Energy Conservation by Modified Conveying System in Cement Industry

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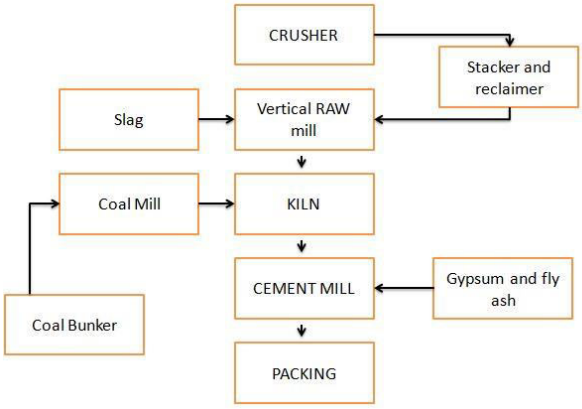
Abstract: Conveying System may be movable or immovable. They are used for product handling and also in processing of the materials. Industrial conveyors need to be in some conditions. They must withstand high temperature and they should carry high load. Therefore the conveyors used in industries must perform in all these conditions. But the conveyors which perform the operation must consume less electricity. Therefore usage of mechanical conveyors is very much necessary. The pneumatic conveyor consumes much electricity. Therefore modifying the conveying system into the bucket elevator will majorly influence in the conservation of the electricity. The major consideration will mainly be on the conservation of electricity.

Keywords: **Conveyor, Pneumatic, Bucket elevator, Electricity.**

INTRODUCTION

Material handling is one of the important processes in the industries. Material handling is defined as the process of movement or storage or handling of a raw material. This also involves transportation of raw materials from one place to other. This handling of material by doing some certain processes will create time and space utility through handling, storage and control of materials. There are two types of material handling system. They are manual material handling system and automatic material handling system. The manual material handling system mainly involves on the human effort. This system can be done only with the physical work of the human. In automatic material handling system, Machines performs the material handling activities. The handling process is programmed and being fed to the machine and this will perform the material handling process. Development of the industry mainly depends upon the energy consumption and less usage of fuel. Todays Industry focuses majorly on the energy consumption. Therefore analyzing the problem on the focus of energy conservation gave a great concept of conservation of energy in the conveying system which is used to transport the powdered limestone to the silo. Therefore various types of conveyors are taken and is being analyzed according to the nature, place, temperature, property of the raw material which is being conveyed. Therefore the primary concern is mainly on the energy conservation.

PROCESS

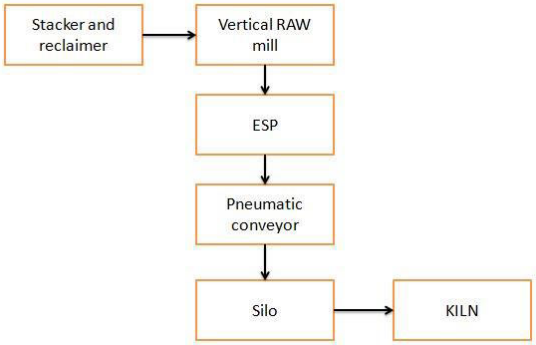


The limestone is being quarried and is transported using Lorries. It is then dumped in the crusher hopper. After that the limestone of uneven size is crushed to 50mm. The power consumed by the crusher is 488KW. Then it is being conveyed using the belt conveyor and stacked in a open area using the stacker. The stock pile height will be 15m. After it is being stacked, It is reclaimed using reclaimer. The reclaimer consist of a skeleton structure which is being kept in a 10^0. Then it is brought to the raw mill hopper. Here in hopper slag is present. 80% Limestone and 20% Slag is being conveyed using the belt conveyor. The power of belt conveyor is 37.5KW. This ratio of slag and crushed limestone is being controlled by the weigh feeder. The proportion of the slag and the limestone is controlled in this weigh feeder and it consumes 11KW power. Now the slag and the crushed limestone is brought to the vertical raw mill. This raw mill will now grind the 50mm crushed limestone to 0.1microns. The water and hot air is given to the vertical raw mill to increase the efficiency. To grind the limestone, the vertical raw mill consumes 1900KW power. After the vertical raw mill, ESP is used. This ESP is mainly used to take only the 100% grinded limestone. The remaining which is not being grinded properly is fed back to the vertical raw mill. In ESP there will be plates. One is positive plate and other is negative plate. When the current supply is given, The powdered limestone becomes negatively charged and it is being attracted to the positive plates. The induced draught system is being used and the remaining hot air goes out through the stack. The collected limestone

powder which is in plate is made to fall in the air slider using the rapping drive. Here the hammering system is used as the rapping device. The ESP consumes 2650KW power. After that it is brought to the aeropol using the air slider. In air slider, Polyester cloth is being used and the powdered limestone is conveyed to the aeropol. Aeropol is a device of pneumatic conveyor. The aeropol is connected with two blowers each of 200KW and this conveys the powdered limestone to the silo of height 90m. The capacity of the silo is 16,500Tonnes and the diameter of the silo is 22,000mm.

