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Impact of fine pulp during sugar beet processing

Abstract

Recycling of fine pulp of fragments produced following the exhaustion of cossettes during the diffusion process is problematic. They are detrimental to the correct operation and the performances of the press station and, in general, negatively impact the profitability of a beet sugar factory through increasing operating costs throughout the campaign. In order to optimise the press station and maximize productivity, it is recommended to separate press fine pulp, which has been removed from the cycle, by means of dedicated presses, thus increasing the overall pressed pulp value. This paper describes the problems caused by fine pulp and discusses effective means of managing fine pulp fragments, with particular reference to case study where new Babbini presses dedicated to press fine pulp were employed.

Keywords: sugar beet processing, fine pulp, presses, Babbini

What is fine pulp and how it is generated

Fine pulp comprises small beet pulp fragments that gather on the perforated plates of pulp presses (Figure1). They also find their way into press water.[1] Therefore, press water should be seen as a mixture of water and suspended and dissolved solids.

The generation of fine pulp is mediated by a combination of factors which are difficult to isolate in terms of their individual impact.Listed below are the main causal factors:

- Beets characteristics and quality: beet maturation degree (fresh or rotten), type of beet storage, possible freezing.

Figure 1: Fine pulp gathering on the perforated plates of pulp presses

- Beet slicing: type of slicer (rotating drum type or wheel type), blades status (wear conditions), Silin number (slices cutting degrees), mash quantity.
- Slices treatment: Temperature in diffusion, retention time, etc.
- DS% of pressed pulp: a higher pressure inside the press tends to break and tear the fibers of the slices to a greater extent, thus generating more sludge.
- Fine pulp recycling: When fine pulp, recovered by filtrating water from the presses, goes back to diffusion, we get a trend like the one shown in Figure 2.

Fine pulp quantity arriving to the presses increases with time up to a point when the quantity coming out with pulp is equal to the quantity at the inlet. Remarkably, fine pulp quantity, influencing the presses performances, corresponds to this length of time (Tf).

Influence of fine pulp on pressing performances

Fine pulp recycling in the pulp to be pressed, often occurs in sugar factories. This negatively affects the press performances both from the point of view of DS% and of capacity. Pulp fragments tend to clog the perforated plates holes, thus reducing the quantity of water draining out of the press.

The reduction of the filtering surface of the perforated plates lessens press performances both in terms of dry substance content and of capacity. This is due to the slow progress forward of pulp as drainage through the perforated plates is reduced,

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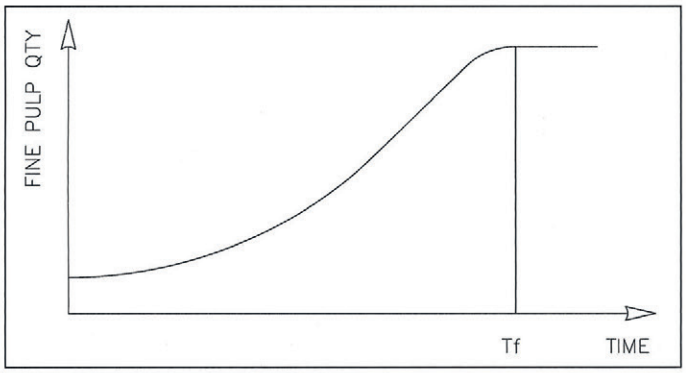
Figure 2: Build up of fine pulp over time in presses

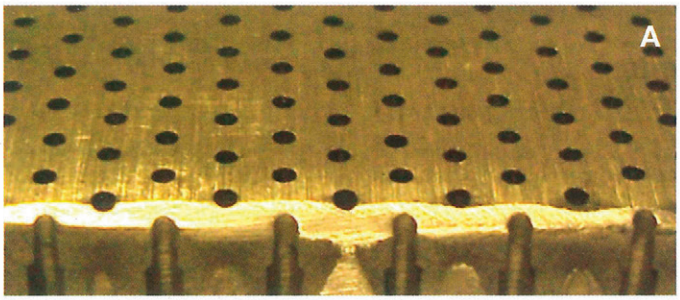


resulting in the volumetric reduction of pulp that is pressed.

