How to improve the performance of pulp pressing?

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Wie kann man die Schnitzelabpressung verbessern?

It is generally much cheaper to remove water from the wet pulp mechanically by pressing rather than by thermal drying. Therefore pulp presses should be able to extract as much water as possible from the pulp to be dried. Drying pulp without pressing would be economically unsustainable because of the excessive energy consumption. Therefore the profitability of a factory depends on the mechanical dewatering, whose efficiency depends both on machine performance and on wet pulp quality, which plays a fundamental role in the control of the total operational costs (TOC). This article deals with both factors.

Key words: sugar beet pulp, pulp presses, mechanical dewatering, total operating costs, energy saving, sugar recovery, increase in dry substance content

Im Allgemeinen ist es sehr viel billiger, Nassschnitzel mechanisch zu entwässern als thermisch (durch Trocknung). Daher sollte mittels Schnitzelpressen so viel Wasser wie möglich aus den Schnitzeln vor deren Trocknung entfernt werden. Die Trocknung der Schnitzel ohne vorherige Abpressung wäre aufgrund des dafür übermäßigen Energiebedarfs unrentabel. Darum ist für die Wirtschaftlichkeit die mechanische Entwässerung ausschlaggebend, deren Effizienz sowohl von der Maschinenleistung als auch von der Qualität der Nassschnitzel abhängt, was für die Gesamtbetriebskosten grundlegend ist. Dieser Artikel befasst sich mit beiden Faktoren.

Schlagwörter: Zuckerrübenschnitzel, Schnitzelpresse, mechanische Entwässerung, Gesamtbetriebskosten, Energieeinsparung, Zuckerausbeute, Erhöhung des Trockensubstanzgehaltes

1 Introduction

Efficient dewatering of wet pulp should be considered as a strategic target in sugar manufacturing, since pulp drying can account for more than 30% of fuel consumption in a beet sugar factory.

High efficiency implies:

- maximum removal of water content (approx. 80%);
- increase in the quantity of water available for extraction;
- reduction in sugar losses in the pressed pulp;
- reduction in energy consumption in the pulp drying process;
- lower quantity of pressed pulp, thus improving the energy balance of the extraction; and
- better preservation of ensiled pressed pulp.

Considering the above benefits, which increase as press performance increases, the economic return – mainly derived from energy savings in the drying process and from the recovery of the sugar that would otherwise be lost – allows operators to recover the costs of their investments in relatively few years.

2 Press design and operating conditions

High press performance depends on: 1) having a high-performing pulp press, and 2) its correct operation, especially the feeding process.

Fig. 1: Babbini pulp press

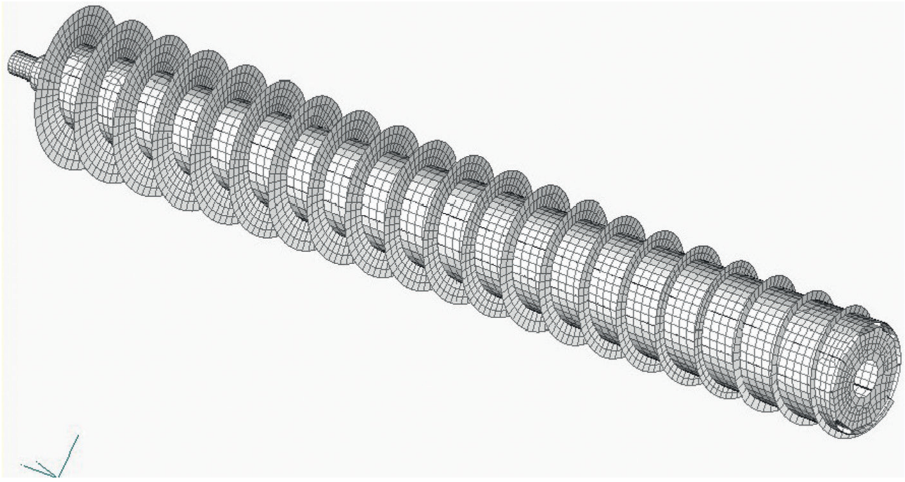

Fig. 2: Press spindle

2.1.2 Presses with self-draining spindles

The use of self-draining spindles, such as those found in Babbini press type FS (Fig. 3), allows for a dry substance content that is approximately 2 points higher than presses equipped with solid (non-perforated) spindles (presses type S), at the same capacity and, nowadays, with the same mechanical reliability.

