

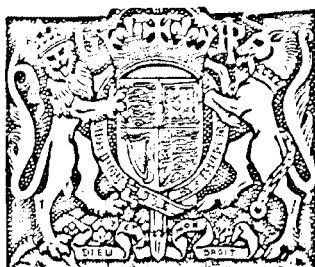
COMPOSITION AND DETERGENCY
OF WASHING SOAP
SPECIALLY OF
THE GRAINED
TYPE

By
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Composition and Detergency of Washing Soap Specially of the Grained Type

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12th SESSION

MALINAGAR
15th October 1955

I have great pleasure in forwarding herewith the Technical Papers that will be discussed at our 12th Annual Convention to be held at Malinagar on 28th, 29th & 30th October 1955.

Dr. Punjabrao Deshmukh, Union Minister for Agriculture, has kindly consented to inaugurate the Convention on the 28th morning.

Members who have submitted Technical Papers but may not be able to attend the Convention are requested to depute some other member attending the Convention to present the paper. Name of such a member may please be intimated to the Secretary in advance.

Members intending to attend the Convention are requested to intimate their travel route and likely time of arrival at Malinagar by the 20th instant. It may not be possible to make accommodation arrangements for members not giving such intimation.

Sd/- P. M. Govitrikar
Hon. Secretary.

Composition and Detergency of Washing Soap Specially of the Grained Type.

*Detergency of soap**.—The detergent action of soap depends principally on two factors: firstly, on the emulsifying power of the sodium salts of fatty acids, and, secondly, on the action of the dissociated alkali of such salts in an aqueous medium, the degree of dissociation being measured by the p_{H} value. It is hardly conceivable that the one factor acts to the exclusion of the other. If emulsification were the only point, an oily emulsion of any substance ought to clean. Nor can the p_{H} value alone be responsible for satisfactory cleansing and removal of dirt, for the dissociated alkali actually bites the article, disturbs its texture by creating a shrinkage or an expansion, and eats into it. Proper detergency without harm to the article is therefore the combined result of these two factors.

It is claimed that economy in soap can be effected by using a little alkaline silicate, or, simply, soda ash, along with the soap, the emulsifying properties being exerted by the soap and the dissociating action by the silicate. Such a soap will cleanse better in the hot than in the cold, not, however, without damage to the fabric. The cleansing by the dissociating action of the abovenamed salts is somewhat sharp as the protective portion, viz., the silica or the carbonic acid, is very feeble. In the case of the salts of the fatty acids on the other hand, the corresponding protection is more substantial with the result that the dissociating action is milder, and, aided by emulsifying power, the cleansing is better without any damage to the fabric. Hence it will be seen that the ideal cleanser would be a pure soap in which the emulsifying power and the dissociating action are well balanced.

The emulsifying action is exerted by the sodium salts of the unsaturated fatty acids such as oleic, linoleic and linolenic. It should also be noted that acids with higher unsaturation possess greater emulsifying powers than the less unsaturated ones. The introduction of much highly unsaturated acids is not, however, beneficial, for it renders the soap liable to change on ageing. The dissociating action is exerted more by the salts of the saturated fatty acids like the palmitic and the stearic than those of the unsaturated acids. In a few exceptional cases soaps of some saturated fatty acids, notably palmitic acid, have good emulsifying properties along with dissociation.

The molecular weight plays an important part. With a decrease in the molecular weight the ability to dissociate decreases, and if the molecular weight is very low, the soap does not dissociate to the extent necessary for effective cleansing. Very high molecular weight, on

*See C. L. Barker. Detergent value of sodium metasilicate, *Ind. Eng. Chem.*, 23, 1025 (1931).

2. W. H. Simmons. Commercial valuation of soap, *Perfumery and Essential Oil Record*, 17, 118-19 (1926).

3. F. H. Rhodes and C. H. Bascom. Effect of p_{H} upon the detergent action of soap, *Ind. Eng. Chem.*, 23, 778 (1931).

the other hand, retards emulsification. It follows, therefore, that a soap consisting of the salts of a mixture of the unsaturated and the saturated fatty acids will cleanse best provided the acids do not have abnormally high or low molecular weights. Fatty acids of high molecular weight are found in varying proportions in the natural oils and fats used as raw materials of soap and their retarding action on the cleansing power of the soap has to be counteracted by judiciously blending the different oils and fats. Account has also to be taken of the fact that the fatty acids of low molecular weight considerably increase the solubility of their soaps.