Now the powdered limestone is transported from the silo to the preheater using bucket elevator. The coal is being handled, stored, grinded and transported using the conveyors. About 65% of the coal is given to the preheater. In preheater, the limestone is heated upto 900^0 to 1000^0C. 80% of the clinker is made in the preheater. Then it goes to the kiln. As the kiln is rotating, it is called as rotary kiln. There are six support rollers which will support the rotation of the kiln. In kiln, the material is heated upto 1400^0C and the red hot clinker is made. The diameter of the clinker will be 10 – 25mm. This clinker goes to the cooler section. 9 Fans and 11 Compartments are there in the cooler. The water is also being sprayed. This will now cool the clinker. The fan speed is 1480rpm and the power consumed by the cooler is 200KW.

The clinker is cooled to 180^0C and the heat is recovered and sent to the preheater. The clinker is now being conveyed using the deep bucket conveyor to the clinker silo. The capacity of the silo is 11,000Tonnes. After that, the clinker is conveyed using the belt conveyor and is dumped in the cement mill hopper. There are three hopper. One contains Clinker, another contains Gypsum and other contains Flyash. 10% of gypsum is being mixed with the clinker. For example, if 100 – 110 Tonnes of clinker is added, 9 – 10Tonnes of gypsum is being added. The addition of gypsum and flyash results in the increase of quality and setting time of the cement. The cement is made in the cement mill and it is taken to the silo. From the silo the cement is taken and is sent to the packer. The packer works automatically. The power consumed by the packer is 2.2KW and the packer packs the cement automatically.



MOTIVATION

The efficiency of the industry majorly depends on the energy which is being consumed. This energy may be electricity or fuel. Therefore the energy conservation is focused. The powdered limestone which comes from the Vertical Raw Mill is then stored in the silo. The height of the silo is 90m and the capacity of the silo is 16,500tonnes. The powdered limestone is conveyed using the pneumatic conveyor to the silo. Pneumatic conveyor uses air as the conveying agent. This air is blowed from the blowers. There are two blowers which are used as the conveying agent. Each blower consumes 200KW. Therefore 400KW power is being consumed in the pneumatic conveyor. As the air is used as the conveying agent, powdered limestone along with the air enters the silo. This air is vented out using the bag filter. The capacity of the bag filter is 9600 m^3/hour. There is an induced fan used in the bag filter and the power of bag filter is 50KW. This pneumatic system consumes much power to convey the material. Therefore to overcome this problem, A new conveyor is being designed and analyzed so that the power consumption of the material conveying is reduced.

OBJECTIVES

The main objectives of the work is,

a. To learn the process of cement production.

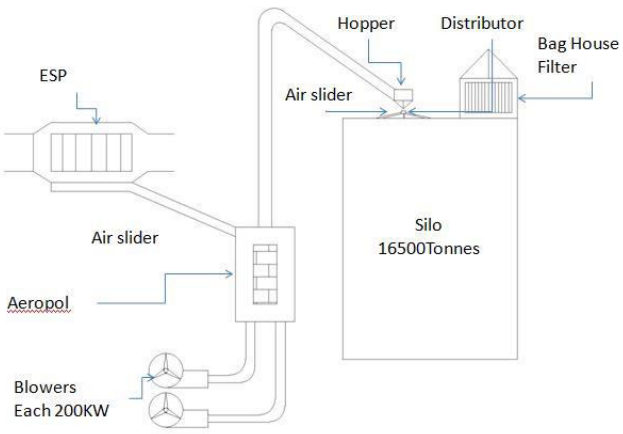
b. To learn about the different conveyors and material handling equipment.

c. To know the importance of power in industries.

d. To conserve the power by modifying the conveying system.

e. To Design and implementing the new system for effective replacement of the existing pneumatic system.

EXISTING SYSTEM



In vertical raw mill, Slag and crushed limestone enters the mill using the belt conveyors. This raw mill will now grind the 50mm crushed limestone to 0.1microns. The

water and hot air is given to the vertical raw mill to increase the efficiency. To grind the limestone, the vertical raw mill consumes 1900KW power. After the vertical raw mill, ESP is used. This ESP is mainly used to take only the 100% grinded limestone. The remaining which is not being grinded properly is fed back to the vertical raw mill. In ESP there will be plates. One is positive plate and other is negative plate. When the current supply is given, The powdered limestone becomes negatively charged and it is being attracted to the positive plates. The induced draught system is being used and the remaining hot air goes out through the stack. The collected limestone powder which is in plate is made to fall in the air slider using the rapping drive. Here the hammering system is used as the rapping device. The ESP consumes 2650KW power. After that it is brought to the aeropol using the air slider. In air slider, Polyester cloth is being used and the powdered limestone is conveyed to the aeropol. Aeropol is a device of pneumatic conveyor. The aeropol is connected with two blowers each of 200KW and this conveys the powdered limestone to the silo of height 90m. The capacity of the silo is 16,500Tonnes and the diameter of the silo is 22,000mm. There are five air sliders at the top of the silo. This will dump the powdered limestone in a even manner. A bag filter is fitted at the top of the silo. As air enters the silo, it affects the stored particles. Therefore the air must vent out. Bag filter is used for that purpose. As the result, capacity of the bag filter is high.

