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Efficient pneumatic conveying of cement kiln dust and raw mill dust in Russia

Pneumatic conveying systems are usually considered high energy consuming systems, but this does not have to be the case if the designer chooses the right equipment concept. There exists a basic rule to use a fluid conveying system for the horizontal conveying of powder materials as much as possible. The second rule is to use a pneumatic conveying system for vertical conveying, which provides a high degree of energy saving. RAYMAN spol. s r. o. (LTD) recently designed and built a modern pneumatic conveying system for a cement plant in Russia according to these principles. The system combines horizontal fluid conveying with Fluid Conveyors and continuous vertical conveying using a Flow Feeder. The conveyed materials are cement kiln dust and raw mill dust. The new system replaced an old, dusty and unreliable system of mechanical conveyors. Here, Petr Rayman describes its installation and how it compares with the old system.

The previous conveying equipment

The Russian cement plant previously had a mechanical conveying system with a low conveying capacity of 42t/hr. The system consisted of a cascade of three screw conveyors and a bucket elevator. The kiln dust did not go evenly from the filter. Indeed, it caused the occasional overfilling of screws and the leakage of dust into the environment. Moreover, due to the high fluidity of the dust, the material very often flowed back downwards through the screws while it was being conveyed upwards.

The new pneumatic conveying system

The new pneumatic conveying equipment replaced the existing mechanical transport equipment, minimising energy consumption, increasing dust conveying reliability and avoiding the leakage of dust to the environment. That was the reason that the design included Fluid Conveyors and a Flow Feeder. The basic technical data of the pneumatic conveying system are in Table 1.

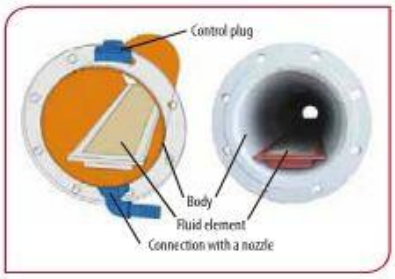
The Fluid Conveyor consists of a circular body with fluid elements at the bottom (Figure 1). The elements divide the fluidising fabric into relatively short sections. There is an exactly-defined amount of conveying air supplied into each section through the De Laval nozzle. This design permits, in contrast with airslides, full and permanent filling of the fluid conveyors by the conveyed material.

The kiln dust flows out from two screw outlets located under the kiln dust filter hoppers into the collecting Fluid Conveyor. It connects both inlet points, is lead through the platform floor and continues with a long branch into the gravity chamber of a Flow Feeder (Figure 2). The Fluid Conveyor is installed at a low inclination to its end.

The Flow Feeder is designed for the economic continuous pneumatic conveying of bulk fluidisable materials. It uses pressure in the column of fluid material collected in the gravity chamber. The material creates 'hydrostatic' pressure, which is approximately in balance with the connected conveying pipeline pressure drop, as shown in Figure 3. The feeder uses a potential energy of conveyed material. It reduces distinctly of 20-50% the energy needed for material feeding compared with other types of pneumatic conveying feeders, especially screw feeders.

The gravity chamber is designed with a cylindrical shape with a diameter of 800mm and a height of 5530mm. The PP400 type Flow Feeder is located

RAYMAN spol. s r. o. has built dozens of pneumatic conveying systems in cement plants, lime plants, heating plants and power stations for the pneumatic conveying of powder materials from silos, filters and ESPs. The first Fluid Conveyor and Flow Feeder designed by RAYMAN was delivered in 1993.

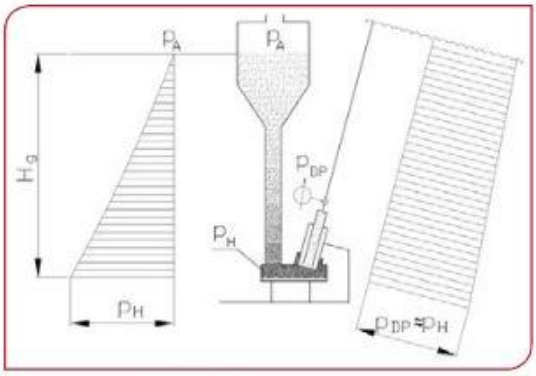


Right - Figure 1: Fluid Conveyor diagram.

on the ground near the storage silo (Figure 4). The pipeline is vertical and is terminated in a terminal box located on the silo roof.