The molecular weights of the fatty acids for yielding effective and highly cleansing soaps may be held to range between C_{16} and C_{18} . If the soap is to cleanse in the cold, the emulsifying power, the staying power of the suds, must be the maximum. But if the soap is to cleanse in the hot, the dissociation will be the more important factor, and since, as stated before, saturated fatty acids dissociate more readily than the unsaturated ones, and again, more in the hot than in the cold, the soap which contains more of the saturated acids of the right range of molecular weights will cleanse better in the hot.

The presence of salt (sodium chloride) in soap hinders the emulsification, and the fatty acids of very low molecular weights are accountable for this. The hindrance is apparent from the breaking up of heavy lather, the greater the saline interference the thinner the lather. A perfect washing soap should have a thick emulsifying lather lasting long in the air as compared with a toilet soap which has a thinner lather with a tendency to break up. As rigorous cleansing is of secondary importance in a toilet soap and the profuseness of the foam is much appreciated, the latter is created by the addition of liberal quantities of cocoanut or palm kernel oil both of which contain good quantities of low molecular fatty acids breaking up sloppy lather to a thin, profuse one.

For washing soap of ideal cleansing and emulsifying powers, the use of cocoanut, an oil containing low molecular fatty acids, cannot exceed a certain limit. Without any cocoanut oil the soap will be too heavy for action, too dull for use and deficient in dirt floating power and hence low in efficiency. The emulsifying and wetting powers of the soap should be kept at the maximum to ensure a good, sloppy and lasting lather. Strictly limited quantities of cocoanut or palm kernel oil can accomplish this.

Another factor influencing the proportion of cocoanut oil is the solubility of the soap. If the soap is to dissolve fast, more cocoanut oil can go in to give an emulsifying and not too thin lather. If the soap is to dissolve moderately, i.e., only as fast as ordinary household use will demand, smaller proportions of cocoanut oil can only go in. The foaming action of cocoanut oil can come into play quickly if the quantity of soap dissolved on a given amount of rubbing is small. It acts slower if the soap dissolved per rubbing is greater, that is to say, if the soap is more soluble. It has been found from practical experience that no less than 15 parts of cocoanut oil can well go in 100 parts of stock mixture in the case of grained soap yielding a fairly soluble soap possessing a normally lasting lather. As a matter of fact, if the soap is to dissolve at a definite and adjusted rate, it can only take in a definite proportion of cocoanut oil incapable of variation by the slightest degree. To attain such a condition, it is found that not only is the

proportion of coconut oil fixed but those of the other constituents also are governed by certain rules. In fact, a triple control of I.N.S. (Webb), titer and proportion of low molecular fatty acids, is necessary to produce a washing soap of any given condition, e.g., the maximum detergency both in the cold and in the hot, the usability under ordinary conditions of household washing, etc. It will be shown later on how this control can be exercised to make the ideal soap.

Composition.—Webb for the first time formulated a constant for controlling the hardness of soap which he termed the I.N.S. factor. This is the difference between the Saponification Value and the Iodine Number of a fatty substance. The I.N.S. is an index of the hardness of the soap, the smaller the value of the constant, the softer the soap. The smaller value of the constant is due to the greater Iodine Number which again is a measure of unsaturation and therefore of softness.

From practical experience it is apparent that Webb's I.N.S. is only one of the factors to control the ultimate hardness of soap. The titer has as much say in the matter as the I.N.S. itself as will be evident from the following typical cases. Cotton seed and sesamum oils have the identical I.N.S. of 85, but the grained soap made from the former is harder than that from the latter. This is due to the difference in their titer, the former having a titer of 32.6 and the latter 23. In the case of bone grease and tallow, the extraordinary difference in their hardness cannot be accounted for by the difference of 10 in the I.N.S. and is mainly due to the much lower titer of bone grease. It will, therefore, be seen that if both these factors, the I.N.S. and the titer, are taken into account in computing a charge with various oils and fats, the resulting soap may in every case be made to have any desired degree of hardness and allied properties.

