

CANADA—DEPARTMENT OF AGRICULTURE

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# THE NEUTRALIZATION OF CREAM FOR BUTTERMAKING

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## THE NEUTRALIZATION OF CREAM FOR BUTTERMAKING

The partial reduction of the acidity of cream, or neutralization, as the process is commonly called, is accepted as an essential procedure in the manufacture of creamery butter. The primary purposes of neutralization are: (1) to reduce fat losses, (2) to improve and obtain greater uniformity in flavour, and (3) to enhance keeping quality during storage.

It is now generally recognized that acidity is one of the most important factors affecting both the initial and the keeping quality of butter. Experimental studies and practical experience have demonstrated that salted butter made from cream with moderate or high acidity undergoes much more rapid and extensive flavour deterioration during storage than butter made from sweet cream or from cream in which the acidity has been reduced to relatively low levels.

As much of the farm-separated cream delivered to creameries has developed acid in varying degrees, neutralization is necessary to reduce this acidity to a satisfactory level. This is done by adding one or more of a number of alkaline compounds, which are referred to as neutralizers.

### Types of Neutralizers

The common neutralizers used in cream for buttermaking may be classed as the "lime types" and the "soda types".

The "lime type" neutralizers may be calcium oxides (quick limes), the magnesium and calcium oxides (dolomitic or magnesium limes), or the hydrated (slaked) limes of these quick limes. Lime neutralizers are seldom used in Canadian creameries.

The "soda type" neutralizers which are used most frequently include caustic soda, sodium carbonate (soda ash), sodium bicarbonate (baking soda), sodium sesqui-carbonate, or various combinations of caustic soda and soda ash, or soda ash and sodium bicarbonate.

### Characteristics and Behaviour of Neutralizers

*Lime types.*—Lime neutralizers are only partially soluble in water and are used as suspensions. They have been found to be only about 80 per cent efficient in comparison with the theoretical value in reducing the acidity of cream. As limes combine with the casein as well as the acid, they increase the viscosity of the cream and make straining somewhat difficult. Limes should not be used alone in neutralizing high-acid cream as the increased viscosity may induce scorching or burnt flavours during pasteurization. Lime neutralizers have one advantage in that they do not produce foaming.

*Soda types.*—These compounds are completely soluble in water and are easily and quickly prepared. Mixtures of the various soda compounds are sold under trade names and have different neutralizing strengths. With the exception of caustic soda, these compounds cause considerable foaming due to the release of carbon dioxide when they react with lactic acid in the cream. This may cause some difficulty with high-acid cream in the summer unless sufficient vat space is left to take care of foaming. Available vat space is thus reduced when it is most needed during the season of peak production.

*The neutralizing factor.*—All neutralizers have a neutralizing factor which may be defined as the weight of neutralizer which will react with one pound of acid in the cream (calculated as lactic acid) under plant conditions. The factor for each neutralizer sold under a trade name is supplied by the manufacturer.

The neutralizing factors for several of the common alkalies used to reduce the acid in cream are given below:

Type of compound	Neutralizing factor (dry basis)
Calcium oxide limes.....	0.31
High magnesium limes.....	0.26
Hydrated magnesium lime.....	0.40
Caustic soda.....	0.44
Soda ash (tech. grade).....	0.61
Sodium sesquicarbonate.....	0.82
Sodium bicarbonate.....	0.93

The factor for any neutralizer may be determined by dividing the pounds of neutralizer used by the pounds of acid in the cream which has been neutralized. It is very necessary in this calculation, however, to make accurate acidity tests before and after neutralization to determine accurately the pounds of acid which have been neutralized.

Example.—If 2,000 lb. of cream with an original acidity of .45% were reduced to .15% acid with 5.0 lb. neutralizer, the neutralizing factor would be calculated as follows:

$$\text{Factor} = \frac{5.0}{2000 \times \frac{0.45 - 0.15}{100}} = \frac{5.0}{2000 \times .003} = 0.83$$

### Preparation of Neutralizers

*Limes.*—In making lime suspensions, both lime and water should be weighed and made up to such strength that two pounds of the lime suspensions are equivalent to one pound of lactic acid.

The following table gives the amounts of lime and water necessary to prepare mixtures of this strength.

