

**AN 5423****Rev. 2****NIRS™ DS2500****Syrup**

After the sugarcane juice has been filtered and clarified, it is concentrated through evaporation steps to get a supersaturated syrup. It is important to measure the total solids and the sucrose contents so they are around 65 % to match the next step in the sugar process, the massecuite crystallisation. It is important to be on target to have the desired crystal growth. Measuring Reducing Sugars and pH is important to track sucrose inversion and reduce sugar losses. The target for the pH of the syrup is around 6.5. This will help also help in the following crystallisation processes and slow down the inversion process that create reducing sugars and less sucrose yield.

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, Purity, Reducing Sugars and pH are analysed in less than a minute.

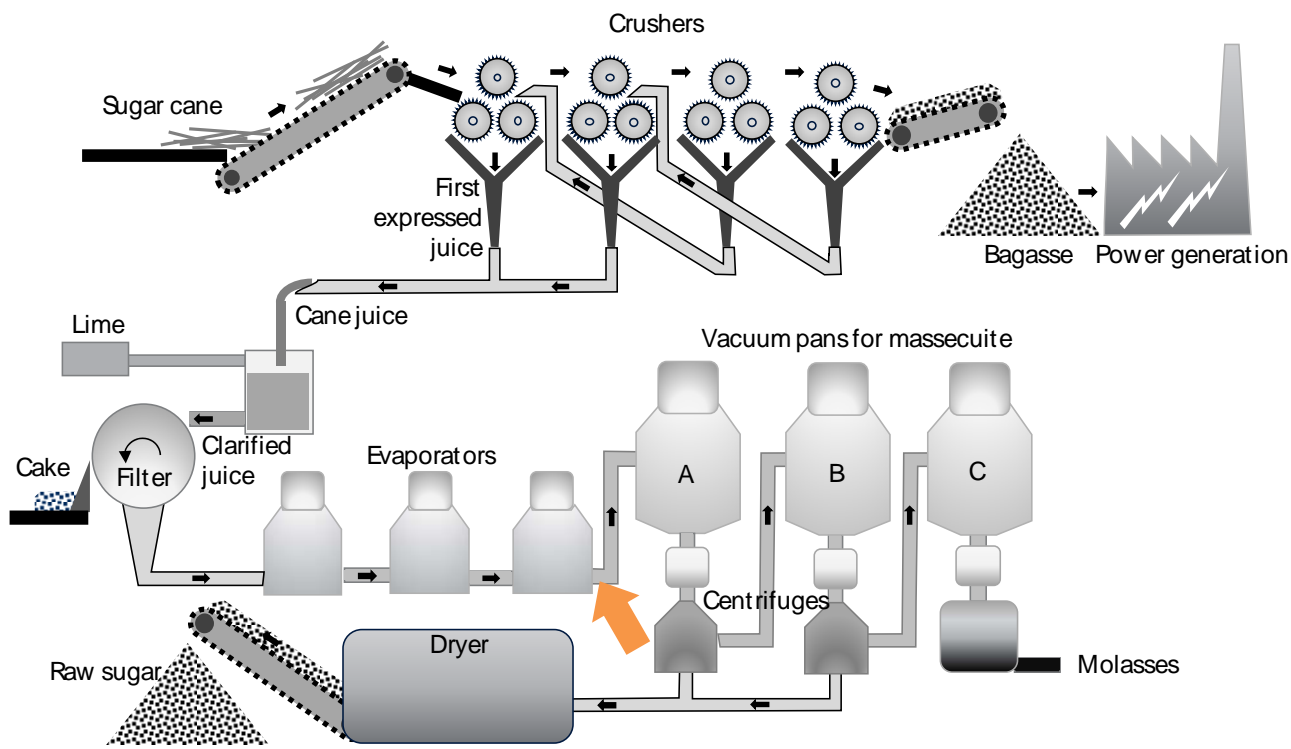


Fig. 1 Conventional mill, measurement points.

