agricultural requirements are to be met.

In conclusion it is urged that no attempt should be made at present to regulate the nitrogen industry by inter-State Agreements. Both the scientific and economic bases for any such regulation are lacking. As soon as equilibrium on a new price-

level is attained, the chief nitrogen producing groups in the world will be able to meet and take suitable steps for the further development of the industry.

3. — *Branches which manufacture products for the building trade, i.e., paint and varnish industries.*

Here again, as in the case of products which go directly to the "final consumer," early development is consequent on the money available to spend on building and decorating and the acquisition of motor cars. But this is purely a question of priority of development. In time the position of these industries will be determined by the general standard of industrial efficiency in the countries. The development is progressing in Great Britain and in Germany, and the disproportion between the production in these countries and in the United States of America is likely to be considerably lessened.

4. — *Branches which manufacture products for the textile industry.*

The various authorities are generally agreed that the world's capacity for production of aniline dyes has at least doubled since the war, whereas the capacity for consumption by the textile, leather, and other principal consuming industries has not materially increased. During recent years the tendency in fashion for wearing apparel has been in the direction of more scanty clothing made from lightweight materials, and pale shades, in place of heavier fabrics of more sombre hue. All of these factors have contributed towards a reduced consumption of dyes. Nor has the enormous increase in the output of artificial silk — from 10,000 Metric Tons in 1912 to 89,000 Metric Tons in 1925 — helped the situation. This is probably explained by the fact that on the one hand much of the artificial fibre has taken the place of cotton and natural silk in textile fabrics, and on the other hand a large proportion of the output is consumed in the undyed state.

It should be pointed out here that sufficient emphasis is not always laid on the auxiliary products used in the textile industry. In viewing the total quantity or value of dyestuffs used in the manufacture of textiles, it appears small as compared with the heavy chemical products used in that industry.

5. — *Branches which manufacture products for other industries (excluding the textile industry).*

These are the heavy chemicals referred to above, and it is necessarily true that the cheaper the product the larger in proportion is the item of carriage when selling prices are considered, but still more must the nature of the product be considered, and it is unwise to generalise on this subject. For example, the British exports of soda and allied products are very large, but, on the other hand, sulphuric acid is not an article of international trade not only because of its relatively cheap price but because of the difficulty of transport owing to its nature.

By way of comment it is suggested that sufficient importance is not attached in the German monograph to the position of the Alkali industry.

The world consumption of alkali is continually expanding and Great Britain's production continues to grow notwithstanding that several countries, which formerly imported, have not only become self-supplied but are now developing an export trade, and also that the product produced by chemical reaction has had to meet material competition from natural deposits such as Magadi Soda.

The growth of population and the advance of civilisation in foreign regions account for much of the expansion; at the same time it must not be forgotten that very material progress is due to technical developments, the introduction of new commodities, and the extension of the field of usefulness of older products. Illustrations of this may be found in the increasing use of Soda Ash (replacing Saltcake) in glass manufacture, the birth and growth of Viscose Silk, and the later uses and possibilities of Sodium Silicate as an adhesive and in road-making.

This growth in production has been accompanied by profound changes in the methods of manufacture. From 1823, the date of the real foundation of the Alkali Industry in Great Britain by Muspratt, the world was mainly dependent on this country's productions over a period of 50 years. The development of the Ammonia Soda Process by Brunner, Mond & Co., Ltd., at Northwich, became increasingly important from a competitive point of view and emphasised the necessity of developing the value of the chlorine possibilities of the Le Blanc process. The Weldon Process was replaced by the Deacon (possibly the first successful catalytic process carried out on large scale manufacture), and the resulting economies sufficed until a further 25 years' progress in electrolysis made fresh and serious attacks on the chlorine side.

These changes in method of manufacture have given other countries opportunity to utilise any natural advantage — such as water power — and have thus materially influenced manufacturing "locala."

To-day the demand for Alkali (Soda Ash, Soda Crystal, Sodium Bicarbonate) is met by the Ammonia Soda Process; for Caustic Soda by the electrolytic process up to the outlet for chlorine (as Liquid Chlorine, Bleaching Powder, etc.), and as regards the balance by causticising Soda Ash.

#### 6. — *Branches which manufacture products for use in other branches of chemical industry.*

To the illustrations given in the German monograph should be added natural products used in pharmacy. In Britain the production of these pharmaceutical chemicals — such as the alkaloids, and other plant products, for example, aloin, salicin, etc. — has always been an important branch of the industry, and should be included in any international study of chemical industry.

Nor must the animal products such as insulin, thyroxine, and other gland products be forgotten. They form a class of substances of rapidly increasing

importance, and their manufacture in Great Britain has been successfully undertaken and is being intensively developed.

#### (B) DEVELOPMENT OF TECHNIQUE.

Agreement may be expressed in general terms with the views set forth in the German monograph, but certain of the points made require emphasis and others might be elaborated. The Chemical Industry has proceeded from the empiric to the scientific and the illustrations given are admirable. The dependence of the industry ultimately on Institutions for scientific research and on scientific teaching is acknowledged. There is, however, an enormous possibility of waste of time and money through lack of co-ordination between the teaching and research institutions and the industry itself. The huge amount of money said to be spent in the United States of America will not necessarily produce the same results as have been obtained in Germany where co-operation between the institutions, teachers, and the industry has been of the most beneficial kind. Nor is indiscriminate State aid of value: the power to give such monetary (or its equivalent) assistance is not the sole consideration. It should only be given on the advice of those engaged in the industry, who alone are capable of forming a sound estimate of how much national good it will produce. No better example of judicious assistance to chemical industry can be found than in the case of that given in Germany.

The manufacture of aniline dyes and of fine chemicals are intensely scientific industries. In none of the other branches of chemical industry is the proportion of scientifically trained chemists and engineers to the rest of the workers so great. In no other section is there so large a number of separate processes each requiring meticulous scientific control by minds trained in science and skilled in the application of that knowledge.

The foundation of Chemical Industry is research, pursued for the discovery of new products, improvements in manufacturing processes, and utilisation of by-products. Where an army of research workers is constantly contributing to scientific and technical knowledge it is inevitable that the industry in which they operate should gradually and continuously expand and extend its scope. During the 70 years of its life, the aniline dye industry has abundantly demonstrated this. It is the parent of the synthetic perfumes, pharmaceutical products, photographic chemicals and even of the synthetic ammonia and methanol industries.

It is, therefore, self-evident that the manufacture of aniline dyes is of first importance not only of itself but also by virtue of its potentiality as a research centre. Nowhere else in industry is such a variety of scope and opportunity presented for the trained chemist. On the other hand, no other industry offers like facilities for the training of the post-graduate chemist.

It has become an axiom that the future of the chemical industry largely depends upon its ability to maintain and develop its technical and scientific sides. Probably it is not an exaggeration to say that the dependence is upon the ability

of the aniline dye industry to do so. Such a view would find support in the very striking examples of chemical industrial achievements typified in the synthesis of ammonia and of methanol by the application of the principle of high pressure catalytic reaction of gases worked out as a side line by the dyestuffs industry.

Development of technique is imperative not only in the manufacture of dyes but also in their marketing. The application of dyestuffs to fabrics, yarns, leather and the host of other materials to be dyed follows scientific principles, and its operations involve scientific method and skilled control. The dye-house laboratories attached to dye factories are virtually the fountains from which spring the best methods of applying their products. In them a vast amount of incessant research goes on. They are, indeed, hardly less important than the manufacturing research departments. Their work is of an extremely catholic nature — they include amongst their functions the control of works processes, and standardisation of products — and they are staffed with chemists of varied denominations: tinctorial, textile, biological and physical chemists.

An excellent example of the type of service rendered by such a department is the evolution of suitable methods and processes for the dyeing of cellulose acetate silk — a new artificial fibre not amenable to the methods and processes in general use for other fibres. In this instance new methods of applying existing dyestuffs were discovered in the dyeing laboratories of dye factories, which were also the source of information leading to the discovery of entirely new groups of dyes peculiarly suited to this purpose.

Too much emphasis cannot be laid on the enormous expenditure involved in chemical industry in the early stages of development in new processes and more especially in proving their usefulness in their varied applications. Even then the country in which the early discoveries are made may not reap the benefit. Perkin's discovery in England of Mauvein was the foundation of the synthetic organic dyestuffs industry, but the industry was first fully developed in Germany, and finally Germany was responsible for producing nearly 90 per cent. of the world's requirements. This example is used in the German monograph to show that "this concentration in a single country was of decisive importance for the development of this industry into a remunerative large-scale industry." The argument is not conclusive, first because the Swiss dyestuffs industry which grew up side by side with the German industry was (although much smaller) remunerative, and secondly, it does not necessarily apply to other industries. It cannot be contended, for example, that because in England and America as well as in Germany there are synthetic ammonia industries none can succeed because the work is not concentrated in one country.

It probably is only sound when applied to goods of which the money value per unit of weight is high. Moreover, a contemplation of the 1,500 different dyestuffs which have been produced in Germany may lead to an erroneous value being given to the argument which has been adduced. It seems to be contended that such a number was necessary, or if not necessary at least desirable, as con-



tributing in some way to the benefit of the colour-using industries. This may be doubted.

It must be remembered that prior to 1914 the German dyestuffs industry consisted of nine firms of major importance and a few smaller firms, all engaged in vigorous competition with each other. There was, therefore, not the concentration of technique and manufacture in Germany which the German monograph appears to suggest. The output of the major firms averaged less than 15,000 tons, the individual output probably varying from 3,000 to 25,000 tons per annum. All the firms were prosperous and secured a remunerative return on their capital. There seems to be no reason, therefore, why a firm carrying on business on a similar scale in other countries of the world should not have been equally successful provided it had at its disposal the same degree of technical skill.

It is true that the German firms had a common advantage in the close co-ordination existing between the Universities and commercial undertakings. This advantage was not confined to the chemical industry, but was a marked feature of German industrial development, which other countries have since followed. It may be true that no country has yet reached the technique developed by the Germans over a long series of years, but the progress made in the big industrial countries which have undertaken the manufacture of dyestuffs has been remarkable, and much more rapid than anyone acquainted with the complications of the industry would have ventured to predict. This progress is being continued, and within a few years there seems to be no reason why these younger industries should not be able to develop and maintain themselves out of their own resources.

Furthermore, commercial organic chemistry has, since the war, shown a tendency to increase its boundaries, and dyestuffs, pharmaceutical and photographic products, which constituted the production in 1914, are not now the only products which can be manufactured in a factory equipped for dyestuffs manufacture.

It should be noted that the vigorous competition between the German dyestuffs firms was the chief reason which led to the multiplication of types of dyestuffs sold. The number is placed in the German monograph at 1,500, but this number could be, and will in time undoubtedly be, considerably reduced with advantage both to the maker and to the consumer. It could be reduced probably by more than one half.

On these grounds, therefore, the British view-point differs a little from that of our German associates. Nor can the views expressed in the German monograph on the steps which have been taken to build up and maintain dyestuffs industries in various countries be accepted in their entirety. It is admitted that to concentrate the industry in one country has certain advantages in fostering its development and very material advantages to the country itself. But the dyestuffs industry is in a very special position for two reasons:

- (1) On it is dependent the, commercially, infinitely greater textile industry, and
- (2) It provides a magnificent training ground for young chemists.

It was, therefore, essential for Britain, in common with other countries, to provide herself with an industry which was of such importance to her national welfare. It is true, as stated in the German monograph, that "the market of each individual industry can, therefore, be only a fraction of the market which Germany monopolised before the war," and that "the consequence is that there is now in each of these industries a thoroughly unsound ratio between overhead costs and current costs of production (expenditure on raw materials, power and wages)." The monograph then continues: "Consequently, in none of the new producing countries have the younger industries been able to develop and maintain themselves out of their own resources. Not only has it been necessary in many countries to spend public money on their maintenance, but the whole market has had to be protected by high customs barriers, and in some cases import prohibitions have been required to regulate and restrict artificially the influx of foreign dyestuffs."

On this certain comments must be made. First, the various countries were compelled to establish these industries by the failure of the supplies of German dyes at the outbreak of war in 1914. Secondly, it is not an unusual thing for an industry to have to adjust itself to a lessened demand for its products; it is unpleasant, it takes time, but it is done. Thirdly, the production of dyestuffs is only a branch of chemical industry, and it can so be linked with other branches as to mitigate the financial hardship involved in reconstruction. Fourthly, it should be recognised that other countries cannot be expected to do in ten years what Germany has had fifty years to accomplish. Lastly, the reference which is made to the assistance which other countries have received by way of public money, high customs barriers, and import prohibitions is incomplete. In the development of her industry over the fifty years referred to above, Germany has not been entirely without the support and assistance of her Government.

### (C) SUPPLY OF RAW MATERIALS.

Agreement can be expressed with the German monograph on this aspect of the subject. In Britain, perhaps, more stress is laid on the importance of coal, not only as a source of power, but as a source of innumerable products obtainable according to the method of treatment employed. Other products — such as pyrites and sulphur — may, to some extent, be substituted, but coal and salt are the fundamental raw products of chemical industry, and of these Britain has ample supplies.

The manufacture of aniline dyes, for example, depends mainly upon supplies of tar products, acids, bases, inorganic salts, bromine, heavy metals, sulphur and alcohol.

At the present time developments are taking place in every direction, and the possible effect upon the dyestuffs industry of the commercial synthetic production of the industrially important alcohols, or of the investigations into the

conditions of carbonisation of coal can hardly be estimated. The availability of cheap alcohols is bound, however, to be highly beneficial to those operations which involve its use as a solvent or as an alkylating agent, or which depend upon formaldehyde which, at the present time, is obtained, commercially, exclusively from methanol.

A very general and widespread activity is abroad in the realm of fuel and coal gas, embracing work on the determination of the influence of temperature of carbonisation of coal on the composition of the resulting tar. This is a question which is of first importance to the manufacturer of intermediates and dyestuffs who is dependent upon coal tar for supplies of essential hydrocarbons, phenols, pyridine, etc.

