**INFANT FORMULA PRODUCTION BY THE WET-MIXING PROCESS**

Infant formula can be manufactured by a wet-mixing process where all ingredients are handled in liquid form, a dry-blend process where ingredients are blended as powders, or a combination of these processes.

Wet-mixing is the most used technology as it ensures control over the milk's composition and microbiological safety. The formula's composition should be carefully monitored to achieve a high-quality product that matches as close as possible to breast milk, and which is safe for infant consumption.

**Application**

The wet-mixing process involves three stages: preparation of the mix, evaporation and drying. For the preparation of the mix, the base liquid can be water or skimmed milk. Other water-soluble powder ingredients are added to the base liquid (e.g. milk proteins) and the resulting mixture is stored in a large vessel for complete hydration.

A homogenization step follows to increase the uniformity and stability of the emulsion by reducing the size of the fat and oil particles in the formula.

Evaporation of the milk mixture is an essential step that enhances the spray-drying operation and increases the final product shelf life. Other ingredients, which are heat-sensitive, are added after evaporation.

Finally, the concentrated milk is typically dried in a spray-dryer system. The temperature as well as the solids content of the milk mixture are kept as high as possible for maximum efficiency. Low solid content results in small particle size, as well as poor wettability and short self life of the final product. Excessively high dry solids content increases the milk's viscosity which results in larger particles and affects the spray dryer capacity.

**Instrumentation and installation**

The K-Patents Sanitary Refractometer PR-43-A is the ideal in-line measurement instrument for safe,
higiene and accurate manufacturing of infant formula. The refractometer is available with 3-A Sanitary and EHEDG certifications. It is designed to withstand CIP and high process temperatures. Moreover, the K-Patents refractometer can be calibrated to measure either Brix, dry solids, or Total Dissolved Solids (TDS).

A refractometer is installed after the hydration tank to measure TDS content. This ensures the right in-line dosing of other ingredients to meet the recipe requirements.

A second refractometer after the heater monitors the dissolved solids content. This helps to determine the right dose of heat-sensitive ingredients and ensures that the right concentration is fed to the dryer. Solid content prior drying is critical to optimize the spray dryer performance, energy consumption and final product quality.

A third refractometer can be installed before the evaporator for maximum evaporation performance control. When the products contain fat or oil, the refractometer should be installed after the homogenizer where the fat globules break down to a smaller size. The refractometer detects fat globules as long as they are smaller than 6 μm.

The pressure in the homogenizer can be adjusted to obtain this globule size. The higher the pressure the smaller the globule. The recommended homogenizer’s primary pressure is \( P_1 = 26 \text{ MPa} \) (260 bar).

Typically, prism wash is not required for any of these applications. However, a steam prism wash solution using Process Refractometer PR-43-AP-L42, aseptic steam ASV valve, and a side flow cell is required for low velocities or for fluids with a dry solid content above 40 %.

The K-Patents refractometer is a stand-alone device capable of operating independently or with one of several different user interface options. It provides an Ethernet or 4-20 mA output signal for real-time process control.

The accurate control achieved with K-Patents precise in-line concentration measurements ensures a high quality and safe end product, as well as optimized operating costs.

<table>
<thead>
<tr>
<th>Instrumentation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="K-Patents Sanitary Compact Refractometer PR-43-AC" /></td>
<td>K-Patents Sanitary Compact Refractometer PR-43-AC 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><img src="image2" alt="K-Patents Sanitary Probe Refractometer PR-43-AP" /></td>
<td>K-Patents Sanitary Probe Refractometer PR-43-AP for hygienic installations in large pipes, tanks, cookers, crystalizers 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-HSS-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. |