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POWER CONSUMPTION REDUCTION WHILE BULK MATERIALS PNEUMATIC CONVEYING

Essential reduction of energy expenses is provided by new pulse technology of pneumatic transport with use of a small-sized blow tank feeder. The new technology is introduced on Slaviansk power station into coal dust transport line to the power unit.

I. INTRODUCTION

A solids pneumatic conveying considerable disadvantage is increased power consumption in comparison with the mechanical conveying. Power consumption intensity per the transported material weight unit is 3–5 kW per hour/ tons per km that is 3–6 times over the mechanical conveying [1]. If consider the pneumatic conveying introduction level into all the sectors of the national economy the problem urgency becomes apparent.

The feeder and the pipeline are the main power consumers in the pneumatic conveying systems (PCS). Power consumption while the material conveying through the line depend upon its diameter, length, conveying method and the mixture mechanical parameters such as concentration, velocity and others. Gas-solid pneumatic conveying flows [1, 2, 3] theoretical and experimental research studies prove that minimum power consumption can be secured only at the mixture high concentration. If the mass concentration, determined as the ratio of the solids mass to the air mass in the mixture volume unit, is considered for the mixture characterizing then for the most of the industrial bulk materials with the specific weight 1500 – 3500 kg/m3 the appropriate concentration value is within 25 – 100 kg of the material/ kg of the air.

There are only two types of feeders ensuring this appropriate concentration value of the conveying flow. They are the blow tank and the pneumatic screw feeder..

The pneumatic screw feeder type refers to the out dated conveying methods. It is equipped with the screw conveyor device consuming a significant amount of power.

The blow tank comprises the tank, regularly filled with the material, sealed with special valves and then emptied by means of compressed air into the conveying line. It doesn't require an electric drive and thus consumes less power. Two tank blow tank with the tanks sequential operation ensures the material continuous conveying.

For the blow tank and pneumatic screw feeders specification comparison the experimental data given in the work [4]. For example PCS continuously conveying flour in the amount of 25t/hour for the distance of 170 m. through the pipe with the diameter 81 mm at the mixture concentration 85 kg/kg require 13.5 kW with any feeder type. Meanwhile the power supply and material conveying process with the two tank blow tank require about 17 kW and with the pneumatic screw – about 43 kW. Therefore the feeder power capacity itself is 3.5 kW (blow tank) and 39.5 (pneumatic screw). The difference progressive increase is observed for PCS of higher efficiency. In addition the pneumatic screw feeder cost is twice as bigger than that of the blow tank of the same capacity.

For the considered problem illustration several one and two tanks blow tanks specifications are given below (see Table 1).

Table 1 – Blow tanks specifications

Pump type	Manufacturer	Capacity (C) t/hour	Tank volume V_t, m^3	$\frac{V_t}{C}, \frac{m^3 \cdot hour}{t}$	Height dimension, m
SB–33V (1t)	LLC "Betsema" Krasnogorsk	16	0,5	0,03	1,5

TA–23A (1t)	– " –	30	1,5	0,05	2,6
TA–29 (2t)	– " –	60	6,3	0,1	4,7
TA–60 (2t)	– " –	100	18,6	0,2	5,4
DVF–50 (2t)	"Hitachi" Japan	50	–	–	3,3
2200-B (2t)	"Sket" Germany	60	–	–	5,0

Considering the mentioned disadvantages pneumatic screw feeders manufacturing has almost stopped already. However a great number of them are still used in chemical, mining, metallurgical and construction supplies industries. Operating pneumatic screw feeders replacement with blow tanks could result in a considerable cost saving effect by means of the electricity power saving.

Yet the problem cannot be solved at once taking into account their mounting dimensions incompatibility. All the pneumatic screw feeder elements: electric motor, screw conveyor, mixing tank are mounted horizontally and their height does not generally exceed 1 m. The charge hopper and other equipment are mounted directly above the tank. The blow tank height is 3 m and more. That is why the pneumatic screw feeder replacement with the blow tank requires considerable investments in hopper facilities and related equipment.

II. SMALL SIZED BLOW TANK DEVELOPMENT FOR POWER EFFICIENT PNEUMATIC CONVEYING SYSTEM

A new feeder type, the so called small sized blow tank (SSBT) [5] has been engineered with the purpose of the blow tank adaptation to the mounting conditions instead of the pneumatic screw one without the existing industry re-equipment and due to other reasons listed below. The SSBT tank volume and height are 2–3 times smaller than those of the production models. That allows its arranging instead of the pneumatic screw feeder under the operating PCS hopper.