2.1.3 Continuous development by Babbini

Obtaining higher performances from a pulp press means subjecting parts to a very high potential of fatigue, due to mechanical stress. It is therefore vital to maximize reliability of the press's critical components – in particular of the press spindles.
All Babbini presses are manufactured in compliance with 4 patents, which allow to have:
– higher pressing performance;
– lower power consumption; and
– higher reliability, both with self-draining and solid spindles.
A new Babbini patent, now being tested, allows a further rise in efficiency for draining water from the spent pulp. The improvements are related to the addition of a fourth factor to those usually considered in the pressing process (i.e. pressure, residence time, filtering surface): Pulp remixing.

2.1 Press design

In order to achieve high performances, the following aspects representing the characteristics of a press are fundamental and need to be adjusted for operation, depending on the requirements of the individual sugar factory.

2.1.1 Geometry of press spindles

The volume reduction of the press spindles must take into account the pressure generated inside the spindles themselves, which is necessary to achieve the best performance without damaging the parts of the machine. By means of special software, Babbini calculates the geometry of the press spindles (i.e. the progressive reduction in the volume ratio) depending on the customer's needs (i.e. required DS content and throughput) and on pulp characteristics. Moreover, nearly all Babbini presses are now manufactured with the spindles and external draining cage having a biconical geometry (Babbini patent), which assures maximum performance if compared with the old bicylindrical shaft geometry.

2.1.4 Filtering cage: enbloc perforated plates vs standard perforated plates

The introduction of enbloc perforated plates with double perforation diameters has increased press reliability remarkably. In case of entrance of small foreign bodies or of slight rubbing

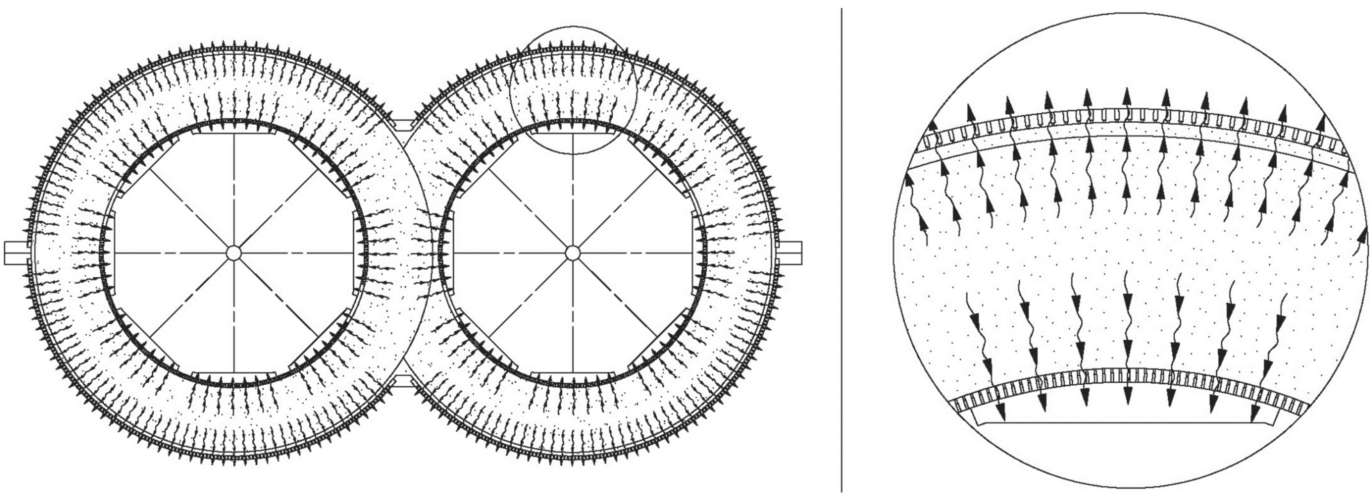

Fig. 3: Water draining in a press with self-draining spindles

Fig. 4: Second flight (Babbini patent)