If, for example, as a result of the research which is being carried out, the composition of the tar were varied in the direction of a greater proportion of the simpler hydrocarbons at the expense of anthracene, the synthetic manufacture of anthraquinone from naphthalene by condensation of benzene with phthalic anhydride by way of benzoyl benzoic acid, would assume relative commercial importance. That is to say, a set of conditions would have been created, which, as in the United States of America at the present time, would render a synthetic process for the manufacture of one of the basic products of the dye industry a possible commercial success.

#### (D) NON-ECONOMIC FACTORS.

Nor can any exception be taken to the statement of fact that of recent years there has been a tendency among the countries to develop chemical industries within their borders for the purpose of making themselves as economically independent as possible. Although it is nowhere so stated, this appears to be regretted by the writers of the German monograph. Reference is again made to the State assistance given in the form of tariffs, prohibitions and "even money subsidies." Preference is apparently given to the system whereby each country makes what it is best fitted to make and exchanges these goods for others made in the countries most naturally equipped for making them. The system is theoretically ideally perfect, but unfortunately is difficult to carry out in practice. If the dyestuffs industry, to which reference has been made previously, be taken as an example it will be observed that development did not follow these lines. It cannot be said that Britain was not as well equipped as any other country to develop the industry after the original discovery of Mauvein. Yet it was most successfully developed in Germany. Further, sufficient attention is perhaps not paid to the fact that although the chemical industry is really a collection of industries they are indissolubly interlocked. It is impossible to divorce economically the distillation of coal from the distillation of tar, the preparation of the intermediate products, the production of dyestuffs and of fine chemicals. To only a lesser degree it is also

necessary that these coal tar industries should be associated with the heavy chemical industries.

National independence is a strong factor to which great importance will continue to be attached on purely economic grounds, for the reason that very many trades are dependent in an ever-increasing degree upon synthetic products. This need for independence in regard to dyestuffs and fine chemical production is all the greater because there have been in the past instances in which a country considered it could keep the method of production secret to compel other importing countries to pay exorbitant prices for the commodity. The production of fine chemicals has in the past lent itself well to secrecy, and secrecy has consequently been a strong factor in the situation.

The production of fine chemical substances requires practice and skill of a very high order, indeed it is practically necessary that a proportion of the workers shall have dedicated their lives to the acquirement of the art from school-leaving age onward. Such intensive training is particularly called for in the manufacture of fine chemicals, consequently the fine chemical industry constitutes in a measure a pivotal training ground for other branches of chemical industry.

Another ground for the retention of independence in fine chemical manufacture is the prospect so clearly foreshadowed that in the long run synthetic productions will displace natural ones on account of the lower cost of production.

The object of tariff barriers goes somewhat beyond that of protecting self-sufficiency, profit or employment, for they render secure an outlet for the abilities and desires of educated workers and craftsmen and afford the workers an opportunity for the exercise of the greatest amount of skill. Wages equalisation would do much to regulate and control tariff barriers, certainly as regards Great Britain, where there is a readiness to rely upon the skill and ability of the race.

The skill required in manufacturing fine chemicals is well illustrated in the manufacture of pharmacological products and preparations of the type of insulin, pituitary, adrenalin and the like. Such delicate substances can only be prepared by the exercise of highly skilled technique and the minutest persistent attention to detail. Similar delicate attention is equally needed to maintain the best economic conditions for producing many of the synthetic chemicals, and fine chemical manufacture is regarded as exceptional among manufactures in calling for acquired skill and good intelligence on the part of the worker. It is an occupation in which, at the present stage, workers are continually employed in applying new knowledge and in introducing new compounds.

Two methods employed in dealing with new knowledge in the case of fine chemicals may be illustrated by examples. Insulin was introduced to the world under the control of a patent held by Toronto University, in which the inventors worked. This University definitely set out to give to the world the knowledge of the method of preparation, and worked to this end to the full extent of its power. It also sought the assistance of the British Medical Research Council, who materially helped the same objects. As a result, insulin rapidly became cheaply available

throughout the world, and its production was greatest in those countries best fitted for the purpose. In consequence, the treatment of diabetes has been revolutionised all over the world.

As an example of another method, reference may be made to Bayer 205, the symmetrical urea introduced as a cure for tropical diseases due to trypanosomes by the Bayer Co., of Germany. This was put upon the market without its composition and method of manufacture becoming known, presumably in order that it might be retained in German hands. No patent was taken out for the final product, although the avenues of approach were protected by numerous patents. The knowledge of the usefulness of this product therefore has developed very slowly. If it proves, as the inventors hope, an agent of great benefit to the world in combating disease, the country of origin, if it successfully retains its secret, would also retain its complete control over the production, distribution and price of the product.

But a solution can be found for the difficulties which have arisen and which are described above and in the German monograph, and will probably be found along the lines of international agreements concluded between the individual national industries when they have sufficiently amalgamated their own interests.

## II & III. — PRODUCTION CAPACITY AND ACTUAL PRODUCTION.

### (A) CHEMICAL INDUSTRY AS A WHOLE.

For reasons already stated no comment is possible on the figures of total production. They are admittedly an estimate; probably a very good estimate, but, nevertheless, an estimate. And if it could be proved that the estimate is exact, it is a little difficult to see what useful deduction could be drawn from the figures.

#### 1. *Sulphuric Acid.*

In pre-war days this chemical was generally regarded as the most important heavy chemical for use as a reagent in almost every staple industry.

To-day probably about one half of the Sulphuric Acid manufactured in the world is used in converting phosphate rock into the fertiliser, superphosphate of lime. The second largest use is in connection with the recovery of ammonia at gas works and at coking plants, where the by-products are recovered. In this way more than 1,000,000 tons of Sulphuric Acid is used annually in the production of sulphate of ammonia for use almost entirely as a fertiliser.

Other large uses of Sulphuric Acid include the refining of petroleum oils (especially in the United States of America), the pickling of iron and steel products and the manufacture of hydrochloric acid, this latter use, however, having decreased materially of recent years owing to the introduction of modern processes for the manufacture of bleach.

In smaller quantities, but nevertheless in considerable quantities, sulphuric acid is used in almost all industries. Strong acid is used in the manufacture of fine chemicals, medicinal and photographic, and in the manufacture of dyestuffs and of high explosives. Weaker sulphuric acid is used in the textile industries for bleaching and dyeing, in the manufacture of copper sulphate for use as an insecticide, in accumulators (now so widely used in the Motor and Wireless Industries), in the refining of metals, for example, gold, and in the manufacture of a large number of sulphates for use as such, including alum, iron, sodium, magnesium, manganese, etc.

Although in pre-war days sulphuric acid was regarded as an index of chemical and industrial progress, the same is not the case to-day to a like extent, and the future of the sulphuric acid industry is being very greatly influenced by progress in chemical research having found alternative methods of manufacture whereby sulphuric acid is rendered unnecessary.

Instances of processes where the tendency is to replace sulphuric acid are as follows:

The superphosphate industry, where the latest processes consist in the production of elementary phosphorus from phosphate rock by use of the electric furnace, and the subsequent burning of the phosphorus to form phosphoric acid, which is then brought into union with ammonia or other nitrogen bases, or potassium.

In the nitric acid industry the use of sulphuric acid for the decomposition of Chile saltpetre is being largely displaced by the production of nitric acid from the air, either by the direct production through the Arc process or by indirect synthesis by way of synthetic ammonia produced by one of the numerous synthetic processes based on the Haber-Bosch principle.

Hydrochloric acid is now being produced in considerable quantities by the direct union of chlorine and hydrogen, the chlorine being produced as a by-product in the electrolytic production of caustic alkali.

Again, the chemical principle of "double decomposition" is being used largely to eliminate the direct use of sulphuric acid; for example, ammonium nitrate is made from nitrate of soda and sulphate of ammonia, the sulphate radical being in its turn obtained by interaction between gypsum (anhydrite) and ammonium bicarbonate.

There are also a number of modern catalytic processes taking place in the gaseous phase, whereby the use of sulphuric acid is eliminated; such processes include the manufacture of formic and acetic acids, alcohols and numerous other simple organic compounds.

Another feature of the sulphuric acid industry to which it is necessary to refer is the fact that during the war very large quantities of sulphuric acid plants were erected purely for war purposes. Doubtless many of these plants have now been scrapped, but certainly many of them still remain, with the result that the productive capacity for sulphuric acid of most of the leading industrial countries

is very materially in excess of the countries' demands. When it is borne in mind that sulphuric acid is a commodity which is cheap in value, but which is very difficult and costly to transfer from one place to another, it will be seen that the solution of this problem is not to be found in encouraging an export trade, but in the scrapping of redundant plant.

The following table, many of the figures in which are obtained from private sources, gives an approximate estimate of the quantity of sulphuric acid manufactured in the countries named. Unfortunately authentic statistics in the main are non-existent, so the figures must be taken only as an approximation:

*Sulphuric Acid Production.*

Metric tons of 100 per cent. H<sub>2</sub>SO<sub>4</sub>. (000's omitted.)

	Pre-war 1913/1914	1925
Austria . . . . .	350 <sup>1</sup>	44
Belgium . . . . .	420	462
Czechoslovakia . . . . .	—	130
Denmark . . . . .	62	109
France . . . . .	900	1,500
Germany . . . . .	1,686	1,125
Great Britain . . . . .	1,082	848
Hungary . . . . .	—	50
Italy . . . . .	600	770
Netherlands . . . . .	320	350
Spain . . . . .	60	320
Sweden . . . . .	77	88
Switzerland . . . . .	30	30
Canada . . . . .	40	60 <sup>2</sup>
United States . . . . .	2,250	4,257
Japan . . . . .	70	210 <sup>3</sup>
South Africa . . . . .	—	60
Australia . . . . .	—	150

*2. Nitrogen Fertilisers.*

The present production of nitrogen in the United Kingdom is almost entirely in the form of ammonia, and according to the Alkali Inspector's report for the calendar year 1925, was equal to 88,450 tons of 2,240 lbs. each, calculated as pure nitrogen.

The total capacity of nitrogen works in the United Kingdom may be put at about 91,720 tons of pure nitrogen per annum, the bulk of this being produced

<sup>1</sup> Includes Hungary.  
<sup>2</sup> 1920.  
<sup>3</sup> 1922.

at shale oil, gas and coke oven works which produce it as a by-product. An increase of about 50,000 tons of pure nitrogen is expected to take place shortly at the Air Nitrogen Works at Billingham.

As regards the world production of nitrogen, the capacity of the by-product plants may be taken at about 360,000 tons of pure nitrogen per annum. As regards the synthetic plants, if the whole of the capacity for producing cyanamide is included, a total of something like 850,000 tons of pure nitrogen per annum would be reached, but it is very doubtful whether much of the cyanamide plant still in existence is capable of producing except under war conditions. Excluding these uneconomical units, the present capacity and actual output are probably more nearly represented by the following table:

	Capacity	Actual Output
	Tons of 2,240 lbs.	
Synthetic Nitrogen . . . . .	650,000 tons	588,000 tons
By-Product Ammonia . . . . .	360,000 „	333,200 „
Chile Nitrate/Soda . . . . .	465,000 „	399,600 „
	<hr/>	<hr/>
	1,475,000 „	1,320,800 „

The total world production of nitrogen in tons of 2,240 lbs. of pure nitrogen for the last three fertiliser years ending May 31st was probably something like the following:

	1923/24	1924/25	1925/26
By-Product Sulphate/Ammonia . . . . .	275,000	290,300	305,700
Synthetic Sulphate/Ammonia . . . . .	231,000	254,800	289,000
	<hr/>	<hr/>	<hr/>
	506,000	545,100	594,700
Cyanamide . . . . .	104,000	115,000	150,000
Nitrate of Lime . . . . .	18,000	25,000	30,000
Other forms of Synthetic Nitrogen . . . . .	58,000	66,000	119,000
Other forms of By-Product Nitrogen . . . . .	30,000	32,400	27,500
	<hr/>	<hr/>	<hr/>
Total production . . . . .	716,000	783,500	921,200
Deliveries of Chilean Nitrate of Soda in consuming markets . . . . .	340,000	363,000	324,200
	<hr/>	<hr/>	<hr/>
Estimated total for agricultural consump- tion . . . . .	1,056,000	1,146,500	1,245,400
	<hr/>	<hr/>	<hr/>
	900,000	983,100	1,072,000



### 3. *Superphosphate.*

The process of manufacturing superphosphate — or monobasic phosphate of lime — originated in Great Britain during the decade of 1840/1850, and is attributed to John Bennet Lawes. It consists of grinding to a fine powder either bones or mineral rock phosphate, subsequently dissolving the ground material in sulphuric acid. For some years bones only were used for the purpose; but in the early part of the decade 1850/1860, Suffolk coprolites were discovered and adopted for the purpose, the resultant product being termed “mineral superphosphate” to distinguish it from the material derived from bones. Practically all the superphosphate made to-day is “mineral superphosphate.” The discovery of the deposits of mineral rock phosphates and later of the Pebble beds in Florida, and of the enormous resources of phosphate of North Africa, resulted in a great and world-wide development of the industry and, up to the outbreak of the war, the world production of superphosphate showed an almost continuous annual increase. So rapid was the extension of capacity for production that it undoubtedly outstripped the demand and there were consequently recurring periods of severe depression in this important industry during the 24 years 1890/1914, corresponding with the periods of depression in agriculture.

During the earlier portion of the period of rapid development of the industry (1890-1914), European manufacturers found a good outlet for the product in export markets, of which the principal were Spain, Russia and Denmark within Europe, South Africa, Australia and New Zealand being amongst the most important of the more distant buyers. The principal European superphosphate exporting countries were Holland, Belgium, Germany, France and Great Britain; but in the ten years immediately preceding the war the exports of superphosphate made by Great Britain were steadily shrinking in volume, whilst those of Holland and Belgium were growing.

The war had very serious effects upon the superphosphate industry throughout Europe. The needs of the various belligerent States for sulphuric acid for explosive manufacture led to a considerable curtailment of production in those countries, whilst the neutral States found themselves unable to obtain sufficient supplies of the two raw materials required, viz.: phosphates and pyrites. Those distant countries which were formerly good export markets for European superphosphate, finding their supplies cut off as a result of the war conditions, proceeded at the end of hostilities to erect superphosphate plants of their own, and thus such markets were practically closed to European exports. Other countries within Europe which formerly imported a substantial portion of the superphosphate they required erected additional or new plants and are, therefore, now in a position largely to meet their home needs from their own resources.