The ideal I.N.S. for a soap charge containing very little low molecular fatty acids may be taken as 195. It may be supposed to represent a fat of a saponification value of 195 but without any iodine number and therefore without unsaturation. The highest titer that can be expected of a hard fatty stock may be taken to be 52.7. Assuming that the titer has as much say as the I.N.S. itself, it can be set down to the same rating as the latter by multiplying it by 3.7, a figure obtained by dividing the I.N.S. by the titer, thus: $195/52.7=3.7$. It is a figure of considerable importance and may be called the Titer Factor. The I.N.S. gives on addition to the above product of titer \times titer factor a figure which may be called the Hardness Number, (H.N.), of soap. This Number can also be calculated by adding, to the average I.N.S., of a charge, the product obtained by multiplying its average titer by the titer factor.

Abnormality is introduced by coconut oil which contains a very high percentage of low molecular fatty acids giving the stock a very high I.N.S. and solubility. Webb sought to explain it by his solubility factor which, however, appears to have no solid grounds to stand upon. The abnormality can better be taken note of, as shown in these pages, by making a definite allowance in the Hardness Number for every unit quantity of coconut oil introduced into the charge. The high I.N.S. of coconut oil is due to the presence of low molecular fatty acids which increases at the same time the solubility of the soap. Hence a higher Hardness Number should be allowed for every unit of coconut oil introduced into the mixture. It has been found that an

allowance of one unit of hardness is necessary to counterbalance the extra solubility or softness introduced by the addition of one per cent. of cocoanut oil, the factor for the allowance being arrived at by dividing by 100 the difference between the I.N.S. of cocoanut oil which is taken as 250 and the average I.N.S. of an ordinary hard stock, like tallow, which is taken as 150.

The following table gives a fair approximation of the hardness of soaps of different varieties containing given percentages of cocoanut oil, the ideal hardness without cocoanut oil being represented by 264. If the requirements of any soap factory demands a change in the figure for the basic hardness (264) the same can be made but the increase in hardness by the introduction of cocoanut oil will still be governed by this rule.

Cocoanut oil. (Per cent.)				Hardness Number.
0	...	...	...	264
10	...	...	...	274
11	...	...	...	275
12	...	...	...	276
13	...	...	...	277
14	...	...	...	278
15	...	...	...	279
16	...	...	...	280
17	...	...	...	281
18	...	...	...	282
19	...	...	...	283
20	...	...	...	284
21	...	...	...	285
22	...	...	...	286
23	...	...	...	287
24	...	...	...	288
25	...	...	...	289

While any proportion of cocoanut oil up to 25 parts can be used to make good soap, the best proportions for washing soaps lie between the limits of 10 and 18. Under special circumstances, e.g., for use in hard water, the higher limit may be exceeded and the oil up to 25 per cent. or more may be used even at the expense of detergency and emulsifying power.

In the case of toilet soap it is best to keep the cocoanut oil, if cost permits, to the maximum of 25 per cent. as the ease of latheration and solubility are improved with larger proportions of this oil and loss in detergency and emulsifying power does not matter. It may be stated

that Webb sets down from practical experience the minimum for cocoanut oil to be 10 per cent. for toilet soap.

A good working rule should be to use 15 parts of cocoanut oil for grained washing soap keeping the Hardness Number at 279, and 18 parts for fitted washing soap with the Number at 282. The Hardness Numbers hold good for balanced compositions containing the usual small proportions of high molecular or highly unsaturated fatty acids. For compositions containing a larger proportion of high molecular fatty acids, the Number should be set down somewhat lower to compensate for the lather interference due to the presence of such acids. For those containing much highly unsaturated fatty acids and little or no high molecular fatty acids, the non-interference of lather will require the Number to be set a little higher than in the table.

When 25 parts of cocoanut oil is used as, e.g., for making toilet soap, the Hardness Number is 289 according to the table. The interference of lather on account of the presence of salt is less. This, together with the non-crystalline state of the milled soap, necessitates the keeping of the Number at 10 to 15 units higher than that indicated in the table. A toilet soap containing the above proportion of cocoanut oil should, therefore, have a Hardness Number lying between 299 and 304. As a consequence, it will be seen, that the Number will, to a certain extent, be governed by the quantity of common salt present in the soap.

