FOSS

Application Note

AN 5427

Rev. 2

NIRS™ DS2500

Centrifugal Raw Sugar

Raw sugar is the final product of the sugar mill. It is brownish and has a mild fragrance from the remaining molasses. Raw sugar is graded based on its purity (sugar content). Various grading of the purity determines the economic value and in general, higher purity has a premium. Recently, however, lower grades have gained attention to make a healthier sugar (low IG). The purity and grading is based on several analyses: Sucrose content based on Pol and ash content. The colour measured as ICUMSA, typically ranging from 600 to 1200 units, also serves as a purity indicator. The higher the value, the darker the sample - and thus less the sucrose purity. Moisture content is important because it influences the characteristics and fluidity of the sugar and a higher moisture results in a darker appearance. Moisture in raw sugar is normally around 0.1 %.

This application is suitable to both conventional- and diffuser mills. Dilution of the sample is not necessary and chemicals like dry lead or Octapol are not required. After inserting a cup with a raw sugar sample into an NIRS™ DS2500, Pol and Moisture are analysed simultaneously in less than a minute.

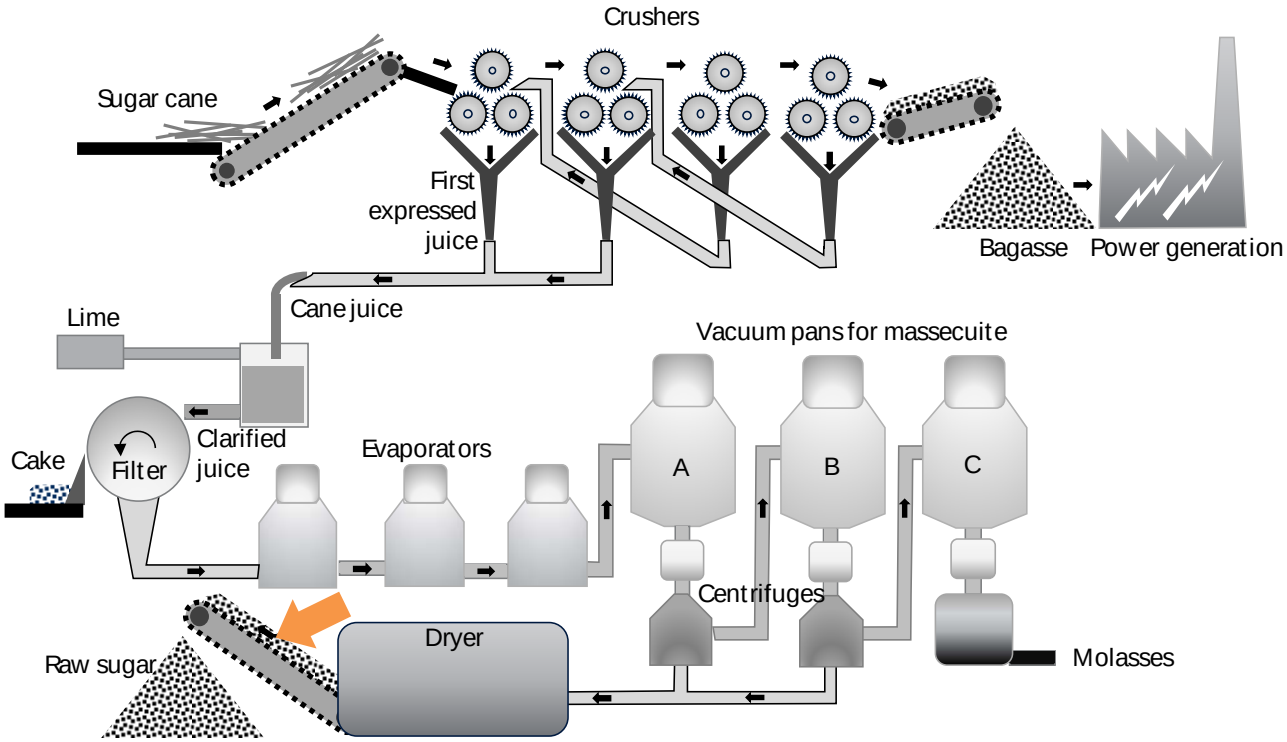

Fig. 1 Conventional mill, measurement points.