Material	Lb. lime	Lb. water	Neutralizing factor
Calcium oxide.....	15.5	84.5	2.0
High magnesium.....	13.0	87.0	2.0
Hydrated magnesium lime.....	20.0	80.0	2.0

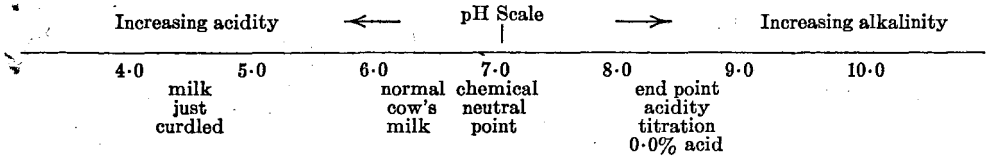
Only lime of the highest purity should be used and enough of the mixture prepared to last several days. Weigh out the required water into a suitable container and add the correct amount of lime slowly with vigorous stirring. The fine lime particles settle out on holding, so that lime suspensions should be thoroughly mixed before use. The required amount of lime suspension should be weighed and not measured.

*Soda neutralizers.*—As these compounds are readily soluble in water, it is common practice to prepare the correct amount of soda neutralizer solution for each vat of cream. When the required amount of neutralizer has been determined and weighed, according to directions given on page 6, it should be diluted in the proportion of one pound of neutralizer to about 10 pounds of water.

As soda neutralizers are more soluble in hot than in cold water, they can first be dissolved in hot water, using one third to one quarter of the total amount, and then made up to the required dilution with cold water.

## The Relation Between Cream Acidity and pH of Butter Serum

The final acidity to which cream should be neutralized is important and depends mainly on the original acidity in the cream and to a lesser extent on the type of neutralizer used. Experimental studies and plant experience have shown that salted butter has better keeping quality if the acidity is reduced low enough to give a pH of 6.7 to 7.2 in the butter serum. The chart below, of a portion of the pH scale, shows that the lower pH value is slightly acid and the higher pH value is slightly alkaline, but essentially this pH range is near the neutral point on the pH scale. Cream is not neutralized to 0.0 per cent acidity by the titration test as this would give a pH value of about 8.3 in the butter, which is quite alkaline as indicated in the chart. Such butters have an alkaline or neutralized flavour.



In commercial practice, the pH of butter serum is controlled by adjusting the titratable acidity of the cream by careful neutralization. Under normal plant conditions, however, there is a fairly close correlation between the final acidity of neutralized cream and the pH of butter serum.

The approximate acidities to which creams of different original acidities should be neutralized to obtain a pH value of about 6.8 in the butter serum are as follows:

Original acidity in cream	Desired acidity in neutralized, pasteurized cream
0.25 per cent	0.11 per cent
0.35 per cent	0.12 per cent
0.45 per cent	0.13 per cent
0.55 per cent	0.15 per cent
0.65 per cent	0.16 per cent

These figures are intended only as a guide for the neutralization of cream with soda-type neutralizers under normal plant conditions. If lime suspensions are used it will be necessary to reduce the desired final acidity further by 0.01 to 0.02 per cent to obtain the same pH value in the butter serum.

When cream which has been neutralized with a soda compound is vat pasteurized, the titratable acidity at the churn will be higher than the desired or calculated acidity. This difference, which may vary from 0.01 up to 0.07 per cent in exceptional cases, is due to carbon dioxide retained in the cream, and is influenced by the original acidity of the cream, the fullness of the vat, and to some extent by the type of soda compound used. High-acid cream requires more neutralizer than low-acid cream to reduce the acidity to be desired level, and therefore more carbon dioxide will be released in the cream. When vats are completely filled, the surface of the cream does not receive as much agitation as with partially filled vats and less of the carbon dioxide is eliminated during pasteurization. The mild soda neutralizers, such as sodium bicarbonate and sodium sesquicarbonate, produce more carbon dioxide than the strong soda neutralizers containing caustic soda, and more carbon dioxide is retained in the cream.

Under normal plant operations, however, where the original acidity of the cream is approximately the same each day and the same neutralizer is used, the difference between the titratable acidity at the churn and the desired acidity will be quite uniform at about 0.02 to 0.03 per cent. The increased titratable

acidity due to carbon dioxide has no apparent effect on the pH of the butter serum, so that if neutralization has been done carefully and accurately, no further adjustment of the acidity in the cream is necessary or should be attempted.

