IMPROVEMENTS IN CONTINUOUS CENTRIFUGATION TO REDUCE NON-SUGAR RECIRCULATION

Presented by E.D. Bosse
at the 27th General Meeting of
the American Society of
Sugar Beet Technologists
Anaheim, California
March 3 to 6, 1993

Author's address:
E.D. Bosse
c/o BMA AG
P.O. Box 3225
3300 Braunschweig
Germany

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1. INTRODUCTION

As all of you know, the quality of white sugar made by multi-stage evapo- and cooling crystallization is subject, in the first place, to the colour of the crystals, the ash content, the colour in solution and the crystal size distribution.

Let me use the following three-boiling scheme (Fig. 1) as an example:

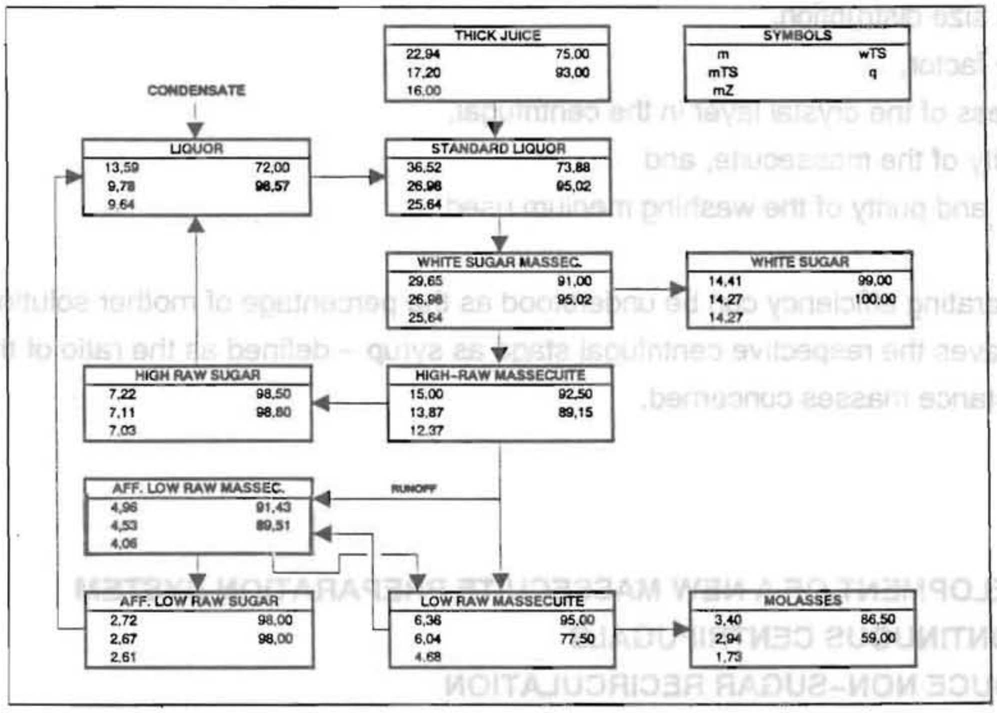

Fig. 1: Simplified 3-boiling scheme

This shows that the lower-valued products from raw and low-raw processing are separated from their mother syrup, are washed or affinated with a certain medium, and are fed in the form of a solution, i.e. liquor, to recrystallization or recycled as seed magma for the higher-valued product.

Every sugar technologist, therefore, has to avoid – to the extent possible – the inevitable recycling of non-sugars, i.e. non-sugar recirculation and, consequently, impurities.

Therefore, centrifugation is of great significance to the non-sugar circulation in the various stages of crystallization, i.e. the efficiency of separation of the mother syrup from the crystal has a decisive importance.

This separating efficiency in turn depends on several technological factors, such as

- mean crystal size,
- crystal size distrubtion,
- gravity factor,
- thickness of the crystal layer in the centrifugal,
- viscosity of the massecuite, and
- quality and purity of the washing medium used.

The separating efficiency can be understood as the percentage of mother solution which leaves the respective centrifugal stage as syrup – defined as the ratio of the dry substance masses concerned.