Conditions such as those outlined have inevitably led to uneconomic competition, and to a lowering of prices to a level below the cost of production in some cases, and the position has been aggravated by unstable currencies.

*Superphosphate Production in Metric Tons.*

Country	Production 1913 <sup>1</sup>	Production 1925 <sup>2</sup>	Increase Tons	Decrease Tons
Germany . . . . .	1,818,700	660,400	—	1,158,300
Poland . . . . .	196,172	192,346	—	3,826
Czechoslovakia. . . . .	—	201,857,	comp. figures not available.	
Belgium. . . . .	450,000	381,000 <sup>3</sup>	—	69,000
Denmark . . . . .	90,000	218,500 <sup>3</sup>	128,500	—
Spain . . . . .	225,000	722,653	497,653	—
Russia . . . . .	158,300	62,439	—	95,861
Italy . . . . .	972,317	1,464,056	491,739	—
France . . . . .	1,920,000	2,379,760	459,760	—
Great Britain <sup>4</sup> . . . . .	830,000	538,676	—	291,324
Holland . . . . .	346,000	572,000	226,000	—
Sweden . . . . .	184,259	213,500 <sup>3</sup>	29,241	—
	<hr/> 7,190,748	<hr/> 7,365,330		

4. *Dyestuffs.*

The British estimate of the production of aniline dyes in 1913 and 1924 is as follows:

	1913		1924	
	Tons	Percentage of production	Tons	Percentage of production
Germany . . . . .	135,000	83	70,000	45
United States . . . . .	3,000	2	30,000	20
Great Britain . . . . .	5,000	3	15,000	10
Switzerland . . . . .	10,000	6	13,000	9
France . . . . .	7,000	4	17,000	11
Italy . . . . .	2,000	2	5,000	3
Japan . . . . .			2,000	1
Other countries . . . . .			2,000	1
	<hr/> 162,000	<hr/> 100	<hr/> 154,000	<hr/> 100

After allowing for the inclusion in the German figures of production in branches outside Germany, there is substantial agreement on the 1913 figures. In regard to 1924, the figures in the German monograph over-state, in the opinion of the

<sup>1</sup> International Year-Book of Agricultural Statistics.

<sup>2</sup> British Imperial Institute Statistics.

<sup>3</sup> Estimated.

<sup>4</sup> Including Irish Free State.

British, the production in Great Britain and Japan and under-state the production in Switzerland. The differences between the two sets of figures are not of great moment.

*Output Capacity.*

The British estimate of the capacity of dyestuffs factories throughout the world in 1924 is as follows:

	Estimated capacity Tons	Estimated output, 1924 Tons	Percentage of output on capacity
Germany . . . . .	250,000	70,000	28
United States . . . . .	60,000	30,000	50
Great Britain . . . . .	40,000	15,000	38
Switzerland . . . . .	20,000	13,000	65
France . . . . .	25,000	17,000	70
Italy . . . . .	10,000	5,000	50
Other countries . . . . .	15,000	4,000	27
	<u>420,000</u>	<u>154,000</u>	<u>36</u>

It will be observed that the British estimate of capacity is very much higher than that given in the German monograph, particularly for Germany, Great Britain and Switzerland. The figure for Great Britain is based on information furnished to the Development Committee of the British Board of Trade and may be taken as approximately correct. The figures for Germany and Switzerland are a British estimate, and it would seem, with the very large extensions made to these plants during the war, the capacity should be materially in excess of that shown in the German monograph.

*5. Tar Products.*

As mentioned before, little reference is made to tar distillation, and it may be suitable at this point to say that the output capacity of British Tar Works is from 50 per cent. to 75 per cent. above the quantity available. This is partly due to the seasonal variations in production and partly to the desire to be able at short notice to meet extraordinary demands. The amount of tar and pitch produced in Great Britain is given below:

	1925 Tons	1924 Tons	1923 Tons
Tar Distilled . . . . .	1,689,493	1,813,728	1,692,168
Pitch Produced . . . . .	519,818	625,222	677,362

Germany is the only serious competitor to Great Britain in the export of tar products in normal times. The production of tar in Germany in 1925 is thought to be about 800,000 tons. Of the pitch produced, Great Britain exported between July 1924, and June 1925, a total amount of 398,400 tons, whilst Germany during the same period exported 83,000 tons in the normal manner and in addition

an estimated 40,000 tons under the Reparation Scheme. It is further estimated that during 1925 Germany exported 25,000,000 gallons of creosote, whilst Great Britain in the same period exported 37,000,000 gallons.

#### IV. — NUMBERS OF EMPLOYED AND UNEMPLOYED.

For the reasons given in the German monograph nothing but an estimate can be made of the total number of workers employed throughout the world in chemical industry. Nor can comparative national figures be given.

In Great Britain it is estimated that the number employed during the last eight years has varied between 200,000 and 250,000.

In the restricted sense in which the British Ministry of Labour regards chemical industry the following figures are available:

	Employed July	Percentage May	of Unemployment November
1926 . . . . .	94,530	12.1	11.3
1925 . . . . .	96,900	8.9	9.1
1924 . . . . .	97,640	8.8	9.2

These figures do not include the industries making Soap, Artificial Silk, Paint, Glue, Oil, Matches, etc.

#### V. — HOURS OF LABOUR — OUTPUT PER HEAD.

The 8-hour day is the rule in British chemical industry and it is thought probable that in few, if any, countries are the hours of labour so short.

The British point of view agrees with the German for the reasons given that figures concerning output per head are valueless.

#### VI. — WAGES.

The reference in the German monograph that "chemical industry employs no specially trained skilled workers" is not understood. In the British view the percentage of skilled to unskilled labour is very high in chemical industry. In between the scientifically trained workers and the labourers are a class which are described as process workers, who are in many instances very highly skilled at their particular work, although they have not had a scientific training. It is thought that this is also the case in Germany, where it was understood these skilled workers received five or six marks per week more than the unskilled workers.

Although the hours worked per week in British chemical industry are shorter than on the Continent the wages paid in Great Britain are fully 50 per cent. higher than on the Continent.

VII. — RAW MATERIALS USED.

It is not desired to comment on this section of the German monograph, save only to suggest that in addition to the materials already chosen for study there should be added coal and limestone.

The production figures for sulphur and pyrites which are adopted in Great Britain are as follows:

<i>Sulphur.</i>					
	1913/14	1922	1923	1924	1925
			Tons (000's omitted)		
U.K. (as sulphur in spent oxide) . . . . .	50	78	73	73	75
United States . . . . .	491	1,831	2,036	1,221	1,409
Italy . . . . .	386	166	256	295	260
Spain . . . . .	8	22	18	19	?
Japan . . . . .	59	35	37	45	40 (?)
<i>Pyrites.</i>					
Country Producing	1913/14	1922	1923	1924	1925
			Tons (000's omitted)		
<i>British Empire:</i>					
United Kingdom. . . . .	12	6	7	6	5
South Africa . . . . .	—	3	3	2	2.4
Canada . . . . .	141	16	25.5	21	14
Cyprus . . . . .	—	29	61	139	173
Australia . . . . .	10	12	12	12 (?)	— (?)
<i>Other countries:</i>					
Austria . . . . .	4	19	15	27.6	24.7
Czechoslovakia . . . . .	?	9	—	15.7	?
France . . . . .	306	184	183	178	195
Germany . . . . .	269	323	190	157	220
Greece . . . . .	127	53.6	51.5	75	?
Italy . . . . .	312	478	485	507	525
Norway . . . . .	434	390	369	397	614
Poland . . . . .	—	2	5.6	6.7	11
Portugal . . . . .	429	201	181	?	?
Roumania. . . . .	?	20	25	32	?
Russia . . . . .	130	27	98	25 (?)	?
Kingdom of the Serbs, Croats and Slovenes . . . . .	—	11	?	?	38
Spain . . . . .	3,119	2,302	2,610	2,177	?
Sweden . . . . .	34	56	57	65	68.7
Algeria . . . . .	?	7	21	18	12
Cuba . . . . .	—	1	—	—	—
United States . . . . .	341	169	182	160	170
Japan . . . . .	113	159	223	217	?

## VIII. — CUSTOMS DUTIES (IMPORT AND EXPORT PROHIBITIONS AND DE-CONTROL.)

Apart from prohibitions of a social character which are dealt with under the Dangerous Drugs Act, Great Britain has Customs Duties and prohibitions on only a very small part of her chemical industry. Artificial silk is subject to a duty under the current Finance Act. All "Synthetic organic chemicals (other than synthetic organic dyestuffs, colours and colouring matters imported for use as such, and organic intermediate products imported for their manufacture), analytical reagents, all other fine chemicals (except sulphate of quinine of vegetable origin) and chemicals manufactured by fermentation processes" are subject to an *ad valorem* duty of 33% per cent. under the Safeguarding of Industries Act, 1921.

The importation into Great Britain of "all synthetic organic dyestuffs, colours and colouring matters, and all organic intermediate products used in the manufacture of any such dyestuffs, colours or colouring matters" is prohibited, subject to the power of the British Board of Trade to admit such chemicals by licence. In practice these products are admitted, of course, without payment of any Customs Duty, unless like products of equal quality are produced in Great Britain.

With these exceptions there are no other prohibitions or Customs Duties on chemical products.

It should be noted that there is no duty, as such, on fertilisers coming into the United Kingdom, but urea, which is a synthetic organic chemical, is at the moment subject to a duty levied under the Safeguarding of Industries Act. The general tendency throughout the world is to exempt fertilisers from any but nominal duties to pay the cost of collection of statistics.

Notable exceptions to this rule are the United States and Brazil, in which countries the duties are calculated to make imports of nitrogen unprofitable to manufacturers outside those countries.

## IX. — EXPORTS AND IMPORTS.

### A. — CHEMICAL INDUSTRY AS A WHOLE.

Again, the difficulty of definition of the term "chemical products" makes the use of general statistics impossible.

### B. — INDIVIDUAL BRANCHES OF CHEMICAL INDUSTRY.

#### 1. *Nitrogen Fertilisers.*

The chief export of nitrogen from the United Kingdom has been in the form of sulphate of ammonia. The following figures have been extracted from the Customs Returns for the year ending 31st May in each case, and are expressed in tons of 2,240 lbs.

	Average 1908-12	1913-14	1923-24	1924-25	1925-26
Scandinavia . . . . .	93	—	792	—	58
North Russia . . . . .	3	49	10	60	129
Belgium . . . . .	3,273	1,135	2,270	497	40
France . . . . .	11,801	3,977	18,917	26,943	3,610
Germany . . . . .	13,325	11,812	450	150	12
Switzerland . . . . .	—	—	40	166	—
Holland . . . . .	4,702	3,361	10,535	2,706	76
Channel Islands . . . . .	651	656	1,330	964	1,553
Spain . . . . .	53,298	52,709	50,449	99,558	68,304
Portugal . . . . .	1,903	3,709	1,771	1,233	2,922
Canary Islands . . . . .	6,919	8,709	9,722	12,802	14,756
Madeira . . . . .	532	811	285	280	435
Italy and Sicily . . . . .	10,360	4,527	5,675	9,018	4,898
Egypt . . . . .	668	279	2,460	4,481	3,143
Greece . . . . .	15	90	521	60	1
Sundry Mediterranean . . . . .	—	1	—	125	19
Algeria, Morocco, Tunis . . . . .	151	205	—	50	—
Java . . . . .	26,097	38,319	35,327	35,660	28,534
Philippines (Straits) . . . . .	663	267	18	2,100	702
Japan . . . . .	61,627	115,012	84,936	36,141	48,397
China . . . . .	481	2,089	10,827	1,245	8,034
Hong-Kong . . . . .	544	2,119	—	6,530	10,420
United States . . . . .	49,073	45,854	165	—	50
Canada, Newfoundland . . . . .	279	533	10	18	62
West Indies, British . . . . .	3,546	2,602	3,545	3,955	2,682
"    "    French . . . . .	874	1,427	600	1,466	—
"    "    others . . . . .	534	2,992	—	—	—
Central America . . . . .	212	2,006	44	120	46
British Guiana . . . . .	7,626	7,311	7,214	5,970	5,123
South America . . . . .	276	727	219	244	71
Pacific Islands (Hawaii) . . . . .	5,217	2,049	—	—	—
Australia . . . . .	9	—	20	110	1
New Zealand . . . . .	82	250	402	250	155
Ceylon . . . . .	1,383	2,109	1,650	2,754	6,384
India . . . . .	113	166	636	509	5,712
South Africa . . . . .	153	351	* 323	125	356
Portuguese E. and W. Africa . . . . .	47	20	108	22	57
Mauritius . . . . .	5,680	5,764	6,043	5,206	7,358
Dutch Indies . . . . .	17	—	2,152	199	613
French W. Africa . . . . .	—	—	5	—	—
Madagascar, Reunion . . . . .	4	23	—	289	—
Spanish W. Africa . . . . .	—	80	—	—	—
Sundries . . . . .	65	—	133	89	50
<b>Total . . . . .</b>	<b>272,296</b>	<b>324,100</b>	<b>259,604</b>	<b>262,095</b>	<b>224,763</b>
<b>Calendar Years (1st year) . . . . .</b>	<b>—</b>	<b>324,704</b>	<b>247,536</b>	<b>263,012</b>	<b>248,752</b>

Nitrogen is chiefly imported into the United Kingdom in the form of nitrate of soda from Chile, the figures being as follows:

Nitrate of Soda imports into the United Kingdom and estimated quantity used for agricultural consumption for the year ending 31st May, in tons of 2,240 lbs. of Nitrate of Soda:		
	Imports	Agricultural Consumption
1914 . . . . .	123,000	80,000
1925 . . . . .	74,000	40,000
1926 . . . . .	70,500	35,000

Apart from the quantities of organic forms of nitrogen such as Peruvian Guano, the only other considerable import is nitrate of lime from Norway, the quantity having varied between about 5,000 and 10,000 tons per annum during recent years.

