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DESIGN OF PNEUMATIC CONVEYING SYSTEM

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Abstract- *The product of KMML Ltd is Titanium Dioxide which is the main constituent in paint and other paint related industry. It is produced from ilmenite. In KMML the sound of engineering ability is announced by turning black raw material ilmenite into the whitish substance ever known to man after a series of chemical and engineering process it is taking place in different units in KMML arena. In our project we look into Unit-400 where Titanium Dioxide from the spin flash dryer in Larox filter. The dried Titanium Dioxide is conveyed to the microniser feed unit through a serious of screw conveyor and bucket elevators, due to the fine nature of Titanium Dioxide different constrains and problems are faced like spillage, jamming of conveyor belts, necessity for frequent maintenance and cleaning. A large quantity of Titanium Dioxide is wasted which causes a considerable financial loss thus in this project a modification to the existing system to rectify this. The proposal is the use of pneumatic system instead of the existing combination of screw conveyors and bucket elevators. To satisfy the plant parameters and considering the fine nature of the substance dilute phase pneumatic conveying is opted.*

1. INTRODUCTION

Those intendant small functional defects in the industry due to the limitations in its infrastructural engineering aspects owe to indirect losses which sum up to a large financial loss over time, this can be avoided by up-to date technical updating and implementations of better designs. This project is a proposed design of pneumatic conveying system to be installed in the spin flash chamber of Larox filter used in unit 400 in KMML industry, replacing the existing conveying system which includes screw conveyors and bucket elevators which is inefficient due to many reasons which are explained in the later sections of this project.

2. PROBLEM IDENTIFICATION

Problem in the conveying section of Larox filter in unit 400 was identified. Since the existing system comprises of screw conveyors and bucket elevators which is partially enclosed and also has too many moving parts owing to spillage and regular maintenance requirement which leads to huge direct and indirect financial loss.

2.1 AIM

To replace existing conveying system connecting the output of Larox filter spin chamber unit and microniser feed unit with a more efficient and economical conveying system by nullifying spillage and maintenance requirement.

2.2 SUGGESTED METHOD

Pneumatic conveying system is found to be best suited to the condition as it satisfy all the plant parameters and the objective. Taking account of the fine nature of titanium dioxide which is to be conveyed dilute phase pneumatic conveying system is opted.

3 PROBLEM IDENTIFICATION AND EXPLANTATION IN DETAIL

3.1 PROBLEM

Spillage of Tio, (power of particle size 0.5 microns and less) from the Larox conveying system (consisting of 2 screw feeders and 1 bucket elevator) at the U 400 unit while conveying Tio, from the output of SPIN FLASH drier to the MICRONIZER FEED unit and the regular maintains and cleaning requirement.

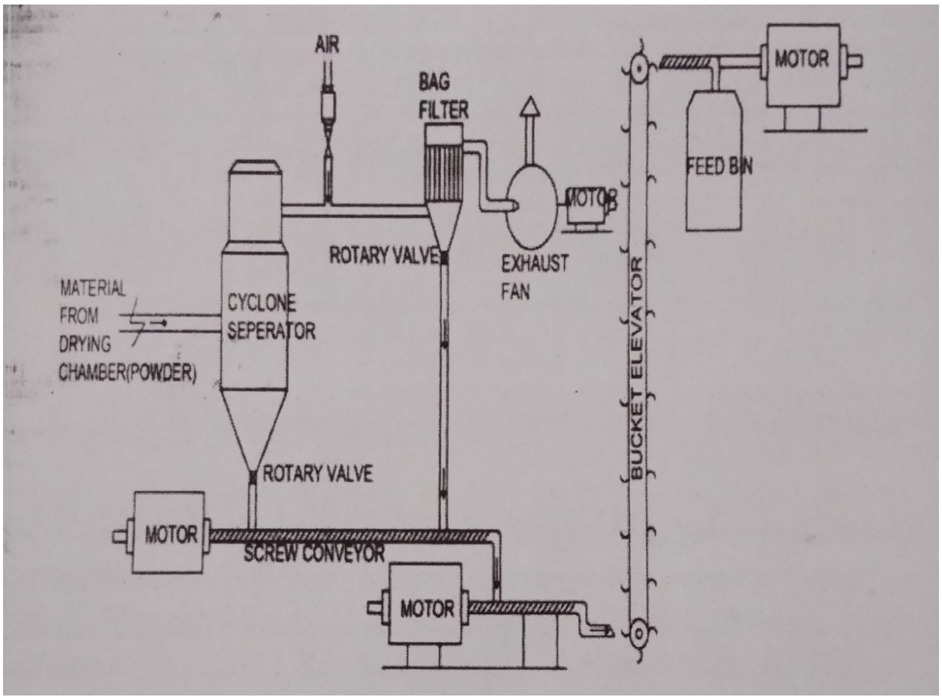
3.2 EXPLANTATION

Material conveying from one part to another has always been an important process. This has to be done efficiently and economically. The U 400 plat receives cake like form of $TiO2$, which contains nearly 70% moisture. This is passed into a drying chamber. An LPG gas burner is used to het the drying chamber. This chamber is maintained at a high temperature of 523 C. Wet cake like to Tio, enters the drying chamber. The high temperature will take up the moisture and make it dry. At the same time an agitator is rotated which crushes the dry cake from TiO2 to fine powered form. This is directed to a cyclone. The air escapes out through the cyclone and TiO2 powder falls down freely to the transportation line. This dry powder of Titanium Dioxide (TiO2) has to be transported to a tank before directed it to the packing section.