When cream is pasteurized under vacuum, as with the Vacreator, carbon dioxide is eliminated from the cream and the titratable acidity at the churn should be the same as the desired or calculated acidity.

### Neutralizing Procedures

The important steps in the actual neutralization of cream to obtain accurate and uniform results are as follows:

1. Make an accurate first acidity test.
2. Determine the exact weight of cream to be neutralized.
3. Calculate the amount of neutralizer and weigh accurately.
4. Prepare and add the neutralizer carefully to the cream.
5. Check the cream acidity before churning.

1. *The Acidity Test.*—An accurate test of the original acidity of the cream is fundamentally important to the accuracy and uniformity of neutralization. The test should be made according to the method outlined on page 8.

2. *The Weight of Cream.*—This can be obtained readily from the patron's weigh sheets or by means of a measuring stick calibrated in pounds or gallons. There should be no guess work in determining the weight of cream to be neutralized.

3. *Calculating and Weighing the Neutralizer.*—To calculate the weight of neutralizer accurately, it is important to use the proper neutralizing factor. The amount of neutralizer may be determined from neutralizing charts, but these are not altogether satisfactory as the acidity and cream weight intervals are frequently too great. It is often easier and more accurate to calculate the amount of neutralizer directly.

A. *Single Neutralization:* When only one neutralizer is used and added before pasteurization, the pounds of neutralizer are calculated by the following formula.

$$\text{Lb. of neutralizer} = \text{lb. cream} \times \frac{\% \text{ initial acid} - \% \text{ desired acid}}{100} \times \text{factor}$$

Example.—2,350 lb. of cream with an original acidity of .45% is to be reduced to .14% acidity with sodium sesquicarbonate having a neutralizing factor of 0.83.

$$2350 \times \frac{.45 - .14}{100} \times .83 = 6.0 \text{ lb.}$$

B. *Double Neutralization:* This term is applied when both lime and soda neutralizer are used, or when two soda neutralizers of different strengths are employed. In some cases both neutralizers may be added to the cream before pasteurization, but the practice frequently used for high-acid cream is to reduce the acidity to 0.3 or 0.25 per cent before pasteurization with lime or a strong soda neutralizer and then complete neutralization to the desired acidity after pasteurization with a mild soda compound. The second neutralizer should be added when the cream has been cooled to between 110°F. and 100°F.

The calculation of the amount of neutralizers when two soda compounds are used is as follows:

A vat of 2,400 lb. of cream of 0.7 per cent acid is to be reduced to 0.16 per cent acid, first to 0.3 per cent before pasteurization with a strong soda neutralizer having a factor of 0.5, and then after pasteurization with a mild soda neutralizer having a factor of 0.83.

$$1. 2400 \times \frac{0.7 - 0.3}{100} \times 0.5 = 4.8 \text{ lb. neutralizer}$$

$$2. 2400 \times \frac{0.3 - 0.16}{100} \times 0.83 = 2.8 \text{ lb. neutralizer}$$

Plant experience has indicated that it is more satisfactory when using a lime-soda combination of neutralizers to neutralize a definite amount of the total acid, for example, two fifths with lime and the remaining three fifths with a soda neutralizer. This stabilizes the ratio of lime to soda regardless of the initial acidity of the cream, and is recommended especially when the buttermilk is dried.

The calculation of the neutralizers according to this method, using a lime suspension with a neutralizing factor of 2.0 and sodium sesquicarbonate with a neutralizing factor of 0.83, is as follows:

Total per cent acid reduction	= 0.70 - 0.16 = 0.54%
The reduction by lime	= 2/5 of 0.54 = 0.22%
The reduction by soda	= 3/5 of 0.54 = 0.32%
Lb. of lime suspension	= 2400 x $\frac{.22}{100}$ x 2.0 = 10.5
Lb. of soda neutralizer	= 2400 x $\frac{.32}{100}$ x 0.83 = 6.4

*Weighing the Neutralizer.*—A suitable scale conveniently placed should be provided for weighing the neutralizer. Dairy milk scales of the Pelouze or batillon type and graduated in 0.1 pound have been found very satisfactory for this purpose. These scales are inexpensive, are easily checked for accuracy, and under normal conditions will give satisfactory service for several years.

