LOW DRAFT EXTRACTION TOWERS – ENERGY AND LOSS ASPECTS

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1 Introduction

BMA has consistently focused on refining and advancing extraction plant systems. The original "Two Column" version of the year 1948 has developed over the years to today's extraction tower version that includes a countercurrent cossette mixer (Fig.1). The most recent step forward – the "Tower 2000" – was presented at the 1999 ASSBT.

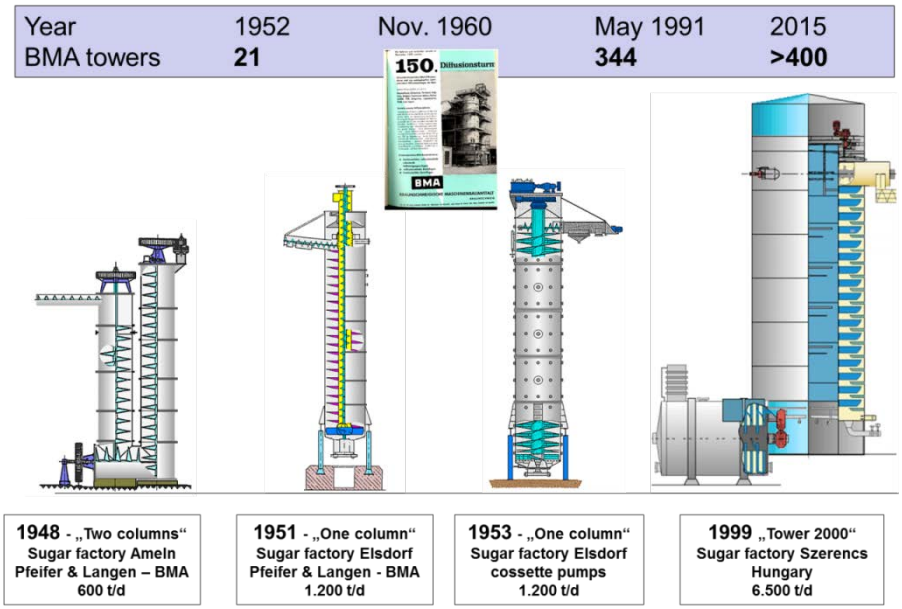

Fig.: 1: BMA Extraction towers – history

In recent years, the focus has shifted to process engineering requirements, and in particular energy savings and yield. These requirements, their consequences and necessary design adaptations will be discussed in this paper.

2 Energy and loss aspects

Extraction plants are key elements in beet sugar factories, both in terms of energy consumption and sugar losses.

The energy consumption of an extraction plant is directly influenced by effective cooling of the raw juice which flows countercurrent to the cossettes entering the system. Energy savings can then be effected by making the best possible use of the residual heat – normally crystallisation vapours and possibly condensate – for heating the cold raw juice.

The water to be evaporated to produce thick juice from thin juice in the evaporation plant is very decisively determined by the raw juice draft in relation to the beet slice rate. A lower raw juice draft results in a higher dry substance content, which implies that less water has to be

evaporated; the juice flow rates in the juice purification section are also reduced. In many cases, this has an immediate effect on energy efficiency.

A disadvantage of the lower raw juice draft are, however, increased extraction losses. The relationships between raw juice draft, extraction time and extraction losses are shown in Fig. 2. It is evident that the extraction losses increase distinctly, when the raw juice draft is reduced to up to 100 % on beet.