Fig. 5: Empty spaces without spent pulp in the feeding hopper

2.2 Correct operation and feeding of the press

Incorrectly feeding the press is often the main cause behind a decrease in performance. Similarly, some cautionary measures taken by the user while operating the press can avoid drops in the press performance or absorption peaks. It is possible to consult with Babbini regarding certain operating standards for optimal press performance. Analysis takes the following issues into consideration:

2.2.1 Feeding wet pulp into the press

Feeding must be continuous and the feeding hopper always full. This is fundamental to avoid detrimental empty spaces without pulp (Fig. 5) that cause a decrease in pressure inside the filtering cage and, consequently, temporary drops in the press performance.
On the basis of the available space, it is possible to improve the shape and height of the feeding hopper. A higher level of wet pulp inside the hopper implies a higher pressure at the press inlet and greater inertia in operation. Press performance, therefore, is higher. When the dry substance content of the pulp at the press inlet is particularly low, it is highly recommended to use a partially draining feeding hopper.

2.2.2 Press operation

It is possible to achieve the best operating conditions for a press (higher press performance and lower mechanical stress) if the speed of rotation is constant, and changes are made gradually.

of the flights against the filtering cage (for example, as a result of a foundations settling) it is no longer necessary to stop the press and to open it to replace a damaged filtering plate. This is the reason why presently most end-users choose to install this type of enbloc plate system.
On the other hand, the old-type standard perforated plates (consisting of a supporting thick plate plus a thin filtering plate), assured higher performance under the same working conditions, approximately 1 point more in the pressed pulp dry substance content if compared to presses equipped with the enbloc plates.

2.2.3 Fine pulp

An excessive presence of fine pulp in the wet pulp negatively affects the press's performances, since it clogs the holes in the perforated plates. This is one of the reasons why fine pulp should be eliminated from the processing cycle and pressed separately. Factories using the above described system achieve better results, both in terms of throughput and of pressed pulp dry substance content, and also reduce the power consumption.

2.2.4 Analysis of press layout before installation

Analysis of the press's best positioning within a new or existing press station, based on age of existing presses and other press characteristics, allows for optimal efficiency.

2.2.5 Assistance and analysis of press operation and performance

During the campaign, perhaps in cooperation with the manufacturer, it could be useful for the operator to conduct:
- An analysis of the press operation and of any potential source for any reduction in performance, both in terms of throughput and dry substance content; and
- A consultation, using technical expertise, toward improving wet pulp pressability during the most suitable extraction conditions, as well as making the best use of the "controlled infection" system.

The use of certain small devices, such as draining screws before pressing, can improve pressing operation.

3 Factors influencing wet pulp quality and characteristics (pressability)

3.1 Cossette properties and characteristics

The marc content of beet and the size of cossettes remarkably influence the dewatering of wet pulp, particularly in the case of deteriorated beets. Press efficiency drops dramatically for beet that has been exposed to unfavourable conditions, such as excessively hot weather or frost, followed by thawing, parasite attacks, etc., either during storage or deteriorated during transport.

Beet-slicing modes (cossettes that are either too small or too large, excessive amount of mash) represent an additional factor influencing the press performance.

Woody beets, even with marc content only slightly higher than standard beet, can influence slicing and press operation, since higher lignin and cellulose contents make the cell wall of the vascular system thicker and more resistant to slicing and squeezing.

3.2 Extraction operating condition

Appropriate extraction conditions should be guaranteed while processing deteriorated beet. Temperature and retention time greatly affect the mechanical properties of beet that have lost their natural turgidity.

In this regard, an important role may be assigned to the microbiological conversion of invert sugar (microbial activity), abundantly present in deteriorated beet, into lactic acid.

This method, apart from improving pressability, allows operators to reduce their use of pressing aid products (sulphuric acid, calcium sulphate).