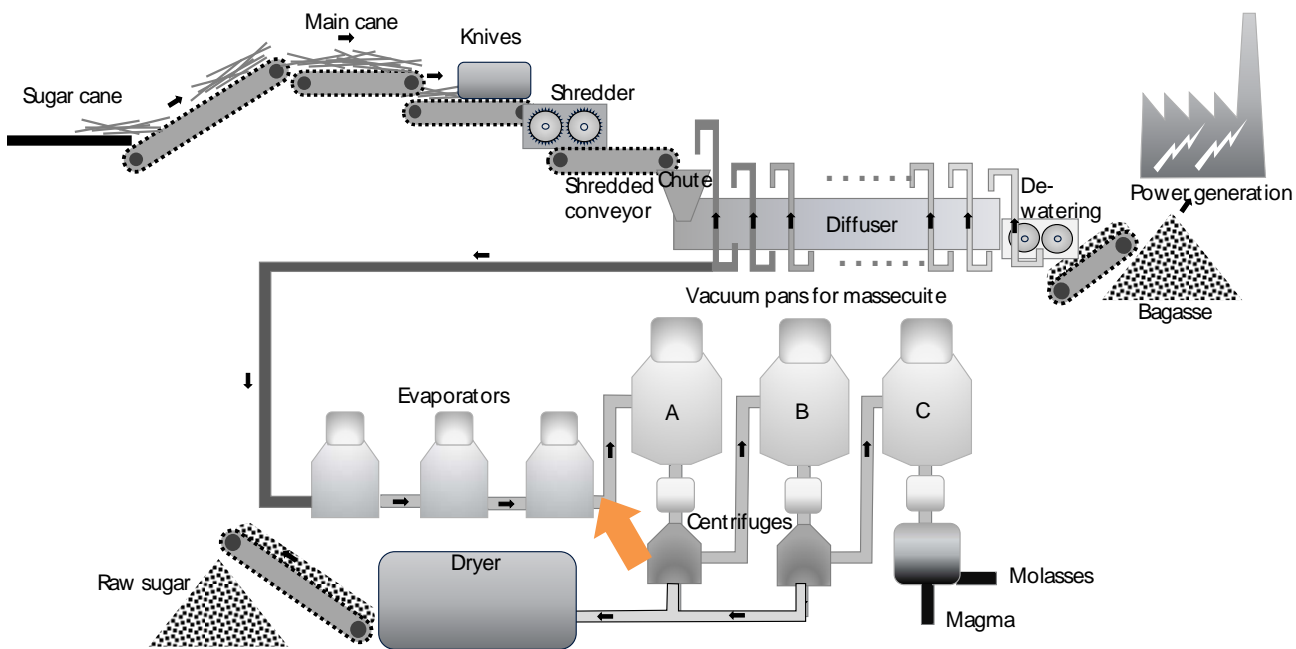


Fig. 2 Diffuser mill, measurement points.



Fig. 3 NIR5 DS2500

## Sample Description

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

Parameter	Version	Min	Max	N	Model type
Brix	2.0.0.0	43.8	73.7	578	MPLS
Pol	2.0.0.0	32.3	62.5	571	MPLS
Reducing Sugars	2.0.0.0	0.8	1.7	314	MPLS
pH	2.0.0.0	4.9	8.3	592	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	52.1	72.0	63	0.37	0.995
Pol	43.6	63.7	65	0.31	0.989
Reducing Sugars	0.9	1.6	33	0.11	0.717
pH	5.5	7.6	68	0.12	0.925

Min.: Minimum reference value in test set.  
 Max.: Maximum reference value in test set.  
 N: Number of samples in the test set.  
 Acc.: Accuracy of test set expressed as Standard Error of Prediction (SEP).  
 RSQ: Linear correlation between NIR5 DS2500 result and reference result.

Table 2 Validation data.