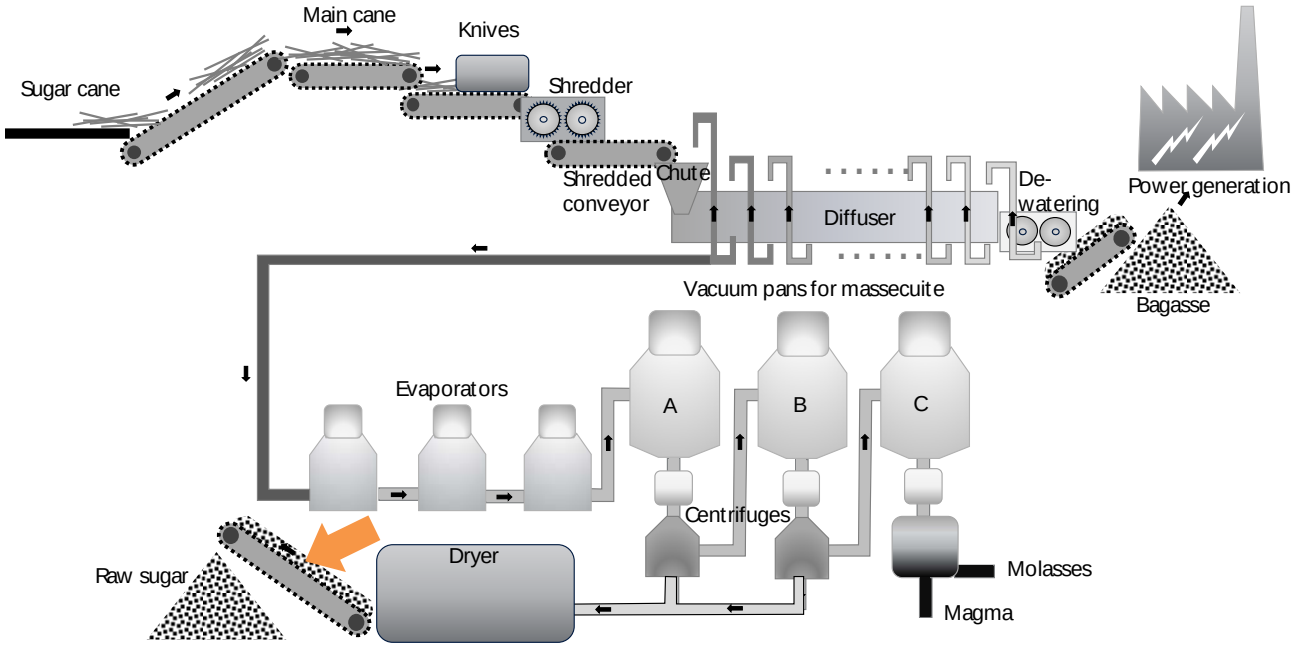

Fig. 2 Diffuser mill, measurement points.

Fig. 3 NIRS DS2500

Sample Description

Reference samples have been collected and analysed over several crushing seasons.

Parameter	Version	Min	Max	N	Model type
Pol	2.0.0.0	96.8	99.8	947	MPLS
Moisture	2.0.0.0	0.01	1.11	843	MPLS
Colour ICUMSA	2.0.0.0	105	2610	1063	MPLS
Ash	2.0.0.0	0.03	0.20	802	MPLS

Table 1 Calibration data.

Performance

Validation statistics is based on samples that were not in the calibration set.

Parameter	Min	Max	N	SEP	RSQ
Pol	96.8	99.8	180	0.15	0.909
Moisture	0.06	1.11	129	0.026	0.986
Colour ICUMSA	110	1800	248	62	0.983
Ash	0.04	0.16	154	0.019*)	0.382

Min.: Minimum reference value in test set.
Max.: Maximum reference value in test set.
N: Number of samples in the test set.
SEP.: Accuracy of test set expressed as Standard Error of Prediction (SEP) corrected for bias.
RSQ: Linear correlation between NIRS DS2500 result and reference result.
*) Approximate accuracy due to a limited range.

