EVAPORATED OR CONDENSED MILK

**Introduction**

Evaporation is one of the oldest methods for preserving milk. In this operation, water is removed from the milk to obtain a concentrated dairy product. Depending on the process, the evaporated milk may be the desired end product, or evaporation may just be a prior step to further processing, for example, to produce sweetened condensed milk or powdered milk.

**Application**

The first step in the production of unsweetened condensed milk (or evaporated milk) and powdered milk is the standardization of the fat and dry matter content of the raw milk to the level required in the final product. This is followed by a heat treatment to destroy microorganisms and to stabilize the milk. Preheating the raw milk before evaporation has a significant effect on the shelf life of the final product.

The milk is then evaporated to a specific dry solid concentration. For the production of unsweetened and sweetened condensed milk, the milk is evaporated to obtain a concentration of 30-40 % dry solids. For the production of powdered milk, the milk is concentrated to about 40-50 % dry solids for a spray dryer, and about 18 % dry solids for a roller dryer. The total dissolved solids concentration achieved in evaporation is critical as it affects the performance of subsequent operations and the quality of the final product.

After evaporation, the milk is homogenized. Homogenization reduces the mean size of the fat globules so that they are distributed uniformly in the milk and do not rise to the top creating a creamy layer. This is not a required step in the production of powdered milk, but it is applied to facilitate milk reconstitution.

The evaporated, homogenized milk then moves on to cooling, sterilization and packing for a canned evaporated milk, or to drying for a powdered milk product.

**Instrumentation and installation**

Vaisala K-PATENTS® Sanitary Process Refractometer PR-43-A provides real-time and accurate Total Dissolved Solids (TDS) measurements for better control and monitoring of the milk evaporation process. The refractometer can be calibrated to read...
TDS or another scale preferred by the manufacturer, e.g. Brix.

The refractometer is used for standardization after the holding tank to achieve the precise milk solids content as indicated by legal standards.

If a homogenization step is performed, a refractometer is installed after the homogenizer to include the fat content in the measurement. The refractometer detects fat globules as long as they are smaller than 6 μm. This globule size can be achieved by adjusting the pressure of the homogenizer. The recommended homogenizer’s primary pressure is $P_1 = 26$ MPa (260 bar).

An additional refractometer between the evaporator and the high-pressure pump to the dryer allows for continuous control of the evaporation performance and dry solids concentration levels.

Accurate TDS measurement after evaporation is important in order to achieve the desired quality of the evaporated milk product and to enhance the drying operation. If the dry solids content exceeds the targeted level, the viscosity of the milk increases and creates problems with atomization during drying. Low solids content increases the energy consumption at the drying stage.

Thanks to the refractometer’s self-cleaning design, a prism wash system is usually not required. However, for fluids with a dry solids content above 40% or a flow velocity below 1.5 m/s, a steam prism wash solution consisting of the Sanitary Probe Refractometer PR-43-AP-L42 with an aseptic steam valve ASV and side flow cell is required.

The refractometer provides Ethernet and 4-20 mA output signals for real-time process control. The refractometer is available with 3-A Sanitary and EHEDG certifications.

The control achieved with the precise and accurate in-line concentration measurements helps to improve end-product quality and to reduce operating costs.

An additional refractometer between the evaporator and the high-pressure pump to the dryer allows for continuous control of the evaporation performance and dry solids concentration levels.

<table>
<thead>
<tr>
<th>Instrumentation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanitary Compact Refractometer PR-43-AC</td>
<td>For hygienic installations in small pipe line sizes of 2.5 inch and smaller. The PR-43-AC refractometer is installed in the pipe bend. It is angle mounted on the outer corner of the pipe bend directly, or by a flow cell using a 3A Sanitary clamp, I-clamp or Varinline® connection.</td>
</tr>
<tr>
<td>Sanitary Probe Refractometer PR-43-AP</td>
<td>For hygienic installations in large pipes, tanks, cookers, crystallizers and kettles and for higher temperatures up to 150°C (300 °F). The PR-43-AP refractometer is installed in the pipe line or vessel through a 2.5 inch or 4 inch Sanitary clamp, I-clamp, APV Tank bottom flange or Varinline® connection.</td>
</tr>
</tbody>
</table>

| User Interface | Selectable multichannel MI, compact CI or a web-based WI user interface options allow the user to select the most preferred way to access and use the refractometer measurement and diagnostics data. |

| Automatic prism wash | Prism wash is required in applications where flow velocity is below 1.5 m/s (5 ft/s) or where dry solids exceed 40%. The wash media is aseptic steam. The components of a steam wash system are refractometer PR-43-AP-L42 with insertion length of 42 mm, Side flow cell SFC-HHSS-H10/15/20/25, Aseptic steam valve ASV-H/ESS-H05, and Multichannel user interface MI for automatic prism wash diagnostics and control. |

| Measurement range | Refractive Index (nD) 1.3200 – 1.5300, corresponding to 0-100 Brix. |