A Roots blower was used as a common conveying air source for the whole pneumatic conveying system for both the Fluid Conveyor and the Flow Feeder.

Right - Figure 2: Fluid Conveyor installation.



Right - Figure 3: Scheme of Flower Feeder.

Process experiences

The equipment was put into service over a two-day period in April 2015 with no difficulties. Since then, it has been in service without any significant troubles.

There was a review after six months of continuous operations, when some dirt from the conveyed material was found in the Fluid Conveyor chambers. The fluidising fabrics were also polluted with grease, which came in with dust from the old mechanical conveying equipment. There were no defects or damage to the Flow Feeder itself.

As the pneumatic conveying system does not contain any movable parts that are in contact with the conveyed material, conveying velocities are very low and the conveying pipeline is straight with only one knee of 30° angle, the whole system is highly wear resistant. Neither the Fluid Conveyor nor the Flow Feeder showed signs of wear.

During commissioning and also during the working time, it was proven that the equipment was able to convey a very quick increase of inlet dust without loss of function and without an increase in environmental pollution. The new pneumatic conveying equipment was designed to be fully leak-proof, which significantly decreased the leakage of dust to the environment from the original mechanical equipment.

Material to be conveyed	Cement kiln dust
Bulk Density	800kg/m³
Temperature (max.)	150°C
Designed conveying capacity (min.)	120t/hr
Conveying distance, vertical included	75m
Vertical conveying distance	35m
Blower installed electrical input	160kW
Blower input at clutch	135kW
Specific energy consumption for conveying at designed capacity	1.2kW/hr/t
Specific energy consumption of existing mechanical transport	0.82kW/hr/t

Right - Table 1: The basic technical data of the pneumatic conveying system.

Conclusion

Comparing the old and new conveying systems of the cement plant, RAYMAN spol. s r. o. has come to the following conclusions:

- Pneumatic conveying equipment has a distinctly higher conveying capacity;
- Pneumatic conveying equipment has a lower dimension and weight, thus it requires less sturdy supports;
- As suspected, the specific energy consumption is higher for the new pneumatic conveying system, but this is fully-balanced by investment and maintenance cost savings;
- Pneumatic conveying equipment is almost maintenance-free and is highly wear-resistant;
- Pneumatic conveying equipment is fully leakage-free.

The new pneumatic conveying system combining Fluid Conveyors with the Flow Feeder also makes significant energy savings compared with other pneumatic conveying systems, especially when compared to high-pressure systems using a screw feeder or a vessel feeder.

Left - Figure 4: Flow Feeder installation.

The pneumatic conveying system described here, with part of a horizontal conveying pipeline substituted by a Fluid Conveyor, could also be used, with great advantage, to convey bulk fluidisable materials from silos or hoppers. In those cases, the Flow Feeder uses a potential energy of stored material. The Flow Feeder can be located at the Fluid Conveyor end as described above, or it is possible to place the vertical conveying equipment at the beginning and to install the Fluid Conveyor at the necessary height. It all depends on the needs of a particular installation. Fluid Conveyors can be used to convey dust from hopper filters or electrostatic precipitators (ESP) to one point and, from there, convey the dust using a Flow Feeder in a similar way, as described above.

The only disadvantage of the described pneumatic conveying system is the requirement of the in-building height to create a sufficient pressure of fluidised material. However, it is possible to solve this by moving the Flow Feeder location into a cofferdam 1-3m deep.

It is a great pity that the new equipment only replaces part of the former mechanical conveying system of dust from a filter to a silo. If the pneumatic conveying system could be used for complete dust transportation, this would prevent the disadvantages due to the combination of a mechanical and pneumatic conveying system, especially the contamination of dust and internal parts of the pneumatic conveying equipment by grease residues. The original mechanical equipment has remained very dusty, as is visible in Figures 2 and 3.