In this regard, it must be considered that about the 60% of the sulphate ions (see Table 1) used in extraction become calcium salts in the thin juice, influencing the molasses yield and the turbidity of white sugar in solution.

Table 1: Influence of calcium sulphate (*Burrough*, 2008)

Origin	Usage	Raw juice	Thin juice
		in mg/L $CaSO_4$	
Beet		200	120
Sulphuric acid	10 kg/100 t beet	100	60
Gypsum	120 kg/100 t beet	400	240
	Total	700	420

Dorr juice purification with lime usage at 1.0% $CaCO_3$ on beet.

As stated above, temperature and retention time remarkably affect the mechanical properties of deteriorated beets. The following is some additional advice on the subject.
- Reduce, within certain limits, the temperature at the top of the tower by adapting the press and fresh water temperature.
- Reduce the retention time and increase, within certain limits, the size of cossettes, considering that higher sugar contents in spent can be compensated, in part or entirely, by the recovery of a larger quantity of press water as given in the pressed pulp balance of *van der Poel* et al. (1998).
- Keep the juice's pH values very close to 5.8, limiting the use of sulphuric acid in fresh water to compensate for the possible additional acidity carried by deteriorated beet.
- Appropriately manage the dosage rate of calcium sulphate.
- Accept higher levels of L-lactic acid, taking advantage of the remarkable quantity of invert sugar in the cossettes.
- Use strong oxidants, such as PAA and H_2O_2, as pressing aids.
- Make the extraction operation stable, in order to achieve constant working parameters for the cossettes.

3.3 Microbial activity

The controlled management of infections carries the benefits of positive impact of L-lactic acid and of pH value on pulp pressability. This approach contemplates the beneficial use of monosaccharaides brought by the beet and/or the Eso-invertase (exo-invertase) activity during extraction.

As it is widely known, during the calco-carbonic purification process, the invert sugar is mainly converted into D-lactic and L-lactic acid, thereby generating colour precursors (Fig. 6).

Table 2: Conversion of invert sugar into L-lactate at 15% pol. sugar content

Invert sugar in g/100 g pol. sucrose	Invert sugar in mg/kg	L-Lactate in mg/kg
0.1	150	75
0.2	300	150
0.3	450	225
0.4	600	301
0.5	750	376
0.6	900	451
0.7	1050	526
0.8	1200	601
0.9	1350	676
1.0	1500	752

