A PROPOSAL FOR THE USE OF AN E.R.S. FORMULA AS A BASIC STANDARD FOR THE COMPARISON OF DEPARTMENTAL FACTORY PERFORMANCES

By A. M. GUTHRIE

Abstract

The paper discusses a proposal to use the Van Hengel Formula, or any similar formula, to establish basic standards for milling performance, boiling performance and undetermined losses. Relative efficiencies of the different factories may then be readily compared by ranking their performances in each department against these standards. The method is illustrated by an analysis of the performance of all factories during the 1970-71 season.

Introduction

The weekly summaries of laboratory reports issued by the Sugar Milling Research Institute provide an invaluable source of comparative data on the performance of the various factories in the sugar industry. However, it is difficult to determine from this data without a considerable amount of arithmetic manipulation how the performance of any factory, particularly by department, compares with others in the industry.

The Natal Ratio, proposed as one of the indices in the new cane payment system, gives a good comparison of overall factory performances if it is borne in mind that the Van Hengel Formula makes no allowance for the reducing sugars/ash ratio in arriving at the exhaustibility of final molasses. However, this gives no indication of the department in which the performance is above or below average. Can the Van Hengel Formula then be divided to give separate performance indices to allow ranking and hence comparison of performances of different mills by department?

Analysis of the Van Hengel Formula

The Van Hengel Formula is based on the average performance of South African Sugar Mills over the 10-year period 1956 to 1966. According to this analysis the average sucrose losses through a sugar factory are:

Lost in bagasse	0,055F
Lost in filtercake and undetermined loss ...	0,0185S
Lost in molasses	0,476N

Where S = Sucrose % cane
F = Fibre % cane
N = Non sucrose % cane

Based upon these figures the Van Hengel Formula has been derived to determine the expected yield of sugar at 98,7° Pol and 0,23 safety factor from cane of a given analysis.

For the purpose of this analysis it is more useful to compute all values in terms of sucrose, and to use the figures given above for the standard losses rather than to convert to standard sugar.

There are numerous methods of arriving at performance indices. For example, actual losses in bagasse, final molasses and combined undetermined and mud loss may be expressed as percentages of the standard losses, or the recovery at each station may be compared with the standard recovery as calculated from the standard losses.

Note that it is considered advisable to treat the undetermined loss separately from the boiling house performance. It is appreciated that the undetermined loss may occur entirely in the boiling house. However it has been shown (Prince. Proc. S.A.S.T.A. 1969, p. 141) that in many factories a considerable proportion of the undetermined loss arises because mixed juice analyses are not adjusted to allow for the suspended solids in mixed juice. The undetermined loss may also be caused by inaccuracies in sampling and analyses, inversion in the clarifier or a number of other causes. The only justification for including the loss in filter cake with the undetermined loss is that this is a very small proportion of the total loss and in the derivation of the Van Hengel Formula these two losses were combined.

The Natal Ratio for comparing factory performances has been defined as the ratio of sucrose made to the estimated recoverable sucrose in cane. For consistency departmental performance indices were computed as the ratio of recovery in the department to the recovery which should have been achieved according to the standards used in deriving the Van Hengel Formula.

Performance indices were computed by first computing the quantity of standard and actual sugar which should have been available in the following sequence:

a. After milling (i.e. in mixed juice).
b. After deducting undetermined and filtercake losses from sucrose in mixed juice.
c. Sugar made (as sucrose) and tons ERS expressed as sucrose.

Performance factors for each stage were then computed as the ratio of sucrose extracted to sucrose available at each stage both for actual and standard conditions. For example, the performance factor for the boiling operation was computed as the ratio of c/b. The performance index for each stage was then calculated as the ratio of the actual performance factor to the standard performance factor.