Dry TiO2 powder coming out from the silicon reaches a circular pipe of 10 inch diameter. Here it is to be transported for a horizontal distance of 10m and then it has to be lifted up for a vertical of 25m. Then this powder is dumped into a sump tank at the tank, In the present scenario, a screw conveyor alone was used, then it will Have to kept at a large angle so as to transport both horizontal and vertical Distance. But the efficiency of the conveyor decreases as the angle increases.

Thus instead of using it for whole distance, the screw conveyor is used only for transporting the powder for the horizontal of 10m. A bucket elevator system is used for transporting TiO2 powder vertically up. The powder is filled in buckets. After filling is done, the bucket will rise up through an elevator system and reach the top. There the powder in the bucket is dumped to the tank. However, this process is time consuming and is of high cost implication.

3.3 EXISTING DESIGN LAYOUT



Fig(5): Layout of Existing Design

3.4 COST ESTIMATION FOR EXISTING CONVEYING SYSTEM

In the pigment production plant(PPP) of the firm, TiO2 powder from spin flash dryer in the Larox Plax is conveyed to the micronizer feed bin by a series of mechanical equipment's like screw conveyors & bucket elevators. Due to fine powdering nature of the material this system has certain constraints like frequent spillage, chocking, leakage & fine power escaping. Though some amount of power is regained with the help of some filtrate recovery process, this is time consuming & expensive.

Thus this spillage & other associated problems are found to be one of the serious problems faced by the company. Here fully refined TiO2 powder is wasted leading to huge losses for the company both directly & indirectly, Even though this wastage is detected by the firm, a proper solution is not yet developed to reduce these losses. Various techniques have been developed like reclaiming it by retreatment & all but it has been found less effective & cost consuming.

This project aims at suggesting a practical solution to overcome this spillage occurring at the Larox conveying by analyzing the root cause of spillage.

3.5 SUGGESTED PENEUMATIC CONVEYING SYSTEM

3.5.1 PNEUMATIC CONVEYING SYSTEM

Pneumatic conveying systems are basically quite simple and are eminently suitable for the transport of powdered and granular materials in factory, site and plant situations. The system requirements are a source of compressed gas, usually air, a feed device, a conveying pipe line and a receiver to disengage the conveyed material and carrier gas. The system is totally enclosed, is required, the system can operate entirely without moving parts coming into contact with the conveyed material. High, low or negative pressures can be used to convey materials. For hygroscopic materials dry air can used, and for potentially explosive materials an inert gas such as nitrogen can be employed.

There are two type of pneumatic system

1 Dense phase pneumatic system

2 Dilute phase pneumatic system

Taking into account of the fine nature of the titanium dioxide dilute phase pneumatic conveying system is opted over dense phase pneumatic conveying system.

Components of simple pneumatic system are :-

- root blower,
- feeder, pipeline,
- hoppers
- air separation

these are mentioned in the below figure

3.5.2 DESIGN CALCULATION FOR THE PROPOSED DESIGN

The total distance to be conveyed

Horizontal distance of 10m + 10m

Vertical distance of 35m

For the vertical distance, we multiply it with a scaling factor and thus the equivalent length in measured

Consider the scaling factor for radial distance as 2

❖ Equivalent length L = 10 +10+2 (15)

=50m

❖ Diameter of pipe =6 inch

=152.4 mm

=0.152m

❖ Area of pipe A, = $\frac{\pi D^2}{4}$

= 3.14 x 0.152

=0.01814 m^2

❖ Mass flow rate of TiO2 powder,

m = 8000kg/sec

=800÷ (600X60)