Along with 15 parts of cocoanut oil, grained washing soap should under ordinary circumstances contain 3 to 4 per cent. of rosin and a small quantity of linseed oil or a similar soft stock. The use of linseed oil or a like stock lies in its introducing certain percentages of linoleic or linolenic acid for the purpose of increasing the emulsifying power of the soap. Abnormally soft stocks of this nature can altogether be dispensed with if the compositions contain large quantities of moderately soft stocks containing very little high molecular fatty acids.

In toilet soaps, however, linoleic and linolenic acids should better be avoided and, on this score, groundnut oil also is objectionable on account of its containing 21 per cent. of linoleic acid.

The part played by cocoanut oil can also be played by palm kernel oil as the latter contains notable quantities of low molecular fatty acids. Hence palm kernel oil can replace, to a certain extent, if not wholly, cocoanut oil.

In the accompanying Table No. 1 for I.N.S., Titer and Hardness Number of the commoner stocks, a set of constants is given under the name of "grain solidifying point." The latter is the temperature at which the soap, made into neat grains, solidifies in the graining medium. The practical utility of this constant lies in the fact that it gives a dependable indication of the suitability of the hot grained soap for moulding or framing. These figures are found to show some abnormalities which indicate that the stocks concerned carry as their constituents some resinous bodies. When such stocks are used in compounding a charge some allowance must be made for these abnormalities, since in such cases, besides I.N.S., titer and low molecular fatty acids, a fourth factor seems to act, viz., the presence of some constituents not affecting the titer but influencing the ultimate hardness of the soap.

In Table II the constituent fatty acids of the well known stocks are given which will help to take proper account of the presence of

individual high molecular fatty acids or very unsaturated fatty acids in setting the Hardness Number to the right point after making proper allowances as indicated before.

TABLE I.

Constants to be used for calculating the hardness of soap.

$$\text{Titer Factor} = \frac{195}{52.7} \text{ or } 3.7.$$

Name of stock.	I. N. S.	Titer.	Hardness Number.	Grain solidifying point.
Cocoonut oil ..	250	22.5	333.2	82°C.
Tallow (mutton, New Zealand) ..	155	47.5	330.7	..
Tallow (average, Webb) ..	150	48	327.6	66.5°C.
Tallow (mutton, Australia) ..	157	46	327.2	..
Kusum oil ..	158	46.5	330	..
Rosin ..	50	72	316.4	..
Mowha oil ..	128	40	276	57°C.
Neem oil ..	127	37.4	265.4	54°C.*
Bone grease (fresh bones) ..	140	30	251	..
Maroti oil (South India) ..	106	37	242.9	..
Punnal oil ..	105	33	227.1	54°C.
Nahor oil ..	134	22	215.4	49°C.
Rayna oil ..	72	37.5	210.7	52°C.
Karanja oil ..	93	31.3	208.8	39°C.
Hoof oil ..	121	23	206.1	..
Cottonseed oil ..	85	32.6	205.6	47.4°C.
Groundnut oil ..	102	25.5	196.3	45°C.
Sesamum oil ..	85	23	170.1	44°C.
Mustard oil ..	75	12	119.4	..
Linseed oil ..	15	15	70.5	..

TABLE II.

Constituent fatty acids of some of the well known stocks used in soap-making.

Cocoonut oil—

Caprylic acid	...	...	9.5
Capric acid	...	...	4.5
Lauric acid	...	...	51.0
Myristic acid	...	...	18.5
Palmitic acid	...	...	7.5
Stearic acid	...	...	3.0
Oleic acid ...	...	...	5.0
Linoleic acid	...	...	1.0

*Revised figure.

