FOSS

Application Note

AN 5420

Rev. 2

NIRS™ DS2500

Sugarcane Juice

Sugarcane juice can be analysed for payment purposes or for production optimisation. Mass balance calculations start with what is coming into the mill so analysing the first juice is crucial. Furthermore, the first juice can also be used for payment analysis and to estimate the final yield. Analysis of the first expressed juice enables adjustments of dilutions and recycling streams. This helps the mill meet specifications and to improve sugarcane extraction.

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 juice sample into an NIRS™ DS2500, Pol, Brix, Reducing Sugars and pH are all simultaneously analysed in less than a minute.

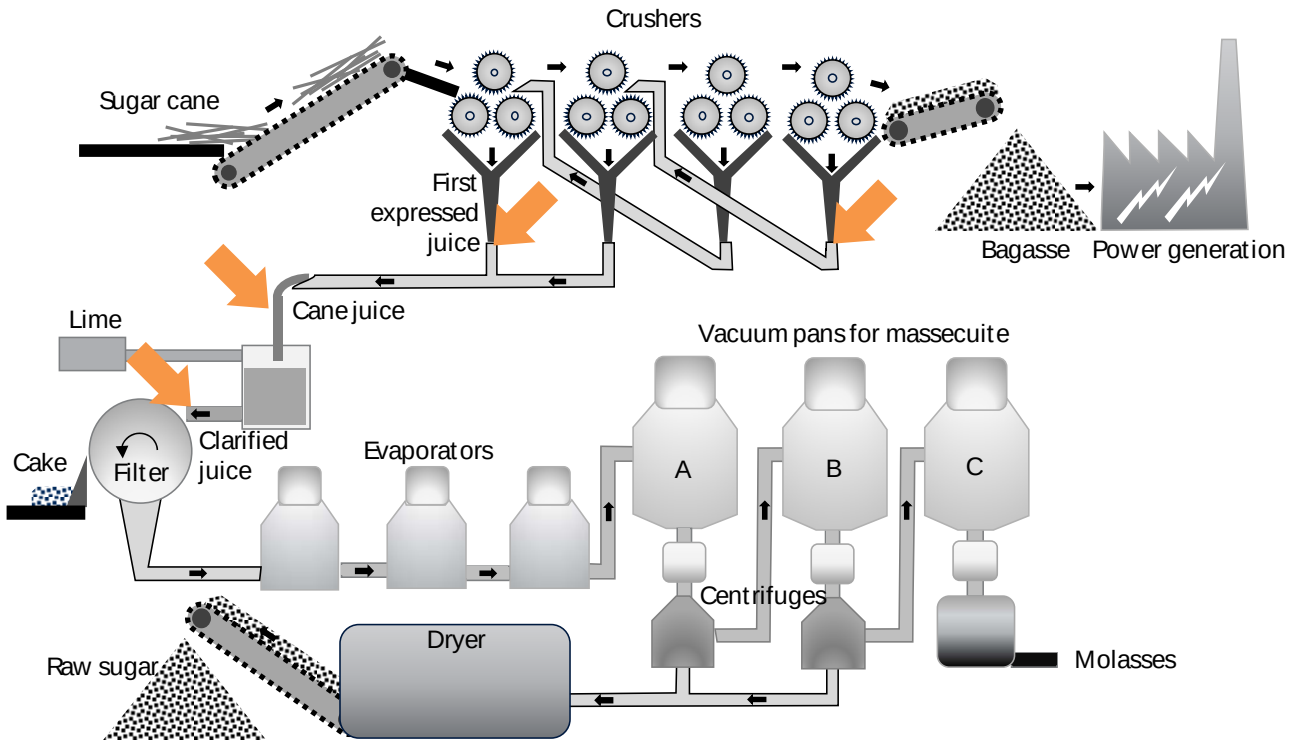

Fig. 1 Conventional mill, measurement points.

