

LARSEN, KASPER GEHL^{1*}, KIKUCHI, FUMIO² and ARNE S JENSEN¹, ¹EnerDry ApS, Kongevejen 157, 2830 Virum, Denmark and ²Nitten Beet Sugar Co. Japan. **Steamdrying of beet pulp in Japan and the latest development of the technology.**

ABSTRACT

The first steamdryer for beet pulp in Japan is now installed and put in operation by EnerDry. This is at the Bihoro factory on Hokkaido belonging to the Nitten Sugar Company. On Hokkaido the winter is cold like in the Mid West, so the beets can be stored with temperature control around the freezing point in large tents. The cossets are cut very fine, which gives a good pressing and another type of pulp than in the Mid West. The dryer therefore has to be adapted to these new conditions, which was successfully done and even with a saving of power. The development on the drying technology is continuously going on. There are especially spent efforts on new and better ways to discharge pulp out of the pressurized system.



Fig. 1 The bottom part of the dryer is lifted in place.

Installation of steam dryer size F:

In 2008 EnerDry signed contract with Nitten Sugar Company to deliver one steam dryer size F for the Bihoro factory. Bihoro is placed on the northern Japanese island Hokkaido. The factory has the following data:

Beets processed:	467.400 sh. tons
Sugar production:	74.800 sh. tons
Pressed pulp sold:	8.100 sh. tons
Pulp pellets sold:	25.200 sh. tons

Boiler pressure 1.460 psi: Capacity: 88 sh. t/h of steam

The campaign runs from mid October to the first week of March, which makes app. 145 days of campaign per year. The factory had a new boiler and turbine with an outtake installed in 2008. The dryer run on 290 psi (20 bar) of steam pressure and is able to evaporate 22,5 sh. ton/h. Normally pulp leaves steam dryers with 88% DS, and the pellets will end up being 90% DS. The factory is interested in getting the pulp as dry as possible in order to mix as much CSB in the pulp before pelletizing. DS of the pulp leaving the dryer is today higher than 92 % where after the CSB is added, and the pellets end up with 90% DS.



Fig. 2, steam dryer building at winter time.

One of the challenges of erecting the steam dryer was the fact, that local authorities don't allow big components to be transported, due to narrow roads. This means that a lot of the components of the pressure vessel were assembled on site. It gets very cold in the winter, so there was made a building all the way around the dryer.

In Fig. 2, the drying building can be seen. This picture is taken in the 2009/2010 campaign after the dryer was commissioned.

Throughout the entire factory everything is kept very clean. **In Fig. 3,** the dryer is in operation.



Fig. 3, steam dryer in operation.

In Bihoro there is done an effort in cutting the beets, so the cossets are of high quality. This is done to reduce the sugar loss in the pulp, it gives good pressing, and it makes it easy to operate the diffusion tower. The knives are controlled very often, and there are no slabs and almost no fines. The knife height 4,5 mm is adjusted carefully. The knives have 27 divisions on 200 mm. There are 3 presses: 1 Babbini PB-17S, 1 Babbini PB-17F and 1 Stord RS-64S. The average dry substance of the pressed pulp is 29.5%.

The steam dryer was designed to handle this pulp, but still it was necessary to adjust the fluid bed bottom of the dryer during commission, in order to get a higher dry substance of the dried pulp. After this adjustment, the dryer was evaporating the wanted capacity with the wanted high dry substance.

When the pulp particles are as small as in Bihoro, the velocity of the steam in the fluid bed cannot be as high as in the American steam dryers. The risk of plugging the dryer is bigger when the velocity is lower. This dryer has however never plugged. The decrease of the fluidizing steam means that the needed power for the fan is reduced significantly.



Fig. 4 The cossets on the Bihoro factory.



Growing sugar beets in Japan:



Fig. 5, paper pots in the soil.

The growing season is very short in Hokkaido. In order for the beets to mature and have high sugar content, the growing season is extended the following way: The beets are seeded in paper pots. The beet plants start their life inside large greenhouses in the late winter time. Seeding the beet seed into the paper pots is done by machines.