4. *Adding the Neutralizer.*—When prepared according to the directions previously described, the neutralizing solution should be added evenly and slowly over the full length of the vat with the coils revolving when the cream is at a temperature of 60° to 80°F. This may be done by means of a perforated distributing trough or by an ordinary sprinkling can from which the sprinkling head is removed and a cork or stopper with a 1/4-inch hole is inserted. Satisfactory results are also obtained by adding the neutralizing solution slowly and evenly along the entire length of the vat directly from the can or pail in which it is prepared. The neutralizing solution should be added on the side of the vat on which the coil is pulling the cream towards the bottom. This will allow thorough mixing and prevent contact of the neutralizer with the thin layer of cream on the coils in partially full vats. When plant practice permits, the neutralizer should be allowed to act in the cream for 5 or 10 minutes, before pasteurization is started.

5. *Checking the Cream Acidity at the Churn.*—It is good creamery practice to make an acidity test of the cream just previous to churning. This provides a check on and a record of the accuracy and uniformity of the neutralization of each vat of cream.

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*5. Checking the Cream Acidity at the Churn.*—It is good creamery practice to make an acidity test of the cream just previous to churning. This provides a check on and a record of the accuracy and uniformity of the neutralization of each vat of cream.



*Selecting the Neutralizer.*—All the common neutralizers have been found to be satisfactory from the standpoint of butter flavour when used properly and accurately to give a pH value of 6.7 to 7.2 in the butter serum. The selection of the neutralizer, therefore, will depend on the preference of the creamery manager, the availability of the product, and the cost in terms of the neutralizing capacity.

Available vat space, especially in the peak season of production, should be considered. The milder soda compounds produce considerable foam and thereby reduce vat space, while limes and strong soda neutralizers produce very little or no foam and tend to conserve vat space.

Costs should be compared on the basis of neutralizing capacity rather than on the cost-per-pound basis. The neutralizer that is the least expensive on a per-pound basis may not be the cheapest when neutralizing capacity is considered. The comparative costs of different neutralizers can be determined readily from the amount necessary to neutralize one pound of acid and the cost per pound.

The aim of the buttermaker in the neutralization of cream should be to produce a butter of uniform acidity from day to day. This requires care and accuracy in every step of the neutralizing procedure and an intelligent consideration of the various factors affecting the whole process. When a neutralizer and a procedure that give satisfactory results under plant conditions have been selected, they should not be changed readily.

*Testing Cream for Acidity.*—The first important factor in making an accurate acidity test is to obtain a representative sample. The coils of the vat should be running and the cream thoroughly mixed. In winter it may be necessary to heat the cream to 70°-80°F. to obtain thorough mixing. A composite sample of several dipperfuls should be taken along the whole length of the vat.

Thoroughly mix the composite sample and weigh a 9-gram sample, or measure the sample with a 9-ml. pipette. Both methods are recommended and commonly practised. If the sample is measured, the pipette should be rinsed with an equal quantity of soft or distilled water. It is also a common practice to add an equal quantity of water to a weighed sample. Some authorities, however, recommend titrating the weighed sample of cream without any addition of water. Add 8 drops of a 1 per cent alcoholic solution of phenolphthalein, and titrate with N/10 alkali (sodium hydroxide) to the first faint pink colour. Take the reading on the burette and add 2 more drops of alkali. If the colour changes to a deep pink on the addition of 2 drops of alkali, the previous reading is the correct acidity; if the colour still remains a faint pink, add 2 more drops of alkali and recheck the colour. The reading just previous to the appearance of a deep pink colour on the addition of two drops of alkali represents the correct acidity.

Boiling the sample before titrating is recommended for high acid yeasty cream in order to drive off the carbon dioxide that has been produced by microbiological activity. Carbon dioxide in solution gives an acid reaction to phenolphthalein and if not driven off results in a slightly high acidity test.

It is also advisable to occasionally boil the sample from vat pasteurized cream which has been neutralized with a soda neutralizer when checking the acidity of the neutralized cream at the time of churning. Such cream contains some carbon dioxide, and it has been found that the acidity test is somewhat higher than the desired acidity unless the sample is boiled.

The procedure for boiling a cream sample is to weigh or measure the cream into a porcelain cup or dish, then bring to a gentle boil for 15 to 20 seconds over an open flame and cool to about 70°F. before titrating.

NOTE.—Neutralizing charts have been omitted as they are available from the manufacturers and distributors.