2. *Superphosphate.*

Comparison of the position in 1913, with that of 1925, in regard to inter-European superphosphate exports and imports, is very instructive.

Table 1. — *Superphosphate Imports in Metric Tons.*

Country	Imports 1913 <sup>1</sup>	Imports 1925 <sup>2</sup>	Increase Tons	Decrease Tons
Germany . . . . .	53,193	39,970		10,987
Poland . . . . .	— <sup>5</sup>	2,236 <sup>1</sup>		
Austria . . . . .	75,224	32,533		15,064
Hungary . . . . .	— <sup>5</sup>	13,130		
Czechoslovakia . . . . .	— <sup>5</sup>	14,507		
Belgium . . . . .	28,012	27,098		914
Denmark . . . . .	110,151	147,332	37,181	
Spain . . . . .	150,235	146,534		3,701
Russia . . . . .	196,850	5,553 <sup>1</sup>		87,350
Estonia . . . . .	— <sup>5</sup>	24,560		
Finland . . . . .	— <sup>5</sup>	26,172		
Latvia . . . . .	— <sup>5</sup>	53,215		
Italy . . . . .	—	22,356	22,356	
France . . . . .	106,822	22,285		84,527
Great Britain . . . . .	55,000 <sup>3</sup>	151,454 <sup>4</sup>	96,454	
Norway . . . . .	4,303	22,019	17,716	
Holland . . . . .	270,378	94,652		175,726
Roumania . . . . .	—	615		615
Sweden . . . . .	3,280	16,653	13,373	
Total . . . . .	1,053,648	862,874		

The most important changes are dealt with in detail.

<sup>1</sup> International Year-Book of Agricultural Statistics.

<sup>2</sup> British Imperial Institute Statistics.

<sup>3</sup> Estimated.

<sup>4</sup> Including Irish Free State.

<sup>5</sup> Succession States.



*Russia.*

The large decrease in imports is probably due to economic difficulties. Finland has, however, erected a State owned and directed superphosphate factory since the war.

*France.*

There has been a notable increase in the consumption of superphosphate in France, but even so imports have decreased by nearly 80 per cent. This is due to the fact that the production capacity has been substantially increased by the erection of new plants since the war.

*Great Britain.*

The heavy increase in imports is, in the main, due to competition arising from an early return to the gold standard.

*Holland.*

Since the war production capacity has been increased by the erection of a plant capable of producing 150,000 tons per annum and by the modernisation of other existing plants.

In order that the changes brought about by the war in the European superphosphate industry shall be fully understood and appreciated it is desirable also to study the position as to exports. These are given in Table 2 which follows:

*Table 2. — Superphosphate Exports in Metric Tons.*

Country	Exports 1913 <sup>1</sup>	Exports 1925 <sup>2</sup>	Increase Tons	Decrease Tons
Germany . . . . .	282,653	45,742	5,283	221,161
Poland <sup>4</sup> . . . . .	—	15,750 <sup>1</sup>		
Austria . . . . .	3,748	3,284		
Hungary <sup>4</sup> . . . . .	—	939		
Czechoslovakia <sup>4</sup> . . . . .	—	4,808	5,448	132,682
Belgium. . . . .	318,922	176,240		
Denmark . . . . .	683	6,131		
Spain . . . . .	—			
Russia . . . . .	—			
Estonia . . . . .	—			
Finland . . . . .	—			
Latvia . . . . .	—			
Italy . . . . .	—	42,588	42,588	
France . . . . .	145,228	229,361	84,133	
Great Britain <sup>3</sup> . . . . .	64,490	6,000		58,490
Norway . . . . .	—			
Holland . . . . .	352,849	383,410	30,561	
Roumania . . . . .	861	9,825	8,964	
Sweden . . . . .	36,037	88,609	52,572	
Total . . . . .	1,205,471	1,012,687		

<sup>1</sup> International Year-Book of Agricultural Statistics.

<sup>2</sup> British Imperial Institute Statistics.

<sup>3</sup> Excluding exports to Irish Free State. (Estimated.)

<sup>4</sup> Succession States.

The principal variations may again be referred to in detail thus:

*Germany.*

Whilst there has been a decrease of 221,161 tons in exports there has also been a decrease in imports, the net position being a decrease in external trade of about 210,000 tons. Unfortunately there is also a very heavy decrease in internal consumption.

*Belgium.*

The principal market for Belgian exports is Holland and, as Table 1 has shown, Dutch imports are down by nearly 176,000 tons. The position is, therefore, that Belgium sold 44,000 tons additional, to countries other than Holland, as compared with 1913.

*Italy.*

The statistics for 1913 are not available.

*France.*

Shows an increase of 84,133 tons in exports and a decrease of 84,537 tons in imports, an extraordinarily favourable change in conditions.

*Great Britain.*

The decrease of 58,490 tons in exports is accompanied by an increase of 96,454 tons in imports, a turnover of nearly 155,000 tons against this country.

*Holland.*

The change in the position is remarkable as an increase of 30,561 tons in exports with a decrease of 175,726 tons in imports gives a total difference, in favour of Holland, of over 201,000 tons.

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Inter-European exports fell by nearly 200,000 tons in 1925 as compared with 1913 and the difficulty created by this large contraction of demand is rendered greater by the incontestable fact that the production capacity is now substantially greater than it was in 1913. In certain countries there has been an expansion in the consumption; but in others again there has been a heavy falling off. Germany and Great Britain are amongst the principal sufferers from decreased home demand, whilst Spain, France and Italy are perhaps the most notable examples of increased home consumption.

### 3. Dyestuffs.

The figures presented in the German monograph should be accepted as probably being as accurate as any which could be obtained.

X. — CONSUMPTION PER HEAD AND BY COUNTRIES.

For the reasons given in the German monograph a calculation of consumption per head is of little use.

A. — NITROGEN.

In the case of nitrogen, figures of consumption by countries are not a safe or significant guide. It is better to take the consumption for agricultural purposes per acre. At the present time the United Kingdom and Ireland are consuming about 40,300 tons of pure nitrogen per annum, about 34,000 tons of which quantity is in the form of sulphate of ammonia and the rest in the form of nitrate of soda and nitrate of lime. The arable acreage is just about 14,000,000 acres so that the consumption per acre is about 6 1/2 lbs. This is about half the quantity per acre consumed in Germany, about one-quarter of the Belgian and about one-fifth of the Dutch consumption. It is, however, nearly double the consumption of nitrogen in France.

B. — DYESTUFFS.

The estimate of consumption in different countries for 1913 and 1924 is as follows:

	1913 Tons	1924 Tons
Germany (including Alsace-Lorraine, 1913) . . . . .	20,000	15,000
United States . . . . .	26,000	24,000
Great Britain . . . . .	23,000	15,000
France (including Alsace-Lorraine, 1924) . . . . .	9,000	15,000
Italy . . . . .	7,000	8,000
China . . . . .	28,000	30,000
Japan . . . . .	5,000	6,000
India . . . . .	8,000	7,000
Austria . . . . .	8,000	} 29,000
Poland and Russia . . . . .	7,000	
Other countries . . . . .	21,000	
	162,000	149,000

These figures are in substantial agreement with the German monograph except in the following instances:

1913. — We estimate the China consumption at 28,000 tons against 34,000 in the German monograph.

1924. — We estimate consumption in Great Britain at 15,000 tons, in France at 15,000 tons and in Japan at 6,000 tons.

C. — SUPERPHOSPHATE.

It is thought desirable to include an estimate of the consumption of superphosphate, and it is here appended:

		<i>Estimate of Consumption Based on Production, etc.</i>			Estimated	
		Production + Imports	= Total	— Exports	Consumption	
Germany,	1925 . .	660,400	39,970	700,370	45,742	654,628
	1913 . .	1,818,700	53,193	1,871,893	282,653	1,589,240
(—) 934,612						
Poland,	1925 . .	192,346	2,236	194,582	15,750	178,832
	1913 . .	196,172	—	196,172	not available	196,172
(—) 17,340						
Belgium,	1925 . .	381,000	27,098	408,098	176,240	231,858
	1913 . .	450,000	28,012	478,012	318,922	159,090
(+) 72,768						
Denmark,	1925 . .	218,500	147,332	365,832	6,131	359,701
	1913 . .	90,000	110,151	200,151	683	199,468
(+) 160,233						
Spain,	1925 . .	722,653				
	1913 . .	225,000				
(+) 497,653						
Russia,	1925 . .	62,439	109,500	171,939	—	
	1913 . .	158,300	196,850	355,150	—	
(—) 95,861						
Italy,	1925 . .	1,464,056	22,356	1,486,412	42,588	1,443,824
	1913 . .	972,317	—	972,319	not avail.	972,319
(+) 471,505						
France,	1925 . .	2,379,760	22,285	2,402,045	229,361	2,172,684
	1913 . .	1,920,000	106,822	2,026,822	145,228	1,881,594
(+) 291,090						
Great Britain	1925 . .	538,676	151,454	690,130	6,000	684,130
	1913 . .	830,000	55,000	885,000	64,490	820,510
(—) 136,380						
Holland,	1925 . .	572,000	94,652	666,652	383,410	283,242
	1913 . .	346,000	270,378	616,378	352,849	263,529
(+) 19,713						
Sweden,	1915 . .	213,500	16,653	230,153	88,609	141,544
	1913 . .	184,259	3,280	187,579	36,037	151,542
(—) 9,998						

Inc. (+) or Dec. (—)

Speaking broadly those countries which show an increase of consumption have increased their production capacity to an even greater extent, and those countries which show a decrease have not less than the pre-war production capacity. The surplus plant capacity existing in Europe is difficult to estimate; but it undoubtedly attains very large proportions. Such a condition inevitably results in heavy pressure to sell, especially during that period of the year when consumption is at its lowest point, and consequently prices are forced down to an unremunerative level. The state of the industry is such that some method of regulation of international production would seem to be the only rational course to adopt. Perhaps the best means of tackling the problem lies in regulating production and, at the same time, endeavouring to increase consumption by intensive propaganda. If some of those countries where the consumption per hectare is small could be brought up to the level prevailing in countries where the consumption is large, much of the surplus production capacity could be employed. A growth of demand to the level required must inevitably take some years and in the meantime a rational method of regulation of production, international in its scope, would unquestionably assist one of the most important of the heavy chemical industries to recover from the existing demoralisation.

## XI. — PRICES.

It is desirable to offer two general criticisms on the price index in gold for chemicals as set out in the German monograph. First, with reference to the figures for Great Britain, it is observed that they are compiled from trade periodicals, and it is felt they are rather on the high side. It is true they are related to a basis figure of 1914, but there has been a change in some of the methods of obtaining market prices for periodicals which would tend to make the figures for recent years somewhat higher.

Secondly, it is thought that the figures for France may be somewhat vitiated by the exchange. It is desirable that the calculation should be submitted to Great Britain in order that it may be studied.

In the meantime it is interesting to compare the prices of certain fertilisers and various feeding-stuffs and crops.

With the exception of nitrate of soda from Chile, prices for the principal nitrogenous fertilisers are now considerably below the pre-war level. The following table gives the index figures for sulphate of ammonia and nitrate of soda and a few other fertilisers, and also for various feeding-stuffs and for the principal crops:

*Prices for Feeding-stuffs, Fertilisers and Agricultural Produce in England and Wales expressed as Index Figures.*

	Average 1911/13	1921	1922	1923	1924	1925
<i>(a) Feeding-stuffs:</i>						
Barley (imported) . . . . .	100	184	132	115	149	144
Oats (imported) . . . . .	100	166	147	135	135	146
Maize . . . . .	100	181	148	152	167	167
Milling Offals . . . . .	100	179	141	129	150	143
Oil Cakes . . . . .	100	193	157	138	153	150
Brewers' Grains . . . . .	100	159	154	132	147	154
Barley Meal and Maize Meal . . .	100	181	138	134	155	153
<i>(b) Fertilisers:</i>						
Sulphate of Ammonia . . . . .	100	133	109	102	96	87
Nitrate of Soda . . . . .	100	176	139	128	130	123
Basic Slag (30 per cent. total Phos- phate) . . . . .	100	324	195	140	112	116
Kainit . . . . .	100	198	107	80	88	102
<i>(c) Produce:</i>						
Wheat (British) . . . . .	100	219	146	130	152	160
Barley . . . . .	100	184	141	119	165	148
Oats . . . . .	100	172	147	135	138	138
Potatoes . . . . .	100	232	179	113	257	204
Hay . . . . .	100	151	140	130	101	101
Vegetables . . . . .	100	246	196	148	165	167
<i>(d) Milk . . . . .</i>	100	263	179	174	170	170

## XII. — INDUSTRIAL ORGANISATION.

### ORGANISATIONS FOR BUYING AND SELLING.

Chemical Industry is probably as well represented by its associations as any other industry in Great Britain and in this respect compares favourably with other countries.

The Society of Chemical Industry represents the science of chemistry as applied to industry, in contra-distinction to the Chemical Society which represents pure chemical science.

The Association of British Chemical Manufacturers represents generally the Chemical Manufacturers and the Industry on all matters except labour questions.

The Chemical Employers' Federation is the leading body dealing with labour questions for the general chemical industry.

In addition to these Associations there are a number dealing with special branches of the Industry, which are affiliated with the Association of British Chemical Manufacturers. The National Sulphuric Acid Association, Ltd., The National Benzole Association, The Fertiliser Manufacturers' Association, Ltd., The Association of Tar Distillers, and the British Sulphate of Ammonia Federation, Ltd., each deal with the particular industry indicated in their titles.

