Continuous Production of Sugar Confectionery

Focussed on Various Kind of Hard Boiled Candies

KLÖCKNER HÄNSEL PROCESSING

Brief History of the Company

The roots of the company go back to 1911, when Otto Hänsel senior founded the company OTTO HÄNSEL in the town of Dresden, situated in that part of Germany that used to be East Germany: This company later was nationalized by the communist government.

In 1952 Otto Hänsel junior started his own operation in Hannover, West Germany, thus being competitor for his father’s company for a while. He named his company OTTO HÄNSEL JUNIOR, later the JUNIOR was omitted. HANNOVER, Germany, is the place where the company is located until today.

The company’s name has changed meanwhile to:
KLÖCKNER HÄNSEL PROCESSING GmbH (in short: KHP)

→ KLÖCKNER stands for the majority share holder, since 1990
→ HÄNSEL stands for the founder of the company
→ PROCESSING stands for the company’s main activity

KHP is not "an only a pure machine supplier". KHP provides technologies for the production of various confectionery products – and supplies the production equipment - mostly tailor made.

KHP’s technologies are focussed on various kind of confectionery products:

- Hard Candy
- Hard Candy, sugar free
- Soft Caramel Candy, Toffees
- Chewy Candy
- Aerated Candy Bar Centers
- French Nougat - Montélimar
- Gums and Jellies
- Fondant
- Specials (New Products)
A technological **CandyLab**, fully equipped with confectionery machines, all in industrial size, is available in Hannover for KHP’s own R&D - activities and for customer trials.

The total staff of Klöckner-Hänsel Processing is 160 employees.

**KLÖCKNER – HÄNSEL PROCESSING**

**Hard Candy -Technologies and Production Lines**

1. **Introduction**

Qualified suppliers of production technologies and corresponding machines for the confectionery industry world wide must not only react on customer’s tenders / specifications / demands, but as well act by doing their own research and developments – so KHP did and does and also will continue to do in the future.

2. **Technologies and Equipment**

In the following this presentation will focus on Technologies and equipment for continuous production of hard candies and will focus on KHP- specials in this field.

Various kind of hard boiled candies (**) are economically produced in continuously operating plants – the candies may be press-formed or deposited, such as e.g.:

- Center filled
- Unfilled
- Laminated Center
- Striped
- Milk
- Medicated
- Two or more flavors at the same time
- Sugar free
- Specials

The KHP continuous production line **SUCROLINER®** for press-formed hard boiled candies covering an **output range from 500 kg/h to 4.000 kg/h** line is generally composed by:

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September 11\(^{th}\), 2003

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2.1 Central Metering and Weighing Unit  CONTIGRAV®
2.2 Dissolving and Pre-Cooking  CROSSFLOW®
2.3 Final Cooking, Vacuuming  CROSSFLOW® / ROTAMAT®
2.4 Flavoring, Aerating  MIXING SCREWS
2.5 Cooling, Laminating  COOLING CONVEYOR
2.6 Forming and Candy-Cooling  STRADA®
2.7 Candy Wrapping  MILLETWIST®

Items 2.1, 2.6, 2.7 will only be touched, Items 2.2 to 2.5 will be elucidated more closely.

In the CADBURY SCHWEPPES Group in total 15 SUCROLINER – Plants are in operation since 1993, e.g. for medicated HALLS, MURRAY MINT,…

2.1 Central Metering and Weighing Unit  CONTIGRAV®

The Central Metering and Weighing Unit is the entrance for the main raw materials into the production lines. These raw materials may be liquid or dry. The metering elements provide two steps “coarse” and “fine”, all the parameters and data are PLC-controlled, incl. tolerance-limits, product flow, tare for each of the weighed components, out flow control, recipe memory and material consumption data.

In this central weighing unit more than one recipe for more than one production line can be automatically handled at the same time.

In case that some raw materials in different recipes for different production lines may interact in a negative way - even in traces left back in the emptied weighing hopper- a supplementary weighing hopper is added to the main weighing hopper to keep these components separated from each other.