2. DEVELOPMENT OF A NEW MASSECUITE PREPARATION SYSTEM FOR CONTINUOUS CENTRIFUGALS TO REDUCE NON-SUGAR RECIRCULATION

It has been common practice to treat the massecuite, before feeding it into the basket of a continuous centrifugal employed almost exclusively for low-raw massecuite, but sometimes also for raw massecuite, in a massecuite preparation system (Fig. 2).

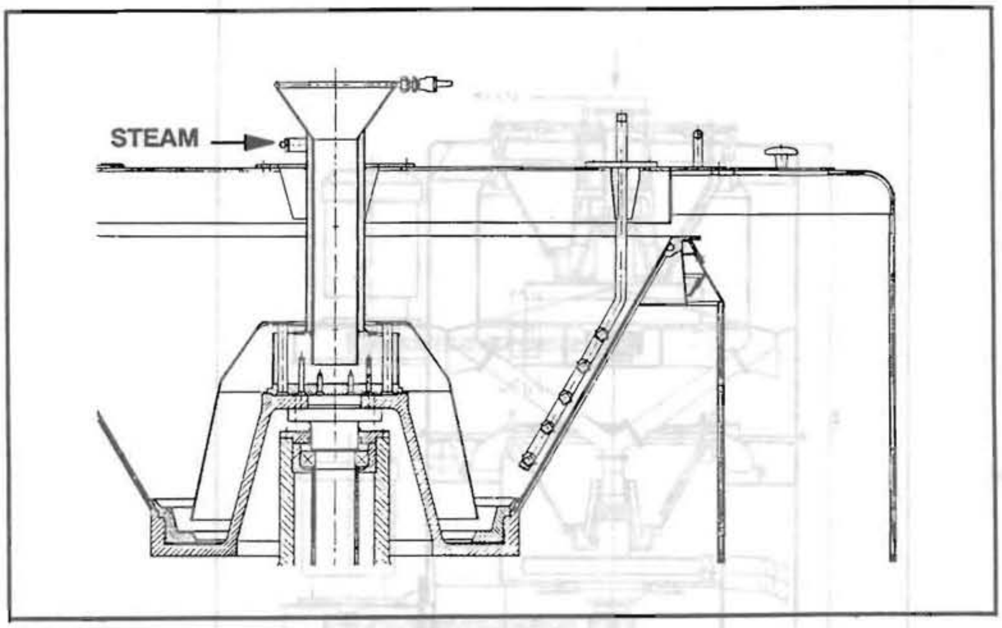

Fig. 2: Standard massecuite distributor

In this preparation system, the massecuite is treated with steam and water to reduce its viscosity and improve its centrifuging properties, homogenized by the rotating pins shown on the picture, accelerated by the accelerator bell to the final speed of the machine and then fed into the centrifugal basket.

In recent years a number of investigations were made to improve the afore-mentioned separating efficiency and, consequently, reduce non-sugar recirculation, and this led to a novel massecuite preparation system in conjunction with our new double centrifugal (Fig. 3).