When soil temperature and weather allows it, the paper pots are planted in rows in the fields with special machines.

Storage of beets in Japan:

It gets very cold in the winter in Hokkaido similar to the mid-west. The sugar factories have learned to benefit from this cold weather, in order to extend the campaign length. At the Bihoro factory, the beets are stacked in long piles. These piles are covered with large tents, standing on the beet piles. The tents are made of scaffold with a plastic sheet over. In the tents are openings, which are opened and closed whereby the temperature is controlled, in order to keep the beets at a steady temperature of 40° F.



Fig. 6, beet piles are covered with tents.



Fig. 7, inside the tents.

The cold is coming from the outside, and heat is generated by the beets. Because of this it is possible to control the temperature inside the tents.

When the factory is ready to process the beets, the tents are removed and the beets are loaded to trucks and transported to the factory.

Development of discharge system for steam dried beet pulp:

In our struggle to improve the steam driers even more, it was decided to take a thoroughly look at the component that usually gives the most downtime; the outlet rotary valve. Two concepts were worked on parallel:

1. Improve the existing outlet rotary valve.
2. Develop another system, which will be described here:

The normal way of discharging the dried pulp from the 40 psig pressure inside the dryer is by using a rotary valve. These valves have a tendency to wear, especially if there is a high sand content in the dried pulp. The two shoes are pressed to the rotor in order to keep the valve steamtight. These shoes are worn, and they are expensive to replace. Changing one shoe takes 4 hours. Total renovation with new wear parts takes 24 hours.

A study of other principles to discharge the pulp was made. High pressure difference over the rotary valve cause high steam velocity. This combined with the pulp causes heavy wear. Therefore a new principle should have a way to reduce the pressure gradually before the pulp comes out into atmospheric pressure.

The concept of a pipe full of pulp came up. The idea is that the steam loses its pressure as it travels through the pulp. The longer the pulp plug is the smaller amount of steam will blow through it. It can be compared with a blocked filter. At the end of a pipe, a valve should be able to hold back the pulp, but not the steam. If the pipe is too long, the steam pressure will not be able to push the plug through the pipe, and down to rotating valve. In figure 8 F_p is the force of the steam pressure (steam pressure x area). F_m is the friction between the pulp plug and the pipe inner wall. F_p has to be bigger than F_m in order for this concept to work.



Fig. 9, perforated plate is holding back the pulp.

In order to find out if the pulp is able to hold back the pressure, tests were made. The initial tests were with a 6 m long 4" pipe filled with dried pulp. Compressed air was applied in one end, and in the other end, a perforated plate was holding back the pulp, but not the air. Manometers were installed on the pipe for each 2 feet. By doing this, the pressure loss through the pulp could be measured.

The pulp was able to hold back the air enough for the pressure to build up, in the end where the compressed air was blow in. The flow of air through the pulp was not as high as expected. Next step was to install a rotary valve to sluice out the pulp, while there was a pressure loss through the pulp.

The valve was turned by hand, and it was easy to remove the product out of the pipe. It was clear to see, that the shorter the pulp plug was, the more air went through it. The valve also got more difficult to turn as the pulp plug was reduced in length. This is because the friction on the pipe wall F_m is reduced.

