STUDY REGARDING THE QUICK METHOD OF SUGAR PRODUCTIVITY EVALUATION

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Abstract

In a sugar factory it is necessary to be able to calculate very quickly the sugar productivity possible to obtain by processing the beet having a certain technological quality. That is the reason why, in the following lines, it is presented a very quick method used by the Institute of Alimentary Chemistry, the laboratory for sugar research and engineering, for such kind of quick calculations, but with a high theoretical and practical precision.

Key words: sugar, productivity, quiq calculation

INTRODUCTION

Increased productivity is the key goal and is a more complex issue than factory output alone. It is related to the efficient use of resources, including energy, equipment design and reliability and performance optimization. New technology is divided in this discussion into two types. Primary technology, which includes new equipment and operations, and secondary technology, which includes all knowledge and data based systems such as design, automation, performance evaluation and optimization. The potential of these technologies and their application to each stage of sugar production processes are outlined. (Clarke,1999)

Table 1 is completed after the calculations.

Table 1

The quick calculation of sugar productivity

No	Name of product	Quantity of: Product	Dry substance	Sugar	Purity	Content of: Dry substance	Sugar
		Product	Dry substance	Sugar	%	Dry substance	Sugar
		Kg/100 kg beet	Kg/100 kg beet	Kg/100 kg beet	%	˚Brix	%
		C	SU	Z	O	B	P
0	1	2	3	4	5	6	7
1	Beet noodles	100,00	-	16,00	-	-	16,00
2	Undeterminable sugar losses, at diffusion	-	-	0,20	-	-	-
3	Moist beet pulp	80,00	-	-	-	-	-
4	Pressed beet pulp	31,10	-	0,28	-	18,00	0,9
5	Water from the beet pulp's pressing	48,90	-	-	-	-	-
6	Total water for diffusion	103,70	-	-	-	-	-
7	Fresh water for diffusion	54,80	-	-	-	-	-
8	Diffusion juice	123,70	18,19	15,52	85,30	14,70	12,50
9	Mud from carbonation	10,00	-	0,07	-	-	0,7
10	Undeterminable sugar losses, at purification	-	-	0,05	-	-	-
11	Thin juice	124,70	17,11	15,40	90,00	13,70	12,35
12	Thick juice	26,30	17,11	15,40	90,00	65,00	58,50
13	Undeterminable sugar losses, at steaming, boiling and crystallization in three products	-	-	0,30	-	-	-
14	Total products	-	17,02	15,10	-	-	-
15	Molasses	5,66	4,80	2,88	60,00	82,00	50,85
16	Molasses type 50%	5,76	4,80	2,88	60,00	83,33	50,00
17	Moist crystal sugar	12,300	12,24	12,22	99,85	99,5	99,35
18	Crystal sugar	12,246	12,24	12,22	99,85	99,95	99,80
19	Water evaporated at the sugar drying	0,054	-	-	-	-	-

For calculating this total the following method is recommended:

C1 has the value of 100.00 because the total is calculated for 100 kg beet noodles;

P1 is determined with the laboratory analysis. In the given example it was admitted the value of 16.00%;

Z1=P1;

Z2 – the value recognized by the extractor's supplier is accepted. In the given example the value of 0.20% was admitted, specific to the extractor type DDS;

SU2 is considered 30% from Z2, because, by fermentation or enzymatic processes, the sugar is not wholly changed into volatile substances and water, but it is particularly changed in lactic acid. The recommendation is given by The Laboratory for sugar research and engineering at the Institute of Alimentary Chemistry, Bucharest;

C3 is considered 80% of C1;

P4 is determined by laboratory analyses. In the given example the value of 0.9% is accepted;

B4 is determined by laboratory analyses. In the given example the value of 18% is accepted;

C4 is calculated from Muck's diagram, according to the known methodology;

Z4 = (C4+P4)/100;

C5 = C3 – C4;

Z8 = Z1 – Z2 – Z3

P8 is determined by laboratory analyses. In the given example the value of 12.50% is accepted;

B8 is determined by laboratory analyses. In the given example the value of 14.70˚Brix is accepted;

Q8 = (P8/B8) – 100;

Z8 = ((Z1 – Z2 – Z4)/P8) – 100;

SU8 = (Za/QB) – 100;

C8 = (Z8/P8) – 100;

C6 = C8 + C3 – C1;

C7 = C6 – C5;

P9 is determined by laboratory analyses. In the given example the value of 0.70% is accepted;

C9 is accepted as being equal with 10.00 kg / 100 kg beet;

Z9 = (C9 x P9)/100;

Z10 = 0.05;

B11 is determined by laboratory analyses. In the given example the value of 13.70˚Brix is accepted;

P11 is determined by laboratory analyses. In the given example the value of 12.35% is accepted;

