K-PATENTS SEEDMASTER SM-3
FOR MULTIPARAMETER SUGAR CRYSTALLIZATION MONITORING AND AUTOMATIC SEEDING
SUGAR CRYSTALLIZATION

Crystallization is a very important part of sugar manufacturing. Crystallization has a major effect on product quality, yield and cost of production. Modern control of crystallization should rely on reliable on-line measurement of those parameters that are critical in controlling the process by a local operator (manual control), or by an advanced automatic process control system.

SUPERSATURATION

Supersaturation is the driving force of crystallization. Crystal growth (speed of crystallization) depends on this parameter. High supersaturation means faster crystal growth and vice-versa. It has also been proven that excessive supersaturation results in poor crystal quality and formation of fines and conglomerates. These need to be melted, concentrated, recycled and crystallized again, resulting in:

• waste of time and energy,
• decreased effective yield of produced sugar, and
• increased use of water and cost of production.

The illustrations of sugar crystals below show the presence of fines and conglomerates.

Large amount of fines

Conglomerates

Supersaturation is defined as the amount of sugar dissolved divided by the amount of sugar required for saturation in the same amount of water at the same temperature. Supersaturation can take place only if this ratio is larger than 1.0 (saturation). Supersaturation is a multivariable function of the liquid phase (mother liquor) parameters and it should be calculated taking into account all of them:

\[ \text{SUPERSATURATION} = f (C, P, T, m, b, c) \]

where:

- \( C \) : syrup / mother liquor concentration (%)
- \( P \) : syrup / mother liquor purity (%)
- \( T \) : temperature °C
- \( m, b, c \) : syrup quality parameters

Therefore, to be able to calculate supersaturation, concentration of the mother liquor should be measured selectively in-line and undisturbed by the crystals and vapor bubbles present in the massecuite.

Critical supersaturation parameters to start nucleation

MULTIPARAMETER CRYSTALLIZATION TRANSMITTER AND SEEDING DEVICE

SeedMaster SM-3 is a unique third generation crystallization transmitter and seeding device to be used with the K-Patents Process Refractometer. The SM-3 allows for accurate in-line and real-time monitoring of supersaturation and crystal content over the complete process of crystallization, and implementation and control of automatic or manual seeding. The SM-3 can be connected to one or two K-Patents Process Refractometer sensors and to one or two crystallizers.

The SeedMaster SM-3 provides the following tasks:

1. Electronic data capture on massecuite parameters.
2. Online calculation and transmission of massecuite parameters for the advanced control of sugar crystallization with control system.
3. Organization and storage of strike history data archive.
4. Advanced communication with the control system.
5. Automatic seeding of the vacuum pans.
6. Serves as user interface for the pan and control system operators.

SEEDMASTER SM-3 INPUTS

Supersaturation is calculated on-line taking into account all parameters of the supersaturation function. Therefore, the use of the following three (3) on-line data inputs C, T and D or S is mandatory, while the use of optional laboratory data L is highly recommended:

- C: syrup / mother liquor concentration (%)
- T: temperature °C/°F
- D: massecuite density (kg/m³), or
- S: massecuite solids content (%)
- L: massecuite level (%)

Laboratory data on certain feed syrup parameters are also needed.

Sources of on-line data input signals:

- C: syrup / mother liquor concentration (%): K-Patents Process Refractometer
- T: temperature: K-Patents Process Refractometer
- D: massecuite density: nuclear or microwave density transmitter, or
- S: massecuite solids content: nuclear or microwave transmitter

SEEDMASTER SM-3 OUTPUTS

Measured or calculated data:

SeedMaster SM-3 provides real-time the following six (6) massecuite parameters per each crystallizer:

1. SUPERSATURATION
2. MASSECUITE DENSITY (kg/m³)
3. MASSECUITE SOLIDS CONTENT (%)
4. CRYSTAL CONTENT (% by vol.)
5. MOTHER LIQUOR PURITY (%)
6. MEAN CRYSTAL SIZE (mm)

Additional outputs:

If K-Patents Process Refractometer(s) or density transmitters are connected to the SeedMaster SM-3, the following data can be shown as outputs:

7. MOTHER LIQUOR CONCENTRATION (%)
8. TEMPERATURE °C/°F
9. MASSECUITE LEVEL (%), option

Product data:

Mean crystal size (if full seeding is practiced), weight of crystals per strike, crystal yield and strike history archive.

MODBUS COMMUNICATION

The measured and calculated data, parameters and digital (ON/OFF) data can be transmitted both ways between the SeedMaster SM-3 and a computer or control system. The communication is based on the MODBUS/TCP/IP client/server communication protocol between the devices on the Ethernet TCP/IP network. The SeedMaster SM-3 plays as a server, takes requests and data from peripheral devices (e.g., the other measuring devices, i.e., clients) and processes the information and sends its output to the control system using the MODBUS.