There is no one organisation controlling the whole of the nitrogen sales in the United Kingdom. Up to the beginning of 1914 no attempt at organised selling in regard to sulphate of ammonia had been made. The by-product manufacturers of that fertiliser had, however, decided just before the outbreak of war to form a selling association. This association, working in conjunction with Government departments during the war, practically controlled the sale of the whole output, and in 1920 led to the formation of the British Sulphate of Ammonia Federation, Ltd. That body represents about 92 per cent. of the present output of ammonium sulphate. More recently a new company called Nitram, Ltd., which is closely connected with Imperial Chemical Industries, Ltd., has been formed to market all forms of nitrogen in the United Kingdom. As far as nitrogen is concerned, there are no buying organisations, except the somewhat rudimentary arrangements of the Co-operative Societies. These Societies do not play any important part in British agriculture, as far as fertilisers are concerned, their share of the trade being only about 5 per cent.

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Sulphate of Ammonia . . . . .	100	133	109	102	96	87
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3.

**THE MAIN ASPECTS OF THE  
CHEMICAL INDUSTRY THROUGHOUT THE WORLD,  
AS SEEN FROM A FRENCH STANDPOINT.**

**By M. DUCHEMIN,**  
President of the Union des Industries chimiques (France).

*Communicated by M. DE PEYERIMHOFF DE FONTENELLE.*

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## THE MAIN ASPECTS OF THE CHEMICAL INDUSTRY THROUGHOUT THE WORLD, AS SEEN FROM A FRENCH STANDPOINT.

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It would be an almost impossible task to set out in a few pages the opinion of French industrialists on the state of the world's chemical industries in the manner adopted for other highly concentrated industries, such as the coal or textile industries. The products manufactured by chemical works are so numerous and varied that it would be necessary in each case to examine the facilities for obtaining raw materials, ascertain the conditions of their production, and determine the possibility of finding an outlet for them in the various markets. Even then we should only obtain an incomplete idea, because the sudden and frequent fluctuations in the exchanges are constantly causing profound alterations in prices and working conditions, and these changes may themselves to a very considerable extent vary for different products.

It would, however, be possible to summarise, either in tables or by means of graphs, the statistics of the various chemical industries in different parts of the world, but it is open to doubt whether such an undertaking would not be premature to-day, since in the next few months, as a result of the appearance of new products, the inauguration of new works, or the variation in the value of currencies, the whole aspect of the world's chemical industry may once more be profoundly modified.

We will therefore merely indicate as briefly as possible how French industrialists regard the main aspects of the chemical industry.

It is a truism to state that the war of 1914-18 profoundly modified working conditions in chemical works, as indeed it modified conditions in all other industries.

### PRE-WAR SITUATION.

And yet, for a proper comprehension of the problem, it is necessary to point out that, before 1914, certain countries which were particularly well provided with raw materials, or where business was mainly organised with a view to export, had greatly extended their field of action and had, by their exports, supplied the lacunæ left by inadequate production in other less scientifically developed countries whose capacity of manufacture had, either voluntarily or involuntarily, been limited to the consumption of the home market.

### CAUSES OF THE PRESENT LACK OF EQUILIBRIUM.

*War Needs.* — The war stimulated consumption to such an extent — for the needs of the armies in the field were far greater than the requirements of normal consumption — that, in belligerent or neutral countries, former factories were extended and new works established.

At the Armistice, none of the extended or newly established factories were willing to close down voluntarily; and this was the cause of the great disproportion between production and the needs of normal civilian consumption.

*The New States.* — A further disturbing influence was the formation of new States and the fixing of new frontiers on the signing of the Treaties of Peace. Many factories, whose connection with neighbouring establishments which had regularly provided them with raw materials was broken, were led to set up establishments for the manufacture of the necessary products and so avoid importation from abroad.

*Reduction of Consumption.* — To this second factor has been added a third — the reduction of consumption in countries which hitherto had been large buyers, such as Russia or the Far East (China), in which internal dissensions have largely reduced the purchasing power of the population.

*Currency Fluctuations.* — Adding currency fluctuations to the various other causes which have disturbed the former balance of trade, it will be realised that the industry is faced with a crisis of over-production, and that important changes are taking place in the normal currents of importation and exportation in the various countries.

It is true that the crisis of 1920-21 wiped out a number of these establishments, but it did not eliminate the latent over-production which continues to exist in the chemical industry throughout the world and which means that in most countries, both in Europe and elsewhere, the possibility of production greatly exceeds the needs of local consumption. Hence an acute struggle for fresh markets and, in the case of countries which have stabilised their currency, the difficulty of regaining in foreign markets the positions held before the war.

### PROTECTIVE TARIFFS.

*The Chemical Industry and National Independence.* — This situation has not been improved by the fact that the war of 1914-18 taught the various Governments that, in case of hostilities, their national independence was in part dependent upon the development of their chemical industries. They realised not only that all kinds of chemical products were necessary for the manufacture of explosives

or gases for attack, but also that the chemical industry fed numerous other industries (textile, skin and leather, glass, pottery, etc.), which were only really independent in so far as they were able to obtain in their own territory the chemical raw materials they required.

Consequently, measures have been adopted for the prohibition of imports and exports, and Customs barriers have been erected in various countries.

*The Rapidity of Technical Progress.* — Lastly, Governments have observed that the industrial concentration brought about by the war and the ever more powerful processes placed at the disposal of the chemical industry lead to an increasingly rapid technical progress and the practical application of such progress. New processes which, before the war, would not have been put to practical industrial use until several years after their discovery are now applied after a few months.

This rapidity of scientific and technical progress compels the producing nations to remain constantly on the alert, as otherwise from one day to the next they may see their industries decline or may be obliged to sacrifice machinery installed at great expense and already obsolete just when it is about to be brought into use. This is a further factor inducing nations to protect their chemical industries; and there are others.

*The Nationalisation of Chemical Production.* — Before the war, there was justification for a powerful chemical industry in a country which possessed in its own territory the three elements of a healthy and rational economy, namely:

- (a) An assured supply of raw materials under favourable economic conditions;
- (b) Powerful financial, scientific and technical resources combined with a plentiful supply of labour;
- (c) A home market large enough to justify, by a ready recoupment of overhead costs, production on an economic scale.

It is quite certain that many countries possessed and still possess these elements of success.

(a) *Raw Materials.* — It is by no means always necessary that these countries should possess in their own territory all the raw materials they require.

A few examples taken from the great mineral chemical industry will suffice to demonstrate this fact.

Let us take phosphate fertilisers, most of which have hitherto taken the form of superphosphates, their raw materials being phosphate of lime and sulphuric acid. In this case, apart from the United States, the phosphate deposits are situated in countries (Tunis, Algeria, Morocco, etc.) which do not themselves possess a

highly developed chemical industry. Most superphosphate-manufacturing countries are therefore on the same footing with regard to the supply of the raw material, account being taken of their geographical position.

As regards sulphuric acid, apart from the fact that the new methods of manufacture from gypsum — of which there are plentiful supplies throughout the world — make it possible for all countries to be independent, the deposits of pyrites — generally used in preparing these substances — are, with the exception of some small deposits in Norway, Italy, Germany and France, to be found in countries like Spain, which could not possibly transform all their production of pyrites into acid.

It should also be remembered that, in the great chemical industry, the problem of transport costs or transport difficulties is an important one. In many cases it is easier and cheaper to send the raw material and have it manufactured near the localities of consumption than to manufacture it on the spot and transport the manufactured article. In this case, too, the various countries are, as regards competition, on the same footing.

If we consider some of the other principal raw materials used in the great chemical industry, such as salt, baryte, sulphur and coal, it will be noticed that there are few nations which do not possess in their territory all or a great part of these raw materials. And, again, though it is true that mineral fuel deposits — coal and lignite — are irregularly deposited over the surface of the globe, countries which do not possess mineral fuel are generally well provided with hydraulic power and are thus able to obtain partial compensation for their poverty in fuel.

Moreover, the recent tendency in the chemical industry to adopt synthetic processes of production from the simplest elements — hydrogen, oxygen, nitrogen and carbon — greatly facilitates the establishment of powerful national industries in almost all countries.

Hydrogen, oxygen and nitrogen exist everywhere and, as we have said above, very few countries are so poorly supplied with resources in fuel or hydraulic power as not to be able to avail themselves to some extent of these elements and to prepare products such as nitric acid and nitrogenous fertilisers.

Everywhere nitrogen and oxygen can be extracted from air; everywhere hydrogen can be prepared by the electrolysis of water or the decomposition of steam, quite apart from the fact that countries which possess large supplies of mineral fuel can obtain hydrogen from coal gas.

In short, though numerous industries which obtain their raw materials from mineral deposits unequally distributed throughout the globe, or which prepare this material locally in the neighbourhood of coalfields, are bound to remain in the hands of a few privileged countries, the chemical industry will, on the contrary, as regards many of its products, find its export markets limited to those countries in which the supply of fuel and hydraulic force is practically nil, to new countries and to countries which have not yet reached a high stage of civilisation.

It may therefore be predicted that a time will come when a great many

nations will be self-sufficing in respect of synthetic products. Perhaps one of the most paradoxical aspects of scientific discovery and its wide application is that it helps, so to speak, to render national the most complex industries and industries which are indispensable to the national life.

(b) *Resources.* — It may be said that most of the greater nations possess sufficient scientific and financial resources for the development of their chemical industry.

Scientific education is daily making immense progress, the spread of new inventions and new methods becomes more rapid as contact through international congresses between scholars and technicians of various nationalities becomes more frequent and capital more readily available; great undertakings no longer depend for their development solely on their own internal financial market.

Requirements in labour are nowadays more easily met, because: (a) the chemical industry employs fewer workers than many other branches of production, the metallurgical and textile industries, for instance; (b) apart from foremen and supervisors, little specialised labour is employed; and (c) the amount of manual labour is steadily diminishing as a result of improved working methods.

(c) *The Capacity of Home Markets.* — The development of the chemical industry is, nevertheless, conditioned by the capacity of absorption of their home or colonial markets.

The consuming industries will be greater in proportion to the extent of these markets, and manufacturers will be able to reduce their production costs owing to the reduction of the ratio of their overhead expenses per unit of product.

The extent of amortisation achieved — which is itself dependent upon the age of the undertakings — is an element which should be taken into account by the State in according Customs protection to their chemical industries.

\* \* \*

## CONCLUSIONS.

These observations seem to lead to the conclusion that it would be difficult, if not impossible, to discover a formula which would to any extent facilitate the trade in chemicals, quite apart from any hope of restoring the pre-war equilibrium.

Such a conclusion would, however, be over-hasty. Though, owing to the necessity of maintaining and developing their chemical industries, States may not be able to take more than partial measures in the matter of international agreements; even though they cannot, without sacrificing important elements in their production and wealth, lower the Customs barriers to any appreciable extent and are unable, for fear of grave functional disorders which might produce very

undesirable reactions, to contemplate a sudden return to a sort of absolute Free Trade, we may yet believe that industrialists themselves may — and indeed should — render this task easier.

If, disregarding frontiers, similar industries get in touch and conclude mutual agreements for the rationing of their products, in conformity with national and international requirements, taking into account the new situations which have arisen; if they succeed, first by national agreements and then by international agreements, in diminishing general expenses, improving output and eliminating second-rate factories or factories whose geographical situation is unsuitable; if they co-operate in organising their sales, they will obtain a diminution of cost prices and greater regularity in production, two results which would be a source of satisfaction to all and which would engender a mentality favourable to a long reign of peace.

In short, the first step is not to conclude inter-State agreements but agreements between the industries themselves which would render the subsequent conclusion of inter-State agreements possible.

To prepare the way for these agreements, the International Conference might, so far as the chemical industry is concerned, accomplish most useful work by enlightening public opinion throughout the world on the difficulty of the problem.

There are, in particular, three points to which it might well draw the attention of States and industries:

- (a) The case of nations which as yet possess no chemical industry, or only certain elements of such industry;
- (b) The problem of raw materials;
- (c) The system of specialisation and rationing.

We will examine these questions in the above order.

(a) THE CASE OF NATIONS WHICH AS YET POSSESS NO CHEMICAL INDUSTRY  
OR ONLY CERTAIN ELEMENTS OF SUCH INDUSTRY.

Apart from nations possessing the various elements which justify the maintenance or extension in their territory of powerful chemical industries, there are numerous countries which lack some or, indeed, all of these elements and which, nevertheless, in certain definite cases, would seem theoretically entitled in their own interest to set up new chemical works.

An example drawn from the chemical-fertiliser industry will illustrate our meaning.

Let us take a State in which agriculture is highly developed but which possesses no chemical industry and is consequently dependent on foreign countries for its supplies of nitrates.



If this country possesses fuel or water power, would not its natural tendency be to encourage the installation of factories for the production of synthetic ammonia or nitric acid, since the elements, hydrogen, oxygen and nitrogen, are, as we have pointed out above, available? Probably; and yet the creation of new undertakings of this kind would be bound to increase the latent over-production in the world's chemical industry. The manufacture of synthetic nitrogenous fertilisers involves the preparation of the necessary adjuncts to nitrogen — sulphuric acid, for instance. But when the manufacture of sulphuric acid, which is required for the preparation of sulphate of ammonia, is established in a country, the foundations of a chemical industry have been laid.

Sulphuric acid is a raw material used in the manufacture of thousands of products and we know that producers are always inclined, when once a branch of manufacture has been established, to encourage consumption or even create a demand at all costs. The moment the manufacture of acid has been introduced in a country, a chemical industry will develop, since every form of chemical manufacture leads to the production of by-products which in turn may be used as raw materials for new products, so true is it that this industry is an endless chain and that economic production implies the control of all the links in that chain.

The situation would consequently be the same if, instead of a country possessing no chemical industry, we contemplated the case of a State possessing only a slightly developed industry and desirous of augmenting it for definite purposes.

In this case, as in the former, all new production would be likely to aggravate the present crisis.

It therefore seems that the Economic Conference, whose task it should be to enlighten public opinion throughout the world regarding the present conditions of production and consumption, should draw the attention of States:

1. To the dangers involved, at a time of latent over-production, in the creation of new undertakings which would not be likely to meet new demands;
2. To the desirability of preventing the expected creation of such undertakings by enabling their nationals, by means of commercial treaties, to obtain on easy and advantageous terms the products of which they forgo the manufacture.

#### (b) THE PROBLEM OF RAW MATERIALS.

We have pointed out above that, in the great mineral-chemical industry, it is often more desirable to work up raw materials near the locality of consumption than to manufacture the products near the source of the raw materials.

