Experience in relocating a fluidized-bed steam drier

Gerald Caspers[1]; Hartmut Hafemann[2], Hans J. Schmidt[3] ,
[1]BMA AG, Am Alten Bahnhof 5, 38122 Braunschweig, Germany
[2]BMA America Inc., 3127 Wild Meadow Ln, Aurora, IL 60504.

Introduction

German sugar factories have been successfully practicing the drying of beet pulp by superheated steam for more than 20 years. Nevertheless the restructuring of the European sugar industry led to the closure of a number of factories even ones with modern technologies. In this context BMA received an order for re-assembly of a fluidized-bed steam drier at a German sugar factory. In addition, the order included an increase of the evaporation capacity. The measures for optimizing the performance: (1) redesign of fan components, (2) installing the patented BMA rotary weir, (3) plug protection sensor system, (4) overhaul of the airlock. Details of the measures, the difficulties and required repairs during the assembly and the results in operation will be reported.

1 Relocation of a fluidized-bed steam drier (WVT)

Since 2003, a BMA fluidized-bed steam drier has been in operation for drying the sugar factory's beet pulp. Because the slice rate of the factory was higher than the drying capacity that the steam drier provided, the factory also still had conventional drum driers in operation.
With the aim of reducing energy costs, BMA was commissioned in 2010 to re-install a fluidized-bed steam drier that had been in operation in a recently closed-down sugar factory, also located in Germany. This drier, which had been in operation from 1993 until the factory's closure in 2008 with an average evaporation rate of 33 t/h, was originally supplied by NIRO.
One condition for placing this order with BMA was that re-installation of the drier was to include measures that would allow the drier's evaporation rate to be raised, so the entire pressed-pulp volume could be dried with fluidized-bed steam driers. This meant that an additional evaporation capacity of at least 37.5 t/h had to be made available. Before the order was placed, various calculations were made with the actual geometric and flow parameters on the basis of the available documents, and the modifications to which the original drier would have to be subjected in order to achieve the required evaporation rate were defined.

In 2008, the drier was disassembled for transport to its new location. Because of their size, many components had to be stored in the open before they could be re-installed. Since BMA had not been in charge of disassembling the drier, it was difficult to tell whether or not all components were complete.
Fig. 1 shows part of the area in which the drier components were stored. For assessing the condition of the relocated drier, the available documents for this drier series were used as a basis.
In connection with this review of the drier condition it also turned out that some of the components would have to be replaced because they were either worn or corroded.

Fig. 1: Storage area for the components of the fluidized-bed drier

One problem that became apparent was that the division after cutting the drier apart did not correspond to that of the engineering documents, and the fact that parts were missing was not detected until the drier was re-assembled.

2 The challenge

Although it was known that at its original location the drier had only produced a water evaporation rate of 33 t/h, it was to achieve at least 37.5 t/h after re-installation.
In order to increase the evaporation rate it had to be determined first of all why the drier had not achieved the expected 40 t/h. Unfortunately, operating parameters were no longer available after the factory's closure. It is, however, known from other factories with driers of the same type that there are three main factors that can prevent a drier from performing as intended.

- The steam circulation rate in the drier is too low.
- The steam is not adequately distributed across the different cells.
- Because of bad experience with the formation of plugs in the drier, the machine is not operated near its maximum capacity.

3 The solution

3.1 Re-designed circulation fan

The higher the circulation rate of the drying vapor inside the drier, the higher the amount of water that can be evaporated.
The vapor circulation rate depends on the pressure loss in the plant and the throughput of the installed fan.

The originally used fan was examined, and it was then decided that a new, optimized fan impeller with flow calming baffles should be used.
With this optimization measure it was possible to raise the circulation rate by almost 10 %, without having to increase the installed motor power. At a connected load of 1000 kW, this is quite impressive.
The bearing system for the impeller was also improved, in that the drive motor was isolated from the hot drier by means of a drive shaft and mounted on the floor, so no vibrations would be transmitted.
To adapt the circulation rate to specific operating conditions, the speed of the fan can be varied with a frequency converter that is designed to match the motor in an optimum manner.

Fig. 2: Drive of circulation fan

3.2 Installation of a rotary weir (BMA patent No. EP 2146167 / US 8844162)

The fluidization properties of the product change in the course of the drying process, as the pressed pulp becomes lighter and smaller.
The steam velocity has to be higher in the cells in the front part of the drier than in those towards the rear end. At the same time, the fluidized bed must be prevented from collapsing, and product must not be allowed to leave the fluidized bed.

Each individual plate of the existing distribution plate was measured, and the resistance coefficients were determined. Plates that did not match the desired profile of the resistance coefficient were replaced.

The distribution of the material above the distribution plate plays a major part in the distribution of the drying vapor across the different drier cells.

In the past, the distribution of the material to be dried was influenced with differently sized openings in the partitions between the cells. However this did not provide the required flexibility under changing operating conditions.

