Energy saving in malt milling

**POTENTIAL USAGES** | In recent years, energy savings have been achieved in the brewhouse, fermenting room/storage cellar and in filling. With modern malt reception and milling, energy usage could be lowered still further while simultaneously raising yield.

**MECHANICAL CONVEYING GENERALLY REQUIRES** significantly less energy (about 1-2 kWh/t) compared to pneumatic conveying (about 2-4 kWh/t) and, in addition, gives rise to less broken kernels. Mechanical conveying is, however, technically more elaborate as it requires a multiplicity of conveyor elements and diverters. There are other arguments that continue to favour mechanical conveying: lower investment and maintenance costs, less motors and electrical sensors, reduced explosion protection and flexible routing runs. As a consequence of plug flow (high pressure and low velocities), the percentage of broken kernels can be reduced to a level equivalent to mechanical conveying. Damage to husks in malt grist on a long pneumatic conveyor section is considerably less than that associated with mechanical conveying. Pneumatic conveying is especially suitable for difficult layout configurations or, generally, for grits and floury products. Selection of the best conveying mode has to take account of the particular situation. Undoubtedly, mechanical conveying as it is used today is cumbersome.

**Efficient material flow**

Bühler AG’s Flow Balancer controls throughput and, at the same time, measures the controlled flow rate. Such units are standard in grain mills, whereas material flow is still regulated manually by manual gate valves in breweries. Product flow is controlled using the preset of a controller, often some considerable distance from the silo. Due to bulk weight fluctuations, throughput quantities initially set change over time and even batch size does not always stay constant. Consequently, the cleaning line including milling and suction has to be operated longer than necessary. Using a Flow Balancer located under the silo, material flow rate is permanently at the design maximum and the product quantity controlled at +/- one per cent so that no preset is necessary. The cleaning and suction units also operate more efficiently because they can be set to run at a constant product flow rate. Furthermore, accurate blending is also possible when simultaneously discharging from several silos. Different malt types can thus be blended consistently and accurately in any quantitative ratio. The flow controller can be used universally, for unmalted grains as well as for barley, wheat, corn and rice, among others (fig. 2).

**Low-pressure filter has an advantage**

Due to cost considerations, filter systems in breweries are fitted with high-pressure filter cleaning systems operating at a pressure of 5 bar. Supply of compressed air is expensive and costs are currently about 0.10 EUR/m³. For large filters, it is worthwhile to go over to cleaning systems with low-pressure filters. This uses a blower at only 0.5 bar, costs drop to a fifth, i.e. about 0.02 EUR/m³. The design of the filter heads is somewhat more expensive, raising investment costs by 15-20 per cent. As a rule, these have a payback time of about 12 months. The round shape of modern filters gives rise to better stability (ATEX pressure shock resistance) as well as a cyclone effect which assists in separating off solids and in achieving a higher degree of separation.

**Less air for double-deck destoners**

In destoners, malt passes over a sifter which has air flowing through it. Malt floats on a cushion of air so that the heavy stones fall on the sifter. Resulting from movement, stones are conveyed along the sifter to the highest point of the sifter deck where they

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**Fig. 1 Functional schematic of the MZAH Flow Balancer (Bühler AG)**

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are collected and removed. Modern destoners have two decks and long sifter runs so as to have an optimal malt residence time in order to separate stones from the product stream. This achieves a degree of separation of >99 per cent (fig. 3).

Compared to older destoners with broad and short sifters, modern double-deck sifters with a long and narrow design require significantly less air. The two-deck destoner from Bühler, with a low-maintenance Vibro motor, operates with high throughput and has proven itself in grain mills. By way of comparison: at 16 t malt/h, an older destoner required up to 240 m³/min of air, Bühler’s MTSC requires only 130 m³/min.