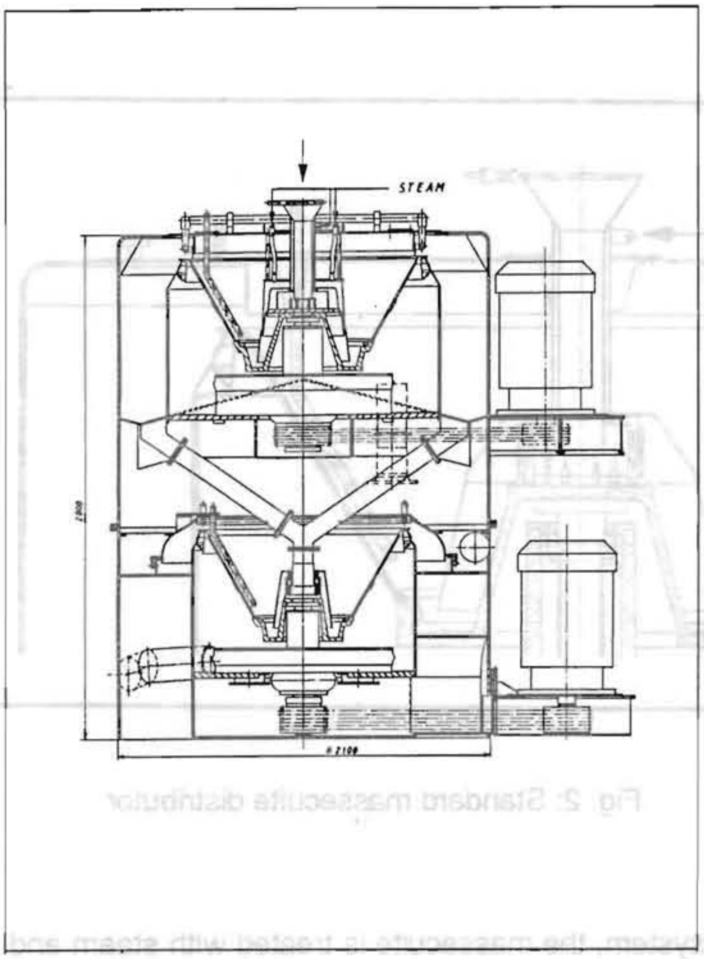

Fig. 3: Double centrifugal

The double centrifugal is a unit with two baskets arranged one on top of the other. The sugar leaving the first basket is mixed with affination syrup and immediately conveyed to the second basket underneath for further processing.

The specific advantage inherent in combining two independent units is that the stages can be adjusted in an optimum way by simply varying the speeds to the technologically required G-factor, which cannot be done when the two baskets are driven by one common shaft.

To provide for optimum separation of the sugar crystals from the highly viscous mother syrup, the pre-seperating stage can be operated at up to 2,000 rpm which means a G-factor of over 2,500 while the affination stage requires a far lower G-factor.

In developing our new double centrifugal, great importance was attached to massecuite preparation (Fig. 4) as due to its high viscosity, low-raw massecuite is very difficult to purge.

