A NEW TOWER PULP PRESS

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1. Introduction

Dewatering of beet pulp is an old and ever-recurring issue BMA is deeply concerned with.

It is widely known that conventional pulp drying plants consume more than 25% of the primary energy input of a sugar factory.

For this reason, the object has been for a very long time to improve mechanical dewatering of the pulp so as to save energy in the subsequent drying process.

As you know, the energy input required for mechanical removal of a certain quantity of water is, to a certain degree, much less than for thermal drying.

What is more, saving of primary energy certainly is the most efficient measure to avoid emissions, as observance of the relevant regulations also involves high costs.

The type of press is preferably used today, i.e. single-spindle or double-spindle, horizontal or vertical, in conjunction with pressing aids, will allow a dry substance content of 30% to 34% in the pressed pulp.

The following picture (Fig. 1), which was published in 1991 by the sugar institute in Braunschweig/Germany [1], illustrates the efficient use of state-of-the-art pulp presses and the cost of wet pulp dewatering. Curve 1 refers to mechanical dewatering, curve 2 to thermal dewatering, and curve 3 is the cumulation of curves 1 and 2.
These curves clearly reveal that mechanical pulp dewatering is the most efficient process to obtain up to 34% - 35% dry substance.

Therefore we believe that in the future pulp presses will still be in great demand, especially for larger units which provide a better price/performance ratio and, if possible, an even higher dry substance content.

Let us now turn to BMA's latest developments in this field, which are identical with a translation of a statement made in a paper [2] on process engineering fundamentals of mechanical pulp dewatering published in 1987:

"Further development of technical pulp presses - preferably of continuously operating ones - should be based on the following principles:
- Low pressing pressure
- Extended pressing time
- Internal shearing in the screen area at a low relative pulp to screen velocity
- Large open screen areas."
2. The new tower pulp press HP 4000

2.1 BMA's range of pulp presses

Besides two smaller vertical presses (Fig. 2) for a beet slice rate of 1,500 mt/d (HP 1800) and 3,000 mt/d (HP 2250), a new tower pulp press (HP 4000) for up to 6,000 mt/d has been developed.

<table>
<thead>
<tr>
<th>Type</th>
<th>HP 1800</th>
<th>HP 2250</th>
<th>HP 4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beet slice rate</td>
<td>500-1500 mt/d</td>
<td>1500-3000 mt/d</td>
<td>3000-6000 mt/d</td>
</tr>
<tr>
<td>Drive power</td>
<td>2 x 37 kW</td>
<td>6 x 37 kW</td>
<td>8 x 75 kW</td>
</tr>
<tr>
<td>Spindle Diameter</td>
<td>1800 mm/5' - 11&quot;</td>
<td>2250 mm/7' - 5&quot;</td>
<td>4000 mm/13' - 1&quot;</td>
</tr>
<tr>
<td>Length</td>
<td>9700 mm/31' - 10&quot;</td>
<td>13600 mm/44' - 7&quot;</td>
<td>21600 mm/70' - 10&quot;</td>
</tr>
</tbody>
</table>

Fig. 2: BMA pulp presses
2.2 Design and construction

Basically, it is the conicity of the press spindle, subject to its height, which determines the compression of the pulp.

Efficient operation of every machine depends not only on the process technology, but also - to a great extent - on its design and construction, especially with regard to service life, frequency of repairs, wear and spare parts requirements.

Dynamic press systems distinguish between the single-spindle and the multi-spindle types, which practise the displacement-friction technology.

For design reasons, there is a limit to the practical size of horizontal multi-spindle presses, and therefore it is our firm conviction that single-spindle presses are the most efficient high-performance solution, especially for large capacities.

Consequently, all BMA presses are based on the single-spindle principle. The great inherent advantage is that it provides for equalization of loads at the spindle circumference and thus minimizes shear loads. There is no bending stress on the spindle and the shell, allowing for the construction of extremely large units.

Another objective of the HP 4000 development was to abandon the high-pressure principle and to adopt the low-pressure principle providing an improved pulp pressability. The high-pressure principle produces pressures up to 12 bar, while the low-pressure principle uses 4 to 6 bar as a maximum.

A disadvantage inherent in high-pressure pressing work is the high shear load in the pulp, which leads to a substantial temperature rise, and the resultant destruction of pulp along with the formation of a considerable percentage of fine pulp.

Moreover, high pressures contribute to narrowing of the pores and ducts in the pulp and, as a result, reduce the velocity of the pressing liquid flow.

This effect and the deteriorated permeability of the pressed pulp pack disclose the limits of high pressures and the great influence of the pressing time. It is just this longer pressing time which vertical low-pressure presses realize in an ideal manner.

In actual practice, pressing time quite frequently shows in overdimensioned plants, i.e. high dry substance contents are achieved at the expense of the throughput, the result being a very large number of presses which operate below capacity and at a reduced efficiency.
The following figures show various structural features of the HP 4000 press:

- An overall view of the press is shown in Fig. 3.
The introduction of torque into the press spindle can be seen from Fig. 4.

- Base with bearing assembly and drive casing (Fig. 5).
- Ease of maintenance is a design feature of utmost importance. All the antifriction bearings and gear components are oil-bath lubricated. The seals of the antifriction bearings have labyrinths and additional steam seals.
The main gearbox suspended from the press base has 8 planetary gears equipped with one asynchronous frequency-controlled motor each. The planetary gear output pinions have double antifriction bearings and are also oil-bath lubricated.

