THE EQUILIBRATION OF THE PNEUMATIC CONVEYOR PIPELINES WHEN EMPLOYING OVERPRESSURED PNEUMATIC CONVEYOR SYSTEMS WITH A SINGLE AIR-BLOWER

— original paper —

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Abstract: For multiple reasons regarding the efficiency of the installation and the appropriate hygiene conditions, the transportation of finite products from the grinding section in modern installations is performed with overpressured pneumatic conveyors. Within the grinding mills with a capacity of over 100 TPD, each pneumatic conveyor uses its own air-blower. For smaller capacity grinding mills, this solution determines a significant increase of the investment expenses and of other additional costs: installation, maintenance, specific consumption items, etc. To eliminate this inconvenience, we present in this paper a technological solution that will successfully solve all the aforementioned problems. This system has been applied successfully on a combined grinding mill unit, on which the charge of the pipelines varies from 0% to 97% on each of them.

Keywords: pneumatic conveyor, pipeline, sonic valve

INTRODUCTION

In modern grinding installation, the finite products obtained in the grinding section, which are flour and bran, are transported through overpressured pneumatic conveyor (Erling et al., 2008). In the case of large capacity grinding mills (over 100-120 TPD), a pneumatic conveyor line is used for each and every one of these products, with every one of these lines

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containing all the necessary elements: fluidization valve, pipeline, air-blower – compressor, deviation switches, etc (Bulat, 1962).

The capital necessary for such an investment is based on the projected capacity of the unit. The volume of the investment being somewhat constant, one can observe that at the same time the grinding capacity is lowered (for the grinding mills of under 100 TPD), the specific cost per grinding capacity unit increases.

This paper proposes a new solution for the improvement of the transport of finite products from the grinding section with overpressured pneumatic conveyors by using a single air-blower.

CLASSICAL TRANSPORT

Figure 1 presents the overpressured pneumatic conveyor.

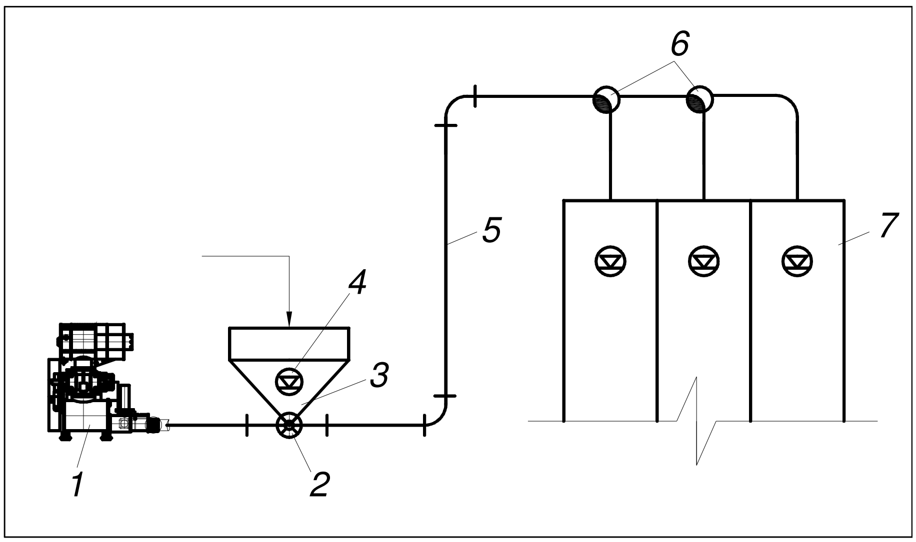

Figure 1. Overpressured pneumatic conveyor installation:
1- air-blower; 2 – fluidization valve; 3 – feeding chute; 4 – level sensor; 5 – transport pipeline; 6 – deviation switches; 7 – silo cell

SUGGESTED SOLUTION

General presentation

In the case of small grinding mills, to reduce the costs of equipment investment, one can use pneumatic conveyor with a single air-blower – compressor, and the number of conveying lines must be equal to that of the products to be transported. Each of the conveying lines must be complete by containing the following: fluidization valves and conveying pipelines equal to the number of products to be transported and a pipeline connecting the air-blower to the fluidization valves (Figure 2).

