High-quality sugar and no bittersweet surprise

Inline quality measurement in sugar production

Quality measurement in sugar production with the standard of ICUMSA.

Benefits at a glance:

- Precise inline real time measurement for better product quality.
- The ROI for the online measurement is less than one month due to the importance of the measurement.
- Low-maintenance sensor with long service life and stable operation.
- Compliance with respective authorities and values according to standard ICUMSA color scale.

To ensure the safety of consumers and plants, very high standards apply in the food industry. Various methods are used to monitor the quality of the food. Purity and quality of sugars need to be measured according to the International Commission for Uniform Methods of Sugar Analysis Ltd. (ICUMSA). This measurement is very costly and time consuming.

Customer challenge

Sugar manufacturers have to meet very high quality standards, which have been approved by the International Commission for Uniform Methods of Sugar Analysis Ltd. (ICUMSA). These standards are internationally recognized by authorities such as the Codex Alimentarius Commission, the OIML, the EU, and the US Food Chemicals Codex.
The ICUMSA Methods Book describes how a sample must be prepared in order to measure the ICUMSA color in ICUMSA Units [IU] in the laboratory. On the one hand these laboratory tests are essential to guarantee meeting the product quality, but on the other hand they are very time consuming, costly and cannot cover real time process monitoring in industrial sugar production.
In a customer's white sugar production process, the expected ICUMSA measurement range is between 75 – 300 IU with a Brix value varying between 62 – 65 Bx and the process temperature being around 80 °C.
In this application the ICUMSA reference value must be measured according to the methods *GS2/3-9 (2005) The Determination of Sugar Solution Colour at pH 7.0* and *GS2/3-10 (2011) The Determination of White Sugar Solution Colour*. It is important to understand the lab procedure in order to know if the inline sensor can achieve the same results.

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Lab procedure ICUMSA measurement

1. **Procedures of laboratory sample preparation**
   For white sugar samples up to 50 IU the required laboratory sample preparation is described by ICUMSA method G2/3-10. First a 50 % sugar solution is prepared using 50 g sugar and 50 g distilled water. This sample is vacuum filtered and de-aerated for one hour. Then the refractometric dry substance (RDS) is measured and correlated to the density. Besides that, the absorbance of that sample at 420 nm is measured.

2. **Expression of results**
   The ICUMSA color is then calculated by the following formula and expressed in whole numbers.

$$\text{ICUMSA} = \frac{1000 \cdot AU}{bc} \quad \text{with} \quad c = \frac{RDS \cdot \rho}{10^5}$$

$$= \frac{10^8 \cdot AU}{b \cdot RDS \cdot \rho} \text{ IU}$$

AU	Absorbance at 420 nm
b	Path length [cm]
c	Concentration of test solution [g/ml]
RDS	Refractometric dry substance (RDS resembles the BRIX value very closely)
ρ	Density [kg/m³]

3. **ICUMSA method GS-2/3-9**
   This method can be used for white sugars and very pure syrups up to 600 IU. Here the sample is mixed 50:50 with a TEA/HCl buffer solution to reach pH 7 before filtering it. Thus, the lab method is not 1:1 comparable to the inline measurement and it must be checked thoroughly if a correlation can be found. In the customer's sugar production comparison between lab and process showed good correlation.

The OUSAF22 color sensor to capture the ICUMSA value in the sugar production.

Our solution

With the OUSAF22 color sensor it is possible to measure ICUMSA color value. Looking at the variables of the ICUMSA formula the density, RDS and absorbance are unknown. If the RDS and thus also the density values are stable, they can be determined once with the described lab method (see above and in the table on the right). Finally, the only unknown variable is the absorbance at 420 nm. This can perfectly be measured with the OUSAF22. The inline photometer measures the slightest color changes. The ICUMSA color value can then be calculated out of these parameters via the mathematical menu in the Liquiline transmitter. It is also recommended to establish an additonional formula or add an additional manual factor within the CM44P that serves as a calibration factor to calibrate the online measurement to the laboratory results. The lab referenced ICUMSA value is used as an output to the control system and is displayed on the Liquiline transmitter. In case the density and RDS (equals nearly BRIX) values vary, a coriolis flowmeter can be installed to measure the BRIX with the built-in concentration capabilities. The ICUMSA formula, that is stored in the Liquiline mathematical function, then includes the online measured BRIX and absorption values to calculate the ICUMSA value.
To protect the sensitive equipment from dust, the CM44P is installed in a cabinet with a hinged door kit, allowing easy maintenance and a relatively hands-free system.

RDS	Density [kg/m³]
47	1213.3
48	1218.7
49	1224.2
50	1229.7
51	1235.2
52	1240.7
53	1246.3

Correlation between RDS and density given by ICUMSA Method *GS2/3-10*

Solution components

- Multichannel transmitter Liquiline CM44P CADINP1M21A1FA-15BAEA + EHEMPKPPZ1
- Sensor cable CUK80-4E25A
- Color sensor OUSAF22-D0D0B+Z1
- Flow-through assembly OUA260-BA1L16C4B1A+Z17
- Promass I 300 8I3B80 -CSIBAD-DGADCAFTWAA1 +EBEDEGZ1

Results

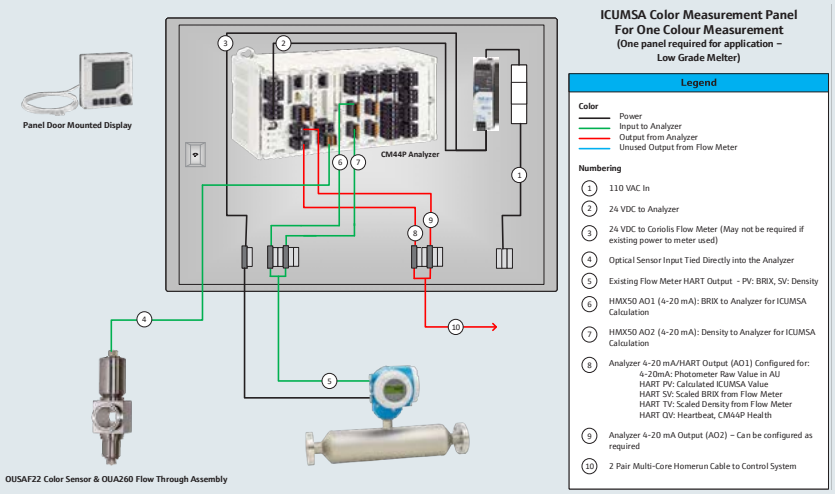
Customers benefit from various advantages in this application.

- Precise inline real time measurement for better product quality.
- Fast reaction possible in case of events e.g. a filter breakage.
- An online measurement allows for more efficiency gains and higher through put.
- The return on invest for the online measurement is less than 1 month due to the importance of the measurement.
- Less error prone and not operator dependent like a laboratory measurement.
- Low-maintenance sensor with long service life and stable operation.
- Compliance to respective authorities and values according to standard ICUMSA color scale.
- Suitable for cleaning-in-place (CIP) and sterilization-in-place (SIP) in hygienic industries.

Additional considerations

- Density and BRIX are very important parameters in this application and ensuring reliable measurement by the flowmeter is a high priority item. The reason being that if the density or the BRIX measurement are not reliably, the ICUMSA value will be calculated incorrectly based on an incorrect variable in the formula. Always ensure that the pipe is fully filled as required for any flow measurement.
- The viscosity of sugar in general is fairly high, as a result there is a potential for micro bubble formation in the product and as such it is highly recommended to utilize the Promass Q with the multi-frequency technology to get the best possible density measurement.

Possible Installation



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