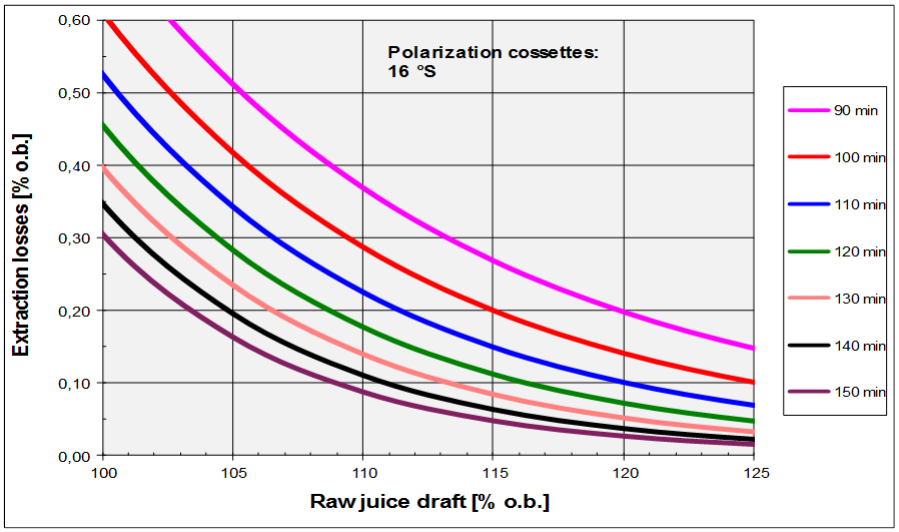

Fig.: 2: Extraction losses vs raw juice draft

The practical solution consists of increasing the extraction time to counteract the effect of rising sugar losses. This can be achieved by making a larger volume available inside the extraction tower. Another option is to maximise the cossette packing in the tower, which means increasing the amount of cossettes in relation to the amount of juice, and consequently enhance the mass transfer from the cossettes to the juice. Based on many years of experience with extraction plants, BMA has arrived at a concept for the flight and stop arrangement that meets this requirement in an optimum manner. However, there are limits to increasing the extraction time, as this implies that the extraction of non-sugars will also go up.

The experience gained with existing plants shows that the raw sugar draft can be reduced to up to 100 % o.b., with extraction losses still at an acceptable level, and without any appreciable increase in the non-sugar content of the raw juice. Fig. 3 reflects a systematic analysis of data collected in the course of several years. The raw juice draft fluctuates between 100 % o.b. and 105 % o.b., while the extraction losses increase slightly as the beet slice rate goes up. It is, however, interesting to note that the increase is much less distinct than theoretical calculations have shown. This suggests that the cossette packing in the extraction tower tends to be higher at a lower raw juice draft, and also that the arrangement of flights and stops has already been well adjusted to achieving the desired transport conditions. Additional analyses to this effect are to produce more insights, so the system can be further optimised.

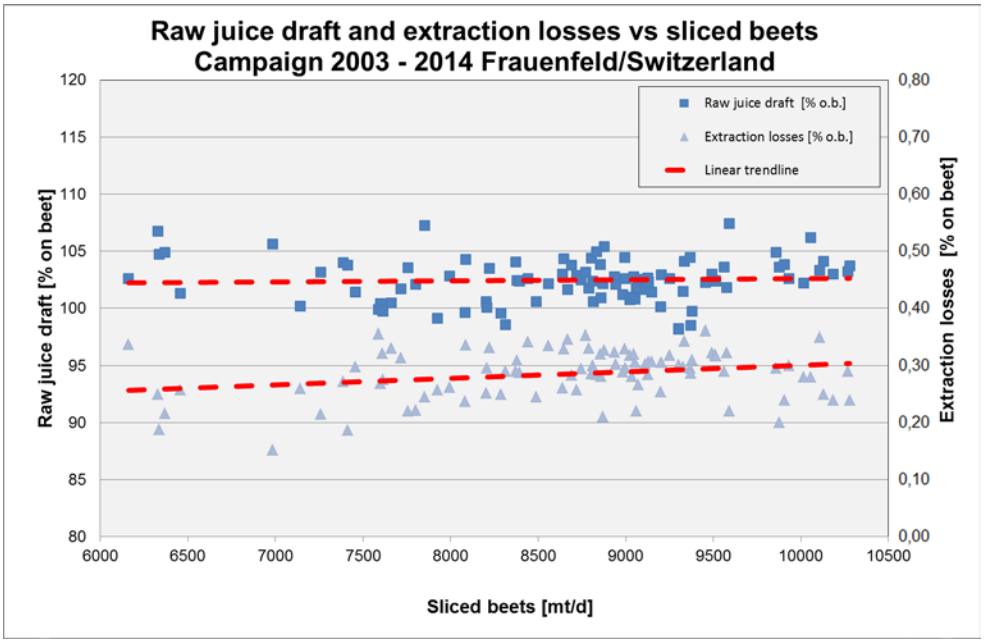

Fig. 3: Operation results

3 Design aspects

For more than 15 years the “Tower 2000” concept has proven its capability for high sugar yields, low raw juice drafts, low infection risks, high reliability, low maintenance and repair costs. The main design feature – the side screens – and its effect on the design of the tower base is shown in different views in Fig. 4. With this concept, infections are prevented by several factors:

- Elimination of the large number of juice chambers, because there are no bottom screens
- Circulation juice discharged through the outer annular duct

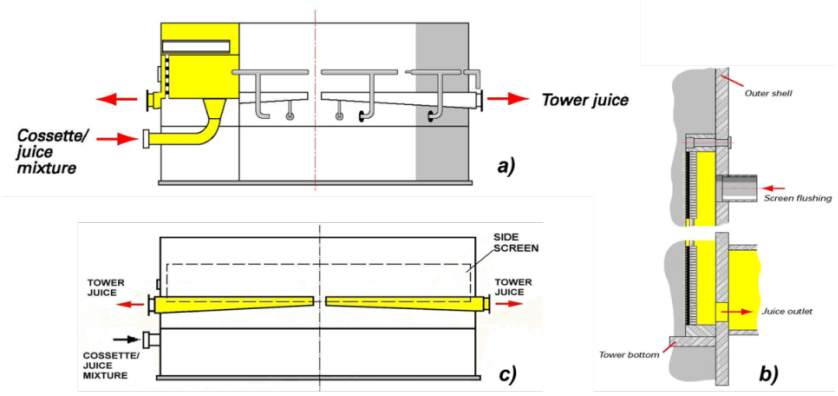

Fig. 4: Side screen design and its effect on the design of the tower base (Tower 2000). (a) Tower Base Design (b) Side Screen Design (c) Circular Tower Juice Collecting Pipe

The sturdy bottom plate considerably reduces the risk of screen damage and provides for flow-optimised application of the cossette/juice mixture. The stable operating conditions that are thus produced in the extraction plant are at the same time an essential precondition for a reduced raw juice draft.

With the development towards plants with a low raw juice draft, the question arises as to what would be the maximum possible extraction length. Using its many years of experience, BMA has extended the possible extraction length for this case. Extraction plants are now generally offered with up to 2.5 m longer extraction lengths for all sizes. This allows the raw juice draft to be further reduced, while the throughput and the extraction losses remain the same.

The result are extraction plants that can be built at lower cost and with larger extraction volumes. Existing plants, too, can be upgraded for these conditions, after the structural stability and the mechanical condition of the plant have been checked. In particular the flights and the stops must still have a mechanical strength, so a high cossette packing is achieved in the tower at the required high torques. This may mean that an additional drive unit has to be added to the drive system.

4 General effect on the process

In particular when upgrading a factory, extraction plant operation with a low raw juice draft can be used very effectively for minimising extension requirements in the downstream plant sections of juice purification and evaporation. In two cases, BMA has designed the extension of beet sugar factories (approx. 25 %) by installing an additional extraction tower, so the entire extraction plant could afterwards be operated with a low raw juice draft (approx. 105 % o.b.). Because of the higher quality of the beet and the reduced juice flow rate, the capacity of the juice purification plant was adequate. In the evaporation plant, too, just one single evaporator was needed to provide the necessary evaporation rate, while reducing the total energy consumption by increasing the dry substance content in the thick juice. Other consequences, such as lower pump capacities and lower juice heating requirements at the front end of the factory, also have a favourable effect.

The main limiting factors with these measures are the sugar content and the resultant dry substance content of the juices in the juice purification plant. A higher dry substance content affects the required drive power of the pumps and the necessary filter capacities. Since the amount of lime that is added is normally based on the non-sugar content, the amount of solids that have to be separated is not reduced.

5 Conclusions

Extraction plants are increasingly operated with a low raw juice draft. This is mainly done because of the energy saving potential. The disadvantage are higher extraction losses, but these can in general either be partly or entirely compensated with longer extraction times. Extraction plants are, in addition, operated with a maximum cossette packing, which also contributes to reducing extraction losses. The experience that has been gained with existing plants shows that BMA's Tower 2000 concept more than meets these expectations.

References

Bosse, D.; Hempelmann R.: Tower 2000: A new tower extraction concept; 30th General Meeting of the American Society of Sugar Beet Technologists, Florida 1999