

# DENSE PHASE PNEUMATIC HANDLING OF SUGAR AND COAL

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## Abstract

Hulett Refineries has had many years experience in the blowing of brown and white sugars using the dilute phase method. In 1985 the refinery started looking into the feasibility of blowing sugar using the dense phase system of transportation. The reason for this investigation was a project involving the packing of hygienic brown sugar from mill road tankers and the difficulty, due to plant layout, of using conventional conveyors to convey the sugar from the unloading point to the packing station. The paper describes some of the difficulties and solutions found during the commissioning of the systems installed at the refinery.

## Introduction

To determine the feasibility of using dense phase pneumatic conveying of sugar and coal the Materials Handling Division of the University of the Witwatersrand (Wits) was sent samples of both products, which they successfully blew over a distance of more than 122 metres. The 100 mm diameter conveying line was made up of 116 m of horizontal and 6 m of vertical pipe and 9 X 90 deg bends as shown in Figure 1. This showed that routes could be followed where normal conveyors could not be used. Although the brown sugar project was dropped for other reasons, the Wits tests proved the feasibility of this type of conveying as there was very little crystal damage (see Tables 1 and 2).

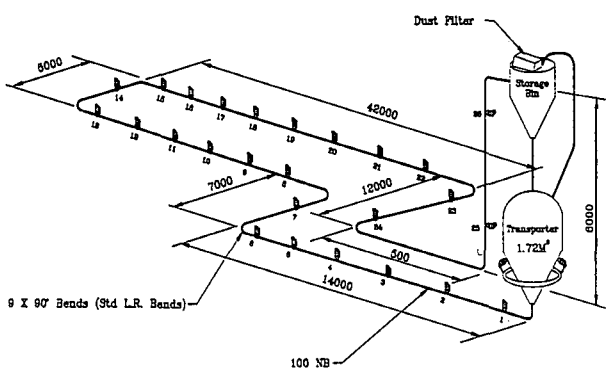


FIGURE 1 Experimental dense phase sugar blowing system at Wits University

Table 1

Screen analysis of the sugar before blowing

Screen	1	2	3	Average
355 micron	73,33	74,76	72,42	73,50
250 micron	16,49	15,41	15,98	15,96
106 micron	9,70	9,25	11,01	9,99
Pan	0,48	0,58	0,58	0,55

Table 2

Screen analysis of the sugar after blowing

Screen	1	2	3	Average
355 micron	69,73	70,03	72,08	70,61
250 micron	18,55	18,17	17,34	18,02
106 micron	10,74	10,82	9,76	10,44
Pan	0,98	0,98	0,82	0,93

## Operation

The main difference between dilute and dense phase conveying is that dense phase is a batch process, using far less air at a higher pressure. During dense phase conveying the product is fed from a storage bin into the transporter vessel as shown in Figure 2. The vessel is then pressurised and the product is blown into the conveying line. When the low level probe has been cleared, the pressure in the vessel is released through the vent valves and the cycle is repeated. The conveying line is never emptied. When the booster line is pressurised air passes through the needle valve into the booster (see Figure 3). If the booster pressure is higher than the conveyor line pressure air is injected into the product fluidising and moving it along the conveying line (see Figure 4).