# Calibration Performance Graphs

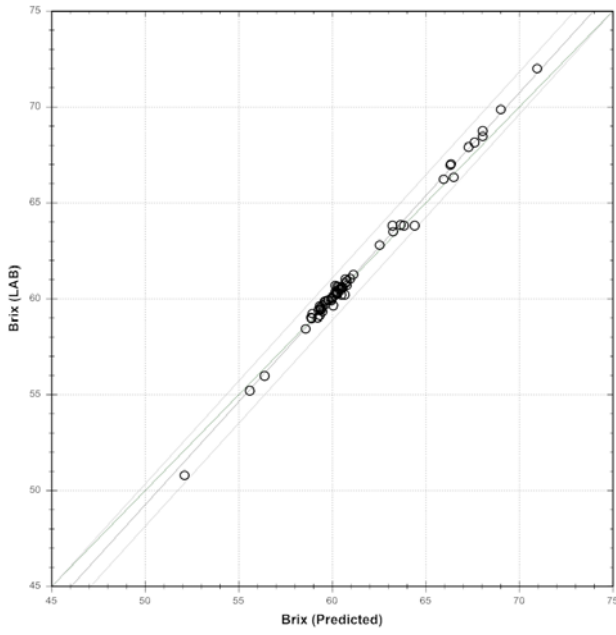


Fig. 4 Brix

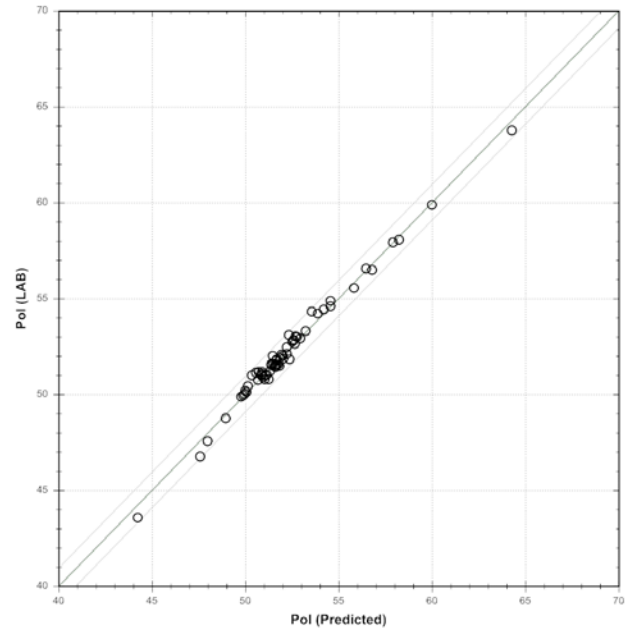


Fig. 5 Pol

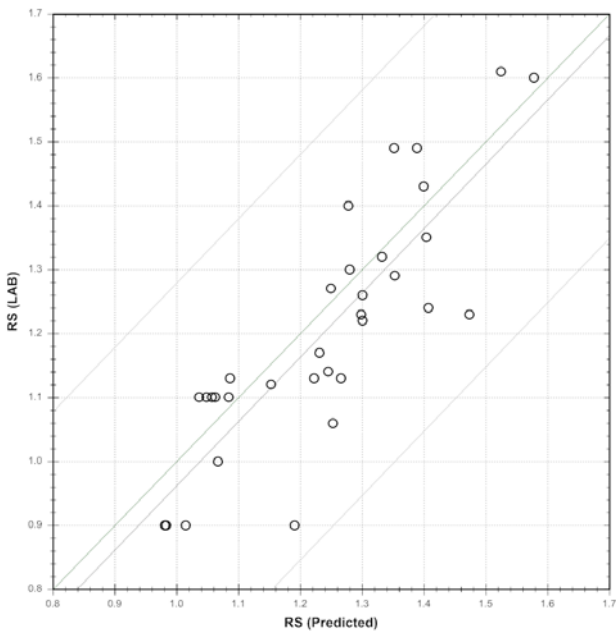


Fig. 6 Reducing Sugars

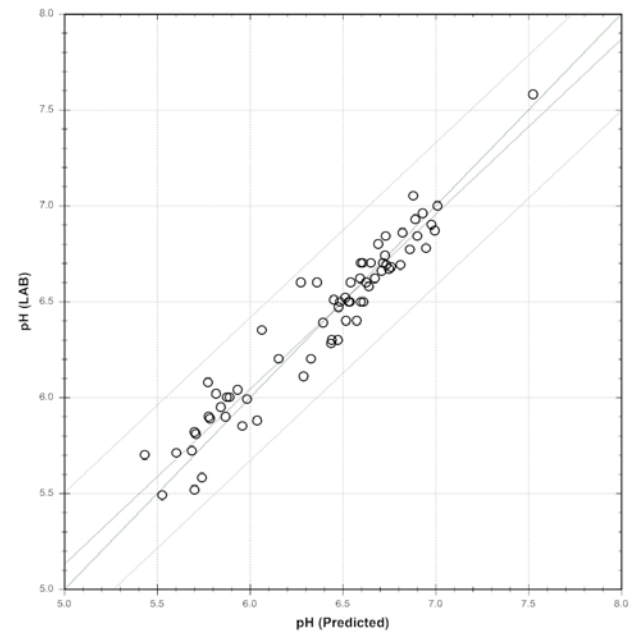


Fig. 7 pH

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

$$\text{Purity} = \text{Pol}/\text{Brix} * 100\%$$

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. Pol (in Syrup) and Brix (in Syrup) provide good accuracy across a wide concentration range. The RS calibration data has a maximum of 1.7 % so the range of the RS calibration has a better range than that for the juice. It can be used to distinguish between low and high levels of RS. The calculation of pH from the spectrum can be used to act as warning for acidic juices, as these will provide a sucrose inversion environment and sucrose losses downstream.

**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 syrup analysis. No special temperature stabilisation has been made so it is recommended to analyse the samples at room temperature.



*Fig. 8 Slurry cup with syrup.*

## Ordering and Further Information

Please contact Henrik Hansen, Head of Market Innovation, [hha@foss.dk](mailto:hha@foss.dk).

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