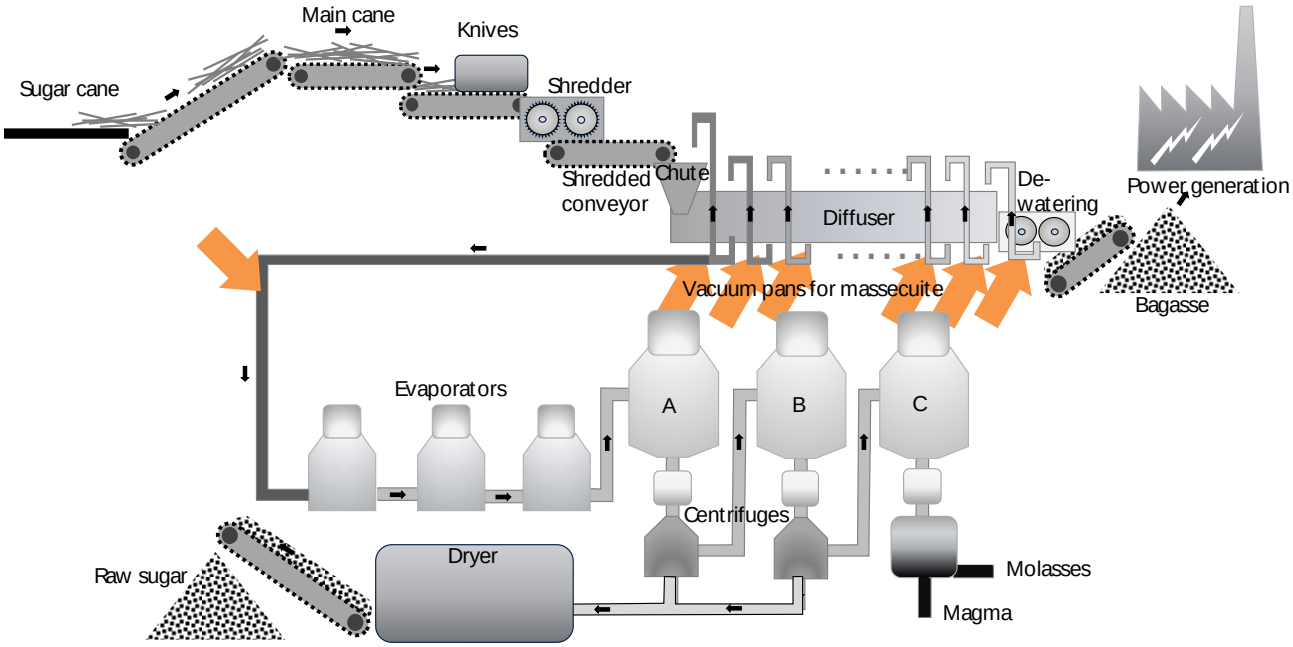

Fig. 2 Diffuser mill, measurement points.

Fig. 3 NIRS DS2500

Sample Description

Reference samples have been collected and analysed over several crushing seasons. Reference methods used were Pol, sample clarification using dry lead followed by polarimeter measurement; Brix, refractive index; Reducing Sugars, Fehling's test; pH-meter.

Parameter	Version	Min	Max	N	Model type
Brix	2.0.0.0	1.5	25.2	1504	MPLS
Pol	2.0.0.0	1.1	22.0	1421	MPLS
Reducing Sugars	2.0.0.0	0.2	0.6	796	MPLS
pH	2.0.0.0	4.7	8.4	1017	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
Brix	1.7	23.6	237	0.19	0.998
Pol	1.2	21.4	221	0.20	0.998
Reducing Sugars	0.20	0.56	106	0.026	0.863
pH	4.7	8.2	147	0.18	0.965

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).
RSQ: Linear correlation between NIRS DS2500 result and reference result.

Table 2 Validation data.