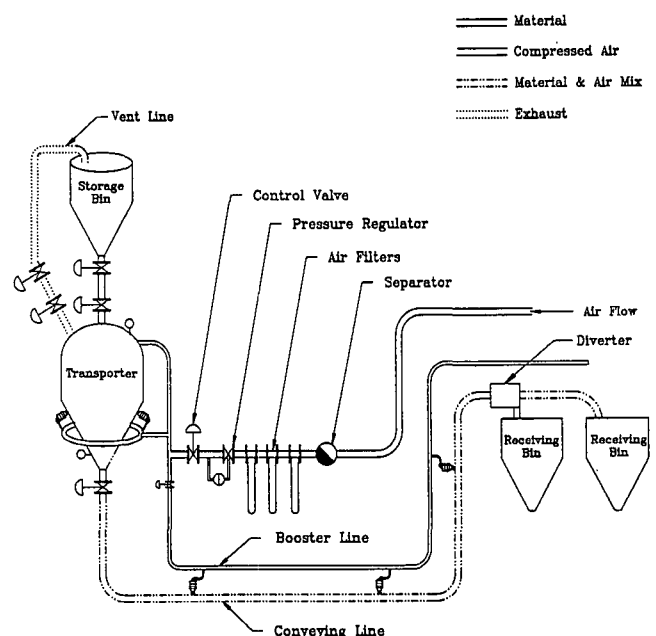


FIGURE 2 Typical dense phase pneumatic conveying system

## Compressors

Because of the increased demand for clean oil free air, it was decided to upgrade and modernise the air system at the refinery, which would allow for the increase in demand of packed products and limited pneumatic blowing in the future. The packing station required a minimum of 70 m<sup>3</sup>/min of oil free dry air. The total air requirement for the refinery during the day shift is 90 m<sup>3</sup>/min. Four 35 m<sup>3</sup>/min Bellis and Morcom oil free compressors were installed, giving a total air supply of 140 m<sup>3</sup>/min. The installed capacity is now sufficient to meet the day shift demand, allowing one machine to be on stand-by.

## Coal blowing

With the surplus air capacity at night, it was decided to investigate the blowing of coal to fill the boiler bunkers during this period.

A visit to the Australian sugar industry had shown that this method of fuelling boilers was possible. In 1987 the refinery staff visited the Nestle factory in Estcourt, where a coal blowing system had been installed and was running. As a result of this visit it was decided to install a spare sugar blowing vessel to evaluate how the system would perform using the coal burnt at the refinery.

A system was installed to supply coal to one boiler and ran well for some time. One of the major problems experienced with the commissioning of this plant was some staff resistance, resulting in tampering with settings. It was only with a fully locked, hands off system that the refinery was able to get the system to work reliably, albeit to one boiler only.

The system has been extended to cover more than one boiler and commissioning and evaluation are in progress.

## H2 sugar blowing

In 1989 it was decided to produce H2 (first crop recovery boiling) sugar in the recovery house. The layout of the plant made it impossible to use conventional conveyors to convey the product to the existing packing station. The alternatives were to build a small packing station adjacent to the crop sugar dryer and to employ additional staff and fork trucks to handle the production, or else to blow the sugar. The blowing system proved to be the most cost effective and it was decided to go ahead with the project.

The total distance of conveying line required to transport the product from the recovery house to the packing station was 130 m. This was made up of 110 m of horizontal and 20 m vertical lines with 6 X 90 deg bends. As with most projects at the refinery, installation had to be completed within a time limit to meet customer's requirements, but the system was not as successful as the blowing of refined white sugar and commissioning took several months.

The product was completely different to white sugar, having a higher moisture and molasses content and consequently it was prone to pack in the blow line, causing chokes.

During the commissioning, recordings of dryer temperature, air pressure, air flow, inlet valve position and sugar moisture were monitored. It was found that during high air flows, when the transporter vessel was being pressurised, water was being carried over through the traps and filters into the vessel wetting the surface of the sugar. Additional trapping was installed but this was still found to be inadequate.

