JAM, JELLY, MARMALADE

Typical end products
Jams, jellies, marmalades, and similar fruit preserves.
Chemical curve: R.I. per BRIX at Ref. Temp. of 20˚C

Introduction
Jam-making is an industry that converts fruits into a spread mixture. Fruits in the form of puree, pulp or juice are dissolved in water in the presence of a syrup, concentrated to a high dissolved material content by cooking, and cooled rapidly to obtain a mass with the appropriate gel consistency.

Application
Jam cooking is usually performed in batches of 500 to 3000 kg (1100 to 6600 lbs). Each batch takes 1-3 hours and consists of four main phases:

1. Ingredients Addition: Berries, fruits, pectin and sugar are mixed with water. Frozen berries thaw as temperature slowly increases.

2. Sweetening Cooking: In this phase, berries and fruits absorb sugar from the liquid until equilibrium is achieved. The temperature of this process is below 90 °C (194 °F). This phase is not required if there are no solid substances present in the medium.

3. Pasteurization: Cooking temperature is raised up to 100-150 °C (212-302 °F) for 10-20 minutes to destroy any bacteria.

4. Cooling: The jam is cooled down to 20-40 °C (68-104 °F) before the vessel is discharged. Aromas are often added during this phase.

Changes in the sugar content, temperature and liquid at different cooking phases are illustrated below:

Instrumentation and installation
The K-Patents Sanitary Probe Refractometer PR-43-AP-L or the Flush Mounted Refractometer PR-43-AP-T provide accurate and in-line Brix measurement. The refractometer allows for continuous monitoring of the cooking process to ensure consistent product quality and to optimize the process.

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Traditionally, it has been possible to check Brix levels off-line through batch sampling at the end of the process. The K-Patents refractometer can be installed directly in any type of cooker to monitor the batch progress and final product quality. The refractometer has a measurement range of 0-100 Brix and provides Ethernet or 4-20 mA output signals for real-time control. The refractometer’s signal can be used to set quality control functions to take immediate corrective actions if the batch reaches unusually low or high Brix levels.

The K-Patents refractometer eliminates the need for batch sampling and off-line analyzing, improves product consistency and quality, and optimizes sugar usage. Typical measurement range is 10-70 Brix (jam cooking) and 50-85 Brix (marmalade cooking), and the process temperature is about 70-90 °C (158-194 °F).

Open boiling pan

The open boiling pan is a traditional cooker type in which the jam is steam heated from the bottom. A scraper or agitator prevents the jam burning from the contact with the hot pan.

The K-Patents Sanitary Probe Refractometer PR-43-AP-L is installed in a pipeline or vessel using a 2.5 inch or 4 inch Sanitary clamp. The Flush Mounted K-Patents Sanitary Refractometer PR-43-AP-T is designed for vessels containing scrapers and mixers. These refractometers are installed through an APV Tank Bottom Flange and can also be installed through steam jackets.

Vertical vacuum cooker

The vertical vacuum cooker is more efficient than the open pan type. During heating and pasteurization, the high pressure prevents overcooking and the berries remain unbroken.

Horizontal vacuum cooker

An Alfa vacuum cooker is horizontally mounted and has double the capacity of vertical pans. These cookers are fitted with a heat exchanging agitator/scaper. They also contain a spiral coil heater, which enables faster heating and cooling either under overpressure or under vacuum.

A K-Patents probe or flush mounted refractometer can be installed either via the steam jacket or at the end of the pan (avoiding having to cut an opening through the steam jacket).

Pipe cooker

The pipe cooker is a continuous flow cooker, where the whole cooking process takes place. Berries, fruit, sugar pectin and other ingredients are mixed and preheated, and then pumped through the cooking tubes for further heating. After cooking, the product is passed through cooling pipes before packaging. The flow velocity is 0.1 m/s for the whole process.

The probe refractometer is installed after the cooking phase to measure the concentration of the end product, since the sweetening of the berries occurs during heating. At this point, the temperature is at its highest and the risk for prism coating due to low product flow rate is avoided. The K-Patents refractometer can also be installed in the feeder tank to estimate the product concentration and to determine the additives quantities to be introduced during cooking, thus optimizing cooking time.

Prism coating is rarely an issue because the batch processing times and CIP cleaning intervals are short.

### Instrumentation Description

<table>
<thead>
<tr>
<th>Instrumentation</th>
<th>Description</th>
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<tbody>
<tr>
<td><img src="image1" alt="K-Patents Sanitary Probe Refractometer PR-43-AP-L" /></td>
<td>K-Patents Sanitary Probe Refractometer PR-43-AP 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>
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<tr>
<td><img src="image2" alt="K-Patents Sanitary Flush Mounted Refractometer PR-43-AP-T" /></td>
<td>K-Patents Sanitary Flush Mounted Refractometer PR-43-AP-T for hygienic flush mounting installations in cookers, cooling crystallizers and other vessels that have scrapers or mixers. Installation through an APV Tank bottom flange.</td>
</tr>
<tr>
<td><img src="image3" alt="User Interface" /></td>
<td>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.</td>
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<tr>
<td><img src="image4" alt="Measurement range" /></td>
<td>Refractive Index (nD) 1.3200 – 1.5300, corresponding to 0-100 Brix.</td>
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