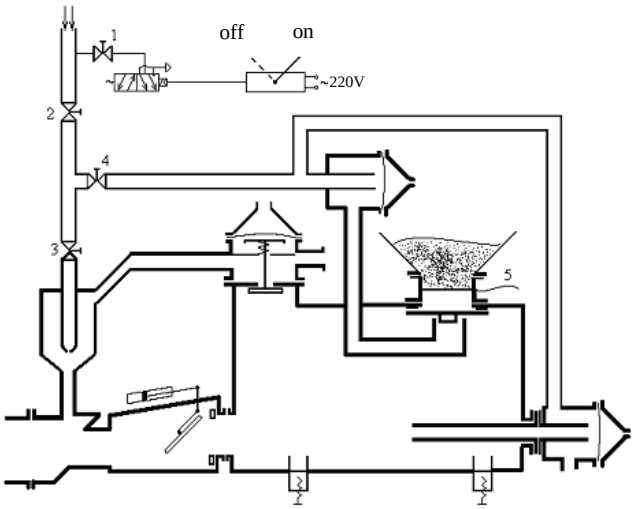

Figure 1 – Small sized blow tank sketch:
1 – control valve; 2 – shutter; 3 – regulating valve; 4 – air supply to the tank shutter; 5 – dust hopper slide shutter

The blow tank control system [6] and new quick-operating accessories and have been engineered to compensate the tank volume reduction.

A new pneumatic conveying power efficient technology [7] was created on the basis of SSBT. Power consumption for materials conveying through pipelines can be decreased by increasing the flow concentration. During the discharge process, the material dense flow is delivered into the conveying line where its concentration level is adjusted by additional air. While discharging, non aerated material makes considerable resistance, the value of which depends upon the material layer depth. The smaller the layer depth the smaller its resistance and the power consumption by the feeder.

The new technology main point is in adjusting the bulk material layer in the tank in such a way that the pressure required for discharge into the conveying line would exceed the pressure at the pipeline beginning by no more than 1.1–1.2 times. The corresponding layer depth is controlled by the level gauge. Power consumption by this feeder type is minimal. The PCS is given in figure 2.

SSBT is intended for use in two tanks version while conveying fine fraction bulk materials such as cement, enriched kaolin, ashes, coal dust and others through high load and long distance lines. The main technical parameter differing SSBT from ordinary feeders is the tank specific volume V_{SP}:

$$V_{SP} = \frac{V_t}{C}, \quad \frac{\text{m}^3 \cdot \text{hour}}{\text{t}},$$

where V_t – the tank volume, m^3;

C – blow tank capacity, tonne/hour.

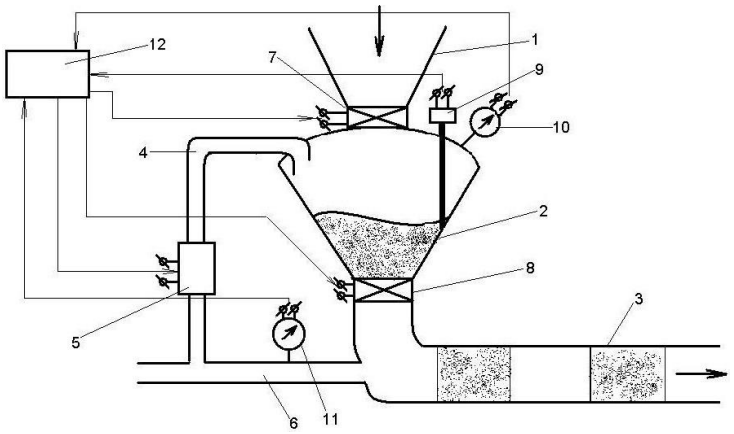

Figure 2 – Power efficient PCS scheme:
1 – hopper; 2 – tank; 3 – conveying line; 4 – nozzle of air supply to the tank;
5 – control valve; 6 – nozzle of air supply to the pipeline; 7 – charge valve; 8 – discharge valve; 9 – level gauge; 10, 11 – pressure gauge;
12 – control box

V_{SP} for SSBT does not exceed 0.02 units, i. e. one order less than that for ordinary high efficient feeders (see table 1). SSBT high efficiency maintenance is achieved by increasing the operations “charge-discharge” switch rate and the charge process intensification by creating quick-operating accessories, vacuum charge methods etc.

The new technology has been successfully implemented at the Sloviansk thermal power station in Donbass. The small sized blow tank was mounted instead of the pneumatic screw one on the line of coal dust supply from the preparation workshop to the power unit No 7 with the capacity of 700000 kW. Coal dust is conveyed by the blow tank in the amount of 60 tons/hour to the distance of 450 m. The electric motor output of 200 kW became needles, compressed air consumption decreased by 20% and the PCS efficiency increased by 20%.

III. CONCLUSIONS

1. Pneumatic conveying systems main disadvantage is a considerable power consumption exceeding that of mechanical conveying systems by 3 – 6 times.

2. Power consumption can be decreased by replacing outdated pneumatic screw feeders with the blow tanks that do not require electrical motors.

3. The new device – small sized blow tank was engineered for replacing the operating pneumatic screw feeders.

4. A new pneumatic conveying power efficient technology was created on the basis of the small sized blow tank.

5. The power efficient technology has been implemented at the Sloviansk thermal power station. It effects the saving of 500000 UAH/year.

6. The new technology can be used in other industries dealing with bulk materials pneumatic conveying.

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