**Combination machine for cleaning**

Regular cleaning of sifters in the destoner contributes to energy savings. In the MTKB combination cleaning machine, the functions of separator, destoner and concentrator as well as an aspiration channel for fine particles are combined. The unit thus requires considerably less installation space and uses up to 30 per cent less air. This is a result of considerably lower suction air usage, compared to individual machines, also requiring less filter surface area as well as volumetrically smaller exhaust air fans. That leads to further savings. Sifter and separators, in combination with an aspiration channel, remove coarse items and fine particles. The latter is especially important so as to avoid blocking of the sifter surface. As a rule, sifters and destoners should be cleaned regularly so as to ensure that throughput capacity is maintained at maximum separation performance and that no air and energy is wasted unnecessarily.

**Vertical hammer mills**

Hammer mills require up to four times more energy than roller mills. Sifter sizes have a major influence on fineness of milling and thus on energy consumption. The larger the sifter holes, the lower will be energy consumption and the bigger will be particle size distribution. The trend emerging from mash filter manufacturers is in the direction of coarser grist. Lower energy consumption, less wear on sifters and hammers as well as shorter residence times in the mash filter arise as advantages. Figure 4 clearly shows that a reappraisal of sifter holes in an existing plant could be well worthwhile. Specific tests with larger sifter holes in combination with slight adjustments of the brewing process would pay off.

Apart from sifter holes, the design can also save energy. Compared to horizontal hammer mills, vertical hammer mills require up to 30 per cent less energy. They can be used in combination with all mash filter makes.

With 2 mm sifter hole size, power required per ton of malt is 5–6 kW for the vertical mill.
The horizontal mill, at 9-11 kW, requires significantly more. The vertical design operates without suction and achieves better efficiency of the hammers as these are used evenly along the whole side edge whereas, in a horizontal mill, only the tips come into contact with product. Maintenance, inspection as well as change-out of hammers and sifters is easy in the case of the vertical design.

**Wet and dry milling compared**

The objective of conditioned dry milling is to make husks elastic by moistening them so that damage is kept to a minimum in subsequent milling. Bühler has developed conditioned dry milling further, adding up to 6 per cent water, with adequate conditioning time. This makes lautering performance comparable to that of wet milling. The milling process in modern 6 roller mills involves three steps: breaking up the kernel, milling of the endosperm, milling of coarse grits to fine grits. Removal of husks through sifting is an intermediate step. For clean separation, Bühler uses Maltomat mills with large sifter surface areas. Each milling pass is provided with different roller flutings and differential speeds so that every step can be optimally set to carry out the respective milling operation (fig. 5).

Milling in three steps lowers energy usage (6 roller mills need only 2-2.5 kWh/t of malt) and simplifies roller control. The system of stepwise milling is especially suited for barley which is hard and tough. Wet milling with one or two squeezing steps does not produce the desired particle size distribution which is reflected in diminished yield in the brewhouse. Energy consumption for wet milling is higher than that required for conditioned dry milling. Depending on the system, it runs at 3.5-3.9 kWh/t. The principle of wet milling is based on one or two milling passes that break up the endosperm, using pressure and a higher degree of wetting. In squeezing the brittle malt kernel while applying a higher degree of wetting, husks remain intact. However, higher friction due to adhering moisture as well as squeezing give rise to a higher resistance on the rollers so that regular refluting of the rollers is required. In dry milling, wear on the rollers is gradual, leading to a gradual drop in yield. In breweries, this becomes often obvious only when the whole set of rollers were replaced, yield then goes up 0.5-2 per cent. Lost extract is also energy. To produce a ton of malt, about 6 m³ of water and 600-900 kWh of energy (of which 140 kWh are electrical) are required.

**Summary**

Energy consumption can be optimised all through from malt reception to milling. A constant and efficient product stream can be assured by installing a flow controller such as the Flow Balancer.

Whether pneumatic or mechanical conveying is preferable has to be decided according to the particular situation. 30 per cent less air is required in cleaning using a combination machine. Choosing the correct filters can reduce energy costs still further. Vertical hammer mills have advantages, compared to horizontal designs, not just in terms of energy consumption. The dry section of a brewery should also be taken into account in energy considerations. Regular maintenance of machinery, replacement of hammers as well as cleaning of sifters should not be underestimated as a means to save energy.