Palm kernel oil (Hilditch*)—			
Caproic acid	...	...	Traces.
Caprylic acid	...	...	3.0
Capric acid	...	...	3.0
Lauric acid	...	...	52.0
Myristic acid	...	...	15.0
Palmitic acid	...	...	2.5
Stearic acid	...	...	2.5
Oleic acid	...	...	16.0
Linoleic acid	...	...	1.0
Tallow—			
Myristic acid	...	...	2.2
Palmitic acid	...	...	28.0
Stearic acid	...	...	19.0
Oleic acid ...	...	...	48.3
Linoleic acid	...	...	2.5
Chinese vegetable Tallow (Hilditch)—			
Palmitic acid	...	...	66.5
Oleic acid ...	...	...	33.5
Mowha oil (Bassia latifolia)—			
Palmitic acid	...	...	17.0
Stearic acid	...	...	17.0
Oleic acid	...	...	66.0
Palm oil (Hilditch)—			
Myristic acid	...	...	1.0
Palmitic acid	...	...	35.5
Stearic acid	...	...	8.5
Oleic acid ...	...	...	48.0
Linoleic acid	...	...	7.0
Punnal oil (Calophyllum inophyllum)—			
Palmitic acid	...	...	14.1
Stearic acid	...	...	11.0
Erucic acid	...	...	3.0
Oleic acid ...	...	...	48.0
Linoleic acid	...	...	14.3
Resinic acids	...	...	9.7
Cottonseed oil (Hilditch)—			
Palmitic acid	...	...	23.4
Oleic acid ...	...	...	23.0
Linoleic acid	...	...	53.6

Groundnut oil (Hilditch)—

Palmitic acid	...	...	7.0
Stearic acid	...	...	5.0
Arachidic acid	...	...	4.0
Lignoceric acid	...	...	3.0
Oleic acid	...	...	60.0
Linoleic acid	...	...	21.0

Soya bean oil (Cruz and West)—

Palmitic acid	...	...	8.9
Stearic acid	...	...	3.8
Arachidic acid	...	...	0.6
Oleic acid	...	...	30.1
Linoleic acid	...	...	53.1
Linolenic acid	...	...	2.1

Linseed oil (Hilditch)—

Palmitic acid	...	...	8.7
Oleic acid	...	...	4.8
Linoleic acid	...	...	62.0
Linolenic acid	...	...	24.0

Practical charge computation.—Examples are given below of computing charges of washing soap to be finished by the grained process. The charges are computed on the basis of some stocks being used in major quantities. If colour and other conditions stand in the way, two or more charges may be compounded to make an average, or a separate formula can be framed according to the availability of raw materials:—

Example 1: Mowha major formula.

A typical calculation is given below with regard to the above charge on the basis of 15 parts cocoanut oil and 279 Hardness Number in accordance with the figures given in Table I:—

	Parts.	I. N. S.	Titer.
Mowha oil	65.5	$65.5 \times 128 = 8,384$	$65.5 \times 40 = 2,620$
Tallow ..	7	$7 \times 150 = 1,050$	$7 \times 48 = 336$
Cocoanut oil	15	$15 \times 250 = 3,750$	$15 \times 22.5 = 337$
Rosin ..	4	$4 \times 50 = 200$	$4 \times 72 = 288$
Linseed oil	3	$3 \times 15 = 45$	$3 \times 15 = 45$
Groundnut oil	5.5	$5.5 \times 102 = 561$	$5.5 \times 25.5 = 140$
Total ..	100	13,990	3,766

I. N. S. of the Soap	=	$13,990 \div 100 = 139.90$
Titer of the Soap	=	$3,766 \div 100 = 37.66$
Hardness Number	=	$139.90 + 37.66 \times 3.7$
	=	$139.90 + 139.34$
	=	279.24

The same result can be obtained directly by using the Hardness Numbers of the respective stocks:—

	Parts.	Hardness Number.	Total Hardness Number.
Mowha oil	65.5	276	18,078.0
Tallow	7	327.6	2,293.2
Cocoanut oil	15	333.2	4,998.0
Rosin	4	316.4	1,265.6
Linseed oil	3	70.5	211.5
Groundnut oil	5.5	196.3	1,079.6
Total	100		27,925.9

$$\text{Hardness Number of the charge} = 27,925 \div 100 = 279.25$$

In the above calculations, the proportions have been fixed by calculation on the principle of trial and error. The proportions of the two important variables, viz., Mowha oil and Groundnut oil (the former representing the hard type of stock and the latter the soft type) can be determined by a simultaneous equation as follows:—

If x and y be the proportions of mowha oil and groundnut oil respectively in the above charge, their values may be obtained as follows, the Hardness Number being kept at 279.25:—