SEEDMASTER SM-3 I/O UNIT

The SM-3 can also be equipped with an optional SM-3 I/O unit that handles analog standard current inputs and outputs and ON/OFF digital inputs and outputs in case the process I/O data are not handled by the control system. The data transmission between the SM-3 and SM-3 I/O unit is based on digital communication.

Process I/O specifications:

<table>
<thead>
<tr>
<th>Analog inputs</th>
<th>Digital inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

SeedMaster SM-3 I/O Unit
K-PATENTS PROCESS REFRACTOMETER AND SEEDMASTER SM-3

K-Patents SeedMaster 3 system with Refractometer, Interconnecting cables, Ethernet switch and SeedMaster SM-3.

The communication is:
- Refractometer to SM3: UDP/IP
- Control system to/from SM-3: MODBUS TCP/IP

K-PATENTS PROCESS REFRACTOMETER, SM-3 I/O UNIT AND SEEDMASTER SM-3

K-Patents fully equipped SeedMaster 3 system with Refractometer, Interconnecting cables, SM-3 IO Unit and SeedMaster SM-3.

The communication is:
- Refractometer to SM3: UDP/IP
- Analog/Digital I/O: SM-3 I/O Unit
- Control system to/from SM-3: MODBUS TCP/IP

PRISM WASH

K-Patents offers an integral prism wash system to avoid sugar crystals’ deposit or scaling on the prism surface. The components of the water wash system are an integral water nozzle mounted at the refractometer sensor head, a warm feed water source (hot condensate), and an indicating transmitter with built-in relays. The relays drive the water valve and they can be configured to control the prism wash cycle.

The temperature of prism wash water should always be higher than the process temperature to avoid crystallization and to ensure good washing result.
DISPLAYS

Different SeedMaster SM-3 displays provide in-line real-time information of one or two crystallizers and access to the SeedMaster configuration modes.

Standard display showing six (6) calculated massecuite parameters

<table>
<thead>
<tr>
<th>INSTRUMENT 1</th>
<th>SEEDING DENSITY</th>
<th>AUTO</th>
<th>142.31</th>
<th>STATUS</th>
<th>GRANULAE</th>
<th>P &lt;&lt;95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUPER SATURATION</td>
<td>1/0.1</td>
<td>CRYSTAL CONTENT</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.27.</td>
<td>6.04.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MASSECUTIE DENSITY</td>
<td>1/0.1</td>
<td>CRYSTAL 9.2E</td>
<td>0.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1433 kg/m³</td>
<td>0.22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUPER SATURATION</td>
<td>2/0.2</td>
<td>CRYSTAL CONTENT</td>
<td>292.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.04.</td>
<td>0.00.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Main display showing data on two crystallizers

<table>
<thead>
<tr>
<th>INSTRUMENT 1</th>
<th>SEEDING DENSITY</th>
<th>AUTO</th>
<th>142.31</th>
<th>STATUS</th>
<th>GRANULAE</th>
<th>P &lt;&lt;95%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUPER SATURATION</td>
<td>1.27</td>
<td>MASSECUTIE DENSITY</td>
<td>1433 kg/m³</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MASSECUTIE SOLIDS</td>
<td>82.73</td>
<td>CONCENTRATION</td>
<td>81.64 %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRYSTAL CONTENT</td>
<td>5.96</td>
<td>TEMPERATURE</td>
<td>75.02 °C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MOTHER LIQUOR PURITY</td>
<td>98.83</td>
<td>LEVEL</td>
<td>39.98 %</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Strike history showing trend and data archive

TOTAL CRYSTAL WEIGHT 28.04 t CRYSTAL TIME 135 min

<table>
<thead>
<tr>
<th>SUPER SATURATION</th>
<th>Seeding: 1.25</th>
<th>End: 1.17</th>
<th>Average: 1.21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimun: 1.17</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Configuration of I/O data