This statement, however, only holds good in so far as the nations which possess raw materials follow a policy of liberal apportionment and refrain from taking steps to secure a monopoly of these raw materials for their own nationals.

It is clear that if a nation, for considerations of economic imperialism, desires to maintain a monopoly over the raw materials it possesses, it runs the risk of provoking measures of retaliation and the erection of high Customs barriers against the products it manufactures. It is difficult to devise any general formula, easily applicable to all the definite cases respecting raw materials and their apportionment, to counteract such a policy of imperialism.

The Conference might, however, recommend States to consider, in concert with their own producers, a liberal policy with regard to the raw materials of which they possess a monopoly, based on mutual trade and compensation.

(c) THE SYSTEM OF SPECIALISATION AND RATIONING.

Though the problem is already complex enough as between States with a highly developed chemical industry and States in which the industry is little developed, it becomes still more so when we have to consider logical production logically balanced and already pushed to such a degree of development that any increase in manufacture should lead to a reduction in the cost of production. In this case, the policy of industrialists in every country is simple: they endeavour to obtain Customs protection with a view to maintaining their supremacy in the home market and then, with or without State assistance, to increase their exports to foreign markets. This, of course, is a perfectly normal business procedure, but at the present time it carries in it the germs of particularly serious conflict.

The problem should be solved by the industrialists of the various countries. They must realise that an exaggerated development of their means of production leads to exaggerated Customs barriers, and that prudence counsels all concerned to secure a balance of production by understandings for:

- (a) The rationing of production;
- (b) The specialisation of production when the stage of development of industry in a particular country makes production costs potentially lower than possible in another country.

These are further recommendations which the Conference might make to the industrialists of the various countries participating.

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4.

**STATISTICS  
AND  
OTHER INFORMATION REGARDING THE ITALIAN  
CHEMICAL INDUSTRY**

**Compiled by the Honourable Ernesto BELLONI**

*Transmitted in January 1927.*

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# STATISTICS AND OTHER INFORMATION REGARDING THE ITALIAN CHEMICAL INDUSTRY

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## I. RAW MATERIALS AND POWER.

The development of a chemical industry is not always directly dependent on a country's wealth in raw materials and the power available for transformation. Without raw materials and power, of course, no chemical industry can exist, since nothing can be produced from nothing, but raw materials and power are not necessarily the main factors of success: there are others, the influence of which may in some cases be decisive.

We should, were we to enter into a discussion of this question, be drawn too far away from our subject. Certain of these factors, however, must be noted. A country's capacity for absorbing its own products is in relation to the requirements of its other industries, its fiscal and Customs system, its transport facilities, foreign outlets and, last but not least, the existence, through the popularisation of science, of that enormous asset to true progress — an enlightened public opinion. These are all factors which affect, and even govern, a country's industrial development.

The case of the dye industries in France and Switzerland provides a striking illustration of this point. Before the war France, though she possessed more than sufficient raw materials for the development of a dye industry, only produced 2 million kilos, whereas she consumed 9 millions. On the other hand, Switzerland, who, then as now, possessed absolutely no materials from which tar can be distilled, could point to a flourishing industry producing 10 million kilos of aniline dyes, mostly for exportation.

Dyes, indeed, with synthetic medicaments, are a typical example of an industry in which the value of the raw material is increased to the furthest possible extent, since the value of the products obtained is incomparably greater than the total cost of the raw material and the force employed in transforming it. In those industries, moreover, human ingenuity is the main factor of success.

In some cases, however, as in the so-called heavy chemical industry, which produces sulphuric acid, soda, superphosphates, etc., success does depend mainly on the availability of raw materials and power.

In the matter of raw materials, Italy possesses no phosphates, and hardly any soluble salts of potassium. She is, however, rich in sodium chloride, sulphur,

pyrites, and other products, though it must be admitted that these products are not to be found in a very convenient and easily adaptable form. Italy, therefore, is not to be classed as a country entirely devoid of raw materials, because she possesses some of the most important ones: but she is far poorer than certain other countries on which Nature has literally lavished her favours.

As regards sources of energy, it is not the 500 million tons of lignite and peat said to exist in our subsoil, or the few oil-wells we possess, that can possibly render us even comparatively independent of foreign supplies. We shall gradually but surely obtain our emancipation by setting up powerful hydro-electric plant and by harnessing the vast hydraulic forces which our mountains can supply.

With the development of Italian industries, the consumption of coal has increased to such an extent that, even if it were possible — which it is not — to rely exclusively on home products, our reserves would soon be entirely exhausted, with a result which can well be imagined, particularly if foreign supplies were no longer available. Our home supplies should therefore be regarded as our ultimate reserves to be utilised only in case of urgent need.

The vast annual tribute which Italy pays to foreign countries for coal has also forced us to devote attention to the important problem of utilising this product to its full capacity. Manufacturers of gas, in particular, are now rapidly erecting new plant or improving their existing installations, with a view to reducing the waste of potential energy to a minimum.

From the gas and coke industries, which, until quite recently, were considered in Italy to be an end unto themselves, the chemical industry will be able to obtain at least 10,000 tons of light oil and more than double this quantity of medium oil, from which it will be able to extract benzol, toluol, naphthaline, carbolic acid, basic substances and many other important products in sufficient quantity to supply all our current needs.

We will now briefly indicate the progress which Italy is making in certain important branches of industry.

## II. ELECTRO-CHEMICAL INDUSTRIES — CAUSTIC ALKALOIDS.

Although we have hitherto been unable to compete, as regards the cost of the "horse-power year", with more favoured countries, inasmuch as we cannot use coal alone for the production of energy, the cost in Italy is nevertheless such that coal can be used on a large scale, particularly in electrolytic processes, as is shown by the encouraging development of the manufacture of caustic soda by electrolysis of sodium chloride.

Whereas, before the war, there were in Italy only two electrolytic soda plants, there are now six large factories, which, in conjunction with smaller concerns, can produce about 90 tons of caustic soda and 80 tons of chlorine every 24 hours. On the other hand, the manufacture of chlorates, of which the country was at one

time able to produce about 50 tons a day, is rapidly declining for various reasons, but mainly because it was almost entirely a war industry, because large stocks were left over from the war, and because these products are little used for mine explosives, or indeed for any other purpose.

It should be noted that the caustic soda produced in the electrolytic plants is almost entirely used in solution at 36 Be., only a portion of it being transformed into the solid product.

In addition to electrolytic production, the "caustication" plant of the Solway Company at Rosignano has proved very successful, since it produced about 190,000 quintals in 1924.

The following table shows the figures for production and consumption in terms of 100% caustic soda:

	Quintals
From electrolytic plant . . . . .	190,000
From the "caustication" of carbonates . . . . .	230,000
Imports. . . . .	150,000
	<hr style="width: 100%;"/>
	570,000

Consumption was certainly not less than 800,000 quintals in 1925, of which about 250,000 quintals came from abroad. The large consumption of caustic soda is due above all to the rapid development of the artificial silk industry in 1925, a year in which 13,500,000 kilos were manufactured — an increase of 5,000,000 on the preceding year. In 1926, however, the demand was less, so that, while the output of Italian factories of liquid electrolytic soda remained unchanged, there was a considerable decrease in imports, which amounted in the first half-year to only 25,000 quintals, or one-fifth of the amount imported in the preceding year. At the same time, the production of solid soda in the Rosignano works decreased considerably. This is proved by the fact that carbonate imports, which were almost certainly required for "caustication" and amounted to about 100,000 quintals in 1925, were in 1926 practically nil.

From this it may be assumed, that although the Rosignano and Monfalcone works now produce enough carbonate of soda to supply the country's needs, the output of solid caustic soda is still inadequate.

We may estimate the home consumption of carbonate of soda in 1924 at 1,000,000 quintals, of which 180,000 quintals were imported. Deducting from this the 250,000 quintals used for "caustication", the actual Italian output — 820,000 quintals — would be 70,000 quintals more than the amount consumed. Indeed in 1925, notwithstanding the increased demand for this product in most industries, imports fell to half the figure for the preceding year. The imported product was, as we have said, destined to be transformed into caustic soda.

Up to a few years ago, the chlorine obtained from the electrolysis of salt was mainly used for manufacturing sodium and calcium hypochlorites. Nowadays, large quantities are used not only for producing synthetic hydrochloric acid, and the organic by-products which are in great demand in the dye industry, and from which important pharmaceutical products are prepared, but also for obtaining from straw, hemp-stalks, and esparto grass the cellulose which is now being used for a great variety of purposes.

Another electrolytic industry to which we must refer is that for the production of zinc through the electrolysis of salt. This industry has not long been in existence, but it already promises well. In the near future, therefore, large quantities of exclusively Italian minerals will be used for this purpose. The production of aluminium by thermo-electric process, which has gradually developed within the last twenty years, is now becoming a prominent industry on account of the large supplies of raw material available in various forms, but mostly in the shape of bauxite and leucite.

From leucite, by means of an exclusively Italian process, it is now possible to obtain pure aluminium at a low cost. Large quantities of aluminium can therefore be supplied to meet the increasing demand for this product in electro-technical and metallurgical work. The potassium will be used, in addition to supplying agricultural needs, for the preparation of every kind of potassium salt required by our chemical industries, and the chlorate and perchlorate used in manufacturing explosives.

Above all else, however, we can point with pride to the great synthetic ammonia works in which the processes employed are almost exclusively Italian. These works, which were established in a very short time, owe their existence to the foresight and initiative of a few citizens. The enterprise was carried through without any assistance on the part of the State although very considerable capital was involved. These works can produce daily 150 tons of anhydrous  $\text{NH}_3$  which is used for the production of nitric acid. Italy, therefore, has not only become independent in the matter of nitrogen fertilisers, but now possesses supplies for exportation.

### III. MINERAL ACIDS — FERTILISERS.

Many persons judge the industrial development of a country by the amount of carbonate of soda and sulphuric acid it produces. With regard to carbonate of soda, we have already seen that Italy now produces more than she consumes, while her output can be increased to provide against all future requirements. The figures for Italy's output of sulphuric acid, compared with world production, in the pre-war period and 1925 are highly instructive.



*Approximate World Production of Sulphuric Acid expressed as Monohydrates.*

	Quintals	%
1914. Italy . . . . .	4,500,000	6.3
1914. Other countries . . . . .	68,000,000	93.7
<i>Total</i> . . . . .	72,500,000	100
1925. Italy . . . . .	7,500,000	7.5
1925. Other countries . . . . .	92,500,000	92.5
<i>Total</i> . . . . .	100,000,000	100

There has thus been a world increase of 27,500,000 quintals, or 38 per cent of the 1924 production, in spite of fluctuations. In England and Germany, which are great producing countries, output has diminished considerably; there has been an increase in most other countries, while the United States output has doubled.

The general increase in the production of this article, which is used not only in the chemical industry but in nearly all others, from the textile to the metallurgical, is evidence of an industrial renaissance throughout the world. This applies to Italy also, whose output has increased by 66.76 per cent; indeed, she is one of the countries which has contributed most to the 38 per cent world increase referred to above.

Our factories can now produce nearly twice as much sulphuric acid as before the war, *i.e.*, 8,500,000 quintals (Mh.). About 91 per cent of this enormous quantity can be produced in the form of weak acid 50-52 Be. in plant with lead chambers, and the remaining 9 per cent by a catalytic method in the oleum factories which produce, in addition to highly concentrated acid (95-100 % Mh.) the whole range of oleum (25 %—30 %—60 % free sulphuric anhydride), which is almost exclusively employed in works for the manufacture of explosives and intermediate organic products for dyes.

In 1924 6,600,000 quintals of sulphuric acid (monohydrate) were produced. The following table shows the various amounts produced and the percentage of concentration.

	Quintals	Mh.	%
Acid 50-52 Be. . . . .	9,300,000	5,879,000	89.22
Acid 66 Be. . . . .	478,000	459,000	6.96
Acid Mh. (25-30-60 % free SO <sub>3</sub> ) . . . . .	240,000	252,000	3.82
<i>Total</i> . . . . .		6,590,000	100

As no official statistics are available, it is somewhat difficult to ascertain the 1925 output, which must, however, be somewhere in the neighbourhood of 7,500,000 quintals, because in no post-war year was greater activity displayed in every branch of industry. The manufacture of mineral superphosphate alone (14.6 million quintals), absorbed 7.3 million quintals of weak acid 50-52 Be., which is equal to 4.6 million quintals monohydrate, or more than 50 per cent of the total output.

Then come other important industries which consume sulphuric acid, though on a far smaller scale; works for producing organic acid, hydrochloric and nitric acid, and sulphate of copper, the metallurgical industry (for cleaning), the dye and explosives industries, and last but not least the artificial silk industry, which absorbed at least 350,000 quintals of monohydric acid. The artificial silk industry made such progress last year that our industrialists decided to construct large new works, either with chambers or on the oleum system, to satisfy the future requirements of many other growing industries, including the synthetic sulphate of ammonia industry, which at the present time can use 150 tons of weak acid *per diem*. But the crisis which set in at the beginning of 1926 and still continues has led to the shelving of some of these vast projects, though they will doubtless be taken into consideration again as soon as circumstances are favourable.

We should mention the advantage which the metallurgical industry may derive from the utilisation of pyrite ash, large quantities of which are produced in the manufacture of sulphuric acid.

Until recent years the output of nitric and hydrochloric acid has kept pace with consumption; only recently has there been any appreciable change in the situation. Muriatic acid — apart from the synthetic product, which is produced in sufficient quantities to meet current demands — is manufactured in large quantities to supply the artificial silk manufacturers' enormous demand for bisulphates. The manufacture of nitric acid from Chilean nitrate had decreased, owing partly to the manufacture of synthetic acid in Italy and partly to increased imports of the synthetic product from Germany, which can supply it at low prices. The importation from Germany, however, must be regarded as temporary, since Italian producers of synthetic acid are gradually increasing their output.