	Parts.	I. N. S.	Titer.*
Mowha oil	x	$x \times 128 = 128x$	$x \times 40 = 40x$
Tallow	7	$7 \times 150 = 1,050$	$7 \times 48 = 336$
Cocoanut	15	$15 \times 250 = 3,750$	$15 \times 22.5 = 337.5$
Rosin	4	$4 \times 50 = 200$	$4 \times 72 = 288$
Linseed	3	$3 \times 15 = 45$	$3 \times 15 = 45$
Groundnut	y	$y \times 102 = 102y$	$y \times 25.5 = 25.5y$
Total	$x + y + 29$	$123x + 102y + 5,045$	$40x + 25.5y + 1,006.5$

The values for x and y can now be found by solving the following equations:—

$$\left. \begin{aligned} 1.28x + 1.02y + 50.45 + 3.7(40x + 25.5y + 10.06) &= 279.25 \\ x + y + 29 &= 100 \end{aligned} \right\}$$

$$\left. \begin{aligned} \text{Or } 2.76x + 1.96y + 87.67 &= 279.25 \\ x + y + 29 &= 100 \end{aligned} \right\}$$

Evaluating in the usual manner,

$$x = 65.5$$

$$y = 5.5$$

so that to give the above Hardness Number of 279.25, the proportion of mowha oil is 65.5 and that of groundnut is 5.5.

Example 2: Mowha without tallow formula.

When tallow is not cheap the following formula with mowha oil may answer well on the basis of 15 parts of cocoanut oil. Linseed oil has of necessity been omitted as otherwise the Hardness Number cannot be maintained at the right point. It is kept as usual at 279:—

	Parts.	I. N. S.	Titer.
Mowha oil	72.5	9,280	2,900
Cocoanut oil	15	3,750	337.5
Rosin	4	200	288
Groundnut oil	8.5	867	216.7
Total	100	14,097	3,742.2

$$\begin{aligned} \text{Average I. N. S.} &= 14,097 \div 100 = 140.97 \\ \text{Average titer} &= 3,742.2 \div 100 = 37.42 \\ \text{Hardness Number} &= 140.97 + 37.42 \times 3.7 \\ &= 279.42 \end{aligned}$$

Example 3: Tallow-groundnut formula.

When mowha is not available this formula may be used. On the basis of 15 parts of cocoanut oil the Number for tallow-groundnut soap is kept at 278 instead of 279 on account of the lather interference of arachidic and lignoceric acids present in groundnut oil which is used in a large quantity:—

	Parts.	I. N. S.	Titer.
Tallow	46	6,900	2,208
Cocoanut oil	15	3,750	337.5
Rosin	4	200	288
Linseed oil	3	45	45
Groundnut oil	32	3,264	816
Total	100	14,159	3,694.5

$$\begin{aligned} \text{Hardness Number} &= 141.59 + 36.945 \times 3.7 \\ &= 141.59 + 136.69 \\ &= 278.28 \end{aligned}$$

Example 4: Tallow-teel formula.

Using teal oil as a softener the following formula may be used. The Number is set down at 279 as usual on the basis of 15 parts of cocoanut oil:—

	Parts.	I. N. S.	Titer.
Tallow	50	7,500	2,400
Cocoanut oil	15	3,750	337.5
Rosin	4	200	288
Teel oil	31	2,635	713
Total	100	14,085	3,738.5

$$\begin{aligned} \text{Hardness Number} &= 140.85 + 37.385 \times 3.7 \\ &= 140.85 + 138.32 \\ &= 279.17 \end{aligned}$$

Example 5: Tallow-cottonseed formula.

As usual the Number is set down at 279 on the basis of 15 parts of cocoanut oil:—

	Parts.	I. N. S.	Titer.
Tallow	41	6,150	1,968
Cocoanut oil	15	3,750	337·5
Rosin	4	200	288
Cottonseed oil	40	3,400	1,304
Total ..	100	13,500	3,897·5
Hardness Number	=	$135\cdot00 + 38\cdot975 \times 3\cdot7$	
	=	$135\cdot00 + 144\cdot30$	
	=	279·20	

Example 6: Tallow-hoof formula.

Using hoof oil as the only softener the following formula may be used. The Number is set down at 279 as usual on the basis of 15 parts of cocoanut oil:—

	Parts.	I. N. S.	Titer.
Tallow	41	6,150	1,968
Cocoanut oil	15	3,750	337·5
Rosin	4	200	288
Hoof oil	40	4,840	920
Total ..	100	14,940	3,513·5
Hardness Number	=	$149\cdot40 + 35\cdot135 \times 3\cdot7$	
	=	$149\cdot40 + 129\cdot99$	
	=	279·39	

Example 7: Tallow-kusum formula.