Specifications of the existing system

Capacity – 320TPH

Density of air – 1.2tonnes/m^3

Velocity of air – 12m/s

Volume of air – 2.85m^3/s

Diameter of pipe – 0.55m

Height – 92m

Calculations

The formula for finding the power for the pneumatic system is,

$$N = 248.4\frac{vol_{air}}{\eta} log[(1.2 \times P_w) + P_{loss}]$$

Where,

N – Power consumed

η - Blower Efficiency

P_w – Working Pressure

P_{loss} – Loss in pressure due to leakage

Substitute all the values,

$$= 248.4\frac{2.85}{0.75} log[(1.2 \times 1.94) + 0.3]$$

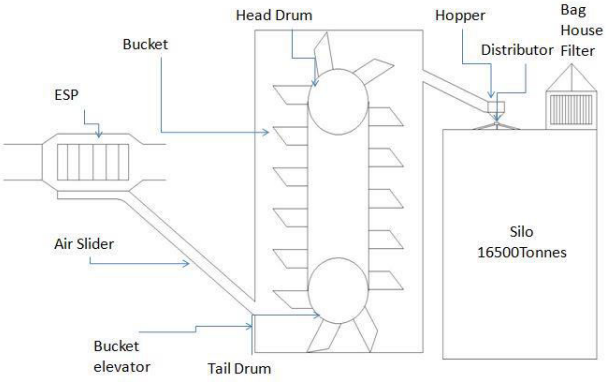
$$= 248.4 \times 4.071 \times 0.42$$

= 396KW

= 400KW (approx)

Therefore two blowers each of 200KW is being used for the conveying of the powdered limestone.

PROPOSED SYSTEM



Bucket elevator is a mechanical based conveyor which comprises of pulley, shaft and bearings. It has the mechanism for hauling the flowable bulk materials. Power is given to the head pulley and is transmitted to the tail pulley through belt. The electrical energy which is supplied to the motor will convert the electrical energy into the mechanical energy by the usage of shaft and bearings and the power is given to the head pulley. As it is for bulk process, the pulley is called as drum. Therefore head drum consumes the power and transfers to the tail drum through the belt. The bucket elevator is the replaced conveyor. Here the pulverized limestone of 0.5microns comes from the ESP through the air slider. This comes to the bucket elevator casing. There will be buckets in the bucket elevator and this conveys the limestone to the silo for the height of 90m height silo. There will be continous buckets and during the power is supplied, the limestone is being conveyed.

Calculation – Proposed System

For bucket elevator the formula is,

$$\frac{I_o}{a} = \frac{Q}{3.6 \times V \times \rho \times \Psi}$$

Substituting the values, we can get

$$\frac{I_o}{a} = 71.20$$

Based on this value we can find the pitch of the bucket and the width of the bucket from the data book page 9.23

Pitch = 400mm

Width = 600mm

Pitch = (2.5 to 3) x height of bucket

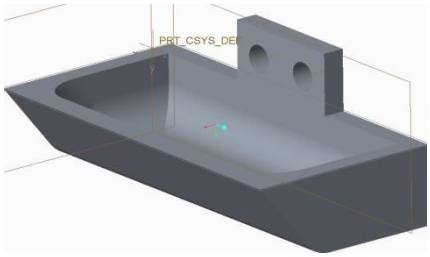
Height = 160mm

To find the number of buckets,

Radius of the drum = 0.5m

Length of belt = 2C+2πr+allowances

=188m



Number of buckets = $\frac{Belt\ length}{Pitch\ of\ buckets}$

$= \frac{188}{0.4}$

= 470 Buckets

Formula for power on the drive shaft for bucket elevator,

$N = \frac{Q \times H}{367}(1.15 + k_2 \times k_3 \times v)$

Where,

N – Power consumed

Q – Capacity of the conveying material

H – Height of the conveying portion

K – Factors from the table

Substituting the values in the formula, We can get,

$N = \frac{320 \times 92.7}{367}(1.15 + 0.5 \times 1.1 \times 1.3)$

=149.6KW =150KW (Approx)

RESULTS

- Power Consumed by the pneumatic conveyor – 400KW
- Power Consumed by the bucket elevator – 150KW

By comparing these two, we can say that the bucket elevator consumes less power than the pneumatic conveyor. 250KW of power is being conserved by modifying the conveyor system from pneumatic conveyor to bucket elevator. The power consumption is less. Maintenance is simple, no leakage problem, Requires only buckets and bearings as the spares.

FUTURE SCOPE

- The pneumatic conveyor is being replaced by the bucket elevator and the power is being consumed.
- Installing this system in the company in future will give a good profit for the industry both in economic and energy consumption.
- This system can be implemented in all bulk production companies for the effective power consumption.

CONCLUSION

The replacement of the pneumatic conveyor with the bucket elevator saves electricity and hence conserved. Eventually, it reduces pollution during electricity generation by burning of fossil fuels. It will also results in the development of the industry in the economic way. This method can be implemented widely in the future by replacing the pneumatic conveyor into the bucket elevator in all the process industries. They will not only conserve the energy but also results in the growth of the industry.

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