To make sure that the press re-starts even after a malfunction entailing a prolonged standstill when the press is still filled with pulp, an emergency program permits a short-time increase in capacity by 25% beyond the continuous torque.

Fig. 5: Base with bearing assembly and drive casing
The pulp discharge by means of a screw conveyor can be seen from Fig. 6.
- Press water discharge from either side of the screen of the press spindle is shown in Fig. 7.

Fig. 7: Press water discharge

- Fig. 8 is a top view of the pulp press base, showing the press water outlet, emergency drain and sluicing connections.
Fig. 8: Top view of press base

- The next photograph (Fig. 9) shows the same press base during erection.

Fig. 9: View of press base during erection
The design of all components is checked by the finite element method (Fig. 10). The maximum stress allowed under load is 160 N/mm². The lattice nodes are calculated for load and then checked for stress and strain.

![Finite element method - base calculation](image)

- A side view of the top with hopper and pulp distributor can be seen from Fig. 11. The hopper compensates fluctuations which might result from the extraction plant.
The design of the pulp distributor is given in Fig. 12.

Fig. 11: Top with hopper and pulp distributor

Fig. 12: Top with pulp distributor
The press-spindle (Fig. 13) is a sturdy welded one-piece component provided with stainless-steel screens. The outer shell and the screen also form a one-piece unit made from stainless steel. The inherent advantages of this feature permit proper and easy shop manufacture as well as quick and safe installation at site.

Fig. 13: Press spindle
- In Fig. 14 the assembly of the pulp press can be seen.

2.3 Control system (Fig. 15)

The capacity of the pulp press is controlled by its speed (rpm) which is influenced by a frequency controller (F2/F1). SIC 01 is a speed indicating controller which, in connection with a level signal (LE 01), transmits a pulse to the frequency converter (f 2/f 1).

The converter in turn controls the speed of the feeder screw conveyor and transmits a signal via a transducer (ST 02) to SIC 02 (another speed indicating controller).
The converter transmits a check-back signal via a transducer (ST 01) and a signal of the electric variable (current, voltage), i.e. the performance, to the speed controller SIC 01.

WT 01 is a computing element computing a signal from the product of speed and current which is proportional to the torque (packing ratio).

The level is measured by an ultrasonic probe.

2.4 Torque and power input

The diagram (Fig. 16) shows that the power requirements go up degressively along with an increasing frequency, i.e. an increasing pulp throughput and a decreasing dry substance content, while the torque goes down.
2.5 Efficiency

The diagram (Fig. 17) clearly illustrates the interdependence of capacity and achievable dry substance, meaning: the higher the dry substance content achieved in the press, the smaller the pulp throughput.

**Fig. 16: Torque and power input**
3. Campaign results

The next table (Fig. 18) shows campaign results achieved at the Elsdorf sugar factory of the Pfeiffer & Langen Sugar Group. It can be seen that in the course of 9 individual tests the beet slice rate reached 5,450 mt/d at an average dry substance content of 31.54%.
The following table (Fig. 19) shows operational results obtained in the last campaign. For the 8 different tests made, where the dry pulp was weighed, the respective torque, the addition of calcium to the fresh water and the press water of the extraction plant, and the pH-value in the tower middle are shown as well. The importance of the press water hardness and the tower pH-value is obvious.

Any decrease in calcium addition, which means a decreasing hardness of the extraction water immediately leads to a decrease in press torque and, as a result, a decrease in the final dry substance content.

An increasing tower pH also influences the two interdependent variables, i.e. the throughput and the dry substance content of the pulp.
Fig. 19: Operational results

Besides the results of the 8 tests mentioned before, the daily average of 3 samples of the pressed pulp dry substance taken over a period of 24 days is shown in the lower chart.

4. Maintenance

The design of the HP 4000 is aimed at low maintenance costs. The low-pressure principle alone leads to much less wear. HP 4000 cleaning and preservation can be handled by 2 men in 1 day. The gearbox oil should be checked every 2 campaigns. After 6 campaigns, one of the gearboxes should be dismantled for inspection.
5. Summary

The features and advantages (Fig. 20) of the new HP 4000 pulp press can be summarized as follows:

**Technically:**
- Low-pressure principle, hence:
  - minimized destruction of pulp
  - reduced fine pulp percentage
  - low power consumption
  - low maintenance costs

**Technologically:**
- Vertical design for optimum removal of press water from perforated spindle and screen basket
- self-cleaning effect
- almost infection-free, therefore
- no need for screen rinsing
- very clear press water due to minimized pulp destruction, and therefore
- reduced fine pulp percentage

**Economically:**
- High degree of availability
  - Vertical design, hence:
  - floor-space saving, i.e. optimum installation
  - directly beside the extraction plant
  - short conveying distances
  - no support structures required
  - requires just a foundation plate

**Fig. 20: Features and advantages**

The next two pictures show press installations at the Groß Munzel (Fig. 21) and Elsdorf (Fig. 22) sugar factories:
Fig. 21: Press installation at Groß Munzel
Fig. 22: Press installation at Elsdorf
Symbols and indices used:

\[ W_{TS, PR, Sn} \text{ [\%]} \]

Residual water (dry substance) in pressed pulp

t/d or mt/d
Metric tons of beets per day
sht
Short tons
Nm
Newton meter
Mt
Torque

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