Using kusum oil to the extent of 25 per cent. the following formula may be used. The Number is kept slightly lower than usual, at 278, due to the presence of some high molecular fatty acids in the mixture:—

	Parts.	I. N. S.	Titer.
Tallow	17·5	2,625	840
Kusum oil	25	3,950	1,162·5
Cocoanut oil	15	3,750	337·5
Rosin	4	200	288
Groundnut oil	38·5	3,927	981·7
Total ..	100	14,452	3,609·7
Hardness Number	=	$144\cdot52 + 36\cdot09 \times 3\cdot7$	
	=	$144\cdot52 + 133\cdot55$	
	=	278·07	

Example 8: Tallow-punnal formula.

The formula is worked out for a portion of the charge on account of the persistent dirty yellow colour of punnal soap. The Hardness Number is kept at 279 on the basis of 15 parts of cocoanut oil. Rosin is omitted as punnal oil contains notable quantities of resins:—

	Parts.	I. N. S.	Titer.
Tallow	36	5,400	1,728
Cocoanut oil	15	3,750	337.5
Punnal oil	49	5,145	1,617
Total	100	14,295	3,682.5

$$\begin{aligned} \text{Hardness Number} &= 142.95 + 36.825 \times 3.7 \\ &= 142.95 + 136.25 \\ &= 279.20 \end{aligned}$$

Example 9: Neem major formula.

The formula is worked out not for the purpose of forming a charge by itself but for constituting a portion only of a charge computed with the help of other formulæ, the quantity of neem oil going into the charge depending on the extent of purification of the oil by preliminary saponification and treatment as outlined in our earlier bulletin*. The Hardness Number is kept at 279 as usual according to the table:—

	Parts.	I. N. S.	Titer.
Neem oil	78	9,906	2,917.2
Tallow	3	450	144
Cocoanut oil	15	3,750	337.5
Rosin	4	200	288
Total	100	14,306	3,686.7

$$\begin{aligned} \text{Hardness Number} &= 143.06 + 36.86 \times 3.7 \\ &= 143.06 + 136.38 \\ &= 279.44 \end{aligned}$$

Example 10: Mowha-tallow-karanja formula.

The formula is kept as usual at 279 on the basis of 15 parts of cocoanut oil. Rosin is omitted as karanja oil contains good quantities of resins. This formula may be used as a portion only in other charges since karanja oil develops a somewhat dark colour:—

	Parts.	I. N. S.	Titer.
Mowha oil	26	3,328	1,040
Tallow	29	4,350	1,392
Karanja oil	30	2,790	939
Cocoanut oil	15	3,750	337.5
Total	100	14,218	3,708.5

$$\begin{aligned} \text{Hardness Number} &= 142.18 + 37.085 \times 3.7 \\ &= 142.18 + 137.21 \\ &= 279.39 \end{aligned}$$

*Neem oil and its treatment for application in making washing soap. (Bulletin No. 47, Department of Industries, Bengal.)

Example 11: Rayna-tallow formula.

This formula should be used for a portion of charge only on account of the yellow colour and the lack of coherency of the lather of rayna soap. The Hardness Number is kept slightly lower than 279, i.e., at 278, on account of the lather interference in rayna soap. Rosin is omitted as rayna oil contains appreciable quantities of resins:—

	Parts.	I. N. S.	Titer.
Tallow	42	6,300	2,016
Cocoanut oil	15	3,750	337.5
Rayna oil	43	3,096	1,612.5
Total	100	13,146	3,966

$$\begin{aligned} \text{Hardness Number} &= 131.46 + 39.65 \times 3.7 \\ &= 131.46 + 146.74 \\ &= 278.20 \end{aligned}$$

Example 12: Nahor tallow formula.

