EXTRACTION RATIO

By TH. FOURMOND

Should milling efficiency be expressed in terms of brix or absolute juice, rather than in terms of sucrose extraction? This represents quite a dilemma as these two schools of thought do put forward plausible and justified reasons.

As mill extraction is closely related to the fibre content of the cane and should, therefore, be correlated with it, we are compelled to have a formula which serves as a yardstick to express milling efficiency.

Many formulae have been written to express milling efficiency such as, "Reduced Mill Extraction", "Extraction Ratio", "Milling performance" and in South Africa it is common practice to express milling efficiency in terms of "lost absolute juice per cent fibre". Although this expression is a better yardstick than the mill extraction figure, it is, nevertheless, an expression which is not entirely correct as we shall endeavour to prove.

It has been known for quite a long time that cane contains some kind of water which is free from dissolved solids and different countries have given different denominations to this particular type of water; absorption, colloidal, undetermined and in South Africa it is known as brix-free water.

Cane may be defined as being made of:

Fibre+brix-free water+undiluted juice

or

Fibre+absolute juice

∴ Absolute juice=Brix-free water+undiluted juice

We also know that this brix-free water is attached to the fibre of the cane and cannot be separated by pressure. This can be proved by the fact that the brix of the primary, or undiluted juice is higher than the one of the absolute juice. It, therefore, stands to reason that during the milling process, only part of the undiluted juice is being extracted and that all the brix-free water remains attached to the fibre of the bagasse which goes to the boilers. Strictly speaking, no absolute juice is ever extracted during the milling process but only part of the undiluted juice and that all the brix-free water is lost in the bagasse.

Therefore, the expression "Lost absolute juice per cent fibre" could be correctly defined as the percentage of absolute juice which would have been lost, should the milling process be in a position to extract brix-free water. But as we know that no brix-free water is ever extracted during milling process, the term "Lost absolute juice per cent fibre" appears to be fallacious.

We are, therefore, entitled to ask the following pertinent question: is it absolutely correct to express milling efficiency by a formula which is fundamentally incorrect in practice?

We also know that the quantity of brix-free water attached to the fibre is not present in a fixed ratio in all canes and that this ratio is assumed to vary between 25 to 30 per cent and we should also say that figures obtained from practical results show even greater deviations.

At this stage, we should draw the attention of mill engineers to the bearing of brix-free water variations in the determination of bagasse moisture content. If pressure cannot separate the brix-free water from the fibre during the milling process, then when bagasse is heated to 105°C for five hours, all this brix-free water is separated, as it is evaporated.

It, therefore, stands to reason that any bagasse with a high brix-free water ratio will show a higher moisture content than one with a low brix-free water ratio. As bagasse contains some 50 per cent fibre, a variation from 20 to 30 per cent in the brix-free water ratio will show some 5 per cent more moisture content in the bagasse.

We could also assume that during the process of digestion, where bagasse and water are heated to boiling point for the determination of sucrose in bagasse, that the brix-free water is also separated from the fibre and mixes with the diluted juice. Should this school of thought be correct, then any bagasse with a high brix-free water ratio, will show a lower sucrose percentage than one with a low brix-free water ratio. However, the difference will not be as appreciable as in the case of moisture content.

In other words, the sucrose and moisture contents of bagasse are, respectively, inversely and directly proportional to the brix-free water ratio of the fibre in bagasse.

This is why mill engineers should not unduly worry whenever they see bagasse moisture content varying by some 5 per cent from one sample to another. It is not due to milling or laboratory carelessness, but rather to variations in the brix-free water ratio of the cane. However, brix-free water ratio should not be turned into a scapegoat for milling or laboratory inefficiency.

The attention of mill engineers should also be drawn to the bearing of brix-free water upon mill extraction. The escribed volume of a mill discharging bagasse can be defined as follows:

Escribed volume=Fibre+brix-free water+diluted juice

As the brix-free water cannot be extracted by the milling process and the volume of fibre being a constant, therefore, the larger the volume of the brix-free water is, the smaller the volume of the diluted juice will be.