TABLE I

1970-1971 SEASON

Mill	Tons Sucrose	Tons Std in Mxd-J	Tons Std in Syrup	Tons Ers	Tons Sucrose			Natal Ratio	Performance Indices		
					in Mxd-J	in Syrup	Made		Milling	Undet	Boiling
1 PG	83971,	79537,	77984,	70733,	80822,	79722,	73521,	103,942	101,614	100,613	101,676
2 UC	32083,	30169,	29576,	26914,	31300,	30781,	27872,	103,561	103,748	100,313	99,507
3 FX	88847,	82977,	81334,	72663,	84707,	82681,	74927,	103,114	102,084	99,581	101,434
4 DL	100522,	94423,	92563,	83258,	96179,	93847,	85216,	102,351	101,860	99,535	100,951
5 GH	124545,	116235,	113931,	102582.	118143,	116474,	104657,	102,022	101,641	100,581	99,795
6 UF	113612,	106965,	104863,	94118,	108090,	107317,	95685,	101,665	101,051	101,275	99,340
7 EM	96684,	89522,	87734,	78655,	92072,	90090,	79921,	101,609	102,847	99,842	98,951
8 TS	166745,	155392,	152307,	138838,	157557,	154622,	141028,	101,577	101,393	100,125	100,056
9 MV	30939,	29011,	28439,	25956,	29314,	29042,	26331,	101,443	101,045	101,065	99,336
10 AK	139751,	131128,	128542,	116579,	133169,	129773,	118085,	101,291	101,556	99,409	100,331
11 SZ	121936,	114301,	112045,	102471,	116327,	115120,	103588,	101,090	101,772	100,954	98,390
12 JB	102931,	97007,	95102,	86299,	99318,	96662,	86234,	99,924	102,382	99,274	98,311
13 IL	64525,	60874,	59680,	54427,	61861,	60028,	54300,	99,767	101,620	98,978	99,189
14 GD	19637,	18486,	18123,	16487,	18343,	18003,	16367,	99,271	99,222	100,115	99,933
15 EN	25155,	23860,	23394,	21626,	24410,	23681,	21449,	99,182	102,307	98,941	97,982
16 DK	41646,	39291,	38520,	35581,	39193,	38468,	35128,	98,726	99,750	100,114	98,860
17 ML	97790,	92323,	90514,	81518,	93604,	90201,	80289,	98,491	101,387	98,290	98,833
18 RN	36274,	34006,	33335,	30218,	33963,	32716,	29639,	98,083	99,873	98,265	99,941
19 UK	59530,	56064,	54963,	50503,	56756,	54530,	48993,	97,010	101,233	98,002	97,781
Totals	1547128,	1451580,	1422958,	1289435,	1475136,	1443765,	1303238,	101,070	101,622	99,842	99,613

TABLE II

1970-1971 SEASON

Mill	Tons Sucrose	Tons Std in Mxd-J	Tons Std in Syrup	Tons Ers	Tons Sucrose			Natal Ratio	Performance Indices		
					in Mxd-J	in Syrup	Made		Milling	Undet	Boiling
1 UC	32083,	30169,	29576,	26914,	31300,	30781,	27872,	103,561	103,748	100,313	99,507
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TABLE III

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					in Mxd-J	in Syrup	Made		Milling	Undet	Boiling
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This approach may be open to criticism, particularly in arriving at a performance index for the boiling process and a different formula may give a more satisfactory boiling performance index. However, the approach used serves to illustrate the principle of the method of analysis.

Once all performance indices had been calculated for all factories except Mount Edgecombe (which was ignored as it was producing High Test Molasses) the results were sorted and tabulated in descending order of each of the four performance indices in turn to obtain a ranking of the relative performances of all mills on each of the factors, Natal Ratio, Milling performance, Undetermined losses and Boiling performance.

A set of analyses of the performance of all mills for the 1970-71 season are included in tables I to IV, the tables showing the rankings in terms of Natal Ratio, Milling performance, Undetermined losses and Boiling performance respectively. In each case a performance index of 100 is equal to the standard, while for comparison weighted industrial average performances are also given.

Discussion

The Van Hengel Formula has been proposed as a basic standard for the cane payment system. It has been shown how a standard of this nature may also be used to provide a relative measure of individual factory performance by department which can be quickly and easily interpreted by mill managements.

For the purpose of illustration the constants derived in Report No. 15 (Revised) Proposals for a New Cane Payment System submitted to the Commission of Inquiry into the Sugar Industry were adopted as the basic standards. Any other similar standards may be equally well adopted for an analysis of this nature.

It is recognised that the performance indices and rankings can be affected by the definitions adopted for the indices, and in particular it is noted that as there is no cognisance taken in the Van Hengel Formula of the effect of the reducing sugars/ash ratio on the exhaustibility of final molasses, this factor is also ignored in the calculation of performance indices.

Conclusion

The principles of comparing factory performances as proposed provide a quick and easy first order comparison of relative factory efficiencies which can act as a valuable guide to direct managements' attention to the departments where maximum return may be obtained. Once a department has been singled out for special attention it is obvious that detailed analysis of the laboratory reports and other operating factors will be essential to determine the causes of the poor performance and whether it can be economically rectified.

The virtue claimed for the proposed system lies not in its accuracy, which is open to doubt, but in its simplicity and in the ease of interpretation. The results tabulated with this paper were produced in two minutes on a relatively simple digital computer.