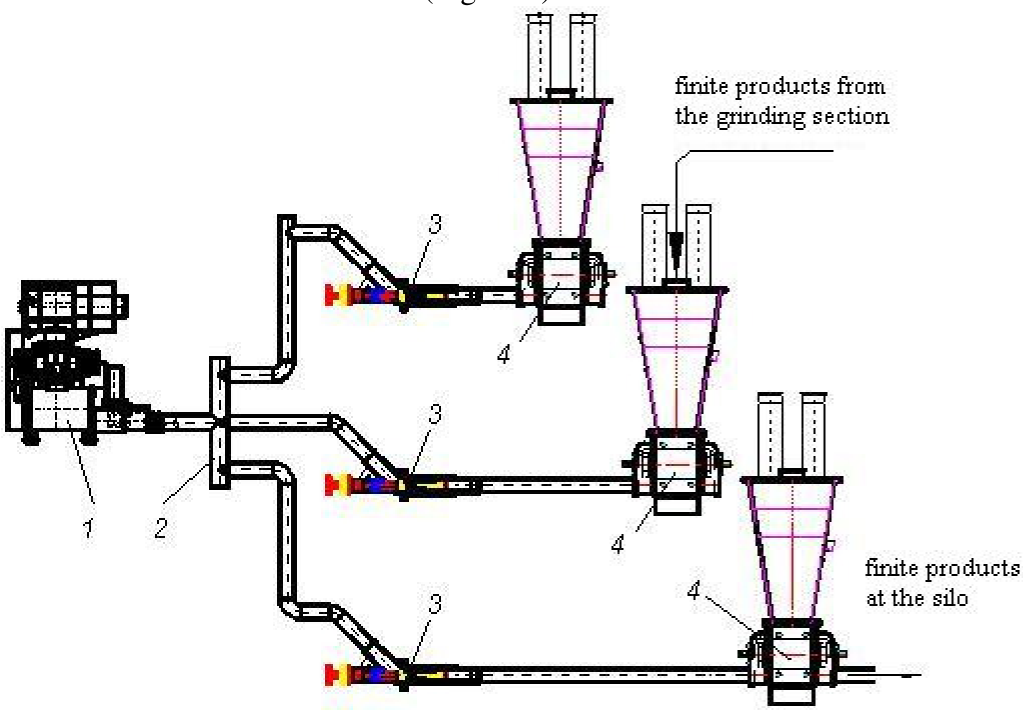

Figure 2. Schematic diagram of the overpressured pneumatic conveyor with a single air-blower: 1 – air-blower – compressor; 2 – distributor; 3 – sonic valves; 4 – fluidization valves

On the pipeline connecting the air-blower to the fluidization valves, in addition to the air distributor, equilibration systems of the hydraulic resistance of the conveying pipelines are inserted there.
One of the systems that can be used, and has been applied successfully by the authors, is a sonic valve (Klinzing et al., 2010). The system is tuned when the installation is started and does not require further adjustments, nor monitoring or maintenance. The system functions without any problems either if all pipelines are charged or only one of them is.
The sonic valve is equipment that transforms the static pressure energy of the air into dynamic pressure energy (Mândrea, 2010), (Emami, 2008), (***, 2010) (Figure 3).

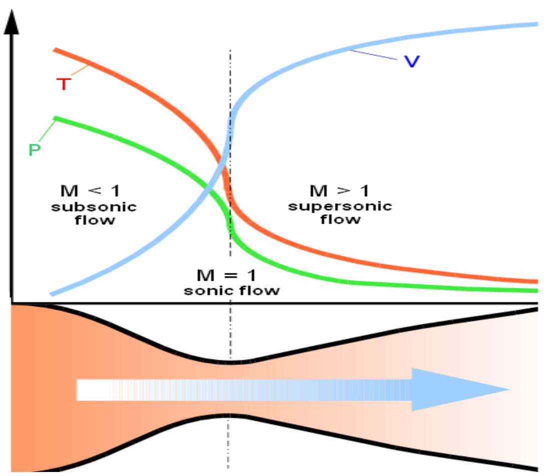

Figure 3. Conversion of static pressure (or thermal energy) into dynamic pressure – De Laval valve: Where: V= air speed; P= static pressure; T= temperature

The sonic valve is designed, produced and installed on equipment as shown in Figure 4.