With a variable weir (rotary weir) at the end of the last discharging cell it was possible to actively influence the distribution of the steam, and to enhance the efficiency of the heat exchange and the material transfer by increasing the hold-up in the last cells of the drier.

To be able to reliably influence the position of the weir, a dependable method for measuring the pressure loss across the fluidized bed has been developed. The measuring signal is used for controlling this pressure loss.

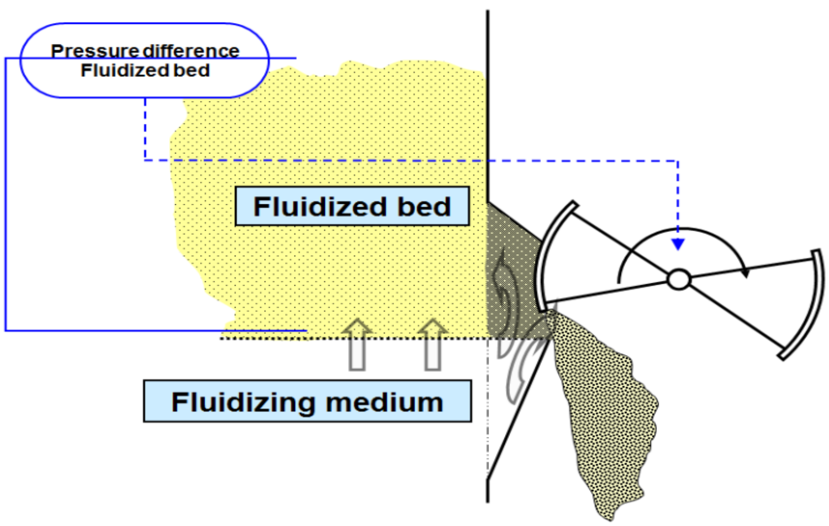

Fig. 3: Principle of pressure loss control in the fluidized bed

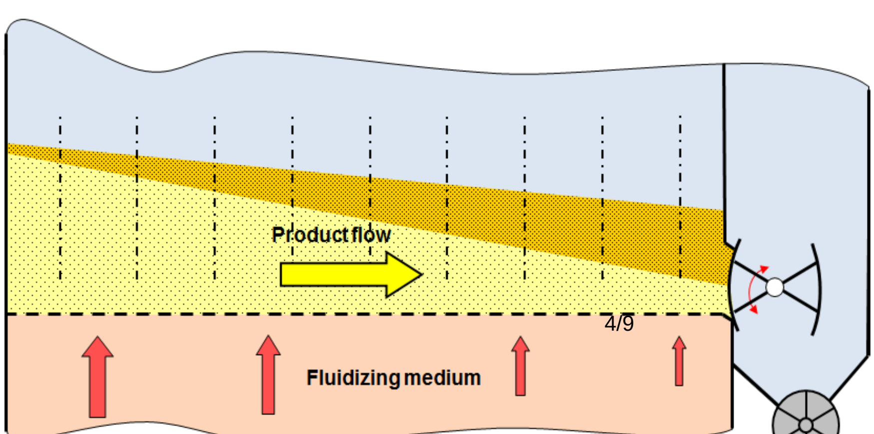

Fig. 4: Product distribution with and without rotary weir

3.3 Plug protection sensor system

When the material fluidization in the drier breaks down because of poorly adapted operating parameters, the fluidized bed cannot maintain its transport function, and the material starts collecting inside the drier. The plugs that will then form can lead to major drier downtimes.

Since the drier is operated under pressure and at high temperatures, it is difficult for plant operators to become aware of incipient plugs. The risk of material plugs increases along with a rising solids throughput.

To minimize this risk, the drier is operated, so there is a certain "safety margin" between the actual throughput and the maximum possible capacity.

A reliable system that allows plant operators to become aware of critical situations at a very early stage, will encourage them to make better use of capacity reserves, and can therefore help increase the throughput.

BMA has developed such a system (PPS - Plug Protection Sensor System).

With this system, the temperature difference is analyzed between a reference sensor below the distribution plate and several sensors directly above the distribution plate in the fluidized bed. A low temperature difference is an indicator of an uncritical operating state.

Should product settle on a sensor for a relatively long time because of inadequate fluidization, this difference will rise significantly. When the differences of individual sensors are critical, the operator receives an alarm; and when several sensors are in the critical region, the product supply to the drier is automatically stopped.