The production of nitrogen fertilisers has also increased although the industry has been unable to keep pace with the demand — 1,786,000 quintals in 1925, of which about 65 per cent was imported. When the plant to which we have already referred for extracting nitrogen from the atmosphere is ready, it will be possible to double the output. The demand for potassium fertilisers rose in 1925 to 520,000 quintals, almost all of which was imported from abroad. This shows that Italy could utilise to her great advantage the leucite to which we referred in connection with aluminium.

At present the output of sulphate of copper is equal to the demand.

#### IV. ORGANIC ACIDS.

This industry, which was already highly developed and particularly well equipped for the production of citric and tartaric acid (the raw materials for which abound in Italy), has recently undertaken the production of formic acid and synthetic acetic acid, chemicals, which, with the acetic acid distilled from wood, and tannic and lactic acids, constitute a very important group from the point of view of national economy.

Until 1924, for instance, all the formic acid required was imported. But now the formic acid produced in Italy is technically on a level with the best foreign products. We shall thus no longer need to obtain from abroad our supplies of this important product of which Italy consumes 350,000 kilos annually.

As regards lactic, acetic and tannic acid, we need only observe that quantities are already being produced for exportation; we feel bound, however, to give a few data showing the progress made in citric and tartaric acid production — this industry being much more important than the others.

Italian tartaric acid factories, which have a potential output of 80,000 quintals per annum, produced last year 50,000 quintals, of which 40,000 were for exportation. The citric acid factories are capable of producing 50,000 quintals; the actual output was 32,000 quintals, of which 28,000 were exported. Exports, therefore, amounted to 80 and 87.50 per cent of output respectively.

The contribution of this industry to our trade balance is about one hundred million lire; further evidence of its importance is therefore unnecessary.

#### V. INTERMEDIATE PRODUCTS — DYESTUFFS.

Although before the war certain far-sighted persons had argued that Italy could, despite her lack of coal, establish a perfectly successful dye industry, such assertions were for the most part regarded as dreams which were never likely to come true. After the great upheaval of the war, however, opinion on this subject began to change and it was admitted that a dye industry could be created, though the task might be long and laborious.

Industrialists who had, during the war, set up large plant for the production of organic explosives began to study the problem of adapting their factories for the preparation of intermediate products; to their acumen, therefore, the Italian dye industry owes its origin.

It was after the war that the regular manufacture of the main intermediate products began. These newly constituted dye industries have established, in consultation with the textile industries which utilise their products, a list of the technical improvements still necessary, and have thus furnished clear proof of their desire to improve and perfect their methods.

Perhaps a table showing the results obtained since 1919 will be more eloquent than any description.

The output of intermediate products is as follows:

800,000 kilos in 1918	2,400,000 kilos in 1924
1,700,000 kilos in 1922	3,600,000 kilos in 1925.

Naturally the output of dyes has kept pace with these figures; some dyes are of such a quality and are produced in such quantities, as to allow of exportation after all home requirements have been met.

We cannot here give a complete list of the intermediate products now being manufactured in Italy; we feel bound, however, to mention some of the main products of which our industry is so justly proud.

The amount of aniline oil manufactured in 1920 was one million kilos. The amount of chlorobenzol was even greater than this, the factories utilising for this purpose chlorine derived from the production of caustic soda by electrolysis.

Most of the chlorobenzol is transformed into binitrochlorobenzol and binitrophenol, from which about 4,000,000 kilos of sulphur black (required by dyeing industries) is manufactured. A considerable amount is also transformed into paranitrobenzol, from which paranitroaniline and orthonitrobenzol are derived. As there is not much demand for these products in Italy, they are exported for use in foreign heliotrope and guaiacol factories.

Acid H. is an extremely complex product obtained by a series of reactions from sulphurisation to nitration, reduction, alkaline fusion, etc., and it was mainly because this acid was so difficult to manufacture that foreign industrialists confidently proclaimed the inevitable collapse of the Italian dye industry. In 1925, however, 350,000 kilos of this acid were produced. In the same year our factories turned out 250,000 kilos of betanaphthol, 150,000 kilos of paranitroline, and 250,000 kilos of benzodine. The latter is obtained by an exclusively Italian process which utilises, for the transformation of nitrobenzol into hydrobenzol, the sodium obtained in the electrolytical caustic soda factories. This process constitutes one of our most brilliant scientific victories in the production of intermediate substances.

To these might be added a long list of other products of more limited use than the above, but directly or indirectly derived from them, ranging from alpha-naphtholine to gamma acid, naphthionic acid, sulphanilic acid, the acids of Cleve, Dahl and Freund, metanitroaniline, binitrobenzol, etc.; but the above details already sufficient by witness to the truly marvellous development of our dye industry.

These intermediate products are now regularly exported, and they enable Italy to obtain a footing in many markets.

Last year 800,000 kilos — or about 22.2 per cent of our output — was exported. As we have pointed out, the dye industry has kept pace with progress in the intermediate products industry, as the following figures show:

1918 . . . . .	975,000 kilos
1922 . . . . .	4,900,000 »
1924 . . . . .	5,400,000 »
1925 . . . . .	6,300,000 »

During this period, imports for home consumption decreased appreciably; whereas in 1924 about 2,700,000 kilos were imported, in 1925 only 2,200,000 kilos came into the country. Imports are still decreasing, although we are not yet in possession of the data for 1926.

In 1924, 250,000 kilos were exported, while in 1925, 350,000 left the country. It will thus be seen that in these years Italy consumed 7,850,000 and 8,150,000 kilos respectively, her output being equal to 74 per cent of her consumption.

The greatest increase in production was noticeable in sulphur colours — for instance, the production of sulphur black alone amounted in 1925 to 400,000,000 kilos, while all other dyes from azotic to basic dyes were produced on a considerable scale.

In 1926 synthetic indigo was produced for the first time so that there are now eight factories in the world which produce this substance.

The potential output of Italian factories is now 6,000 kilos *per diem*, an amount considerably in excess of national requirements, which are about 600,000 kilos per annum.

Enormous quantities are therefore available for export.

Now that synthetic indigo is being produced, other important articles will be manufactured by the Italian chemical industry — monochloric acetic acid, from which very useful dyes and synthetic medicaments are derived, and trichloride of ethylene, which are being increasingly employed in the oil-refining industry.

The problem of manufacturing “dyes in the vat” has also been courageously tackled with such encouraging results that we may shortly expect to see Italy participating in this branch of the industry, which hitherto has been the sole monopoly of certain great companies abroad.

Perhaps the most striking evidence of the progress realised by the Italian dye industries is afforded by the figures for the world's output before the war and after:

	1913	1924
	%	%
Germany . . . . .	88	46
United States of America . . . . .	2	20
Great Britain . . . . .	3	12
Switzerland . . . . .	6	6
France . . . . .	1	9
Italy . . . . .	nil	3
Japan. . . . .	nil	4
	<hr/>	<hr/>
	100	100

The two years subsequent to 1924 will doubtless show further changes. Italy's production has, at any rate, risen to very near 3.5 per cent.

Though we may point with legitimate pride to the progress already made by the Italian dye industry, it is obvious that we still have to face other difficulties, greater possibly than those which have already been overcome. Future results will depend on still closer co-operation between science and industry, and on the possibility of convincing our fellow-countrymen that these results will justify the continued protection of the industry which is necessary if its initial progress is to be maintained.

## VI. PHARMACEUTICAL PRODUCTS.

There are so many points of contact between the pharmaceutical products industry and the dye industry that the development of the latter is bound to stimulate the former. Italy therefore now produces a far greater variety of pharmaceutical products than she did before the war; in some cases she now fully supplies the demands of the home market.

There has been development not only in the matter of synthetic medicaments, but in the preparation of ophthalmic and organo-therapeutical products and arseno-benzols. The number of patent medicaments prepared in Italy is steadily increasing, and many of these are exported.

There has also been an appreciable increase in the production of aromatic and medicinal plants. This will, we hope, lead to further developments in one of the many interesting branches of this industry.

## VII. EXPLOSIVES AND GASES FOR MILITARY PURPOSES.

Even before the war, manufactures of explosives in Italy could hardly be called negligible. They could not, on the other hand, be described as a great industry since, apart from the Army and Navy with their very limited requirements, their only other clients were railway and road constructors and mining enterprises.

The enormous demand for arms and munitions during the war enabled these very modest undertakings to become huge organisations capable of supplying dozens of tons of explosives daily. Italy's output, which before the war amounted to about 4,500 tons per annum (2,300 black powder for sporting and mining purposes, 1,200 dynamite, 700 ballistite and about 300 tons chlorate explosive), had, in 1918, reached 100,000 tons, consisting mostly of projectile explosives, the basic component being some organic derivative of nitrogen such as picric acid or tritol, or a mixture of such derivatives — with oxidising salts (nitrate of potash, nitrate of lead, chlorates and perchlorates).

As soon as the war was over, production fell to below the pre-war level, mainly because the existing supplies held by the Army and Navy had to be utilised first.

Only in the last two years — now that important work is again being undertaken on the railways, and mining and hydro-electric activity has been resumed — has there been any sign of the explosives industry reaching its former level (annual production 4,500 tons). This, of course, does not apply to factories of nitrogen derivatives which are almost entirely engaged in working for the dye industry, though they do, of course, still manufacture small quantities of war explosives (for projectiles or high explosives) which are more than sufficient to meet the requirements of the State.

Before the war, Italy did not export any explosives apart from the small quantities of black powder which she sent to her African Colonies.

After the war, however, the large factories which suddenly found themselves unemployed were forced to seek an outlet for their products abroad. In spite of all efforts, however, exports of explosives only amounted in 1926 to 500 tons, mainly trinitrotoluene in various forms.

This industry is still struggling to overcome its difficulties without any great measure of success. The fact is that there exist large stocks of this war material which, having been acquired at an opportune moment at trifling prices, are thrown, from time to time, upon the European market.

For some time now, it has been apparent that the explosives industry will again have to be re-organised owing to the necessity of reducing raw material imports to a minimum and utilising the increasing supplies available in our own country.

We refer to the opinion now gaining ground that the use of nitrate of ammonia and perchlorate explosives should be encouraged. The first-named is particularly suitable for this purpose, because the great industries which transform nitrogen into ammonia can already produce large quantities at a reasonable cost and will be able in the near future to improve their output still further.

The gas industry, which not only produces gases but also liquids and solids, and attained great importance during the war, is in the same situation as the explosives industry. At present the only gases produced are those which are employed on a very important scale in the manufacture of dyes and medicaments.

#### VIII. MISCELLANEOUS CHEMICAL INDUSTRIES.

Further evidence of the remarkable development of our chemical industry in the last ten years is afforded by the amount of capital invested and the number of workmen employed. In 1914 not more than 50,000 workmen were employed; the capital, as far as can be ascertained, amounted to 200,000,000 gold lire. In 1925 the capital had increased to 700,000,000 gold lire, while the number of workpeople had risen to 120,000. Italy has greatly improved her position in the world

chemical trade; in 1914 she accounted for 4.7 per cent of the world's total imports and 2 per cent of its total exports. In 1925 Italy's share in the world trade was 4.6 per cent imports and 4.2 per cent exports, the ratio of exports to imports being:

2.35 in 1914,  
1.10 in 1925.

The progress realised should not, however, be ascribed solely to the main industries which we have mentioned. There are many others which are less important individually but which have, as a whole, contributed in no small measure to Italy's industrial development.

In 1925 the vegetable oils and soap industry produced about 3,000,000 quintals; 110,000 quintals of glucose and dextrine were manufactured (four times the 1919 output); the output of tanning extracts trebled in the same period, and now amounts to 450,000 quintals; 1,000,000 quintals of carbure and calcium cyanide are produced, and 180,000 quintals of mineral colours.

The output of compressed gas is far greater than before the war, as the following table shows:

	M <sup>3</sup>
Oxygen . . . . .	6,000,000
Hydrogen . . . . .	1,400,000
Acetylene . . . . .	90,000
	Quintals
Liquid chlorine. . . . .	5,000
Carbonic acid . . . . .	30,000
Anhydrous ammonia . . . . .	20,000

The potential output of the various factories is, of course, far greater than this.

The output of carbon sulphide, which is largely employed in the manufacture of artificial silk, has attained 100,000,000 quintals; that of celluloid and other plastic materials is now over 8,000.

The bromine and iodine industries are also making some progress, but the amount of raw material available in the country is limited.

Iodine is now being produced in the Salsomaggiore Government Works to the extent of 150 quintals per annum: this amount will shortly be increased to not less than 300 quintals. The extraction of bromine direct from the waters of our salt marshes will furnish a by no means negligible contribution to the wealth of the country as soon as the experiments now being conducted lead to practical results.



**OBSERVATIONS ON THE CHEMICAL INDUSTRY  
IN GENERAL AND ON THE RATES OF IMPORT  
DUTIES LEVIED ON CHEMICAL PRODUCTS  
ENTERING POLAND**

**BY M. TREPKA,**

**Director of the Polish Union of Chemical Industries.**

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# THE CHEMICAL INDUSTRY IN GENERAL AND THE RATES OF IMPORT DUTIES LEVIED ON CHEMICAL PRODUCTS ENTERING POLAND.

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## I. GENERAL OBSERVATIONS.

In all States which have given proof of their vitality and are developing economically and politically, the tendency to seek independence in the chemical industry was stimulated by the war. The chemical industry can only progress in an atmosphere of patient scientific research; in no other industry is careful and intelligent workmanship so essential. Its products generally reach the consumer in an intermediate or even unrecognisable form, so that their importance is often estimated not as an intrinsic monetary value but in terms of their eventual utility to the main branches of national economic life. Formerly, this industry did not arouse wide public interest; and yet, without an adequate comprehension of its far-reaching effects, the economic policy of a State can never be adapted to meet the essential requirements of this industry and ensure its proper development.

The war certainly helped to bring home to the general public the importance of the chemical industry in every branch of modern life. The huge quantities of explosives and military gas manufactured, the absence of medicaments, or the difficulty of obtaining them, these were facts which stirred the public imagination from the very beginning of the war. During the four years' struggle, in which not mere armies but whole nations were engaged, it became evident that, in the matter of food and all other supplies, including medicaments, chemical production was one of the main factors of endurance.