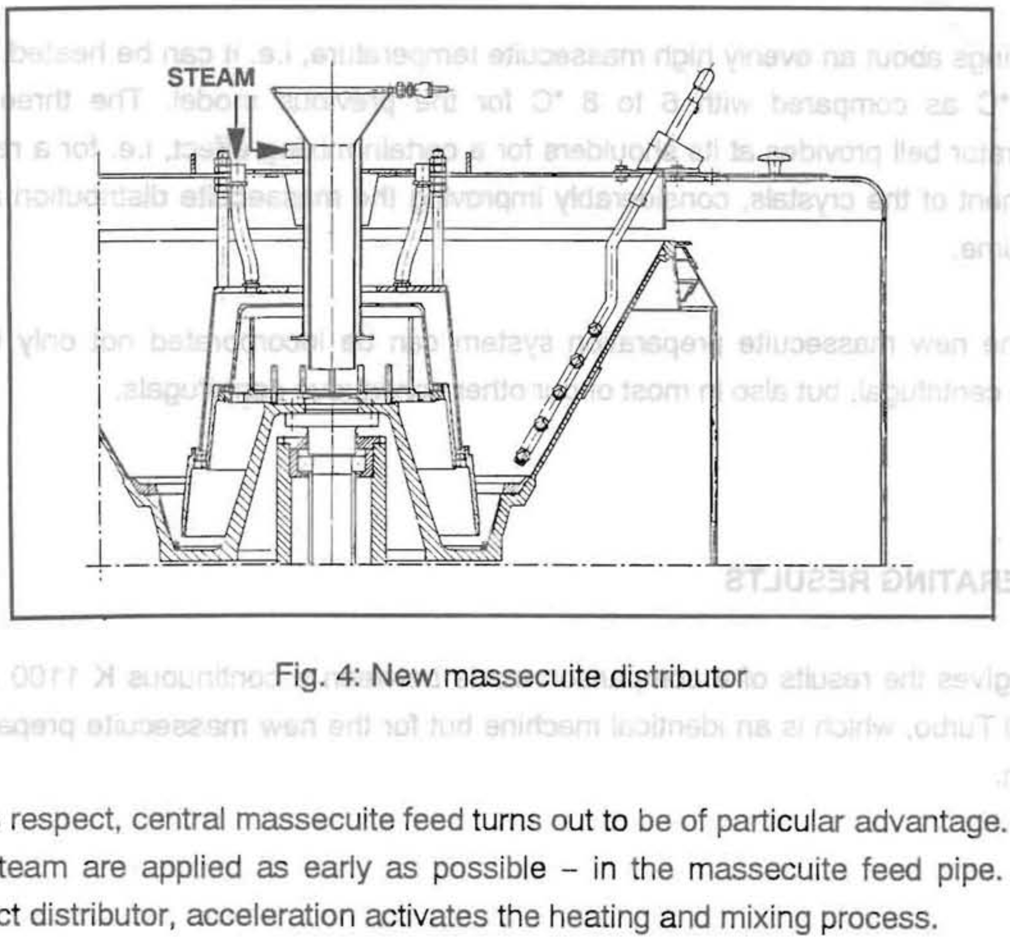

Fig. 4: New massecuite distributor

In this respect, central massecuite feed turns out to be of particular advantage. Water and steam are applied as early as possible - in the massecuite feed pipe. In the product distributor, acceleration activates the heating and mixing process.

The newly developed massecuite preparation system is a three-step distributor bell which has now been efficiently employed already in many centrifugals for 3 campaigns. It consists of a rigid outer section and a rotating inner section with two shoulders, the so-called accelerator bell which, in addition, is heated with steam.

This additional application of steam in the area of the multi-step accelerator bell provides for better massecuite mixing and heating, i.e. much more efficient heat transfer between steam and massecuite, without even the slightest melting of sugar crystals. The result is an excellent separation of the sugar crystals from the mother syrup.

This brings about an evenly high massecuite temperature, i.e. it can be heated by up to 15 °C as compared with 6 to 8 °C for the previous model. The three-step accelerator bell provides at its shoulders for a certain mixing effect, i.e. for a relative movement of the crystals, considerably improving the massecuite distribution at the same time.

Now the new massecuite preparation system can be incorporated not only in the double centrifugal, but also in most of our other continuous centrifugals.

3. OPERATING RESULTS

Fig. 5 gives the results of a comparison made between a continuous K 1100 and a K 1100 Turbo, which is an identical machine but for the new massecuite preparation system.

