Arne S JENSEN.

Steamdrying of Beet Pulp.
Development by rebuilding old dryers.

Introduction:
Sugar technology has a long history of development that continues today and will continue into the future as we strive to be competitive against new challenges. It is amazing how much change has occurred. It is hard to believe we are the same industry when we look at figure 1.

As you can see, the juice had to be concentrated just like today, but it took place in direct fired pans, where the primary energy from burning bagasse or wood was used once and only once. There was no capture of the vapour being generated as the need was to just concentrate the juice. Today, you would never think of concentrating the juice in anything but a multiple stage evaporator. The energy waste in a single concentrating evaporator could not be tolerated. Further, to improve energy utilization, the high pressure steam would have produced electrical power before being used at the evaporators. Direct steam from the boiler house would not supply steam for pan boiling and juice heating, this would only come from the evaporator station after multiple pounds of water had already been removed from the juice with that single pound of steam from the boiler. Reduction of energy and wasteful operation is natural - But what are we doing when we dry our beet-pulp in a conventional drum dryer? We are spending our fuel on evaporating water in one step. We make no electrical power, and the vapour is of no practical use. Instead this vapour is pollution, and the process burns between 3 and 15% of our product. We can reduce much of the air pollution by scrubbing, but you will still have smell, and the scrubber has only moved the air pollution to the water. This water will require treatment. Both processes use additional energy to move the pollution. Is it really amazing how far we have come in energy conservation?

Yes because steam drying the pulp solves those energy and pollution problems. It conservatively saves 90% of the fuel you need for drum-drying.

The development by Danisco
The development of the technology took place in the eighties at Danisco in Denmark. The development is described in earlier papers by Arne S Jensen as well as recently in the International Sugar Industry, February 2003 issue. The prototype was build at Stege Sugar factory. The first dryer was sold by Danisco and installed in France. In the summer of 1990 the technology was transferred from Danisco to Niro A/S along with myself. In the following years, eight different factories in Europe installed steam dryers supplied by NIRO. In 1997 Niro decided to stop investing and developing steam drying. I, Arne Sloth Jensen, left Niro and later founded the company EnerDry.
The development by EnerDry
In 1997 the steam dryers that attempted to operate at loads higher than 2/3 of the maximum design still encountered problems. They could not reach the rated capacity, and the operation was not steady. The availability of the steam dryer was far too low even for the short European campaigns. In most cases the availability was averaging between 80 and 90%. Coupled with factories desiring higher capacities the steam dryer needed improvements or a good concept might be loss. That task was taken up by EnerDry.

One problem was that a highly loaded fluid bed would lose fluidization and plug randomly and the job to clean it up took several hours. It was necessary to improve the fluidization. The perforated bottom support plates for fluidization were rebuilt in several steps from 1998 to 2001. This new perforated bottom design is curved. The distribution of the holes in the perforated plates was changed and some jet effect was added.

Figure 2. is a photo of the steam dryer in Cagny, France. It has been rebuilt by EnerDry.

In many cases the dryer has become too small for the increased capacity required by the factories. Those factories asked EnerDry as well as NIRO to develop dryers with a larger water evaporation capacity. NIRO had no alternative to the new EnerDry patent.

A larger capacity was only possible by circulating a larger steam flow in the dryer. That would be risky with the old design as too much wet dust would fly into the cyclone at the top of the dryer. A new design was therefore prudent and necessary. The first version was installed at Nangis factory in France in 1999. It has been further optimised in the years thereafter. The concept was to make a pre-separation of the dust along with a post-drying in the top of the dryer, outside the main cyclone. This was accomplished by letting the steam circulate outside the main cyclone before it could pass into this cyclone mainly over the last part of the cyclone, and only at the top of the cyclone. The risk of this design is it may block the bottom for the cyclone with pulp, but that has never taken place.
Figure 3 is the new dust separation in the top of the dryer.

The fluid bed should also be more robust, so it can handle the larger amount of pulp. That need was already covered by the development and installation in Cagny.

The larger circulation of steam needed for these improved evaporative capacities then demanded a larger fan and motor. The new design obtained up to 25% more capacity.

Also the dividing of the fluid bed in high vertical cells is a hindrance for the increased capacity. The division in high vertical cells was the main claim in the patent for the Danisco/Niro/BMA dryer. Thereby a new dryer, not divided in cells, was created and is patented or patent pending world wide.