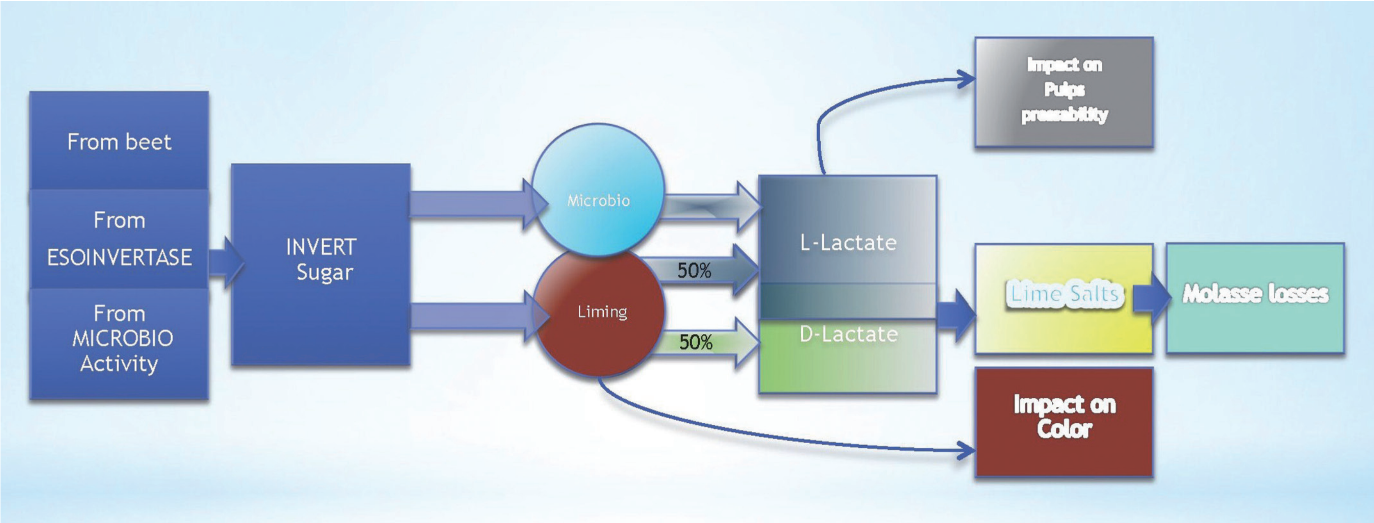

Fig. 6: Invert sugar degradation

It seems reasonable to think that part of invert sugar could be converted into L-lactic in advance, owing to the microbial activity in the extractor, with positive effects on:

- the dry-substance content in the pressed pulp;
- the consumption of $CaSO_4$ and of sodium hydroxide and, consequently, on the molasses yield; and
- the colour precursors.

Of course, the maximum acceptable level of lactic acid depends both on the available amount of invert sugar and on the raw juice pH value (Table 2).

4 Conclusions

Mechanical pressing plays an important role in reaching higher standards of performance. To this end, Babbini is investing in research and offers its customers a range of services for maintenance, assistance and press operations monitoring. The company does this both to maintain high press performance and to reduce mechanical stress. With more than 40 years of experience in the field, Babbini presses are now more reliable than ever before, able to reach the highest dry-substance content levels.

It is necessary, however, to be aware that good press performance not only depends on press design and manufacturing, but also on how the machinery is operated and fed. Moreover, the treatment of spent pulp before pressing has a remarkable influence on press performance. Taking all this into consideration, Babbini works to help its customers determine operating standards for the best possible press performance.

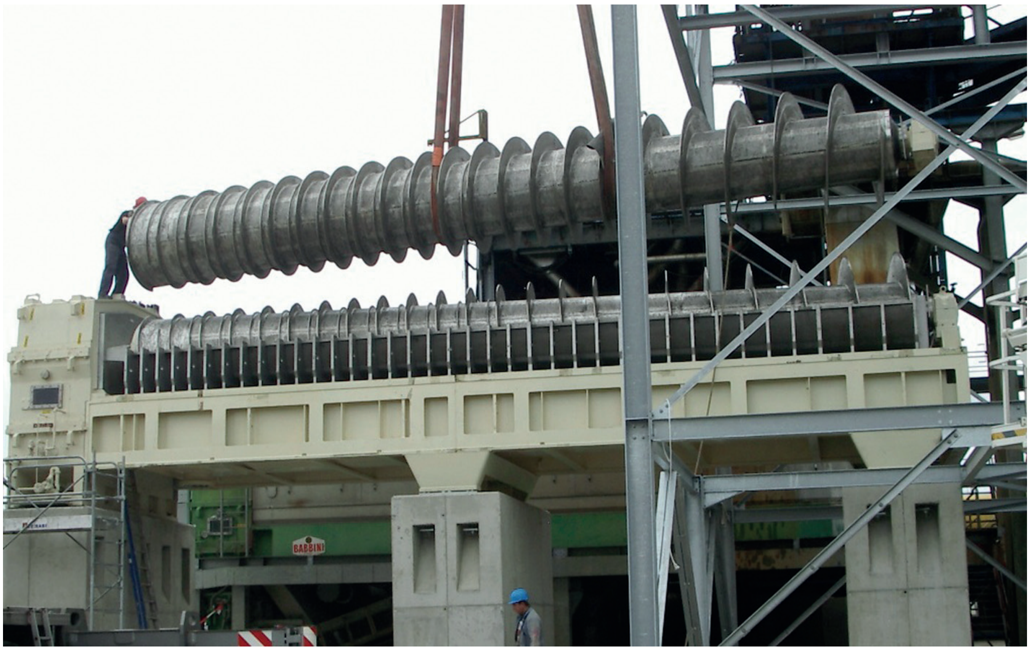

Fig.7: Babbini press installation

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