The sizes of the weighing hopper and the underneath installed holding tanks are calculated depending upon the requested slurry throughputs for the linked production lines. The actual slurry throughput requirements go up to 8,000 kg/h. The requested “coarse” metering throughput data into the weighing hopper is calculated depending upon requested slurry throughput for each line and depending upon number of raw materials and the number of batches per hour.
As a clue: The metering throughput for all raw material at “coarse - flow” should be minimum twice the total slurry throughput fed into the production lines

Example:

<table>
<thead>
<tr>
<th>Line 1</th>
<th>Line 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.000 kg/h</td>
<td>1.700 kg/h</td>
<td>2.700 kg/h</td>
</tr>
</tbody>
</table>

→ “coarse flow” ≥ 5.400 kg/h ≥ 90 kg/min

2.2 Dissolving and Pre-Cooking CROSSFLOW®

For dissolving and pre-cooking Klöckner-Hänsel Processing has developed a new type of cooker: the CrossFlow®. It was presented first at INTERPACK 2002 in Düsseldorf. This new universal cooker is designed to replace the traditional coil cookers for dissolving, pre-cooking and final cooking in Klöckner-Hänsel’s confectionery plants.

For Gum and Jelly lines Klöckner-Hänsel’s program provides the JellyStar®, in heat transfer characteristics similar to the CrossFlow®, but different in through flow details

• CrossFlow® ↔ JellyStar® - comparison in the following

2.2.1 The Design

The CrossFlow® and the JellyStar® are both completely made of stainless steel. A bundle of straight thin steam pipes is placed in a vertical cylindrical barrel. The mass to be treated is pumped into the bottom of the barrel and goes up stepwise to the outflow nozzle at the top. The through-flow area is intersected by multiple baffle plates, one above the other:

• in CrossFlow® with cut-outs on alternate sides
• in JellyStar® alternately with a clearance at the circumference and a circular passage in the plate center,

thus maintaining a product cross flow with an 90-degree angle to the steam pipes.

Whereas in traditional coil cookers the mass-flow is parallel to the heating surface of the coil - with the risk of burning of the mass to the steam heated surface, predominantly in the infeed zone - in the CrossFlow® and in the JellyStar® the 90-degrees angle of the mass cross-flow is maintained from the bottom infeed into the cooker up to the top outflow nozzle, thus leading to an
excellent heat transfer from the steam heated pipes into the mass and as well
to an excellent heat exchange within the mass itself.

These excellent heat exchange characteristics consequently allow a low steam
pressure, particularly advantageous when masses are sensitive to heat.

As the bundle of the steam heated pipes is completely surrounded by the mass
to be heated, the barrel only can reach mass temperature and thus thermal
radiation is negligible meaning: only 10% energy losses by radiation compared
to traditional coil cookers

CrossFlow® and JellyStar® are space saving: The space need of the cooker
itself is as little as 10 % only (!) compared to a traditional coil cooker.

2.2.2 The Applications

CrossFlow® is an universal heat exchanger for
sugar- and non-sugar recipes (*):

• Dissolution of crystal sugar in slurries
• Pre-cooking of all kind of sugar solutions
• Final cooking of all kind of sugar solutions
• Operation in vacuum / atmospheric pressure / pressure
  (*) sugar replaced by e.g. ISOMALT, LYCYSIN HBC, MALTITOLE, HSH

• CrossFlow® cookers are available in modular sizes from 3 m² to 13 m², thus
  covering an output range of up to more than 5.000 kg/h.
• JellyStar® cookers are available as well in modular sizes from
  1 m² to 12 m², thus covering an output range of up to more than 6.000 kg/h

2.3 The Specials

\[
\begin{align*}
C & = \text{CrossFlow}^{\circledast} \\
J & = \text{JellyStar}^{\circledast} \\
\end{align*}
\]

• Execution in all stainless steel \quad C + J
• No moving parts \quad C + J
• Vertical heat exchanger, space saving 90% \quad C + J
• Built-in bundle of small and compact pipes, steam heated \quad C + J
• Steam room 40%, mass room 60% - allow quick response of control in case of external parameter changes
  (e.g. through flow, steam pressure ) \quad C + J
• The small barrel diameters allow installation in closest
  neighborhood to the flash-off chamber \quad C + J
• Product flow from bottom to the top, intersected by special \quad C + J
configuration of baffle plates

