THE INFLUENCE OF BRIX FREE WATER WHEN ASSESSING MILLING PERFORMANCE

by T. H. FOURMOND

Whenever mill engineers are at a loss to explain the fluctuations of the milling performance of their mills, they blame the quality of the cane.

Investigations into the incidence of Brix Free Water on milling performance seem to prove that the mill engineers are quite justified in blaming cane quality for such fluctuations.

From the milling point of view, cane can be defined as being composed of Bone Dry Fibre + Brix Free Water + Undiluted Juice — which means that Natural Fibre = Bone Dry Fibre + Brix Free Water.

Taking for granted that the Brix Free Water is attached to the fibre and cannot be expressed by mechanical means, it stands to reason that during the process of milling, the Brix Free Water is never extracted and does not mix with the juice, undiluted or diluted.

It is also known that Brix Free Water % Fibre is not always present in a fixed quantity but varies considerably from day to day, week to week and month to month. Whether such variations are due to varieties and age of cane, climatic conditions, burnt or trashed cane it is hard to say. But the fact remains that Brix Free Water % Fibre can vary by some 10% as shown from data collected at Amatikulu.

Week Ending:
4.7.64—25.7.64—22.8.64—12.9.64—10.10.64—7.11.64
Brix Free Water:
16.4 18.7 24.7 23.8 27.0 29.4

Now, to demonstrate how such fluctuations can upset the calculations of mill settings: Mills are set to discharge bagasse at a certain % of Fibre. Provided that the Imbibition % Fibre remains constant, we could assume that two mills, discharging bagasse at the same % of Fibre, should have the same milling performance, assuming also that the efficiency of the Imbibition was the same in both cases. However, in practice, we often see that it is not the case. Why?

The answer can be found in the variation of the Brix Free Water % Fibre and to illustrate this, let us take the case of two units discharging bagasse at 50% Fibre. In one case, the Fibre will be associated with 20% Brix Free Water and in the other with 30%. The picture is as follows:

Fibre % Bagasse	Brix Free Water % Fibre	Natural Fibre % Bagasse	Diluted Juice % Bagasse
50	20	60	40
50	30	65	35

It stands to reason that the mill manipulating cane of 30% Brix Free Water will have a higher milling performance as the final bagasse will contain 5% less diluted juice.

Should we apply the same train of thought to all the units of two tandems composed each of five units discharging bagasse at 30, 35, 40, 45 and 50% Fibre respectively, the picture is as follows:

Unit	Fibre % Bagasse	Brix Free Water % Fibre	Natural Fibre % Bagasse	Diluted Juice % Bagasse	Difference in Juice Extraction
1st	30.0	20.0	36.0	64.0	3.0
		30.0	39.0	61.0	
2nd	35.0	20.0	42.0	58.0	3.5
		30.0	45.5	54.5	
3rd	40.0	20.0	48.0	52.0	4.0
		30.0	52.0	48.0	
4th	45.0	20.0	54.0	46.0	4.5
		30.0	58.5	41.5	
5th	50.0	20.0	60.0	40.0	5.0
		30.0	65.0	35.0	

It is clear that the tandem handling cane of 30% Brix Free Water will extract 3.0, 3.5, 4.0 and 5.0% more juice in the 1st, 2nd, 3rd, 4th and 5th unit than the tandem with cane of 20% Brix Free Water.

These figures can lead to confusion if we do not know how to interpret them. It does not mean that we have extracted 20% more of the undiluted juice. If it is true that in the 1st unit we have extracted 3% more of the undiluted juice, it does not follow suit for the other units because from then onwards the residual juices will be more and more diluted. However, we can conclude that 3.5, 4.0, 4.5 and 5.0% more diluted juice will be extracted from the bagasse coming from the 2nd, 3rd, 4th and 5th units respectively.

To prove this, let us draw the following picture of the bagasse coming from the 4th units, with application of imbibition at the rate of 250% on Fibre.

Fibre % Bagasse	Brix Free Water % Fibre	Natural Fibre % Bagasse	Residual Juice % Fibre	Imbibition 250 % Fibre	Parts Diluted Juice in Bagasse
45	20	54.0	46.0	112.5	158.5
45	30	58.5	41.5	112.5	154.0

Therefore we have 158.5 and 154.0 parts of diluted juice going to the 5th units respectively. As the final diluted juice % bagasse after the 5th unit will be 40 and 35% respectively, then the parts of diluted juice extracted by both 5th units will be as follows:

Brix Free Water % Fibre	Diluted Juice Extracted from Diluted Juice in Bagasse
20	$158.5 - \frac{(158.5 \times 40)}{100} = 91.5$ Parts
30	$154.0 - \frac{(154.0 \times 35)}{100} = 100.1$ Parts

giving a difference of 5% more diluted juice extracted in the case of cane of 30% Brix Free Water — which

corresponds exactly to the figures arrived at previously for the 5th units, and so it goes on for the other units.