But why revert to the tragic memories of the war? Looking in other directions, we are bound to observe that the characteristic of the present epoch is the enormous and far-reaching influence of chemistry in every aspect of life.

The fertility of the land, health and food, heating, lighting, clothing, and many other essentials depend on the standard of chemical production, which directly or indirectly supplies commodities daily to every living being.

Before the war several countries enjoyed a hegemony over, if not a monopoly of, many branches of chemical production, and it can hardly be said that all countries have definitely solved the problem of freeing themselves from this hegemony since the war. It is clear, however, that the economic and political importance of the chemical industry is being more and more widely realised; the effect of economic depression is not to weaken but rather to encourage efforts to attain independence in this direction; creative effort will no longer allow itself to be hindered or stifled; energies will rightly be directed towards a more uniform distribution of chemical productive forces throughout the world.

In surveying the tendencies and needs of the world chemical industry we must bear in mind two fundamental considerations:

(1) The chemical industry is not an isolated unit in the national economy and life of a nation. Consequently, in studying the problems of this industry, we must remember that its ultimate object is not merely to satisfy the direct needs of consumers and secure a dividend for shareholders in chemical enterprises. If we were to deal with the problems of the chemical industry solely from the point of view of its usefulness or productivity at a given time in a given country, we should undoubtedly be guilty of the self-same error which certain groups of economists committed when they attributed none but economic functions to man (*homo economicus*) and urged him to consider naught else but personal gain.

(2) Industrialists, merchants, and economists should, even if they hold the most advanced humanitarian views, consider the welfare of their own country first. No system which diminishes the prosperity of certain countries under the pretext of increasing the common weal could ever arouse genuine enthusiasm.

The idea of international economic co-operation must be allowed to evolve gradually, and consideration must be paid to the interests of individual countries. A tendency to eliminate the small manufacturer on the vague plea of general progress might tempt some people to ask whether ideals alone were at stake or whether this was not really an attempt to eliminate the possibility of competition.

The economic policy of every State should be to enhance the prosperity of its citizens by encouraging economic activity to the fullest possible extent. In the field of chemical production, its policy should be to meet the needs of the home market, particularly by utilising raw materials available in the country and other favourable local conditions.

In certain countries, and particularly in Poland, population is increasing rapidly. If the surplus population — the increase in Poland amounts to over 400,000 men per annum — could migrate abroad, either seasonally or permanently, the serious problem of providing it with work would soon be solved. Unfortunately, those watchwords of liberalism which are fervently proclaimed in connection

with international trade are never — lofty principles though they be — involved in connection with the free movement of workers in search of employment.

A country, therefore, which is anxious to save its workers from pauperism must organise and develop its industries, even though such a policy may involve a certain amount of world over-production. It is true that, in proportion to its productivity, the chemical industry does not employ many work-people, but it helps to create employment in a number of allied industries; in the mines, for instance, which supply the fuel and various minerals used as raw materials, in the numerous branches of the engineering industry as applied to the chemical industry, in the textile industry, which produces the sacks used for carrying chemical products, etc. By providing employment for a large number of chemists and engineers, the chemical industry also helps to promote the cause of technical science in each country.

We are bound also to mention the importance of the chemical industry from the point of view of national defence. We can well remember how speedily, in 1914, the chief European chemical works, which in peace-time manufactured dyes and other products, adapted themselves to war requirements and became veritable arsenals producing explosives and poisonous gases on a vast scale.

Thanks to the efforts of the League of Nations and of eminent statesmen, there now reigns throughout the world an atmosphere of peace which is favourable to the development of industry; and naturally every effort will be made to perpetuate these conditions. But we cannot shut our eyes to the fact that true moral and material disarmament has not yet been attained. As long as there are armies with guns, rifles and other arms, no Government will be justified in leaving its country entirely without chemical weapons; for there can be no doubt that, if hostilities ever break out again, the warfare will be mainly chemical.

There are, however, other reasons that oblige States, and even States which are not great Powers, to encourage the chemical industry, at any rate to a certain degree. The principal of these is that the price of chemicals is higher in countries which produce no chemicals at all. Of this we had adequate proof before the war, when dyestuffs were then sold at high prices in countries which did not produce them, and at reasonable prices in countries where they were manufactured to some extent. Even at the present time, dyestuffs which are a speciality of certain factories are sold at exaggerated prices in countries which only manufacture other dyes, for instance the simpler dyes, produced by methods of mass production. When at last the market thus exploited makes an effort and commences to manufacture the dearer products, the price of imported dyestuffs falls suddenly.

It is an acknowledged fact that post-war conditions have led to increased protectionism on the part even of wealthy countries like the United States and the British Dominions. We can hardly be surprised, therefore, if their example has been followed by other countries which have had, since the war, to struggle with budgetary difficulties and endeavour to eliminate exchange fluctuations.

It should be remembered that, for such countries, a favourable trade balance means a stable currency, because their banks of issue do not generally possess large gold reserves.

Is it reasonable to ask these countries to abolish their Customs barriers? No, for that would entail exchange fluctuations and create a further obstacle in the way of exports to such countries.

The scale of Customs duties may be made the subject of a highly interesting debate. The only level which is justified is that which equalises conditions of production in one country with those of its principal rival. Among the factors which increase the cost of production should be mentioned the lack of capital and dearness of money in certain countries. Countries in which the official bank-rate is as much as 15 per cent are bound to protect the products of their industries by means of suitable Customs duties; otherwise they could not possibly compete with countries in which the bank-rate is only 5 or 6 per cent. We regret to observe that the claims of liberalism have not hitherto included the free circulation of capital. On the contrary, there is no doubt that some Governments, for political reasons, carefully watch the expansion of credit, and even limit it, thus preventing an equitable distribution of capital.

We must frankly admit that, as long as liberal principles are denied in world financial and emigration policy, countries which are stifled through over-population and dear credit will continue to follow a policy of protection and regulation.

Consciously or unconsciously, a liberal policy in Customs matters is always advocated by those whose immediate interests would be best served by such a policy. When we come to study the development of economic doctrines, we soon perceive that free trade has always been urged by branches of industry which, for the time being, have no competition to fear. When, however, a country calls for the abolition of Customs duties on industrial products, and at the same time levies high duties on agricultural produce and foodstuffs, it displays a very high degree of economic eclecticism, and departs from the ideal of international co-operation which should harmonise all economic interests throughout the world.

## II. THE LEVEL OF IMPORT DUTIES ON CHEMICAL PRODUCTS IN POLAND.

If we admit the hypothesis that an international debate may help to promote economic co-operation between different countries and peoples, we must at the same time insist that the discussion shall be based on a wide range of very accurate data. Every care must be taken to avoid even the slightest distortion of facts; it would, indeed, be difficult to arrive at reasonable conclusions if the starting-point were other than the truth. If, therefore, it is proposed to discuss the scale of Customs duties on economic products in the various countries — the ultimate aim of the discussion being obviously to decide that these duties must be lowered

to facilitate the trade in chemical products — the statistical data concerning the duties must be absolutely unassailable.

The memorandum prepared by the chemical group of the General Federation of German Industries, and communicated by Dr. Lammers, contains, however, on page 39 (Comparative Table of Customs Duties), figures which are not correct as regards the Customs duties levied on chemical products imported into Poland.

The authors of the memorandum, while admitting the difficulty of drawing up a comparative table of *ad valorem* Customs duties for chemical products in the different countries, adopted the following method. They endeavoured to calculate the scale of *ad valorem* Customs duties for three main groups of chemical products — heavy chemical products for technical purposes, fertilisers and synthetic dyestuffs.

Whether the three groups selected are really the most characteristic of the chemical industry is a matter which may be open to question. We might also enquire what arithmetical method was employed to calculate a uniform index for *ad valorem* Customs duties on the chemical products belonging to these three groups. But we cannot in any case admit that the figures given in this table for Poland are correct. According to the table, the minimum import duties levied by Poland on products in these three groups amount to 112.4 per cent, whereas, from the figures given below, it will be seen that the import duties on the products in these three groups vary in Poland from 0 to 59.85 per cent *ad valorem*, or an average of 19.97 per cent *ad valorem*. The difference between 112.4 per cent and 19.97 per cent is so great that there must be some misconception, since there can be no question as to the sincerity of the authors of the German memorandum.

We will now set out the arguments which prove the figure 19.97 per cent to be the real average *ad valorem* duty.

Since the memorandum gives figures for August 1926, we would first of all point out that there was in force then, as now, the Customs Tariff of June 26th, 1924, published officially in the “*Dziennik Ustaw Rzeczypospolitej Polskiej*” (*Bulletin of Laws of the Polish Republic*, No. 54 of 1924, Item 540), supplemented by the Decree of October 30th, 1925 (*Bulletin of Laws of the Polish Republic*, No. 113, Item 800). There are several official and unofficial editions of this tariff — some in German — which should make it easy to verify the following data.

The Customs duties in the Polish tariff are specific and are quoted in Polish zlotys per 100 kilos. In August 1926 the rate of exchange was about the same as at present — *i.e.*, 100 Polish zlotys to 56.87 Swiss francs.

We have calculated both the prices of chemical products and the Customs duties in Swiss francs. There should be no difficulty in estimating the degree of *ad valorem* protection afforded by comparing these two sets of figures.

Following the method employed in the memorandum of the Federation of German Industries, we give below the prices and Customs duties for chemical products belonging to all three groups. We have chosen in each group the most typical products.

The first group includes the following: sulphuric acid, hydrochloric acid, crystallised soda, caustic soda, caustic potash, Glauber's salts, lithopone, acetone, and glycerine.

The second group (chemical manures) contains the following: superphosphates, Chile saltpetre, synthetic saltpetre of soda, ammonium sulphate, urea, potassium salts.

For the products mentioned in the above groups, we have taken the prices quoted in the well-known and reliable German periodical *Chemiker Zeitung*, No. 87, of September 11th, 1926 — these are practically the same as the price-levels in August 1926. In any case, the variations in so short a time are bound to be slight.

The third group includes the following synthetic dyestuffs: schwefelblau R, benzopurpurin 4B, benzopurpurin 4B (highly concentrated), chrizophenin G, chrizophenin G (extra strong), rhodamin 3B, indigo-green alizarin B.

The prices of these dyes are based on the offers of first-class German factories.

The arithmetic mean for the Customs duties of the first group is 20.01 per cent *ad valorem*; for those of the second group, 12.30 per cent *ad valorem*; for the third group, 27.61 per cent.

The mean for all three groups is only 19.97 per cent *ad valorem*.

*Group I.*

Sulphuric acid 66° Bé:		
£6 10s. per ton	=	16.338 fr. (100 kilos)
Customs duty 1.20 zloty	=	0.682 „
		<hr/>
		4.17% av.
Hydrochloric acid:		
£4 10s. per ton	=	11.311 fr. (100 kilos)
Customs duty 3 zloty	=	1.708 „
		<hr/>
		15.08% av.
Crystallised soda:		
£3 17s. 6d. per ton	=	9.74 fr. (100 kilos)
Customs duty 5 zloty	=	2.843 „
		<hr/>
		29.18% av.
Caustic soda:		
£12 13s. 6d. per ton	=	31.86 fr. (100 kilos)
Customs duty 11 zloty	=	6.256 „
		<hr/>
		19.63% av.

Glauber's salts:		
\$1	=	5.158 fr. (100 kilos)
Customs duty 3 zloty	=	1.706 „
		<hr/>
Caustic potash:		33.07% av,
\$12.85 per 100 kilos	=	66.28 fr. (100 kilos)
Customs duty 11 zloty	=	6.256 „
		<hr/>
		9.43 % av.
Lithopone:		
\$8.75 per 100 kilos	=	45.133 fr. (100 kilos)
Customs duty 25 zloty	=	14.218 „
		<hr/>
		31.50 % av.
Acetone:		
£71 10s. per ton	=	179.71 fr. (100 kilos)
Customs duty 70 zloty	=	39.81 „
		<hr/>
		22.15 % av.
Glycerine:		
\$52 per ton	=	268.22 fr. (100 kilos)
Customs duty 7 zloty	=	42.65 „
		<hr/>
		15.90 % av.

Average rate =  $180.11 \div 9 = 20.01\%$  av.

*Group II.*

Superphosphates:		
£2 6s. per ton 18%, i.e.	=	6.535 fr. (100 kilos)
Customs duty 1 zloty	=	0.5687 „
		<hr/>
		8.70 % av.
Chile saltpetre:		exempt.
Synthetic saltpetre of soda:		
1 % kg. of nitre 1.25 Mk., i.e. 6 Mk.	=	25.34 fr. (100 kilos)
Customs duty 11 zloty	=	6.256 „
		<hr/>
		24.68 % av.



Ammonium sulphate:

1 % kg. of nitrogen 0.92 Mk., i.e. 19.49 Mk.	=	23.97 fr. (100 kg.)
Customs duty 12.50 zloty	=	7.11 „
		<hr/>
		29.66 % av.

Urea:

1 kg. % of nitrogen 0.92 Mk., i.e. 42.93 Mk.	=	52.80 fr. (100 kilos)
Customs duty 10 zloty	=	5.69 „
		<hr/>
		10.77 % av.

Potassium salts (for agriculture), subject to the  
permission of the Ministry of Finance exempt.

$$\text{Average rate} = 73.81 \div 6 = 12.30 \% \text{ av.}$$

*Group III.*

Synthetic dyestuffs.

Customs duties per kilo, 5 zloty	=	2.843 Swiss fr.
Schwefelblau R.		
4.75 Swiss fr.	=	59.85 % av.
Benzopurpurin 4B:		
5.65 Swiss fr.	=	50.31 % „
Benzopurpurin 4B, highly concentrated:		
8.65 Swiss fr.	=	32.86 % „
Chrizophenin G.:		
9.40 Swiss fr.	=	30.24 % „
Chrizophenin G, extra strong:		
21.80 Swiss fr.	=	13.04 % „
Rhodamin:		
56.10 Swiss fr.	=	5.06 % „
Alizarin Indigo-green B:		
149.50 Swiss fr.	=	1.90 % „

$$\text{Average rate} = 193.26 \div 7 = 27.61.$$

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