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Pneumatic conveying of cement from a purge silo

When cement plants switch from grinding one type of cement to grinding another, there is a period of transition in which cement of intermediate composition is produced. Traditionally this cement has been discarded. In order not to waste resources, the LafargeHolcim Čížkovice plant in the Czech Republic recently installed a purge silo and pneumatic conveying system to remove and reuse cement from the transition period.

To build the new purge silo for cement from the transition period the Čížkovice plant co-operated with two main suppliers: TI-Centrum a. s. Plzen (as main contractor) and RAYMAN spol. s r. o., the designer and supplier of the equipment. The plant wanted to use existing equipment as far as possible and have the possibility of filling cement from transition period into silo-trucks.

Purge cement silo

A purge silo with a diameter of 4600mm and a volume of 150m^3 was built, mounted at the loading bay steel structure. The silo was fitted with a mechanical feeding system that combined a screw feeder and a bucket elevator. A pneumatic conveying pipeline to unload silo-trucks into the mentioned purge silo was included. The silo equipment contains a filter installed at the top of the silo, aerating system (including a fluidising air source), one limit level indicator and one continuous level indicator, a release device and hand-operated slide valve at its outlet.

Pneumatic conveying equipment

The task of the new pneumatic conveying system was to transport cement from the grinding transition period into the existing dosing bin, with the possibility of emptying the cement into silo trucks. This is why a slide valve with a two-way diverting chamber and aerated bottom with 90° angle between its outlets was installed underneath. One of the chamber outlets was equipped with a pneumatic discharger valve to close and limit the material flow into a filling spout. The second chamber outlet was used to connect the pneumatic conveying system.

The silo outlet flange is situated relatively high, 7600mm from the ground, so as to have sufficient free height for silo-trucks. This meant that using a pneumatic conveying system with a Flow Feeder was a great advantage (Figure 1). So that silo-trucks could pass under the silo, the feeder was placed out of the silo between the supports of the steel structure of the bucket elevator. A pressure resistant Fluid Conveyor (Figure 2) was used for the horizontal conveying of cement from the silo outlet into the gravimetric chamber of the Flow Feeder. This allows the pressure of the aerated cement to be transferred from the silo space into the Flow Feeder.

The Fluid Conveyor consists of a circular body with fluiding elements at its bottom. The elements divide fluidising fabric into relatively short sections. This design permits, in contrast with air-slides, full and continuous filling with material. The Fluid Conveyor is equipped with a bending chamber, which changes its direction to meet the inlet of the Flow Feeder gravimetric chamber. The Fluid Conveyor is installed with declination of 6% (3.4°) to its end. This allows it to be emptied if necessary.

Below Left - Figure 1: Flow Feeder installed at the Lafarge-Holcim Čížkovice plant.

Below Centre - Figure 2: The pressure-resistant Fluid Conveyor.

Below Right - Figure 3: The Flow Feeder uses pressure columns of material in a fluid state collected in the gravity chamber.

The Flow Feeder (Figure 3) uses pressurised columns of material in a fluidised state collected in the gravimetric chamber. The material creates a 'hydrostatic' pressure, which is approximately in balance with the connected conveying pipeline pressure drop. In the case of the Čížkovice plant, the Flow Conveyor additionally transfers the hydrostatic pressure of the material from the silo into the top of the gravimetric chamber. This means that the Flow Feeder also uses the potential energy of the conveyed material collected in the silo, which reduces the energy needed to convey the material by 20-50% compared to other types of pneumatic conveying feeders.

The gravimetric chamber is designed with a slightly conical shape with diameters of DN250/DN300 and it is 5750mm high. The PP300 Flow Feeder is located on the ground between the supports of the steel structure of the elevator. The pipeline is routed into the neighbouring building and it is terminated in a terminal box located on the dosing bin roof. The diameter of the conveying pipeline was calculated with respect to required conveying capacity, conveying distance and elevation, material features and also a capacity of the existing blower to be used. The conveying pipeline has an optimal design and includes only five bends, all of them less than 45°.

A ROOTS blower has been used as a common conveying air source for the whole pneumatic conveying system. This was the existing blower with an outlet pressure of only 60kPa.

The pneumatic conveying system is equipped with a Remote Pneumatic Release System (RPRS) in the event of a blocked conveying pipeline. The RPRS system removes material plugs from the pipeline without the need to detect its position or remove parts of the line.

Process experiences

The equipment was put into service in a one day period in May 2014. Since then it has run broadly trouble-free, with only one issue. Lumps of cement occasionally fell into the Flow Feeder in front of the material orifice plate from time to time, reducing the capacity.

To remedy this, an additional segregation chamber was installed in February 2016 (Figure 4). It was inserted into the Fluid Conveyor line. The segregation chamber is equipped with a fluidised bottom. The material is fluidised in the chamber, which caused heavier lumps to fall to the bottom. They must still be removed from time to time. The segregating chamber has very low consumption of the compressed air so it could be connected to the blower of the silo aerating system. The equipment has worked without issues since the time of installation of the segregating chamber.

Due to the fact that the built 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 as straight as possible, the whole system is highly wear-resistant. Neither the Fluid Conveyor nor the Flow Feeder have shown any sign of wear so far.

Above Left - Figure 4: An additional segregation chamber was installed in February 2016.

Parameter	Value
Material	Cement from transition period
Bulk Density	1000-1100kg/m^3
Temperature	<80°C
Capacity	15 t/hr
Distance	41m
Elevation	23.4m
Bends	1 x 15°, 4 x 45°
Blower electrical input	45kW
Blower input clutch	31.9kW
Spec. Energy Consumption	2.1kWh/t

Above - Table 1: Summary of project parameters.

Conclusion

The installation by RAYMAN and TI-Centrum at the LafargeHolcim Čížkovice cement plant has proven the ability of the pneumatic conveying system with the Fluid Conveyor and Flow Feeder to convey cement from a grinding transition period. Like most other pneumatic conveying equipment it is prone to problems with lumps. However, these types of failure were easily removed by installation of the segregating chamber in this case

The built pneumatic conveying system has the following positive features:

- It saves energy due to the use of considerable heights and transfers the pressure from the silo to create high pressure in the Flow Feeder;
- It is almost maintenance free;
- It is wear resistant;
- It is completely leakage free.

The pneumatic conveying system combining Fluid Conveyors with the Flow Feeder also saves significant energy compared to other pneumatic conveying systems (particularly screw feeders and vessel feeders) because its uses the potential energy of the stored material.

The project realised LafargeHolcim's request to use the existing ROOTS blower, which was originally intended for another pneumatic conveying system. This significantly reduced the investment cost. Since the one minor modification described above, the equipment has worked reliably at its design capacity.