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EXTRACTING SUCROSE FROM SUGAR CANE

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The invention relates to a method and apparatus for extracting sucrose from sugar cane, and more particularly to improvements in the process of reducing the sucrose content of the juice and to decrease the cost of extraction.

In one of the known methods, sugar cane stalks are first reduced to particle size so that they can be fed into a roller mill or a roller mill type crushing machine. The cane particles are subjected to maceration in a liquid which is passed to the next mill. The efficiency of extraction is increased due to more complete dilution of the residual juice by the maceration liquid which reaches every broken cell and interstice in the bagasse.

Several ways of discharging the bagasse from the mill under liquid seal can be devised. In one method, the discharge opening of the crushing mill extends into a tank filled with maceration liquid, so that the bagasse after leaving the mill, expands within that liquid, and is then transported out of this tank to the next milling stage.

In another case, a similar liquid seal is provided at the mill outlet, but of such a shape that the mixture of bagasse and surplus maceration liquid overflowers from the sealing trough into a further receptacle from which it is transported to the next mill.

The above arrangements can be further improved by a liquid seal arrangement in which the bulk of the surplus liquid is drained from the bagasse before the latter leaves the sealing arrangement. Thus the bagasse is suitable for handling on belt conveyors or the like and with minimum further drainage is suitable for feeding into a subsequent mill.

It has been found that with the invention outlined above, an improvement in extraction is obtained at each of the successive mills of a tandem giving an overall improvement approaching 1.0% in the sugar extracted, provided that all mills in the tandem, except the last one, are equipped with the invention. Further advantages resulting from the invention will appear hereinafter.

The invention will be described hereinafter in more detail in connection with the drawings in which:

FIGURE 1 shows schematically a sugar mill stage incorporating one embodiment of the invention;

FIGURE 2 shows schematically the sugar mill stage of FIGURE 1 incorporating another embodiment of the invention;

FIGURE 3 is a side elevation of the embodiment of FIGURE 2 with modifications showing details of the new liquid seal at the outlet of a sugar mill stage;

FIGURES 4 and 5 show details of the embodiment of FIGURE 3;

FIGURE 6 is a perspective view of part of the embodiment shown in FIGURE 3.

Referring to FIGURE 1 three rollers 1, 2 and 3 rotating in the direction as indicated by the arrows form a sugar mill stage. These rollers are rotatably mounted between side cheek plates and driven by suitable driving means of conventional design.

The sugar cane 4 previously broken up into particle size is fed into the mill by a suitable chute 5. At the output side of the mill a trough 6 is arranged in such a manner that the discharge or outlet opening of the mill is completely enclosed by the trough 6.

The level of liquid in trough 6 is maintained above the outlet opening of the mill stage by maceration liquid 7 supplied through an inlet 8. Visual evidence that the outlet of the mill is properly sealed is obtained by allowing the liquid to also fill the space between the trough front plate and roller 2 as indicated by the dotted lines 9.

The bagasse resulting from the crushing of the sugar cane particles 4 is thus discharged from the rollers 2 and 3 in a compressed state under the liquid seal in trough 6, where the bagasse expands under complete exclusion of air. Suitable conveying means 9 extend into trough 6 to transport the bagasse 7 to another mill stage or other location.

In the arrangement shown schematically in FIGURE 2 the trough 13 is funnel-shaped and is arranged at an angle so that the outer edge of the lower plate of the funnel forms an overflow edge 14 which is connected over a slide 15 with a further receptacle 17 into which the conveyor means 9 extend.
Two inlets 8 and 16 are provided in the top and bottom plates of the funnel-shaped trough 13 to pass the maceration liquid into the funnel and thus to maintain a liquid seal across the discharge opening of the mill. As described above visual evidence that the outlet of the mill is properly sealed is obtained by allowing the liquid to also fill the upper plate 20 and the roller 2.

This arrangement provides a constant maceration liquid level in the trough above the mill discharge opening and any surplus liquid together with the bagasse flows over the over-flow edge 14 into the receptacle 17 from which it is drained at outlet 10 and recirculated to the inlets 8 and 16 by the pump 11 together with any additional liquid drawn from tank 12 to maintain the level of liquid in the trough above the output opening of the mill stage.

Details of the last mentioned arrangement including some further modifications are described hereinafter in connection with FIGURES 3 to 6.

The three rollers 1, 2 and 3 are arranged as described earlier. The chute 8 guides the prepared sugar cane into the mill from which it emerges as bagasse from the discharge opening 37 formed between the rollers 2 and 3.

This opening 37 is completely enclosed by the funnel-shaped trough 13 which is filled with maceration liquid. The trough has a rectangular cross-section, two opposite sides being formed by the two side plates 18 and 19 and the other two sides being formed by an upper plate 20 (FIGURE 5) and a lower plate 21 (FIGURE 4) arranged at different angles to the horizontal plane to form a tapered funnel with the narrower lower end in contact with the rollers 2 and 3 above and below the discharge opening 37 of said rollers respectively and the upper end 38 being above the level of said opening. To achieve a good seal at the roller the lower plate carries a serrated sealing strip 40 which fits into corresponding grooves of roller 3.