**Actual results.**

The largest and latest rebuilt dryer was the size 10 dryer at the Suiker Unie factory in Puttershoek in Holland. The dust separation, the fluid bed, and the fluidizing fan and motor were replaced. The outer pressure vessel, and the large heat exchanger in the centre of the dryer was still the same. It would have been a process advantage to put in a new heat exchanger. However, this was not justifiable based on the installation cost and expected economic gain.

**Comparison of the Puttershoek steam dryer**

<table>
<thead>
<tr>
<th>Steam description</th>
<th>dryer</th>
<th>Input</th>
<th>Output</th>
<th>Evaporation rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old style dryer</td>
<td></td>
<td>60 short tons per hour of pulp at 71% moisture</td>
<td>19.3 tons of dried pulp per hour</td>
<td>40.7 tons per hour of water evaporation</td>
</tr>
<tr>
<td>New Steam dryer (modified)</td>
<td></td>
<td>75.6 short tons per hour of pulp at 71% moisture</td>
<td>24.4 tons of dried pulp per hour</td>
<td>51.2 tons per hour of water evaporation</td>
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</tbody>
</table>

The supply steam was at 22.5 barg or 326 psig

Five of the eight sugar factories in Europe having the Niro steam dryer have had their dryers rebuilt by EnerDry.

**Rotary valves.**

Another development has occurred. The rotary valves used for getting the pulp in and out of the pressurized vessel have been improved over the last 6 years by implementing a new design by EnerDry. The availability has improved and the lifetime of the new wear parts has been doubled. The original valves with the 3 chambers were a design used in the Swedish paper industry. The steam supply to set pressure in the chamber was described in a paper by Arne S Jensen published in Zuckerindustrie on October 1995.
Figure 4. Inlet rotary valve. The form of the inlet and the outlet for steam is very important for reduction of the wear.

Figure 5. The outlet rotary valve with the EnerDry designed rotor, that reduces wear by 50%.

Figure 6. Drwg H 01 005 demonstrates how all the waste steam/vapour is recovered, and pollution is avoided.
The new dryer from EnerDry.
The new dryer from EnerDry is more compact and has a higher capacity. Therefore it is offered at a better price especially when compared on cost per ton of evaporation.

Figure 7. The dryer from different angles.

Figure 8 shows a balance for a size H dryer with its guaranteed capacity. With the latest results from the steam dryer in Puttershoek, Holland, an additional 10% higher capacity is expected or over 60 short ton evaporation per hour. That is enough for drying all the pulp from a 12000 t/day factory when the pulp is pressed to 72% moisture.
Steam drying will provide more income to a factory. How much will depend on the particular factory and their individual set ups, so budgets must be set up for each individual factory. An example for 110000 lb/hr evaporation that was using natural gas is provided. This is sufficient to handle a 10,000+ ton/day beet slice.

- Saving on gas: $3,187,000 per year.
- No lost product: $540,000 per year.
- Saving on labour: $100,000 per year.
- Saving on maintenance: $200,000 per year.
- Total saving: $4,027,000 per year.

It is assumed:
- Campaign: 180 days.
- Natural gas: 5.50 $ per 1,000,000 Btu.
- 7% losses on the old drum dryers.
- Pellets at $75 per short ton.

A budget for such a dryer installation could be.

- Dryer ex works: $3,6 million.
- Transport and erection: $1.2 million.
- Dryer in place: $4.8 million.
- Foundation, Building Conveyors, piping, electric supply, modification to the evaporator station: $2.1 million.
- Total: $6.9 million.

**Dryer for Minn-Dak Farmers.**

EnerDry have sold a dryer to Minn Dak Farmers that will be operational in 2003. Minn -Dak Farmers cooperative expects a pay back on the investment of 3.3 years. At the same time the air pollution will be reduced considerably. No monetary value has been placed on this.
Figure 10 A recent photo taken mid February at the site. The new building is in the background and in the foreground is the superheater waiting to placed.

Figure 11 Photo from the tubing of the superheater.

Conclusion.
A steam dryer based on new patents is now available from EnerDry. Compared to the competition this dryer gives more capacity for less investment. As always, the steam drying installations reduce the energy usage at the drying station by at least 90% compared to drying in conventional drum dryers. Additionally it saves on labour and maintenance. No product loss occurs...and it solves the air pollution problem for good.

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Arne Sloth Jensen