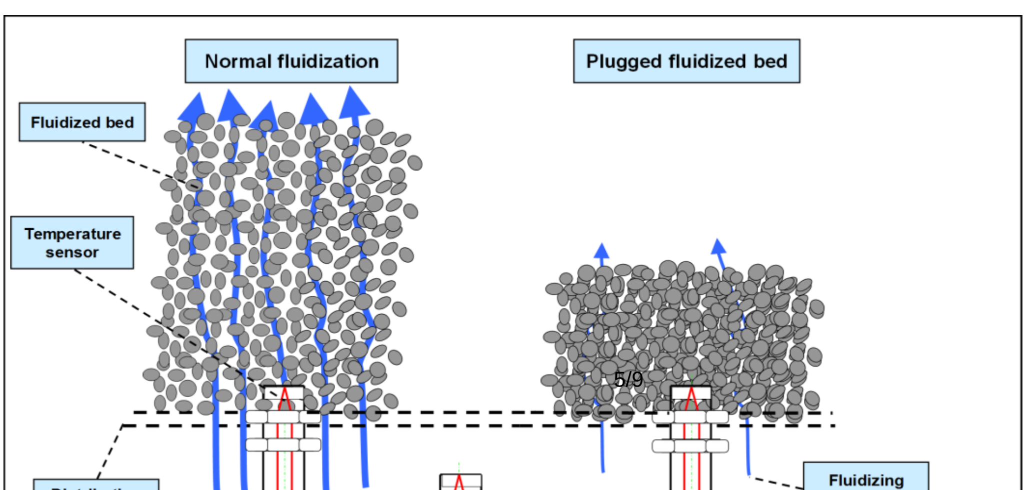

Fig. 5: Principle of the PPS system

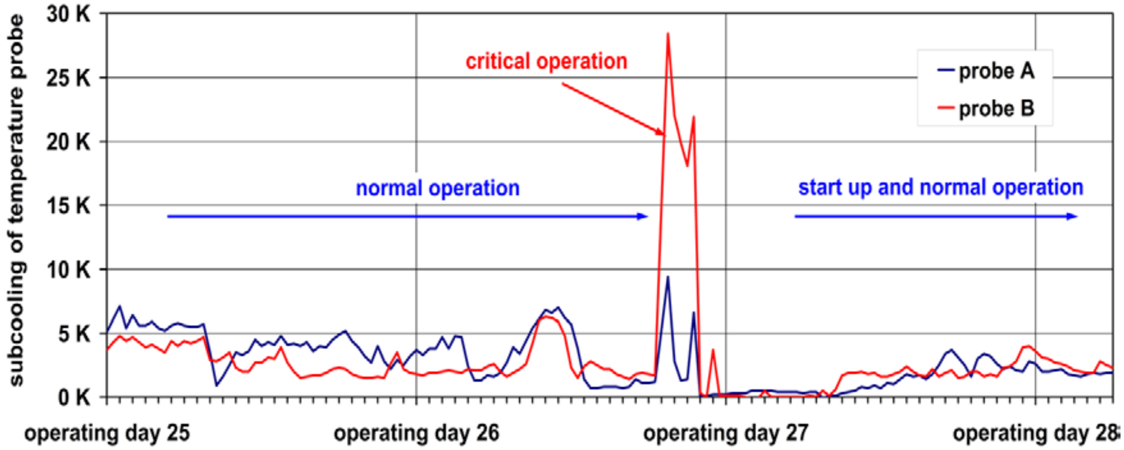

Fig. 6: Temperature graph PPS system in a critical situation

4 Overhauling and modernizing drier components

An assessment of the drier components produced the following results:

- The outer shell with the wall heating system, the superheater and the cell heating panels could be used without any major repairs.
- The fan impeller, with bearing system, motor and frequency converter were worn and had to be replaced; also in view of the required capacity upgrade.
- A new expansion cyclone had to be manufactured.

- The feed screw and the rotary feed lock had to be mechanically overhauled and provided with new drives.
- The rotary feed lock had to be provided with a new controller, hydraulic system and lubricating modules.
- The dimensions of the distribution plate had to be checked in respect of the opening ratio, because documents were no longer available.
- The ejector and neighboring elements had to be replaced.

While overhauling of individual drier components could start as soon as the order had been placed, the installation of the main drier components depended on the progress with the new building for the drier.
The separated elements of the outer shell were welded together, and the welds were inspected in close collaboration with the TÜV inspection body.
Wall thicknesses were measured, and material thicknesses were increased wherever this was necessary.

Fig. 7: Drier during assembly

Joining the pipes of the wall heating system, the internal steam and condensate piping, and the internal drier elements created some problems, because these parts had been separated in a rather haphazard manner and without providing proper marking.
After successful pressure testing, the other components were installed.

5 Results achieved in operation

On October 25, 2012, the performance run was successfully carried out.
During the performance run, the water evaporation rate at times reached values of more than 40 t/h, without fully utilizing the available heating steam pressure.
Although the evaporation capacity of the drier was higher than before, the electric energy consumption was not. The fluidization conditions in the different cells of the drier were stable, and the retention time of the product in the drier could be influenced as required with the rotary weir.
Owing to the plug protection sensor system (PPS) it was possible to raise the drier performance without risking a drier stoppage, prevent plugs in a number of cases, and reliably re-start the drier after stoppages.
The PPS system has now also demonstrated its benefits in other fluidized-bed steam driers.

Fig. 8: Fully assembled drier

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