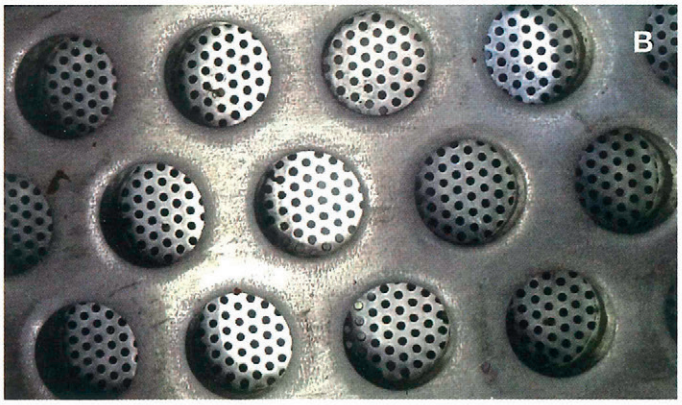
This phenomenon mainly occurs where presses are equipped with:

- Perforated spindles, where fine pulp tends to clog the spindles perforated plates and, sometimes, also the draining channels, thus reducing the advantage derived from the use of presses equipped with perforated spindles, quantifiable in approximately 1.5 - 2 percentage points in the dry substance content of the pressed pulp.
- Special filtering cage enbloc plates (type A, Figure 3A), whose holes clog much easier than the holes in the old design perforated plates (type B, Figure 3B), consisting in a thick supporting plate and a thin filtering plate.

Figure 3: Special enbloc perforated plates (A) VS Standard perforated plates (B)

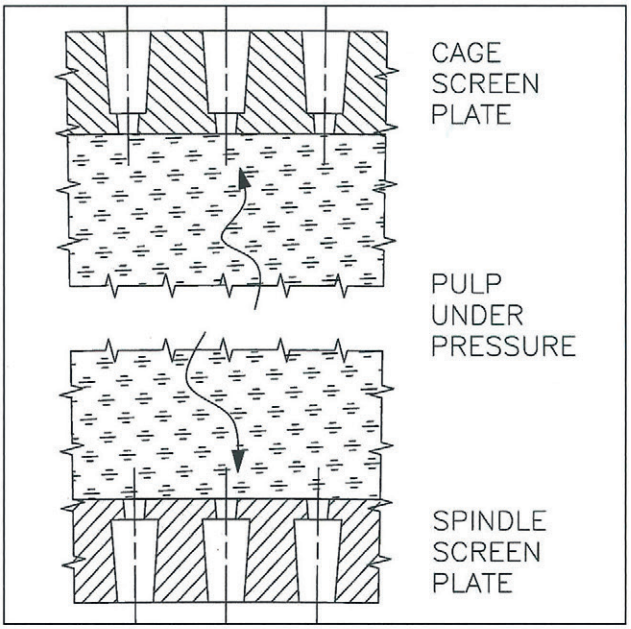


Moreover, considering the holes geometry (double concentrical holes) and the water flow while pressing, the clogging of holes in the draining enbloc plates (type A) after rolling is more evident in



the spindles perforated plates, where the holes tend to close, than in the cage perforated plates where, on the contrary, the holes tend to open (Figure 4).

Figure 4: Deformation of the holes special perforated plates (type A) of the spindle and of the cage after rolling



It must be said that the need to eliminate fine pulp from the cycle was less important in the past, since the holes in the old type thin filtering plates (type B) rarely got clogged[2]. With enbloc

perforated plates having double perforation (type A), instead, fine pulp certainly causes a reduction in the perforated surface, as demonstrated by the typical water spurts that can be seen with these plates, showing that small holes get clogged and forced opened thanks to the effect of the press internal pressure (see Figure 5).

Figure 5: Spurts of water from the enbloc perforated plates (type A) following the opening of the holes clogged by fine pulp

However, presently these enbloc plates (type A) are generally preferred because of their higher reliability in case of entrance of foreign bodies inside the press.