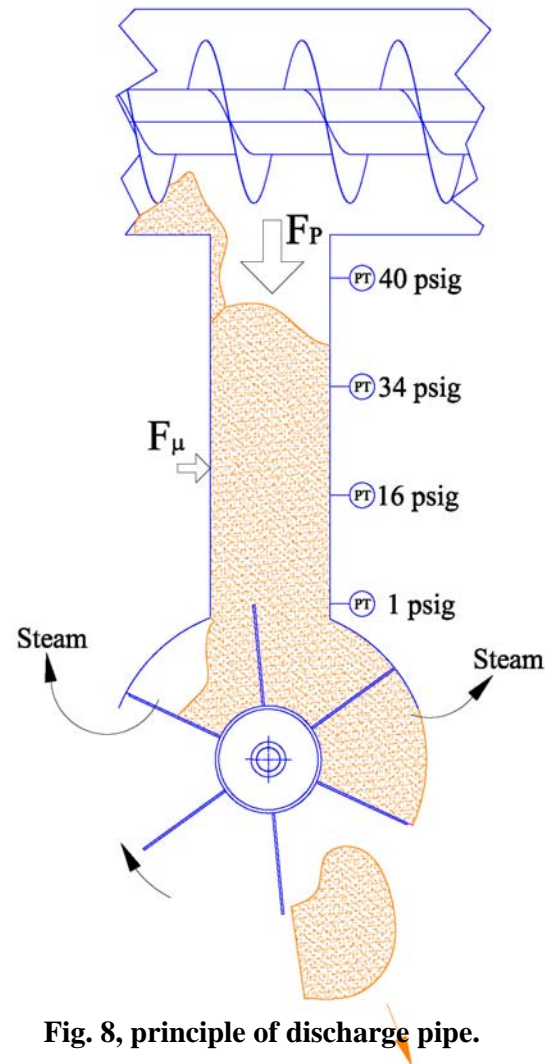


Fig. 8, principle of discharge pipe.



Fig. 10, valve for discharging pulp. Chambers are made of perforated plates.

Next step:

As the results seemed promising, it was decided to test this new principle on a real steam dryer. In the summer of 2009 an outlet pipe was installed on an EnerDry steam dryer. The pipe was installed on the discharge conveyor between the dryer and the outlet rotary valve. At the end of the pipe at the floor a Pulp Flow Control Valve (PFCV) (not airtight) was installed. To measure how much pulp was inside the pipe, pressure inside the pipe was measured every 2 feet, down through the pipe. The filling of the pipe controlled the speed of the Pulp Flow Control Valve.

In Figure 11, the principle can be seen.

- No. 1 is the nozzle on the discharge conveyor.
- No. 2 is a pneumatic slide valve
- No. 3 is the outlet pipe
- No. 4 is the PFCV (not airtight)

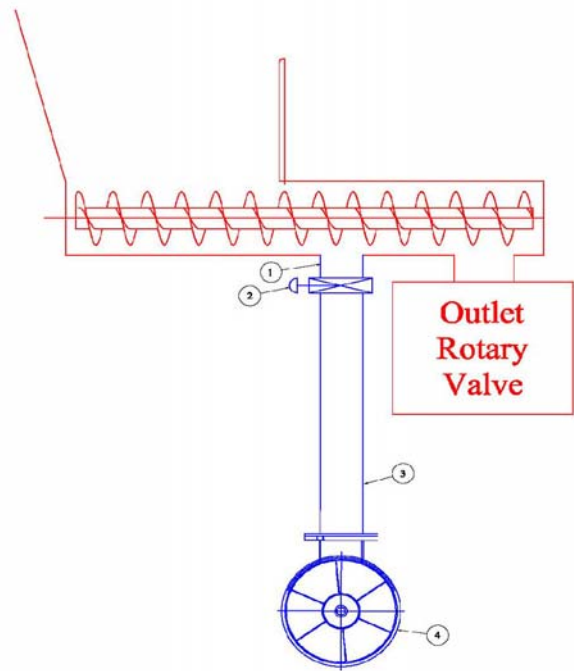


Fig. 11, principle of outlet pipe.



Fig. 12, first pulp discharged trough the outlet pipe.

The system was able to sluice out pulp, with almost no steam loss. There was however a problem; the pulp got stuck in the PFCV. The product was building up and the chambers were filled up with compressed pulp after app. 2 min. This meant that the PFCV had to be redesigned to a design where the pulp didn't get stuck.

In Figure 12, the first pulp discharged from a steam dryer through this outlet pipe can be seen. It is not possible to see the rotor on the PFCV, due to the housing around it. The pulp is reclaimed into the pelletizing system, so no pulp is lost during these tests.