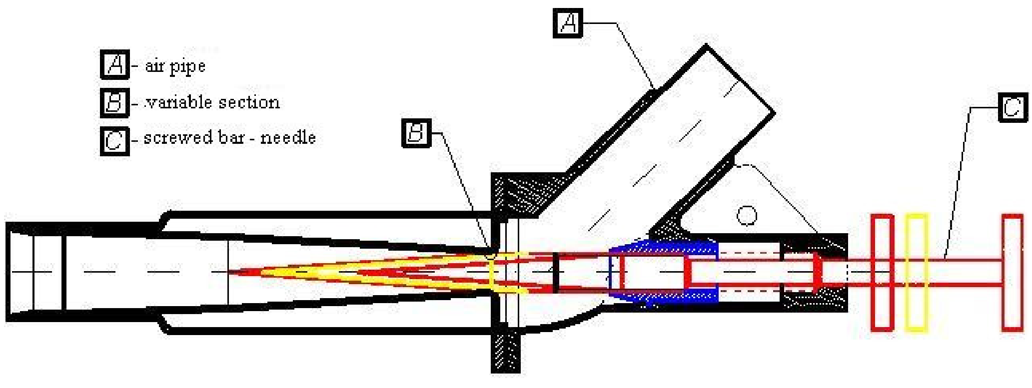

Figure 4. Sonic valve

By means of the C screw, one can adjust the opening of section B so the speed of the air matches the speed of the sound. The air-blower in use will create behind the adjustment section a residual overpressure that will make the speed of air stay the same on every pipeline used for conveyance. Moreover, even if some of the pipelines (or only one of them) are charged with product, the air flow on each and every one of them will remain constant. The loss in pressure on these sonic valves is around 500-1200 mmH_2O.

General dimensioning and adjustment

The dimensioning of an air-blower – compressor for the pneumatic conveying of finite products from a grinding unit, is calculated using the same formulas as for the dimensioning of fans used for vacuum pneumatic conveyance in the grinding unit, as follows:

- The flow with an initial diameter of the pneumatic conveyor pipeline is calculated, a standard is set and the mix coefficient is recalculated.
- The air flow is calculated taking into account the mix coefficient determined as mentioned before.
- The condition of having a mix coefficient lower than the clogging mix coefficient is also to be verified, according to the ratio:

$$m_s < 1,2 \ x \ m_î$$

where: - m_s , [kg of product/ kg of air], the mix coefficient in the system, calculated as mentioned before;

- m_i , [kg of product/ kg of air], the clogging mix coefficient

- The same procedure is applied to all the pipelines in the system
- The air flows obtained are added up, their sum is increased with 10% and the air flow obtained this way is noted as *La*
- Pressure losses are calculated for every pipeline and the heaviest pipeline in the system is identified
- The highest value of the pressure losses is increased with 15% and the value obtained is written down as *Hc*
- To the value of the pressure loss noted as *Hc*, one adds the value of pressure loss of 1.200 mmH_2O, estimated on the sonic valve.

Having obtained the values of the flow and of the pressure, namely *La* and Hc, the appropriate air-blower - compressor is identified and chosen.

Going back to the value of the clogging mix coefficient, its value is deduced from the limit condition of the system, evaluated by means of the following ratio:

$$m_î = Dc \ x \ C \ x \ Fr^2$$

where: - *Dc*, [m], the standard diameter of the transport pipeline;

- *C*, [kg of product/kg of air / m^2 of pipeline surface/s], the constant product clogging value;
- *Fr*, dimensionless , Froude's number – similarity criterion.

The adjustment of the sonic valve can be performed in two manners:

⇒ By evaluating the necessary opening of the bar – needle in section B (Figure 4) so that the air speed in this section is equal or very close to that of the sound (inferior to the speed of the sound in the air)

⇒ By using air gauges in front of the sonic valves and adjusting the screwed bars – needle so as the pressure indicated by them has the same value.

As general trait, the sonic valve is actually a Venturi air jet with a sonic flow running.

CONCLUSIONS

The advantages of this system when compared to the one with more air-blowers (with an equal number to that of the conveying pipelines), are obvious:

- Investment needed for the equipment is slightly lower;
- The specified electricity consumption for transported product is lower;
- Maintenance costs are lower;
- Investment needed for the placement space is lower.

LITERATURE

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