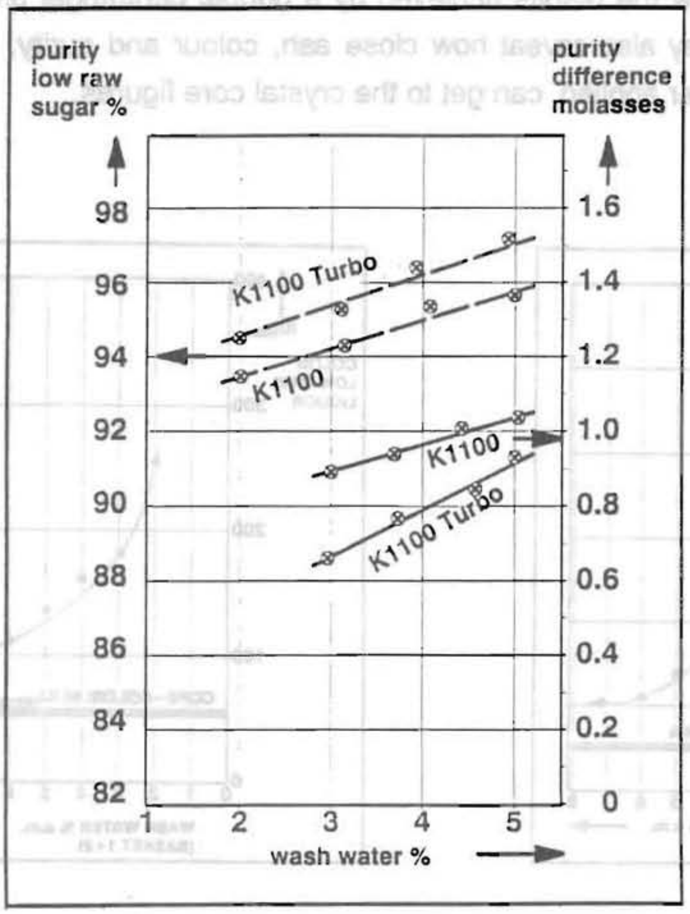

Fig. 5: Comparison of new K 1100 Turbo vs standard K 1100

At a basket operating speed of 2,200 rpm and the associated gravity factor of 2,900, as related to the largest inside diameter of the basket, the throughput of the K 1100 Turbo is some 15 – 20% higher than that of a continuous centrifugal of the standard K 1100 type, and the technological data of the sugar and molasses leaving this machine are identical or even better.

The chart shows the curves of sugar purity and difference in purity between molasses and cyclone molasses (Nutsch) versus the percentage of wash water applied at a constant throughput.

Figs. 6, 7 and 8 show the results achieved by a double centrifugal processing low-raw massecuite. They also reveal how close ash, colour and purity, subject to the quantity of wash water applied, can get to the crystal core figures.

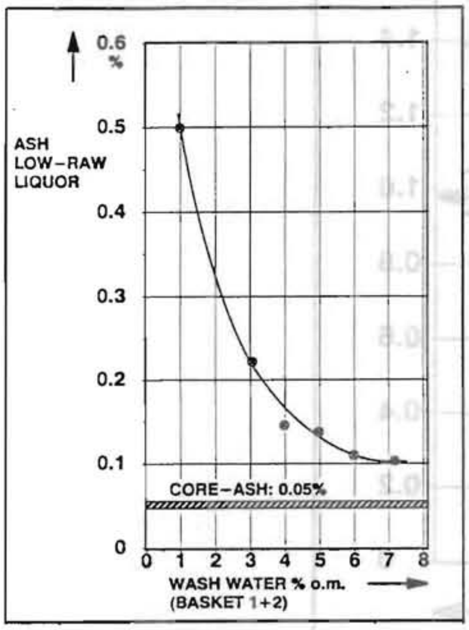

Fig. 6: Ash of low-raw liquor

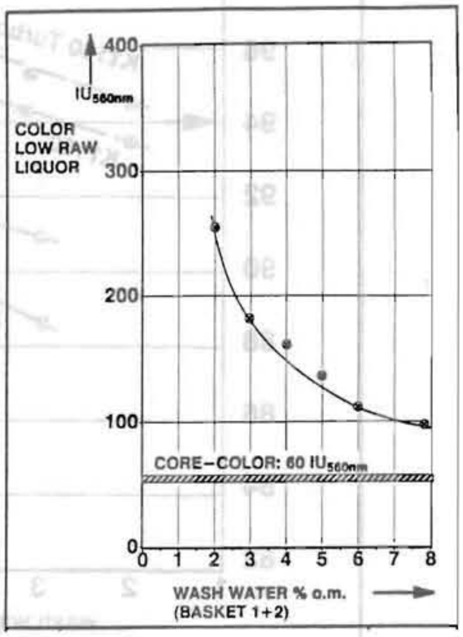

Fig. 7: Colour of low-raw liquor

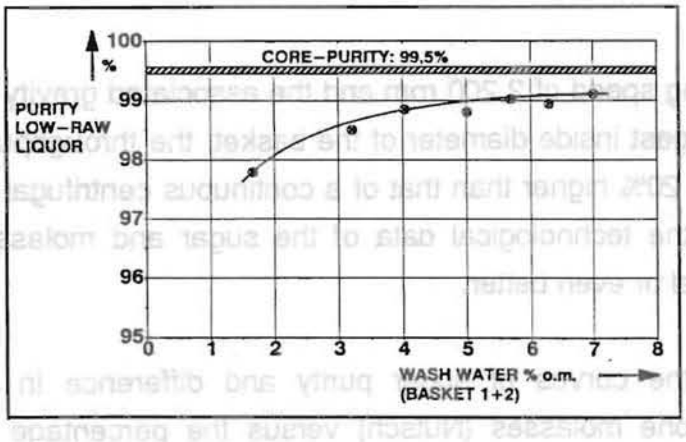

Fig. 8: Purity of low-raw liquor

4. NON-SUGAR RECIRCULATION

Now, what do these improved results mean to sugar house work in general in conjunction with the afore-mentioned boiling scheme?