Comparative tests have been run at a sugar factory on no. 2 Babbini PB22 presses, placed side by side and running under the same operating conditions, but equipped with different types of cage perforated plates (having similar filtering surface). These tests showed what was already known, i.e. that on presses equipped with standard plates (type B) an increase in the dry substance content percentage equal to more than 1 point is recorded (Tab. 1): this confirms the influence of fine pulp on the pressing performances depending on the type of perforated plates.

The Figure 6 shows the actual performances recorded on the same press fed with pulp containing and not containing fine pulp.

Table 1: Comparative performances on Babbini PB22 presses under the same operating conditions with different types of cage perforated plates

Pressed pulp DS %	
Standard plates (B)	Special plates (A)
28.2	26.3
28.4	26.3
27.3	25.8

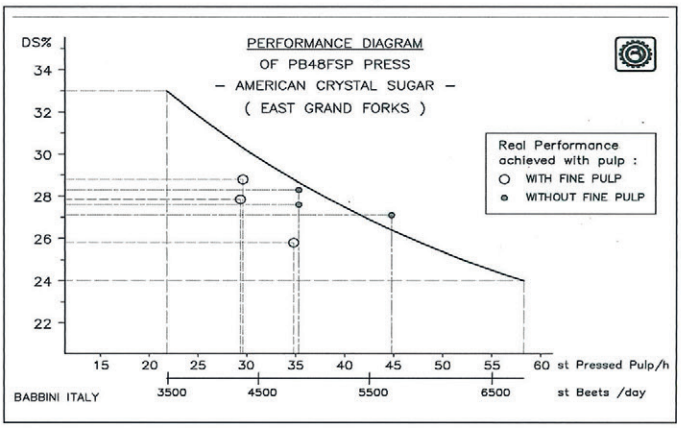
It is apparent that the negative influence of fine pulp recycling on DS% of pressed pulp increases in time, increasing by more than 1 point to 2 points depending on the amount of fine pulp which is removed.

Advantages from the elimination of fine pulp – in the processing cycle

Since fine pulp has an adverse impact, , especially in the press station, its elimination from the cycle and or diverting it for separate pressing holds several benefits. While these benefits are difficult to quantify individually – research in this field is currently wanting – their impact is clearly significant.The benefits are:

1. **Increase in DS% of the pressed pulp**, with the many advantages deriving from that, including the lower fuel consumption in the following thermal drying, etc.

Figure 6: Performances achieved by the same press fed with pulp containing (O) and not containing (o) fine pulp



2. **Increase in the press capacity**, therefore the number of presses needed to process the same amount of beet is reduced, i.e. the same press can deliver a higher absolute dry substance content, i.e. a higher DS% per pressed product unit;
3. **The enbloc perforated plates (type A) are better exploited** on pulp presses. This type of plates is preferred for its higher reliability, but in case of fine pulp they drain less water than standard plates (type B);
4. **Presses equipped with perforated spindles are better exploited**: these presses certainly have higher pressing performances if compared with presses equipped with unperforated spindles; because fine pulp tends to plug the holes of the perforated plates and thereby reduces the draining surface and clogs the draining channels of the spindles
5. **Lower mechanical stress on pulp presses**. Perforated plates clogged by beet sludge, fine pulp and tails lead to an increase in presses internal pressure and therefore to high absorptions and higher mechanical stress on the press elements (press spindles, perforated plates etc.).
6. **Less water needed for spindles flushing** in presses equipped with perforated spindles, and lower risk of channels clogging.
7. **Higher sugar recovery**, even if in a minimum amount, from fine pulp press water.
8. **Higher raw sugar pureness**, thanks to the higher press water pureness.
9. **Reduced fuel consumption in thermal drying**: fine pulp can easily be dried, therefore they do not negatively affect dryer performance or, even better, they tend to partly burn and therefore to produce heat.
10. **Reduced microbial infection**, leading to advantages such as a lower use of biocides and anti-foam products.

Minimising fine pulp generation means reduced deposit, and therefore reduced fermentation in the press stagnation areas, which are the ideal places for colonies of thermophilous bacteria to thrive, as well as in the collecting trough for press water, whose recycling in diffusion implies further contamination of pulp.

