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Design and Development of Automated Conveyor System for Material Handling

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Abstract: *In the process or manufacturing industry, raw materials and products need to be transported from one manufacturing stage to another. Material handling equipment are designed such that they facilitate easy, cheap, fast and safe loading and unloading with least human interference. For instance, belt conveyor system can be employed for easy handling of materials beyond human capacity in terms of weight and height. This project discusses the design calculations and considerations of belt conveyor system for press machines, in terms of size, length, capacity and speed, roller diameter, power and tension, idler spacing, type of drive unit, diameter, location and arrangement of pulley, angle and axis of rotation, control mode, intended application, product to be handled as well as its maximum loading capacity in order ensure fast, continuous and efficient movement of material. The successful completion of this project work is help to the development of an automated belt conveyor system which is fast, safe and efficient. It is aimed to reduce human effort and at the same time increase the productivity & accuracy levels that cannot be achieved with manual operations.*
Keywords: *Belt Conveyor system, Frame, Material handling equipment.*

I Introduction

Different methods such as fork lifting, use of bucket elevators, conveyors systems, crane, etc. has been identified for lifting or transporting bulk materials or products from one place to another in the manufacturing industries depending on the speed of handling, height of transportation, nature, quantity, size and weight of materials to be transported.

In today's fast moving, highly competitive industrial world, a company must be flexible, cost effective and efficient to survive. Industrial automation has acquired importance owing to the ever-increasing demand for more productivity, better quality standard, better accuracy and optimum utilization of available resources and manpower. The main aspect of the project is to automate the process of transportation of the materials to the respective press machines.

II Literature Review

Alspaugh M. A. presented latest development in belt conveyor technology & the application of traditional components in non-traditional applications requiring horizontal curves and intermediate drives have changed and expanded belt conveyor possibility. For Examples of complex conveying applications along with the numerical tools required to insure reliability and availability will be reviewed. This paper referenced Henderson PC2 which is one of the longest single flight conventional conveyors in the world at 16.2611 km. But a 19.123 km conveyor is under construction in the USA now, and a 23.52 km flight is being designed in Australia. Other conveyors 30-50 km are being discussed in other parts of the world.

I. A. Daniyan discusseed the design calculations and considerations of belt conveyor system for limestone using 3 rolls idlers, in terms of size, length, capacity and speed, roller diameter, power and tension, idler spacing, type of drive unit, diameter, location and arrangement of pulley, angle and axis of rotation, control mode, intended application, product to be handled as well as its maximum loading capacity in order ensure fast, continuous and efficient movement of crushed limestone while avoiding halt or fatalities during loading and unloading. The successful completion of this research work has generated design data for industrial uses in the development of an automated belt conveyor system which is fast, safe and efficient.

II. Design

Design parameter of a belt conveyor system

Dimension, capacity and speed
Roller diameter
Belt power and tension

Pulley diameter
Motor
Type of drive unit
Location and arrangement of pulley
Maximum loading capacity

Belt Dimension, Capacity and Speed

The diameter of the driver and driven pulley is determined by the type and dimension of conveyor belting. The diameter of the pulley must be designed such that it does not place under stress on the belt. The length of a belt conveyor in metres is the length from the centre of pulley parallel to belt line. Belt length is dependent on both the pulley diameters and centre distances.

$V = d \times 2\pi$

Where:

V = Belt speed; d = diameters of rollers; π = pi

Belt Capacity

Capacity is the product of speed and belt cross sectional area Generally, belt capacity (kg/sec) is given as:

$B.C = 3.6 \times A \times \rho \times V$

Where:

A= belt sectional area (m2); ρ = material density (kg/m3); V= belt speed (m/s)

Conveyor Capacity

The mass of material M_m (live load) per metre (kg/m) loaded on a belt conveyor is given as:

$Mm = C/(3.6 \times V) 50 = C/(3.6 \times 1.5)$

Where

C= Conveyor capacity (tonnes/hr); V= belt speed (m/s).