Select active instrument

<table>
<thead>
<tr>
<th>INSTRUMENT 1</th>
<th>INSTRUMENT 2</th>
<th>BOTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>REFRACTOMETER connection</td>
<td>Seeding mode</td>
<td>AUTO SEEDING</td>
</tr>
<tr>
<td>MODBUS (not direct) Connection</td>
<td>AUTO SEEDING</td>
<td>AI + DI</td>
</tr>
<tr>
<td>Third input</td>
<td>MASSECUTIE DENSITY</td>
<td>MODBUS IN</td>
</tr>
<tr>
<td>keyboard</td>
<td>REPORTING</td>
<td>RANGE</td>
</tr>
<tr>
<td>INSTRUMENT 2</td>
<td></td>
<td>Keyboard</td>
</tr>
<tr>
<td>REFRACTOMETER connection</td>
<td>Seeding mode</td>
<td>SEEDING ON MODBUS</td>
</tr>
<tr>
<td>UDP Connection</td>
<td></td>
<td>AO + DO</td>
</tr>
<tr>
<td>Third input</td>
<td>MASSECUTIE SOLIDS CONTENT</td>
<td>IO MAP</td>
</tr>
</tbody>
</table>

Configuration of communication

<table>
<thead>
<tr>
<th>SEEDMasters CU IP ADDRESS</th>
<th>MODIFY</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>REFRACTOMETER 1 IP ADDRESS</td>
<td>MODIFY</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>REFRACTOMETER 2 IP ADDRESS</td>
<td>MODIFY</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>STANDARD</td>
<td>MODIFY</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>SUBNET MASK</td>
<td>MODIFY</td>
<td>ACCEPT</td>
<td>DEL</td>
</tr>
<tr>
<td>GATEWAY</td>
<td>MODIFY</td>
<td>12</td>
<td>1.254</td>
</tr>
<tr>
<td>MOXA LIO MODULOS</td>
<td>MODIFY</td>
<td>MORE</td>
<td></td>
</tr>
<tr>
<td>ILOLOGIC 1241 IP ADDRESS</td>
<td>MODIFY</td>
<td>CHOP</td>
<td></td>
</tr>
<tr>
<td>ILOLOGIC 1242 IP ADDRESS</td>
<td>MODIFY</td>
<td>CHOP</td>
<td></td>
</tr>
</tbody>
</table>
SPECIFICATIONS

SEEDMASTER SM-3

On-line calculation, display and transmission of up to nine (9) massecuite parameters during sugar crystallization for up to two (2) vacuum pans simultaneously. Automatic seeding of vacuum pans based on calculated supersaturation or selectable density seeding set-point. Electronic data capture of measured and calculated data for the last 100 strikes; display of strikes’ history trends.

Display and keypad:
10” color touch screen display 2024x768, 4-wire resistive; Wall, table-top and panel mount.

Power:
+24 VDC +/−10%, Max. 8.5W.

Electrical classification:
Unclassified, ordinary locations.

Connections:
1xM12-4pin, D-coded, F (External Ethernet); 1xM12-8pin, A-coded, F (System); 1xM12-4pin, A-coded, M (24 VCD, (mA))

Input/outputs:
Power, Ethernet (Sensor and external)

Dimensions:
Height: 242 mm; width: 312 mm; depth: 49 mm

Enclosure:
Aluminum enclosure for control room conditions; IP65, NEMA 4 protection.

SeedMaster SM-3 weight:
5.4 kg (11 lbs)

PROCESS REFRACTOMETER MODEL

K-Patents Process Refractometer PR-23-GP

Sensor mounting:
Via flange connection and Counter flange adapter -AP for vacuum pan installations.

Sensor process connection:
ANSI-flange 150 lbs, 3 inch, insertion lenght 130 mm/DIN-flange 2656, PN25 DN80, insertion lenght 130mm/JIS-flange 10k 80A, Insertion lenght 130 mm.

INDICATING TRANSMITTER

DTR: Connectivity for one or two refractometer sensors; two built-in signal relays; polycarbonate enclosure, IP66 NEMA 4X protection.

Current output:
Isolated 4-20 mA, max. load 1000 Ohm, galvanic isolation 1000 VDC or AC (peak), hold function during prism wash.

Power:
AC input 100-240 VAC/50-60 Hz

Remote and Ethernet connections
10/100BaseT Ethernet, web server for configuration and diagnostics, UDP/IP Protocol connection for data acquisition.

PRISM WASH

Integral pressurized water nozzle -WN mounted at the refractometer sensor head; Power relay unit, Indicating transmitter with built-in relays.

SM-3 I/O UNIT

For digital transmission and handling of analog standard current inputs and outputs and ON/OFF digital inputs and outputs; Polycarbonate enclosure, IP66 NEMA 4X protection.

Power:
AC input 100-240 VAC/50-60 Hz

INTERCONNECTING CABLES

Standard length 10 m. Interconnecting cable length is field-adjustable with Platform 4 Cable extender for up to 100 m.

SERVICES

To ensure continuous support before and after purchase of our products, we offer local application consultation, training, maintenance and support expertise via our authorized sales representative network. Please refer to www.kpatents.com to contact your nearest representative.

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