The non-sugar balances (Fig. 9) show the great variation of non-sugar circulation at different low-raw purities. The core purity of the raw sugar was assumed to be constant at q_{HR} = 98.8.

The following versions relate to extreme low-raw purities of q_{LR} = 92.5 and 98 with an average of q_{LR} = 95.

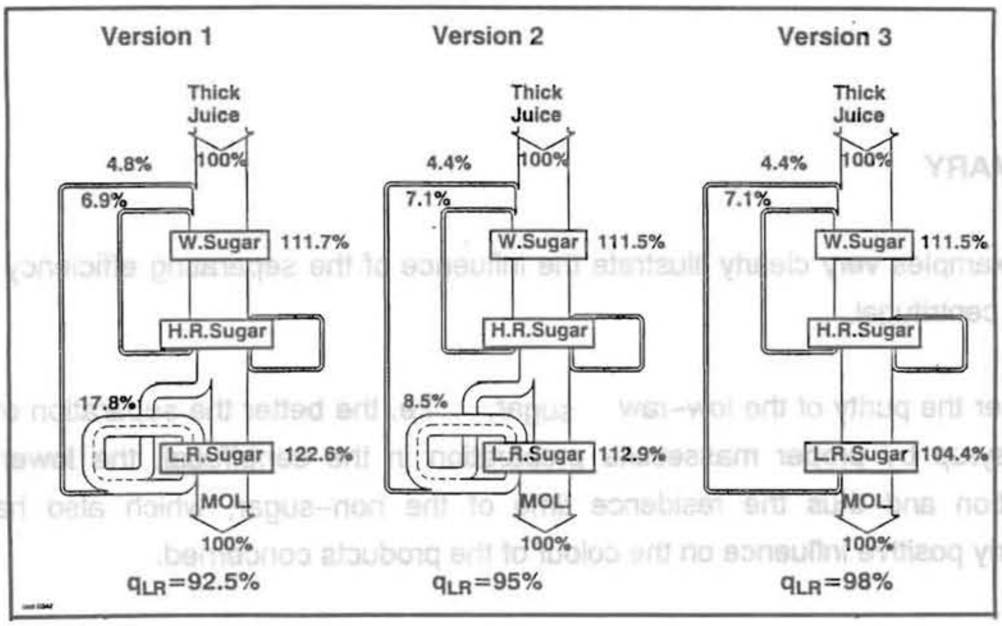

Fig. 9: Non-sugar balances

Version 1:

Assuming that the low-raw product with 92.5% purity is mixed with raw green syrup and the affination syrup is recycled to the low-raw stage, there is a non-sugar circulation of 4.8% to the white and of 17.8% to the low-raw stage.

Version 2:

It is evident that better separation in the centrifugal and, consequently, a higher low-raw sugar purity (95%) reduce the non-sugar circulation to the white sugar station and, in particular, to the low-raw station from 17.8% to 8.5%.

Version 3:

If it were possible, in an extreme, to produce low-raw sugar with a purity of q_{LR} = 98%, non-sugar circulation would be the lowest, and in addition to that no affination would be necessary.

5. SUMMARY

These examples very clearly illustrate the influence of the separating efficiency in a low-raw centrifugal.

The higher the purity of the low-raw sugar, i.e. the better the separation of the mother syrup by proper massecuite preparation in the centrifugal, the lower the recirculation and thus the residence time of the non-sugar, which also has a particularly positive influence on the colour of the products concerned.

Therefore, the first rule to be obeyed is to produce a very uniform low-raw sugar crystal providing the largest possible mean crystal size so as to achieve the set goal of optimum separating work.

Symbols used:

m	=	Mass flow
m_{TS}	=	Mass dry substance
m_Z	=	Mass sugar
w_{TS}	=	Dry substance
q	=	Purity
q_{HR}	=	Purity high–raw sugar
q_{LR}	=	Purity low–raw sugar

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