= 2.22kg/sec

Consider the velocity of air inside the pipe as 35m/sec

Density of TiO2 powder is 4320 kg/m^3

Density of air = 1.2 kg/ m^3

Volume flow rate = Q Tio2 = $\frac{m}{\rho}$

=2.22 ÷4320

= 5.14 x 10^4 m/sec

Head Loss

Friction loss in pipes hf = $\frac{4flv^2}{2gD}$

From Moody's chart,

Friction factor 4f = 0.04

∴ hf =0.04x50x35^2

2x9.81X0.1524

= 819.374m of TiO2

Bend loss in pipe = no of bend * (0.3)" x $\frac{v^2}{2g}$

Here no of bends = 2

∴ bends loss = 2x*(0.3)*^2x*35^2*

22x9.81

Total head loss :-

= 62.43m of Ti02

= 819.374 + 62.43

= 881.804m of TiO2

Equivalent total loss of head of air, H air

= ρTiO2xHTiO2/ρ air

=4320X881.804 /1.2

= 31.7744 x 10°m of air

3.6 DESIGN LAYOUT OF PROPOSED SYSTEM

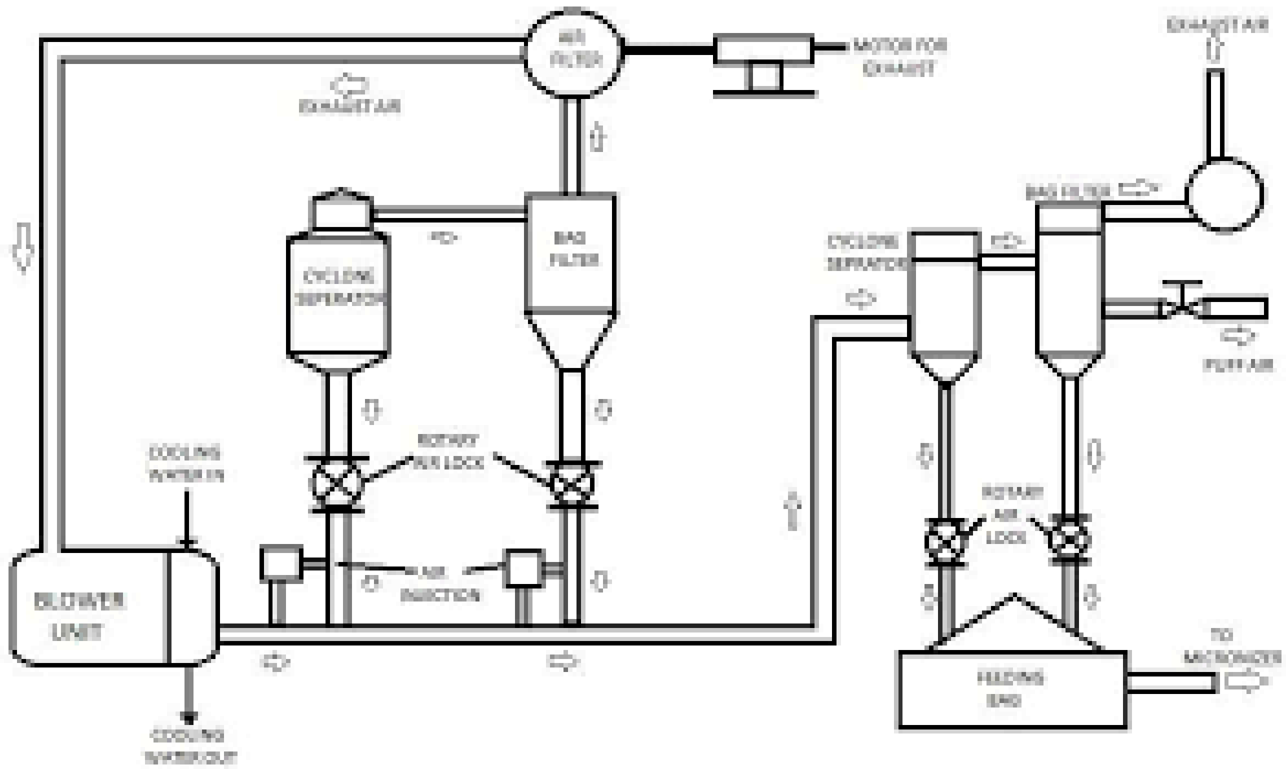


Fig (8): Diagram of Proposed System

3.7 STIMULATION AND PROTOTYPE ANALYSIS RESULT

3.7.1 Stimulation Result

Stimulation of the proposed system is runned in the vibrotahl stimulation thus the visualization of the functional characters are determined and analyzed and the overall efficiency is determined to be 89% with negligible duration influences and minimum deposition in the bends.

3.7.2 Prototype Analysis Result

A 1:20 prototype of the proposed design is fabricated and the efficiency of the system is determined to be 94%. Due to the reduced pipe diameter positions were formed in the bends.

4. CONCLUSION

The main objective of this project was to identify and eliminate the cause spillage of finished powdered product. In order to reduce the spillage rate and to avoid loss of revenue a new system was proposed. So a new system was introduced which is a long term solution for this. The proposed system replaces existing conveying system to pneumatic conveying system. Pneumatic conveying system is more advanced and effective mode of conveying. Since pneumatic systems are closed the chance of spillage is minimized. The benefit estimation and design layout is drawn along with n calculation of the overall system. From the above two results it can be concluded that the proposed design to standards and satisfies the functional requirements. The set up cost for the proposed design will be approximately 1, 50,00,000 /-and the annual total loss from the existing system will be approximately 65,00,000 considering the running cost and the different internal parameters the return of investment can be achieved in a period of 3 years and in the preceding years an annual profit of nothing less than 50,00,000 profits can be gained.

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