11. **Better diffusion performances**: fine pulp recycling in diffusion reduces the migration of water among the slices and interferes with the normal juice circulation inside it. However, its worst consequence is the clogging of the grids (normally due to the presence of small particles mainly coming from beet cutting), which

has negative effects mainly in vertical diffusers.

The press water filtration should prevent the risk of fine pulp recycling in diffuser. However, the separators, overloaded by a high load of fine pulp, often let some fine pulp pass through. in During the course of a campaign, there is an increase in the amount of fine pulp passing through the separators.

In order to counterbalance the reduced throughput during the diffusion process, i.e reduced sugar extraction caused by the clogging of the screens, it is necessary to increase temperature or in any case to overload the diffuser a little bit more.

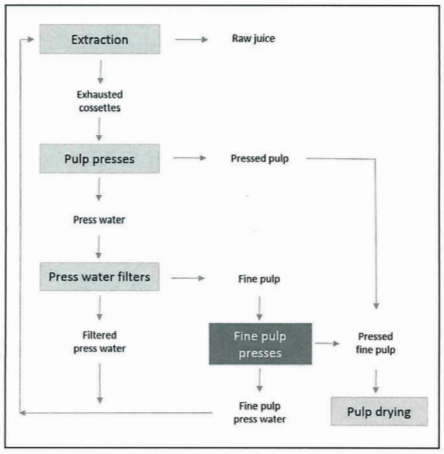
Fine pulp press

The installation of a fine pulp press as shown in Figure 7 could solve these problems by elimination of the recycling of fine pulp.

The fine pulp would then not be returned to the pulp presses with its negative consequences for pulp pressing and extraction.

The fine pulp press water can be added to the extraction together with the pulp press water.

Figure 7: Schematic scheme of mass flows after installation of a fine pulp press



Twin screw presses, much smaller than the ones used to process beet exhausted slices, are used to press fine pulp.

Moreover, considering the characteristics and the dimensions of fine pulp, some elements of these presses are different from the ones used in pulp presses. In particular, the press spindles are specially designed on the basis of a different compression ratio and of a different geometry. The perforation in filtering plates is specifically adjusted to drain water out of the specific material to be pressed.

After pressing, fine pulp, having now a dry substance % even higher than 30%, can be mixed with the pressed pulp (without lowering its dry substance content) and can, be easily be dried.

Experience in fine pulp pressing – a case study

While the use of small dedicated presses to process fine pulp after its separation from press water has yet to be adopted widely in the beet sugar sector, where it has been exploited, benefits from its use have been significant as the follow case study shows.

The sugar factory in Minerbio (COPROB, Italy, capacity approx. 14,500 t of beets/day) has been using a small Babbini P40BC press since 2002 to partially press fine pulp. They have recently started up a second Babbini P30BC press in order to completely eliminate it from the cycle.

The two small presses working in parallel (Figure 8) process all fine pulp coming from 4 press water separators (Figure 9), with a 5-7% dry substance content, and deliver a pressed product having a final dry substance content equal to 29-32.5%, that is then sent directly to the pulp dryer.

Figure 8: Babbini's fine pulp presses (P30BC + P40BC)

Considering the overall sugar factory capacity and the performances of the pulp presses, it is possible to quantify an increase, at the end of the campaign, of more than 1 point in DS% in the pressed pulp, thanks to the elimination of fine pulp from the cycle.

Conclusions

Fine pulp recycling, which is commonly tolerated in beet sugar factories, but should not be as it is costly because it adversely impacts smooth running of a factory.

Removing fine pulp from the cycle, after separating it from press water, is a first important step that optimizes the presses operation. The benefits are wide ranging, from increase in dry matter content of pressed pulp to improved diffuser performance and reduced microbial contamination. Babbini produces presses of various sizes, depending on the total capacity of the sugar factory, dedicated to optimize pressing of fine pulp. Two of these presses have been proved to be very effective at a beet sugar factory in Italy. Its low investment price and its many advantages widely justify its use in sugar factories.

Endnotes

1 According to Mr Filippo Buia (*Industria Saccarifera Italiana*, 4/2011, page 60).

2 . Please see in this regard the regular and fluent water draining from these perforated plates.

Figure 9: Fine pulp separators from press water