The formula may be used to form a charge by itself for soaps in which colour is not objected to. The yellowish brown colour of the soap is intense and hence the soap should be used only to a limited extent in making other blends. Rosin is omitted as the stock contains high proportions of resins. The Hardness Number is kept at 279, as usual, on the basis of 15 parts of cocoanut oil:—

	Parts.	I. N. S.	Titer.
Tallow	41	6,150	1,968
Cocoanut oil	15	3,750	337.5
Nahor oil	44	5,896	968
Total	100	15,796	3,273.5

$$\begin{aligned} \text{Hardness Number} &= 157.96 + 32.73 \times 3.7 \\ &= 157.96 + 121.12 \\ &= 279.08 \end{aligned}$$

Further examples are appended of some well adjusted compositions possessing no disadvantage and involving the use of the various stocks in suitable quantities:—

Example 13: Mowha-tallow with cottonseed as softener.

H.N.—278.94:—	Parts.
Mowha oil	55
Tallow	10
Cocoanut oil	15
Rosin	3
Cottonseed oil	17
	<hr/>
	100

Example 14: Mowha-tallow with punnal and groundnut.

The H.N. is kept slightly below 279 on account of groundnut oil, i.e., at 278.48:—

			Parts.
Mowha oil	...	...	53
Tallow	...	...	12
Cocoonut oil	...	...	15
Rosin	...	...	2
Punnal oil	...	...	4
Groundnut oil	...	...	14
			<hr/> 100 <hr/>

Example 15: Mowha-tallow with karanja and groundnut as softeners.

H.N.—278.67:—			Parts.
Mowha oil	...	...	54
Tallow	...	...	12
Cocoonut oil	...	...	15
Rosin	...	...	2
Karanja oil	...	...	5
Groundnut oil	...	...	12
			<hr/> 100 <hr/>

Example 16: Mowha-tallow with groundnut and rayna as softeners.

H.N.—278.5:—			Parts.
Mowha oil	...	...	53.5
Tallow	...	...	12
Cocoonut oil	...	...	15
Rosin	...	...	2
Rayna oil	...	...	6
Groundnut oil	...	...	11.5
			<hr/> 100 <hr/>

Example 17: Mowha-tallow with groundnut and nahor as softeners.

Rosin is omitted as nahor oil is resinous. H.N. is kept at 278.17:—

			Parts.
Mowha oil	...	...	55.5
Tallow	...	...	12
Cocoonut oil	...	...	15
Nahor oil	...	...	7
Groundnut oil	...	...	10.5
			<hr/> 100 <hr/>

Example 18: Tallow with cottonseed and groundnut as softeners.

H.N. is kept at 278.69:—

				Parts.
Tallow	...	...	...	43.5
Cocanut oil	...	...	...	15
Rosin	...	...	...	3
Cottonseed oil	...	...	...	12
Groundnut oil	...	...	...	26.5
				<hr/>
				100
				<hr/>

Example 19: Tallow with neem and groundnut.

H.N. is kept at 277.34:—

				Parts.
Tallow	...	...	...	37
Cocanut oil	...	...	...	15
Rosin	...	...	...	3
Neem oil	...	...	...	12
Groundnut oil	...	...	...	33
				<hr/>
				100
				<hr/>

Example 20.

H.N.—277.85:—

				Parts.
Tallow	...	...	...	45
Cocanut oil	...	...	...	15
Nahor oil	...	...	...	10
Groundnut oil	...	...	...	30
				<hr/>
				100
				<hr/>

Example 21.

H.N.—278.84:—

				Parts.
Tallow	...	...	...	43.5
Cocanut oil	...	...	...	15
Rosin	...	...	...	2
Punnal oil	...	...	...	8
Groundnut oil	...	...	...	31.5
				<hr/>
				100
				<hr/>

Example 22.

H.N.—27825:—

				Parts.
Tallow	...	...	...	44
Cocoanut oil	...	...	...	15
Rosin	...	...	...	2
Karanja oil	...	...	...	10
Groundnut oil	...	...	...	29
				<hr/>
				100
				<hr/>

Example 23.

H.N.—2781:—

				Parts.
Tallow	...	...	...	43·5
Cocoanut oil	...	...	...	15
Rosin	...	...	...	2
Rayna oil	...	...	...	12
Groundnut oil	...	...	...	27·5
				<hr/>
				100
				<hr/>

Example 24.

H.N.—27882:—

				Parts.
Tallow	...	...	...	30
Mowha oil	30
Cocoanut oil	15
Rosin	4
Linseed oil	3
Groundnut oil	9
Teel oil	9
				<hr/>
				100
				<hr/>

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