- Mass cross-flow in 90-degree angle onto the pipes  
  - No uncontrolled residence time close to the steam heated pipes
  - High efficiency in heat transfer from the pipes and excellent heat exchange within the mass allow low steam pressure
    - careful mass treatment
  - Short residence times
  - Constant product quality parameters: temperature and product outflow

- Lateral nozzles for infeed of additional components into the mass during through flow (option for CrossFlow® only)
- Negligible thermal radiation, energy saving
- No dead space inside the heat exchanger
- Easy and short CIP-cleaning process, in closed circuit.
- Easy maintenance

Traditionally the slurry is heated up to 110°C = 80% TS (see Boiling Graphs) to securely dissolve all crystals. At atmospheric pressure.

Pressure dissolving is energy saving, but may lead to some browning:
   \(\rightarrow\) less dissolving water \(\rightarrow\) less water to be boiled out.

KHP has a long experience in this field of balancing between reduced dissolving water quantity and complete crystal dissolving in time, meaning: in through flow time

2.3 Final Cooking, Vacuuming CrossFlow® / ROTAMAT

After precooking the mass is continuously pumped into the final cooker. Either another CrossFlow® cooker, or a ROTAMAT(®) with scraped surface can be used for products sensitive to heat.

The little clearance in the ROTAMAT® between steam heated vertical cylinder and the unheated rotor of the ROTAMAT® allows cooking time in seconds only, no time for burning to the steam heated surface.

Both cookers CrossFlow® and ROTAMAT(®) can operate under permanent vacuum.

Candy mass cooked under atmospheric pressure, if not cooked under permanent vacuum, is sucked into the vacuum chamber for some cooling and for final increase to final TS%. 1% TS-increase = 10 °C temperature drop.

The boiling temperature, for sugar and for sugar free candies, is \(|±140°C|\), depending upon the desired TS-content.
Vacuum is applied at –0.8 bar for sugar candies, up to –0.95 bar for sugar free candies.

Cooking under permanent vacuum (KHP-patent) is applied for:

- sugar free recipes using ISOMALT, or LYCASIN HBC, etc. when a final water content of 1% or less is requested.

  **The advantages:**
  - approx 25°C lower boiling temperature compared to boiling of sugar free hard candies under atmospheric pressure
  - no special heat resistant ingredients, such as flavors..., needed
  - sufficiently higher viscosity - to form constant slabs of candy mass on the cooling belt

- White cream / milk hard boiled candies with suppressed caramelisation such as e.g. deposited “CreamSavers“ and “Campinos” and others

Major know how is concentrated in the extraction device, that extracts the cooked and vacuumized candy mass continuously out of the vacuum chamber into the downstream mixing devices. Klöckner-Hänsel’s extraction-screw is world wide best known for:

- extracting against a vacuum as high as – 0.96 bar
- needing no constant level on the vacuum side
- maintaining mass flow constant, basic condition for medicated candies
- covering a sugar/glucose-rate from 60:40 to 20:80

### 2.4 Flavoring, Aerating

The cooked and vacuumized candy mass goes out of the extraction screw into the downstream mixing screws – one, two, three, or even more.

In lines with e.g. three mixing screws the candy mass is divided by special remote controlled membrane valves.

Into these mixing screws all the minor ingredients are injected:

- colour- and flavour-solution
- medicated active ingredients
- buffered liquid acid
- crystalline acid – by gravity, with K-Tron twin-metering screw
- compressed air (replacing traditional pulling machines. KHP-patent )

The volume of air incorporated in candy mass to be press-formed later in a chain die set or in a turret(drum) die set is up to approx 10 to 15%.

Higher % of air lead to compressibility of the candies with the negative
consequence that they loose shape after press-forming – not too advantageous for wrapping. In candy masses such as “Star Light Mints”, cut with rotating knives, the vol. percentage of incorporated air can exceed 30%.

**Accuracy of metering** for medicated candies is:
- ± 5% for liquid ingredients
- ± 7% for crystalline acid with a loss-in-weight K-Tron feeder.