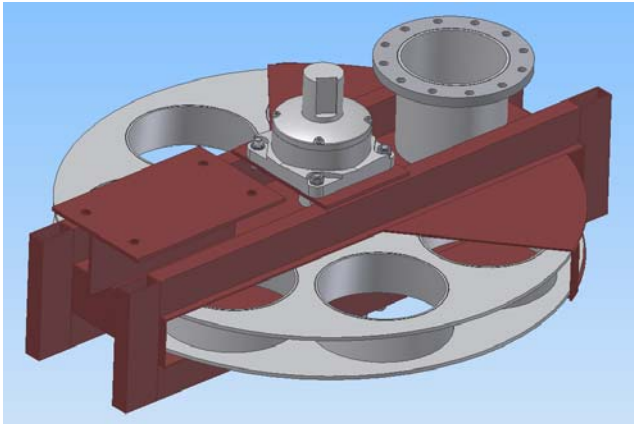


Fig. 13, drawing of the new PFCV.



Fig. 14, the new PFCV installed.

Between the 2009 and 2010 campaign, a new PFCV was designed, fabricated and installed. Instead of the product entering the rotary valve in the radial direction, the pulp now enters the PFCV in the axial direction. This means that the shaft of the rotor is vertical. On figure 14 the new valve has been in action. Notice the lumps in the pulp. These are made because of the pulp being compressed by the pressure inside the steam dryer (F_p). When the pulp is compressed, it also blocks the way for the steam to exit the dryer. This means that there will be less steam leaving the dryer with the pulp than with an ordinary rotary valve.

The speed of the PFCV is regulated on basis of how much pulp there is inside the pipe. To measure the filling, the pressure is measured. The top of the pulp plug is defined to be where the pressure is 5 psi less than inside the dryer. The nozzles on the outlet pipe are connected to the pressure transmitters. To make sure that the nozzles not are blocked by pulp, flush air is introduced. There was however some challenges on controlling the pulp plug inside the pipe.

Improving the existing outlet rotary valve:

The last couple of years a lot of improvements have been made on the existing outlet rotary valves. A lot of data from the rotary valves has been analyzed. This has lead to an optimization of the control system, for the hydraulic control of the two shoes. The position of the shoes is of very big importance, in order to have non-stop operation throughout the campaign. There have also been tested different types of material, and different types of hardening processes in order to get the optimal material.

One thing that also has big influence on the wearing of the shoes is the sand content of the dried pulp. Some of the factories had very high sand content in the pulp in the 2009 campaign, due to a lot of rain in the harvest season. The goal has been reached, since the rotary valves now are operating a long time.

Conclusion:

The first size F dryer for the Japanese market was successful. The good cooperation between Nitten Sugar Company and EnerDry has resulted in a good steam dryer installation with a well designed steam system and good setup of conveyors, which gives a practical and clean installation. The dryer is able to dry the pulp to more than 92% dry substance, which is good for maximizing CBS addition. The dryer has never been plugged. EnerDry is looking forward to do more business in Japan.

EnerDry has worked on two ways of improving the discharge system:

1. **New concept:** EnerDry has developed a new principle of discharging the pulp. The pulp is discharged through a pipe where the pressure reduction takes place through a plug of pulp. Reducing the pressure this way gives no high differential pressure, whereby high velocity of steam and pulp causing wear on the equipment is avoided. Until now the results are promising. This method has 3 main advantages compared to the existing outlet rotary valves: Price, lifetime and less steam goes out with the pulp. The development will continue.
2. **Improving the existing outlet rotary valve:** Normally pulp is discharged from the pressurized steam dryer by a rotary valve. These valves have two shoes which are pressed onto a cylindrical rotor in order to be steam tight. The hydraulic control of the shoes has been improved and more wear resistant materials for the shoes and rotor have been found. Stand time is now more than doubled. Furthermore all wear parts on these valves can be exchanged on site within 24 hours. Exchanging one shoe takes only 4 hours.