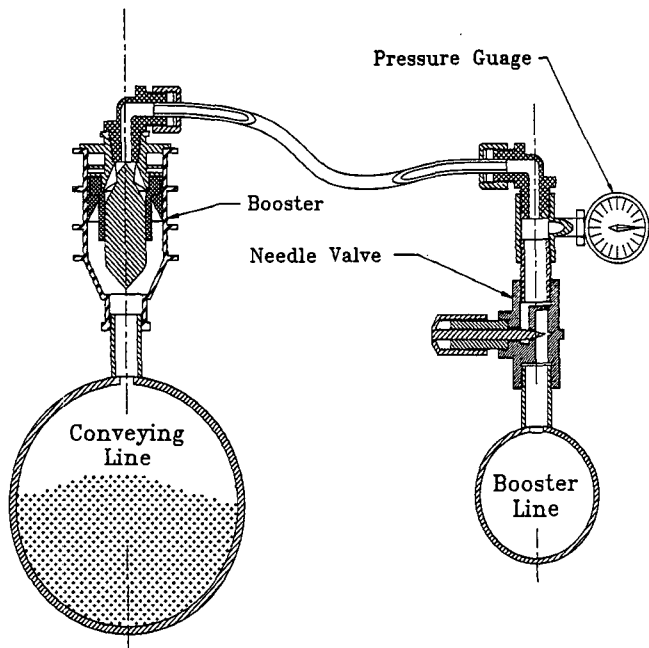


FIGURE 3 Section through conveying and booster line

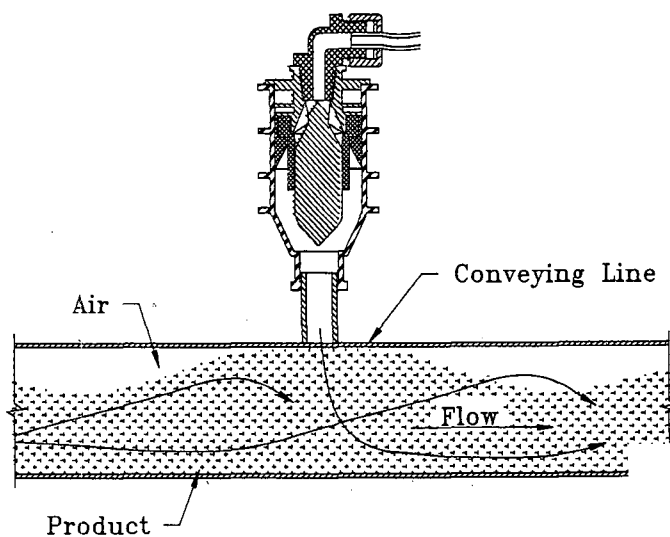


FIGURE 4 Air flow through conveying line

## Refined sugar tests

During 1986/87 a short blowing system to the Fewema packing machine was installed for evaluation and to gain experience for future projects. The product blown was refined white sugar at a rate in excess of 20 t/h through a 100 mm dia pipe. No problems were encountered, with the exception of the control system which was hard wired, allowing no flexibility in the operation. A Programmable Logic Controller was installed to replace the hard wiring and the system was extended to cover the Brecknell Dollman Rodgers packing machines. The PLC also controlled the diverter valves which supplied sugar to the three machines. The additional 50 m of pipe had no effect on the performance. After the system had been run successfully for some time, it was shortened and now supplies white sugar to the Fewema packing machine. This system has been in operation for about four years.

Due to increased air demand in the packing station, the existing Tegnion air dryer had become inadequate and had been replaced by two 70 m<sup>3</sup>/min air refrigeration units. An air supply from these units to the blowing vessel was installed and the water problem was solved. The air supply to the vessel was controlled by a pressure regulating valve. It was found that pressure fluctuations during the blowing cycle caused chokes. The varying air pressures were caused by the fluctuating air demands in the refinery and packing station. The regulating valve was replaced with a high volume low pressure, pressure reducing valve. After the fitting of the new valve the system became far more reliable and tuning of the booster valves was possible.

The velocity of the sugar in the blow line could be changed by varying the transporter air pressure and/or by changing the booster settings within their upper and lower limits.

To achieve the required flow rate of sugar through the blow line it was necessary to run the system at high pressure with a high booster gradient which caused additional friction between the product and the blow line. This resulted in the system being unreliable and prone to blockage.

It was now obvious that, due to the high friction of the H2 sugar, a larger pipe was required to handle the production rate. The 100 mm dia conveying line was removed and transferred to a new project involving icing and castor sugars. A new 150 mm dia blow line was installed and commissioned. The commissioning took about two days and the system has run a number of months with very few chokes. These could have been caused by wet sugar or air supply problems. With the reduced friction after the installation of the 150 mm dia pipe the air consumption dropped from 7,9 m<sup>3</sup>/min to 3,8 m<sup>3</sup>/min.

The H2 system, including the dryer, is fully automatic and depends on the availability of sugar or production requirements to dictate throughput which often reaches 50 tons/day. The plant runs with no hands involved other than the centrifugal supervisor who checks the plant from time to time.

The dust extraction plant and the dust from the discharge end of the pipe are a problem and are receiving attention.

#### Cost of the H2 system

##### Configuration

This consists of:  
 110 m horizontal conveying line  
 20 m vertical conveying line  
 6 X 90 deg bends

##### Cost

Total length of system 130 m @ R415/m	R 54 000
Transporter vessel	R 35 000
Pneumatics	R 12 000
PLC	R 7 000
Compressor installed value	R 27 000
Air dryer installed value	R 6 400
Total	R141 400

#### Conclusions

##### Advantages of dense phase blowing

- Clean – no scrapers and only two transfer points.
- Flexibility of conveying system.
- Space saving.
- Low maintenance – few moving parts.
- No chance of outside contamination.
- Safe – no moving belts or buckets.
- Quiet operation.
- Cost effective over difficult routes.

##### Disadvantages of dense phase blowing

- The need for clean dry air.
- Chokes can be difficult to clear.
- High cost over short distances.
- Dust collection at end of pipe.

In conclusion, the refinery is committed to dense phase pneumatic handling of products and it is intended that this system will provide the coal supply to the boiler house, including two new 45 ton boilers, in the near future.

#### Acknowledgements

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