The maceration liquid is passed into the funnel 13 by means of orifices 8 and 16 in the upper and lower plate respectively. The liquid is pumped from the reservoir as described above through the pipelines 22 and 23 which end in suitable heads 24 and 25 enclosing the orifices 8 and 16.

To minimise leakage of maceration liquid from the lower end of the chute the lower plate is always kept in close contact with roller 3, the plate being supported on a linkage system which is under permanent spring loading and allows a limited parallel movement of the plate (21). This is shown in FIGURE 3 for the lower plate 21 by the linkage 29 connected with a control arm 30 and under the influence of compression spring 31.

The upper ends of the plates 20 and 21 are extended by grids 32 and 33 respectively to permit surplus maceration liquid to be drained from the bagasse before the latter leaves the upper end of the trough for transportation to the next milling stage. The grid 32 extends in the same plane as the corresponding plate 20 while the lower grid 33 extends in the same plane as plate 21 with its apex at 14 serving as an overflow edge for the bagasse.

The build up of bagasse between the beginning of the top grid 32 at the end of plate 20 and the beginning of the bottom grid 33 at the end of plate 21 and the apex 14 of grid 33 obstructs the flow of maceration liquid over apex 14 and helps to force excess maceration liquid through the upper and lower grids.

Excess maceration liquid drained through grid 33 is collected in a receptacle 17. Surplus liquid drained through grid 32 passes through a suitable opening 35 in side plate 18 into a duct 34 which connects with receptacle 17.

An outlet 10 in the lower part of receptacle 17 connects the latter by a duct 36 with a suitable pumping device for recirculation as described above in connection with FIGURE 2.

This arrangement ensures a permanent liquid seal of the discharge opening 37 between the rollers 2 and 3 with a minimum quantity of excess maceration liquid. As described before visual evidence that the outlet of the mill is properly sealed is obtained by allowing the liquid to also fill the upper plate 20 and the roller 2.

The drained maceration liquid has only a small if any content, as the bagasse itself acts as a screening agent, and is thus suitable for re-circulation with a minimum of screening.

The arrangement as described above furthermore facilitates handling of the bagasse on belt conveyors or the like, reduces the quantity of recirculated maceration liquid to a minimum and simplifies the plant thus reducing the cost of the installation.

When a milling stage is equipped with the invention no forward leakage of maceration liquid occurs through the discharge opening 37 into front roller juice either when the mill is operating normally, when the mill is running but the feed is stopped or when the mill is stopped.

Small quantities of maceration liquid in the form of a film, wetting and adhering to the surface of roller 2, are however, carried over and will mix with front roller juice. In cases where it is important to prevent this carrying over of the above film of maceration liquid may be removed from the surface of roller 2 by blowing with air jets.

The invention has been described above in connection with one milling stage only, but it must be understood that the arrangement can be repeated for further milling stages arranged in tandem.

We claim:

1. In a milling apparatus for extracting sucrose from sugar cane in which sugar cane particles are passed through a mill with a discharge opening to discharge the resulting compressed bagasse, said apparatus comprising a funnel shaped trough of substantially rectangular cross-section arranged adjacent to and across said discharge opening, said discharge opening being completely submerged in said maceration liquid to form an air-tight seal for said discharge opening two opposite sides of said trough being formed by side plates of said funnel, the upper and lower sides of said funnel being formed by an upper and a lower plate each having a plurality of orifices therein, said plates being arranged at different angles to the horizontal plane and extending upwards from said said orifices in said upper and lower plates being arranged nearest to said opening for the admission of maceration liquid, a grid extending from the upper plate of said funnel in the same plane thereof, a further grid extending from the lower plate in the plane of the lower plate with its outer end forming an overflow edge for said bagasse.

2. In a milling apparatus for extracting sucrose from sugar cane in which sugar cane particles are crushed between rollers of a mill and the resulting bagasse is subjected to a maceration liquid, said mill having a discharge opening extending horizontally along said mill to discharge said bagasse into a maceration liquid, the improvements comprising side plates adjacent said opening, a first plate and a second plate extending above and below said discharge opening and abutting said plates, said first and second plate being arranged at different angles to a horizontal plane and sloping inwards away from said plate, a further grid extending from and in the same plane with said said plate, the outer end of said further grid forming an overflow edge for said bagasse, a receptacle arranged underneath said second grid to receive maceration liquid drained from said bagasse through said second grid, an
aperture in at least one of said side plates above said first plate and adjacent thereto and a duct between said aperture and said receptacle to guide maceration liquid drained through the grid in said first plate into said receptacle, pumping means for said maceration liquid and a duct from said receptacle to said pumping means, a pipeline connecting the orifices in the first plate with said pumping means, and a further pipeline connecting the orifices in said second plate with said pumping means to pump maceration liquid from said receptacle through said orifices into said funnel.

3. A milling apparatus according to claim 2 and having spring loaded linkage means pivoted at said side plates and supporting said second plate for parallel movement of said plate, said spring loaded linkage means maintaining the lower end of said plate on contact with the corresponding roller of said mill.

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