Concentration of milk fat

Pure milk fat is liquid at temperatures above 36°C. Below this temperature crystallisation starts. There are two main processes for production of milk fat. One starts from cream and the other from butter as raw material.

Process

From cream
Cream from a milk separator is concentrated to approximately 75% fat content. Phase inversion is made, from a fat in water, to a water in fat emulsion. The emulsion is fed to the milk fat concentrator where the fat, the light phase, is concentrated to at least 99.5%. The heavy phase, buttermilk, is re-circulated for re-separation.

From butter
The melted butter is heated to 60°C and held at this temperature for at least 20 min. in a buffer tank. The emulsion is fed to the concentrator where the fat, the light phase, is concentrated to at least 99.5%. The composition of the heavy phase, the buttermilk, depends on the butter quality used. Fresh butter produce a buttermilk, with high fat content, that has to be reseparated. The buttermilk produced from stored butter normally contain less than 1% fat, whereof the main part is phospholipids and not reseparable.

Salted butter accumulate chlorides in the water phase and produce a buttermilk containing up to 10% salt. Risk for corrosion!

From fresh uncultured butter a buttermilk rich in phospholipids is obtained. It can be dried to a powder with emulsifying properties.

Factors influencing safety
When producing milk fat from salted butter, or a mixture of unsalted and salted butter, there is always a risk for corrosion as the heavy phase has a high concentration of chlorides. Do not separate at higher temperature than necessary. Special attention must be paid to the CIP program to minimize the risk for corrosion. See “Cleaning” below.

Cultured butter contains denatured protein. This protein sediment must be discharged with an interval of 3-5 minutes in order to maintain the bowl operational. The discharge volume should be equal to the sediment space of the bowl

A proper cleaning of the centrifuge is essential not only for the performance of the machine but also for the safety. Inspection of the CIP starts at commissioning. The centrifuge should then be checked for corrosion, erosion and cavitation damages frequently.

Adjustments in concentration process
Adjustments in the concentration process is necessary now and then to maintain an optimal performance. Some parameters are however not changed during normal operation.

Temperature should be approximately 60°C to avoid excessive protein precipitation and minimize corrosion risk.
Throughput should be as constant as possible. A change in inlet pressure will result in a corresponding change in throughput.

The back pressure is set by an automatic control unit, normally fitted in the buttermilk outlet.

**Outlet flow**
The fat contents in the milk fat and the buttermilk respectively is controlled by changing the light phase flow. An increased flow of milk fat out of the concentrator decreases the fat content and vice versa. Whether a change in fat content of the buttermilk will follow on a change in light phase flow depends on the raw material and the operating conditions.

**Discharge interval**
The discharge interval must be set according to the type and quality of the raw material used. The clarity of the oil and the consistency of the discharged sediment can be used for tuning. Discharge volume should correspond to the sediment space volume.

With first class cream quality, the discharge interval may be as long as 60 minutes, but the lower the quality the shorter the interval must be.

Set 30-60 minutes for melted uncultured butter as start value, and 3-5 minutes for cultured butter.

A too long discharge interval may cause build up of sediment in the bowl, that can be difficult to discharge and ultimately cause imbalance.

**Efficiency of concentration process**
Of the fat being fed to the separator 99% or more should be recovered in the concentrated oil. About one percent of the fat is lost in the heavy phase and in the discharges. The more frequent the discharges are made the higher the losses.
Product quality

There are three different grades of anhydrous milk fat as shown in the table below (FIL-IDF International standard 68A:1977)

<table>
<thead>
<tr>
<th>Product</th>
<th>Min % milk fat</th>
<th>Raw material</th>
<th>Additives allowed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butter oil</td>
<td>99.3</td>
<td>Cream or butter</td>
<td>For neutralization of FFA</td>
</tr>
<tr>
<td>Anhydrous butter oil</td>
<td>99.8</td>
<td>Cream or butter</td>
<td>For neutralization of FFA</td>
</tr>
<tr>
<td>Anhydrous milk fat</td>
<td>99.8</td>
<td>Fresh cream or butter</td>
<td>None</td>
</tr>
</tbody>
</table>

The abbreviation AMF is used as a common designation for all these products.

By using centrifuges, it is only possible to reach 99.5% fat. To reach 99.8 it is necessary to heat the product and evaporate the remaining water under vacuum.

If the oil contains too much free fatty acids (FFA) these can be removed by neutralisation, but that requires another separation step.

If a more clear oil is desired the oil can be polished, which means that hot water is added and removed together with most of the remaining proteins by re-separation. These proteins are soluble in water than in oil.

Sampling and analysing methods

The water content in the oil can be analysed with the Karl Fischer method. The amount of free fatty acids is determined by different titration methods.

Cleaning

The cleaning should start with a thorough rinsing with warm water (>40°C) to keep the fat still inside the bowl fluent, followed by lye, a second rinsing, acid and the final rinsing and cooling. See our general recommendation for concentrations, temperatures and duration of lye and acid cleaning.

It is important to make proper sediment discharges during the first rinsing to get rid of sediment from the bowl. Remaining protein sediment will make detergent cleaning less effective.

The flow over the separator during CIP is important. It should be at least the same as during production. The higher CIP capacity the better. Throttle the heavy phase outlet during CIP in order to get sufficient flow through the light phase outlet.
When processing salted butter there is always a risk for corrosion. To minimize the corrosion, the following precautionary measures must be taken:

- Make a short lye cleaning after 8 hours production.
- Cleaning with acid should only be made when absolutely necessary (to remove calcium deposits and milk stone).
- After an acid cleaning and water rinse always make a short run with lye, and rinse with water to make sure that there are no rests of chloride/acid in the machine when the machine is stopped.
- Open the machine for frequent inspections regarding corrosion on surfaces in contact with product.