Furthermore, the residual juices will also be more diluted after every unit. For instance, the residual juice, coming from the 4th units will be more diluted to the extent of:

Brix Free Water % Fibre	Dilution % Residual Juice
20	$\frac{158.5 \times 100}{46} = 34.46\%$
30	$\frac{154.0 \times 100}{41.5} = 37.11\%$

which will also contribute to achieving a higher extraction through greater dilution. And so it goes on for all the other units.

A pertinent question would be: Is the application of this school of thought justified in practice?

At Amatikulu we plotted daily, Brix Free Water against milling performance during the last crushing season and we found the correlation to be very significant whenever the calculation of Brix Free Water % Fibre was not influenced and vitiated by rainfall.

To support this we quote figures for a fortnightly period where there was no rainfall. These figures not only prove the incidence of Brix Free Water on milling performance, but also show the daily fluctuations of Brix Free Water in cane.

Date	Brix Free Water % Fibre	Tons Fibre Per Hour	Imbibition % Fibre	Lost Absolute Juice % Fibre
13/10/64	23.0	19.1	250	40.2
14/10/64	23.6	18.8	248	39.8
15/10/64	16.8	16.3	289	40.4
16/10/64	25.0	18.3	269	41.7
17/10/64	25.5	18.2	251	41.7
19/10/64	20.6	16.3	294	38.4
20/10/64	24.2	16.8	280	39.4
21/10/64	34.1	18.5	258	37.4
22/10/64	31.5	18.1	265	40.0
23/10/64	32.2	17.9	263	39.5
24/10/64	22.0	17.1	272	40.5

It can be seen that for a given tonnage of fibre per hour and imbibition % fibre, there appears to be a significant correlation between Brix Free Water and milling performance.

In 1961, Amatikulu for two weeks milled only overburned cane from the raging fires in the Gingindhlovu area. Whilst this dessicated cane was manipulated, the lost absolute juice, 34.5 previously, went up to 44%. It was also found that during this period that the Brix Free Water, 20.8 previously, had dropped to 4.7%. When the mill started to manipulate fresh cane again with a Brix Free Water of 20% fibre, the lost absolute juice went back to a normal 34.4%.

In the light of such figures we can therefore, conclude that Brix Free Water content has a marked influence on milling performance. Mill engineers are therefore, well advised to look up this figure, not only whenever they are at a loss to explain unusual fluctuations in the milling performance of their mills, but also when they set their mills according to Dr. Douwes Dekker and Van Hengels' formula (1) where the Brix Free Water is taken as being 30% and any large deviation from this figure would upset greatly the efficiency of the mill setting.

For the guidance of mill engineers, let us say that Brix Free Water content seems to follow the same pattern every year; low at the beginning of the season in May, it gradually increases until December and starts to decrease again as shown by the following figures.

	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
1963	14.8	15.8	17.8	23.0	24.2	21.7	24.7	26.5	24.9	21.5
1964	19.0	16.6	19.7	23.8	22.2	25.1	28.3	29.2	23.5	22.5

Considering the effect of Brix Free Water on milling performance, is it wishful thinking to say that we ought to calculate our milling performance in terms of LOST UNDILUTED juice % Natural Fibre rather than of LOST ABSOLUTE Juice % BONE DRY FIBRE?

We should also bear in mind that the milling process is not restricted to a purely mechanical achievement only where constant roller lift, maximum roller grip and juice drainage will contribute to ideal escribed volume leading to maximum extraction. There are also other aspects which are quite important. For instance, we know that in the process of compound imbibition, the mixing of the imbibition water with residual juice is never complete. However, the degree to which this mixing is achieved will have a considerable bearing on milling performance as proved by Dr. Douwes Dekker (2). The present paper also draws attention to cane quality (Natural Fibre) on mill extraction.

Therefore, in order to obtain a clear picture of milling performance, those different factors should be looked into and correlated with a view to finding where the faults lie and to achieving the highest milling performance.