Roller diameter

The relationship between the maximum belt speed, roller diameter and the relative revolution per minute is given as:

$n = (V \times 1000 \times 60) / (d \times \pi)$

Where

n = no of revolution per minute; d = roller diameter (mm); V= belt speed (m/s)

Belt basic length

Belt basic length= 2 × (length along conveying route)

Belt Power and Tensions

The longer the length of the belt, the more the power required for the conveyor and the higher the vertical distance of the lift, the higher the magnitude of power required.

Power required driving the pulley

$P = (C \times L \times 3.75)/1000$

The belt of the conveyor always experience tensile load due to the rotation of the electric drive, weight of the conveyed materials and due to the idlers. The belt tension must be great enough to prevent slippage between the drive pulley and the belt .

Belt tension at steady state

Belt tension at steady state is given as:

$Tss = 1.37 \times \mu \times L \times g \times [2 \times Mi + (2 \times Mb + Mm)\cos(\theta)] + (H \times g \times Mm)$

Where

Tss = Belt tension at steady state (N);; μ = Coefficient of friction (0.02)
L = Conveyor length (m); g = Acceleration due to gravity (9.81 m/sec2);
Mi = Load due to the idlers (50 kg) ; Mb = Load due to belt (55.7 kg);
Mm = Load due to conveyed materials (50 kg); Θ = Inclination angle of the conveyor (0o); and
H=Vertical height of the conveyor (0.7 m).

Belt Tension while starting

During the start of the conveyor system, the tension in the belt will be much higher than the steady state.

The belt tension while starting is

$Ts = Tss \times Ks$

Where

Ts= Belt tension while starting (N); Tss =Belt tension at the steady state (KN); K_S=Start up factor(1.08) .

The effective load F (N) is given as

$F = \mu T \times g(Mm+Mb/2)+\mu R \times g(Mb/2+Mi)$

Where:

μT= Coefficient of friction with support rollers(0.033); μR=Coefficient of friction with skid plate (.033);

g =Acceleration due to gravity (9.81m/s2); Mm=Total load of conveyed materials (50 kg)
Mb = Mass of belt (55.7 kg); Mi= Mass of roll idlers (50 kg)

Minimum Motor Power

The minimum motor power for sizing of the motor is

P min = P /η

Where,

P min=Minimum motor power (kW); P = Power at drive pulley (kW); η = Efficiency of the reduction gear

Torsional moment is given as

Mt = 0.5 × d × (F + μ W g)

Where:

d = Diameter of pulley (m); F= Effective load (N); μ = Coefficient of friction; W = Weight of material and Belt (kg/m); g = Acceleration due to gravity (m/s2)

The cycle time of conveyor is given as

C_t = 2L/V

Where,

L=Length of conveyor (m); V= Belt speed (m/sec)

Shaft Design

Shaft design consists primarily of determination of the correct shaft diameter that will ensure satisfactory rigidity and strength when the shaft is transmitting motion under different operating and loading conditions. The values of belt width and pulley diameter helps in selecting the size of shaft diameter from different conveyors hand book.

Control

Variable Frequency Drives (VFD) can be used for the control of the system. These controllers can e used for time control and supervisory functions such as: conveyor speed control, speed control of individual drives, speed and belt slip control, driving drum. start and stop control, acceleration and deceleration, and overload protection. In addition, VFDs can reduce the amount of motor startup inrush current by accelerating the motor gradually. For these reasons, VFDs are suitable for conveyors that benefit from reduced and controlled motor operating speed.

Gear Box

We are selecting the suitable gear motor from the BONFIGLIOLI Handbook with the required suitable parameters. The selected gear motor is Planetary gear motor – 300.

Which is Compact, and yet extremely powerful, are the units of the 300 Planetary gear motor series. Their planetary drive train makes them the ideal choice for all the severe duty applications where shock loadings and impacts are more the rule than the exception. The product configuration is highly versatile, due to several options as far as the mounting, the gear layout, the output shaft and the motor interface. Finding the perfect match to any drive problem is therefore more than a wish, it is something users can safely rely on - always.

III Model Of Conveyor Belt System

Fig. Actual conveyor belt

IV Conclusion

This Conveyor Belt System for material handling is improves the speed of material handling. And this system reduces the human effort. The workers are eliminated and the ultimately the operation cost is reduced and profit get increased. This system is beneficial and safety for the material.

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