Z11 = Z8 – Z9 – Z10;

SU11 = SU8 – SU12;

Q11 = (Z11/SU11) x 100;

C11 = (Z11/P11) x 100;

B12 is determined by laboratory analyses. In the given example the value of 65.00˚Brix is accepted;

P12 is determined by laboratory analyses. In the given example the value of 58.50% is accepted;

Q12 = (P12/B12) – 100;

SU12 = SU11;

Z3 is accepted with the value of 0.3 kg/100 kg beet;

Z14 = Z12 – Z13;

B15 is determined by laboratory analyses. In the given example the value of 82.00˚Brix is accepted;

P15 is determined by laboratory analyses. In the given example the value of 50.85% is accepted;

Q15 = (P15/B15) – 100;

Z15 = (SU11-Z11) x (Q15/(100-Q15));

C15 = (Z15/P15) x 100;

SU15 = (Z15/P15) - 100;

Q16 = Q15

P16 = 50;

B16 = (P16/Q16) x 100;

SU16 = SU15;

C16 = (Z16/P16) – 100;

Z17 = Z14 – Z15;

B17 is determined by laboratory analyses. In the given example the value of 99.50% is accepted;

P17 is determined by laboratory analyses. In the given example the value of 99.35% is accepted;

Q17 = (P17/B17) x 100;

SU17 = (Z17-Q17) x 100;

C17 = (Z17/p17) x 100;

SU18 = SU17;

Q18 = (Z18/SU18) – 100;

B18 is determined by laboratory analyses. In the given example the value of 99.95% is accepted;

P18 is determined by laboratory analyses. In the given example the value of 99.80% is accepted;

C18 = (Z18/P18) – 100;

C19 = C17 – C18.

CALCULATION FORMULAS OF SOME TECHNOLOGICAL PARAMETERS

Calculation of the water quantity for diluting the thick mass final product

The following relation is used in order to calculate the water quantity necessary for the diluting of the thick mass final product before the additional crystallization through cooling:

$$A = 100 - b\left(\frac{\frac{NZ_1}{A_1}}{\frac{NZ_2}{A_2}} - 1\right)$$

[1 l water/100 kg thick mass final product], in which:

B is the content of dry substance in the thick mass final product while discharging it from the vacuum apparatus, in ˚Brix:

NZ1 – content of non-sugar in the thick mass final product while discharging it from the vacuum apparatus, in kg/100 kg thick mass;
A1 – content of water in the thick mass final product while discharging it from the vacuum apparatus, in kg/100 kg thick mass;
NZ2 – content of non-sugar expected to be produced by diluting the thick mass final product, in kg/100 kg thick mass;
A2 – content of water in the thick mass final product after dilution, in kg/100 kg thick mass

Relations between the values of different indicators determined in laboratory analyses

The following indicators are:
O – purity;
Z – content of saccharose polar-metrical determined from a product, expressed in %;
S – content of apparent dry substance of a product refractory-metrical determined, expressed in ˚Brix;
A – content of water of a product, expressed in kg/100 kg product;
NZ – content of non-sugar of a product, representing the sum of the content of organic substances and mineral substances in a product, expressed in kg/100 kg product;
Z/A – ratio non-sugar / water or solubility of sugar in water;
C – content of conductor-metric ash of a product, expressed in %;
SO – content of organic substances in a product, expressed in %;
RO – organic ratio that represents the ratio between the content of organic substances and conductor-metric ash in a product;
CS – saline coefficient, expressed in the ratio between the content of sugar and conductor-metric ash in a product
There are the following calculation relations between these indicators:

A = 100 – B [kg/100 kg product];

$$Q = \frac{Z}{B} * 100 = \frac{S/A*(100-B)}{B} = \frac{100*S/A}{S/A+NZ/A} [\%]$$

$$Z = \frac{Q*B}{100} = Z/A * (100 - B) [\%]$$

$$B = \frac{Z}{Q} * 100 = \frac{Z/A*(100-B)}{Q} * 100 [\%]$$

$$NZ = B - Z = \frac{Z}{Q} * 100 - \frac{Q * B}{100} \text{ [\%]}$$

$$Z/A = \frac{Z}{100 - B} = \frac{Q * B}{100 * (100 - B)} \text{ [\%]}$$

$$RO = \frac{B - Z}{C} - 1 = \frac{Z / Q - Z}{C} - 1 = \frac{Z}{C} * \left(\frac{1}{Q} - 1 \right) \text{ [\%]}$$

But Z/C is the saline coefficient, noted CS. It results:

$$RO = CS * \left(\frac{1 - Q}{Q} \right) - 1,$$

From where results:

$$CS = (1 - RO) * \frac{Q}{1 - Q} .$$

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