### 2.4 Cooling, Laminating Technology

For continuous and homogeneous cooling of the coloured, flavoured, medicated, aerated hard candy mass Klöckner-Hänsel Processing has developed the cooling conveyor series 2107 – 2111,

- Length from 6 m to 12 m,
- Width 800 and 1.200 mm,
- with two, three, four or more independent cooling zones.

Cooling is effected with water in circulation, thus no cooling water consumption. The cooling water is kept at controlled sufficiently high temperatures in the separate cooling zones. Too cold cooling water would lead to partially overcooled candy mass negative for high center filled candies with a thin casing. Special turn-over ploughs and rollers lead to uniform cooling of the candy mass with direct continuous infeed in the batch roller of the downstream STRADA® forming line.

Remark: Masses for deposited hard boiled candies are – after flavoring – conveyed into the hopper of the Depositing Machine, prior to the cooling process. KHP has realized numerous high output production lines in renowned companies world wide, in cooperation with high ranking companies specialized in depositing machines

For the continuous production of hard candies with laminated center – the best configuration is a SUCROLINER® line with two mixing screws to form two different slabs: one aerated, the other not aerated

Chocolate or ground almonds or peanut paste is metered by means of a center filling pump onto the surface of one of the two slabs of candy mass – onto the aerated one – and spread out. Special ploughs roll this slab to a closed continuous roll, with a cross cut section showing a spiral of
chocolate paste. This endless roll is continuously fed into the upper side of the batch roller of the downstream forming line STRADA®. The second slab that may be differently flavoured with no paste layer is as well continuously fed into the same batch roller but at a position of approx. one foot closer to the rope sizing machine. This slab will completely encase the laminated mass, meaning: this mass will be the casing of the candy.

**Advantages of this Laminating Technology:**
- no heavy work for the operators, surveying only
- No pulling machine
- No extra machine- for laminated candies only in use - needed
- The pump used for the metering of the fat paste also can be used for other filling masses that are pumped into the batch roller using a center filling pipe.

**2.6 Forming and Candy-Cooling STRADA®**

Klöckner-Hänsel's forming line series STRADA® 700 – 1200 – 2000 configured by

- (center filling pump)
- batch roller
- rope sizer
- (relax belt for e.g. chewy candies)
- chain die forming machine
- candy cooler

is famous for highly center filled hard boiled candies using chain die sets for forming. The percentage of center filling in chain die formed candies can exceed even 35% percent – depending, among others, upon candy shape.

KHP has developed a new generation of chain dies manufactured in Hannover that allow high speed forming velocities. The forming velocity of STRADA® 2000 goes up to 200 m/min, meaning more than 2,000 kg/h of output, depending, among others, upon candy shape and weight.

On the basis of the Lamination Technology (Klöckner-Hänsel patent) the continuous production of twin-layer candies has become possible:

- outer layer = candy casing: Hard candy mass, flavour A: \( \leq 20\% \)
- inner layer = candy center: Hard candy mass, flavour B: \( \geq 80\% \)
- The two masses are produced on SUCROLINER® at the same time

And in addition to this liquid center filling may be pumped into the center of the center.

2.7 Candy Wrapping MILLETWIST®

Klöckner-Hänsel’s STRADA® lines are famous for high center filling percentage, and consequently the casings of the highly filled candies are thin and fragile. Thus it is evident that Klöckner-Hänsel, when developing a new candy wrapper for double twist wrapping, has concentrated predominantly on smooth handling of each candy in this machine and not that much on a high output rate. The double twist wrapper MILLETWIST® is designed for a performance of up to 1,100 pieces per minute, depending upon, among others, the quality of the wrapping material.

CandyLab

Since 1986 Klöckner-Hänsel Processing runs a CandyLab, in Hannover, Germany, meanwhile well known in the confectionery world. The CandyLab is equipped with all full size production machines, including

- CONTIGRAV®
- CrossFlow®
- SUCROLINER®
- STRADA®
- ROTAMAT®
- JellyStar®
- SIEIDOMAT / TURBOMIX®

for all kind of confectionery products - for internal R & D activities and - this is evident - for customer tests and trials.

R. Mergelsberg