Therefore, we can conclude that mill extraction will vary directly to the brix-free water ratio of the cane.

It should also be said that the determination of brix in cane is not entirely correct: if the determination of brix in mixed juice offers a certain degree of reliability, the determination of brix in bagasse is merely a blind assumption, as the purity of the residual juice in bagasse is assumed to be the same as that of the last expressed juice. The investigations carried out by R. Pole and quite recently by Dr. Douwes Dekker on the "Brix of juices expressed from cane and bagasse by static pressure" are sufficient proofs of the fallacy of the calculation of brix in bagasse by our present method. It is a pity that Dr. Douwes Dekker did not also include the purity of the various juices in his experiments as more enlightening evidence would have been obtained.

On the other hand, we know that sucrose can be accurately determined in mixed juice and although sucrose in bagasse is merely a pol determination, we also know that the difference between pol and true sucrose in bagasse is so small as to be negligible. Therefore, we can conclude that sucrose, being more accurately determined, offers better grounds than brix or absolute juice for expressing milling efficiency.

In Hawaii, Queensland and Mauritius, milling efficiency is expressed in terms of sucrose, which is correlated to the fibre content of the cane by a formula known as the *extraction ratio*, which is as follows :

$$\frac{\text{100—Mill Extraction}}{\text{Fibre \% Cane}} \times 100$$

It is very similar to the lost absolute juice per cent fibre in the sense that it expresses the percentage of sucrose lost per cent fibre of the cane and also offers the advantage of being based on accurate determinations.

The following figures clearly show the similarity between the lost absolute juice per cent fibre and the Extraction Ratio figures:

	Lost Absolute juice % juice	*Extraction Ratio*
FX	40.1	41.0
DL	30.6	31.7
MV	45.1	46.9
TS	31.4	32.6
IL	43.4	44.8
RN	39.3	40.7

Should one be looking for the needle in the haystack, one could logically say that the determination of fibre is also not correct as it is calculated from the brix in bagasse, which, as we know, is not very reliable. Nevertheless, one incorrect factor is still better than two and, therefore, the Extraction Ratio is a step better than the lost absolute juice per cent fibre for expressing milling efficiency as it offers more accuracy.

Furthermore, we should also remember that the milling process is only interested in extracting sucrose and not brix, which influence is only felt in the factory. In other words, the mill engineer is only interested in separating the sucrose from the fibre whilst it is the duty of the factory manager to crystallise sucrose from the brix.

Therefore, in the light of all the reasons quoted above, we can logically ask the following pertinent question: should milling efficiency be expressed in terms of brix extraction rather than in terms of sucrose?

Mr. J. L. du Toit, in the chair, said that the author had stated that he considered the use of the figure, Absolute Juice per cent Fibre, was theoretically wrong because it did not take into account brix-free water which could not be expressed by a milling plant. He then came to the conclusion that if there was a 5 per cent difference in moisture per cent bagasse from sample to sample it was nothing to worry about, but the Speaker thought that there would not be such a big difference from sample to sample.

Dr. Douwes Dekker said there were so many points in the paper, each of which could be discussed for hours, and it was not possible to go into the various points raised. The sucrose content of the juices squeezed out of cane by continued exertion of pressure dropped more than the brix, and for this reason, he could not agree that we should change to sucrose figures.

He thought it very dangerous to explain a difference in moisture per cent bagasse of 5 per cent as being due to brix-free water.

Mr. Fourmond asked if Dr. Douwes Dekker had continued his experiments on the juice expressed by static pressure so as to include purity figures.

Dr. Douwes Dekker replied that such experiments had not yet been carried out, but Mr. Hugot in Reunion was going to carry the investigation further using even higher pressures than had been employed here, and no doubt he would determine purities. He was sure that variations in sucrose would be found to be even greater than variations in brix.

Mr. Rault thought it more practical to express sucrose figures as sucrose extraction was what we were really interested in.

Mr. Fourmond confirmed that most engineers were more impressed by sucrose figures than brix figures. The Extraction Ratio, which was more or less similar to Lost Absolute Juice per cent Fibre, would be more readily understood.