Bibliography

(1) Some notes on the operation of Mills by Van Hengel & Dr. Douwes Dekker. Proc. 32nd A. Congress S.A.S.T.A.

(2) Dr. Douwes Dekker. Again Imbibition. S.A.S. Journal Jan. 1961.

Mr. Perk: I agree with using Lost Undiluted Juice % Fibre rather than Lost Absolute Juice when calculating milling performance.

Lost Undiluted Juice per cent Fibre can be calculated every hour from the analyses, and bagasse weight and juice weight are not required. Care must be taken, however, to have a good sample of first expressed juice. When it has been raining the brix goes down, as it also does if cane is washed before milling, and it is then even possible to get a negative brix-free water.

Mr. Fourmond: Wet cane must be considered from two angles. If cane is weighed dry and then gets wet, the surface water on the cane is expressed by the first unit. Bagasse per cent cane will also be affected and

this will compensate more or less for the change in brix in first expressed juice.

If the cane comes wet from the weighbridge then a decisive misleading factor is introduced.

Dr. Douwes Dekker: Brix-free water is the amount of water physically attached to the fibre and which we have determined lies between 20 and 30 per cent of fibre. However, it is extremely difficult to determine exactly how much brix-free water is physically attached to the dry fibre and that accounts for the 10 per cent variation.

But with brix-free water in cane another factor might affect the amount present. For example, a lot of trash in cane will decrease the amount because fibre in trash will have less brix-free water than cane fibre.

There is also a brix-free water figure derived from milling control data. When calculated this way the final figure includes all the basic errors which are in in the figures we use.

When we note daily fluctuations in brix-free water as demonstrated by Mr. Fourmond these probably are due to normal inaccuracies in the determinations and calculations.

I therefore do not think the figures could be used to calculate Undiluted Juice sufficiently accurately to draw conclusions.

Mr. Perk: A certain mill in Java for years had 33 per cent brix-free water. Then it was discovered that by changing the angle of the juice sampler the figure was reduced to a more normal figure.

Mr. Fourmond: Nowadays with continuous samplers, as recommended by the S.M.R.I., we should not get such errors.

Mr. Gunn (in the chair): You mentioned in the paper that overburnt cane had very low brix-free water and extraction was poor. I think the general damage to the cane probably accounted for the poor extraction, not the lower brix-free water.

Mr. Fourmond: I do not think damage to sucrose in the cane affected extraction, that is when regarding extraction as loss of sucrose in bagasse. The inverted sucrose would equally affect the juice extracted and the residual juice in bagasse.

Mr. Phipson: I would like to know how brix-free water affects final moisture in bagasse. One would expect that a high brix-free water content would lead to a higher moisture content in final bagasse.

Mr. Fourmond: It has no effect whatsoever because brix-free water is so much less than the total moisture in the bagasse, apart from the fact that dilution water is also added.

Mr. Phipson: Moistures for each mill are very much the same from day to day so if brix-free water increases more moisture must be extracted otherwise there would be variations in moisture content of the bagasse.

Dr. Douwes Dekker: If bone dry fibre was say 45 per cent of final bagasse and brix-free water was 20 per cent of that, it would be 9 per cent on bagasse weight. If in another case brix-free water is 33 per cent on fibre, the brix-free water amounts to 15 per cent of the bagasse weight. This is a difference of 6 per cent, which maybe should appear as a fluctuation in the moisture content of the bagasse. But as we do not get these moisture fluctuations we can only conclude that big fluctuations in brix-free water also do not take place. Any apparent fluctuations are due to errors in the basic figures.

Mr. Kramer: As last season the moisture content of final bagasse at Amatikulu was remarkably consistent it is obvious that the large variations in brix-free water, as shown by Mr. Fourmond, did not affect the moisture content.

Mr. Gunn: That is actually what Dr. Douwes Dekker was saying — that there are no large fluctuations in brix-free water and hence the moisture content is not affected.

Mr. Perk: Further support for arguments against claiming too much value for variations in "W" can be obtained in "The Annual Summary of Laboratory Reports — Season 1964/65", under the section "Factory Control" and also in Table 3, which shows varying values for "W".

Mr. Fourmond: Brix-free water will affect extraction and not moisture content for the simple reason that mills are set to discharge bagasse at a pre-determined escribed volume. When brix-free water is high, the diluted juice will be low and vice versa, as the volume occupied by both brix-free water and diluted juice remains the same, bearing in mind that brix-free water represents only 25 per cent of the total moisture content.