Table 2 Validation data.

Calibration Performance Graphs

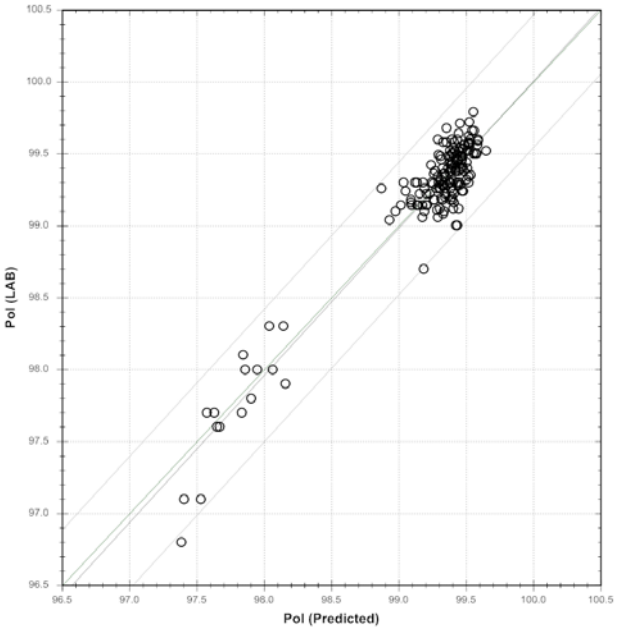

Fig. 4 Pol

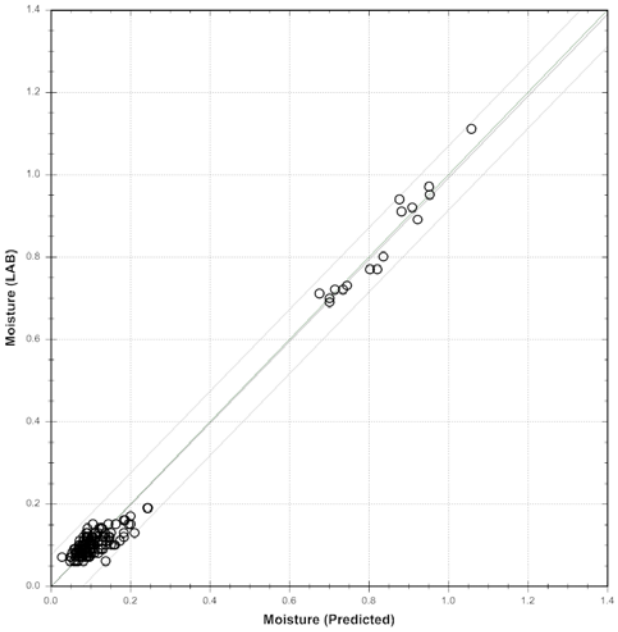

Fig. 5 Moisture

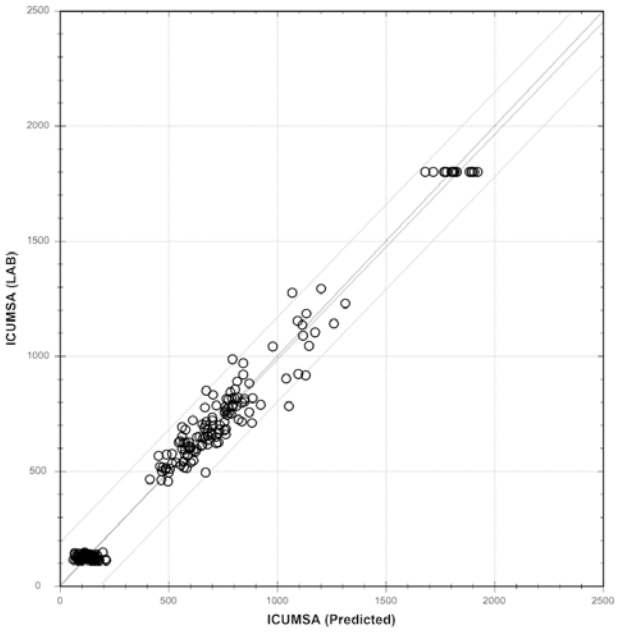

Fig. 6 Colour ICUMSA

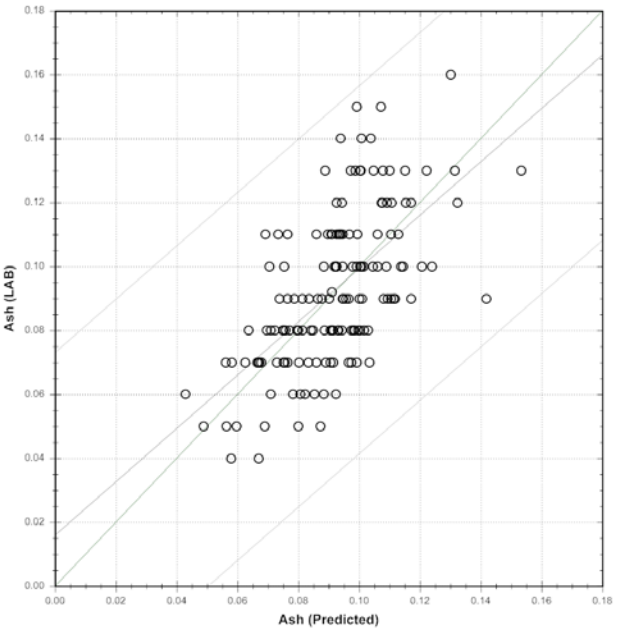

Fig. 7 Ash

In the sugar industry, Pol is synonymous with sucrose. Pol has a concentration wide concentration range, from 96.8 to 99.8%. This makes the RSQ-value good and the accuracy measured as SEP also being good. The concentration level of moisture is low but because the moisture peaks in the NIR spectra are strong, RSQ is high and the accuracy error measured as SEP is very good. The Colour (ICUMSA) SEP is reasonable and around 70. The Ash calibration is based on a subset of the data and while the SEP is reasonable for this parameter, the RSQ becomes poor due to the narrow range and the calibration is only indicative.

Note:

The performance example outlined in this note should only be regarded as a guideline for the expected performance of new installations. The performance of new installations will always depend on the uniformity of the sample preparation and the homogeneity of the product, as well as the accuracy of the reference method used and the range for the test samples. An indication of the obtainable performance can be found as approximately 1.5 to 2 times the reproducibility of the reference method. If the samples measured exceed the stated calibration ranges, or have non-common variations of other components, this might also influence the performance of the calibrations.

Each sample will be analysed and compared to the calibration database. Three key values will be given as an indicator to how well the unknown sample fit the calibration samples:

- Global H value (GH) - measures how far the spectrum is from the centre of the database. A high GH value corresponds to a sample far from the calibration database, meaning a sample different from the calibration samples. If the GH value exceeds a certain limit, the sample is suspected to be out of the calibration working range.
- Neighbourhood H value (NH) - measures how close the sample is to the nearest sample in the database. A high NH value corresponds to a sample far from the nearest neighbouring sample in the calibration database, meaning a sample different from the calibration samples. If the NH value exceeds a certain limit, the sample is suspected to be out of the calibration working range.
- T-statistics - measures the predicted parameter compared to its calibration range in the database counted as number of standard deviations. A value of zero corresponds to the average of the parameter in the database. A high positive value of, say, more than 3 indicates that the predicted value is at the high end or outside of what is in database. A negative value of, say, less than -3, corresponds to the predicted value being at the low end or outside of what is in database.

Default Warning and Action limits for GH, NH, and T-statistics are set for each prediction model in the software.

Sample Preparation

We recommend using the small or the large cup for analysing raw sugar, or the slurry cup can be used without any Gold Reflector. No special temperature stabilisation has been made so it is recommended to analyse the samples at room temperature.

Fig. 8 Small cup example.

Ordering and Further Information

Please contact Henrik Hansen, Head of Market Innovation, hha@foss.dk.