Calibration Performance Graphs

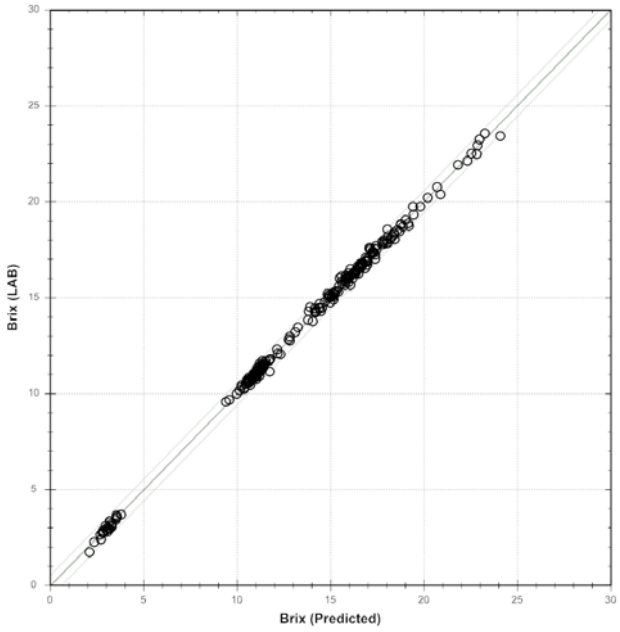

Fig. 4 Brix

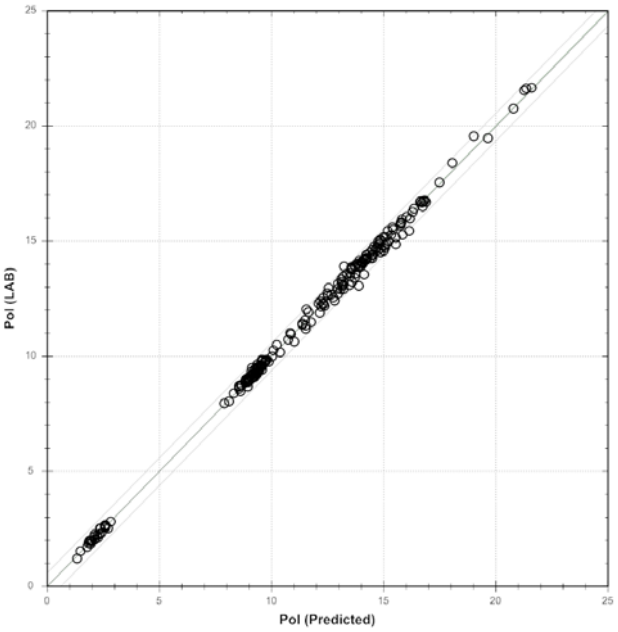

Fig. 5 Pol

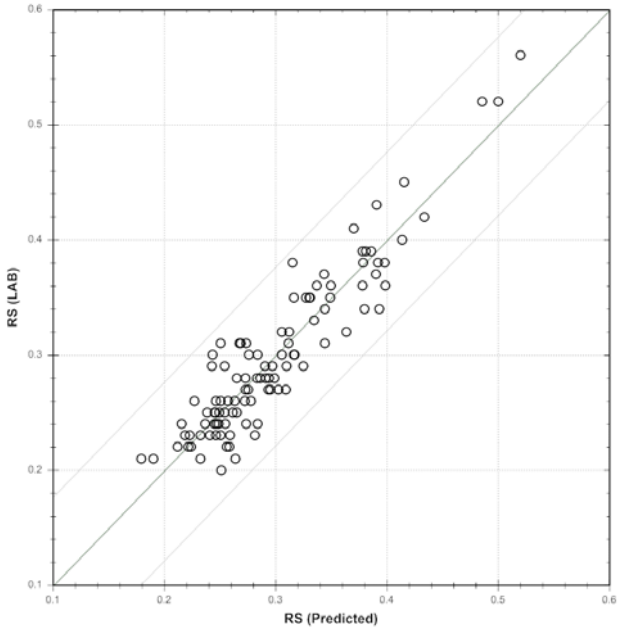

Fig. 6 Reducing Sugars

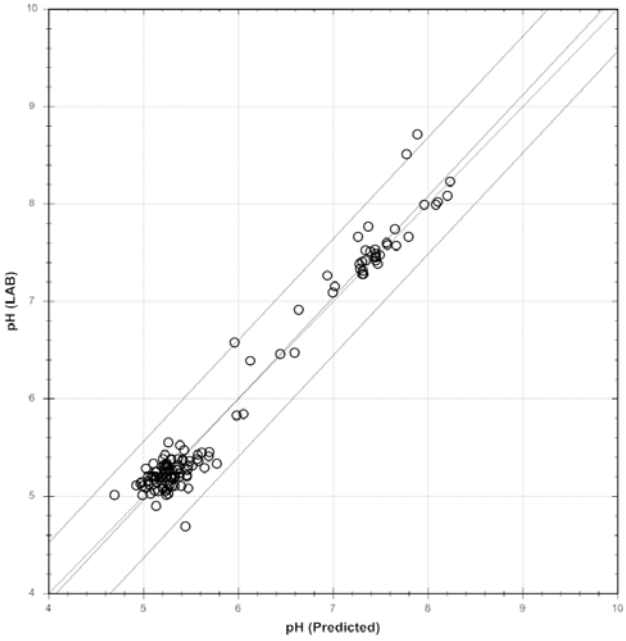

Fig. 7 pH

In the sugar industry, “Pol” is an abbreviation for Polarisation and it is synonymous with sucrose. “Brix” is synonymous with Total Dissolved Solids. “Purity” is a key for process optimisations and we strongly recommend to add it as a calculated parameter:

Purity = Pol/Brix*100 %

The amount of Reducing Sugars (“RS”) is another quality indicator. RS or “Invert Sugars” consist mainly of glucose and fructose originating from sucrose inversion. The less RS, the better. As it can be seen in the performance graphs Pol (in Juice) and Brix (in Juice) provide very good accuracy across a wide concentration range. The RS calibration data has a maximum of 0.5 % so the range of the RS calibration is limited. It can however still be used to distinguish between low and high levels of RS. The calculation of pH from the spectrum can be used to warn for acidic juices, as these will provide a sucrose inversion environment and sucrose losses downstream, see Fig. 1.

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 more than 3 standard deviations indicates that the predicted value is at the high end or outside the range of the database. A negative value of less than -3 standard deviations indicates that 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 slurry cup with a 0.5 mm gold reflector for analysis of sugarcane juice. No special temperature stabilisation has been made so it is recommended to analyse the samples at room temperature.

Fig. 8 Sample handling.

Ordering and Further Information

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