An extension to the above analysis which may also merit attention, and which could be produced with negligible additional computation is a ranking of mill groups on the basis of ERS. % cane. This will highlight those groups where attention to cane quality may produce substantial returns to both grower and miller.

Discussion

Mr. van Hengel: In 1968 cane was paid for on a parameter called sucrose, whatever that might mean in a Java Ratio system. Even had sucrose been determined in a correct way it would have been a direct sucrose system but it would not take into account its value for making sugar. A certain amount, depending on fibre content, is lost in bagasse and some is lost in molasses varying with the non-sucrose content.

I do not think it will ever be possible to find a formula that will accurately predict the amount of sugar that can be made.

It was restricted at that time to three easy parameters, namely, sucrose, molasses and fibre.

Any calculation made, as opposed to the originally proposed one, will have the same weakness because when you make the projected amount of sugar you will still make more or less.

If you divide the projected by the actual the temptation is to call it performance, or efficiency. If 2% more sugar is made the efficiency is 102%. It might be said that a factory making 102 is better than one making 101,5.

The ERS formula would here fall down completely for the same reason that BHP was suspect and was therefore discarded.

When a standard is set and it is provided that for every unit of non-sucrose so many units of sucrose may be lost, let us say ,476, then if by good work we manage to lose only ,456 we claim efficiency. But if you do this per unit of non-sucrose added then the number of such units added in the factory become important because you make a small profit i.e. you make more than the formula expects you to do. When you get in more non-sucrose than the neighbouring factory you make relatively more sugar than it does.

So, as M. J. Purity in BHP interfered with the standard set, so the same interference will be introduced in sugar 'made' over sugar 'predicted'.

It will be claimed by some than the Natal Ratio is a satisfactory basis for a cane payment system. This is not correct and it has never been proposed that it should be part of a cane payment system.

Milling efficiency is based on bagasse exhaustion. If boiling house efficiency has dropped from say 100,0 to 99,6 we first look at molasses purity now as compared to what it was. It is not necessary to use a calculation that is based on an empirical formula which is connected with something you have achieved in the past.

I have no wish that the ERS formula should be given more status or function than it was meant to have in the first place.

Dr. Guthrie: I do not propose ERS as a standard but as a guide to indicate which part of the weekly,

monthly or annual summary requires the closest study.

It was announced in an earlier paper that laboratory reports would be prepared on a computer. To provide a tabulation in the ranking indicated in this paper means a few more seconds work and a further half page of computer print-out. If the appendix saves the time of supervisory personnel by directing their attention to where results are best likely to be obtained by thorough inspection of laboratory reports then the object has been achieved.

Dr. Graham: Mr. Christianson presented a paper some years ago and showed how to draw the line of best correlation using the method of least squares, and he was criticised because of it.

Dr. Guthrie says that targets can be quickly calculated using certain formulae that are considered reasonable. He has used the ERS system to explain the results.

The Tongaat weekly sheet also shows the previous year's figures for comparative purposes but it is better to use a more reasonable set of figures as a comparison.

With ERS we can still get our figure of 106 but this will be because of high reducing sugars. This is something that will have to be looked at.

Dr. Guthrie: If Tongaat was top of the list because of high reducing sugars it would be easy to go to the report and pin-point the reason for this.

Similarly, it could be picked up if the reducing sugars ratio was poor, depressing the efficiency.

Mr. Camden-Smith: I think Dr. Guthrie and Mr. van Hengel are ahead of their time.

The S.M.R.I. sends out a weekly report which contains some figures that are technical and some that are not.

Mr. van Hengel mentioned the technical figures, e.g. absolute juice, as being the accurate ones, which is quite true. But overall recovery, boiling house recovery and extraction are reported and even though they are non-technical they can be interpreted financially.

In the new system Natal Ratio will take over from overall recovery for measuring performance on a financial basis and Natal Ratio should be split up to show how gains or losses are arrived at.

Mr. van Hengel: I agree to regard overall recovery and extraction as financial figures as long as you do not confuse them with performance.

I can assure you, however, that the worse the cane quality the higher the Natal Ratio will be if you are efficient, and the lower it will be if you are inefficient.

We expect our figures to come down from say 104 to 102, not just because of molasses purity but because cane quality will improve, i.e. its pure ERS content.

If we tell our financial people that 103 is good and 101 is bad we will be doing ourselves a disservice because we have only a limited control over the value of the figures.

Dr. Guthrie: It is possible to partly overcome your objection regarding the effect of cane quality by having a fifth tabulation—ERS per cent cane by mill group—which will indicate if the field work is producing the necessary cane quality or the factory is performing well on poor cane.