Design of belt conveyor system engineering essay

Belt conveyor is the transportation of material from one location to another. Belt conveyor has high load carrying capacity, large length of conveying path, simple design, easy maintenance and high reliability of operation. Belt conveyor system is also used in material transport in foundry shop like supply and distribution of molding sand, molds and removal of waste. In this paper the study is carried out on DISA pattern moulding machine to meet the requirement of higher weight castings. The DISA machine is having the capacity of 100 moulds per hour. The mould size and density of material is given parameters. The present discussion aims to design the conveyor system used for cooling of mold, which includes speed, motor selection, belt specification, shaft diameter, pulley, idler spacing, gear box selection, with the help of standard practice. Also from ergonomic point of view some advanced control switches can be considered such as pull cord switch, belt sway switch, zero speed switches etc.

Keywords: Belt, Conveyor, DISA machine, Mould, Control Switches.

2. INTRODUCTION:

Whenever the bulk material requires continuous transportation belt conveyors supply a reliable means. If the handling rate and total quantity warrant, they usually are the most economical. All lifting and conveying machines can be divided by their operating principles into two large groups:

(i) Intermittent motion, (ii) Continuous motion Intermittent motion includes all types of cranes, lifts; surface transport means (trucks, loaders, prime movers), aerial tramways and cable ways, scrappers and the like.

Continuous motion includes conveyors, pneumatic and hydraulic transport means etc. which may generally called continuous transport machines or conveying machines.[1]

Continuous machines are characterized by non-stop motion of bulk or unit loads along a given path, without hallts for loading and unloading. The principle purpose of continuous conveying machine is to transport loads along a particular path. At the same time they can distribute loads among a number of destination points, deliver them to stores, transfer products from one technological operation to another and ensure the desired pace of a production process. [1]

Belt conveyors are employed for conveying various bulk and unit loads along horizontal or slightly inclined paths and for transporting articles between various operations in production flow lines.

Belt conveyors are used as the principle components of some complex machines such as wheel excavator, conveyor bridges and many other type of hoisting and conveying machines.

Belt conveyors are used for various applications such as material transportation in foundry shop (supply and distribution of moulding sand, moulds and removal of wastes) coal and mining industry, sugar industry, automobile industry, Bagasse industry, fuel supply system of electric power stations etc.

3. DESIGN OF BELT CONVEYOR SYSTEM:

It is necessary to have design related basic information about various components of belt conveyor before attempting to design belt conveyor. The design of belt conveyor is depends upon design/construction of individual component, but the design of many individual component depends upon the ultimate design construction of belt conveyor.

3. 1 Data available for belt conveyor system:

Input data used for designing the belt conveyor system

(Disa match 32X32 high pressure flaskless horizontal moulding line with disa cool).

Material density

Belt speed, v

Length of conveyor, L

Height of conveyor, H

Inclination angle

Mould Size 833 mm

Mould Temperature degrees.

Mould rate 100 moulds/hr

3. 2 Design procedure for belt conveyor system:

Note: Most of the formulas are in MKS units and for better understanding, converted into SI units.

The following procedure is followed to design present belt conveyor system:

3. 2. 1 Belt Capacity: [2]

BeltCapacity ……. (1)

3. 2. 2 . Belt Width: [3]

Belt width …… (2)

Live load (A):

Live load

Total live load (A)

Dead Load (B):

This load consists of weight of roller, belting and drive pulley.

B

Belt Pull (C):

Belt pull (C) in lbs

For roller bed belt conveyor coefficient of friction

Inclines/declines (D):

Tangent of angle

Additional belt pull

Additional belt pull

The maximum of above two is consider as a value of D

Deflectors (E): There are no deflectors in our system

Transition point (F):

Additional belt pull

Effective belt pull

T1 T1factor

From table T1factor

T1

As mould temperature is 180 degrees, heat resistant belt is required. Therefore pyroshield belt (KEP 800/4) is selected having the properties like high tensile strength, longer working life, robust construction, corrosion resistance, wear and tear resistance.

Belt Strength / inch [4]

Substitute the value of belt strength and T1 in equation (2),

Belt Width

3. 2. 3 Belt Tension: [2]

Effective tension (Te) …….. (3)

Return side tension

For horizontal and elevating conveyors,

Fe

W

Weight of material, Wm

Where, v= 0. 1 m/s= 19. 68ft/min

Wm

Weight of belt, Wb

W

Return side tension

Total empty friction

Standard edge distance

For standard edge distance 0. 0899 tf

Total empty friction

Total empty friction

Carrying side empty friction

Load friction

For horizontal and elevating conveyor, Fl

Load friction

Load slope tension

Load slope tension

Load slope tension

Effective Tension Te

Effective Tension Te

3. 2. 4 Power Calculation: [5]

Power HP ..... (4)

v

Substituting the values in equation (4),

Power

Power, P

3. 2. 5 Idler Spacing: [2]

Idler Spacing ..... (5)

Sag

Substituting the value of Te, W and sag in the equation (5),

Idler Spacing Si

Idler Spacing Si

3. 2. 6. Motor RPM calculation: [6]

Motor RPM, N ..... (6)

Here torque is not known and hence it can be calculated by following method

For belt conveyor application,

Mt ..... (7)

To find out the diameter of roll

Material weight density

Material weight density Wm

From table of bulk material handling handbook , for weight density of material Wm and belt width 48 inch , the diameter of pulley D[7]

According to CEMA (Conveyor Equipment and Manufacturers Association) the coefficient of friction [8]

Substitute the values of F, W, and g in equation (7),

Torque Mt

Substitute the value of Mt in equation (6),

Motor RPM, N

N1500 RPM

3. 2. 7. Diameter of shaft: [9]

According to ASME standard, the diameter of shaft is calculated by following formula

d ……. (8)

Diameter of shaft d is depends on various factors such as shear stress , Kb combined shock and fatigue factor applied to bending moment, Mb maximum bending moment, Kt combined shock and fatigue factor applied to torsional moment, Mt torsional moment.

To finding the maximum bending moment following procedure is adopted. The figure 1 shows the bending moment diagram for shaft as the beam is simply supported at two ends. [10]

Vertical load diagram (VLD)

Let RAv and RDv be the bearing reactions at A and D due to the vertical load

Now taking moment about A.

RDv

RDv

Also RAvDv

RAv

Vertical Bending Moment Diagram (VBMD):

Bending moment at A

Bending moment at B

Bending moment at C

Bending moment at C

Bending moment at D

Horizontal Load diagram (HLD)

Let RAH and RDH be the bearing reactions due to horizontal loads

Now taking moment about A

RDH

RDH

Figure 1: Bending moment Diagram

Also RAH

RAH

Horizontal Bending Moment Diagram (HBMD)

Bending moment at A

Bending moment at B

Bending moment at C

Bending moment at D

Resultant Bending Moment Diagram (RBMD)

Bending moment at A

Bending moment at B

17396574. 54 Nmm

Bending moment at C

17396574. 54 Nmm

Bending moment at D

Maximum bending moment , Mb

From table, for load to be applied gradually

Kb and Kt

For shaft material EN 8 AISI 1040 steel

Ultimate tensile strength utmm2

Yield strength ymm2

From ASME code,

Select minimum of above two values of

Considering the key way effect,

Substitute above values in equation (8)

d

3. 2. 8. Pulley Diameter: [11]

D ..... (9)

N

Considering fluid is not forming a part of drive, S.

i ic

Substitute all the values in equation (9),

D

From the diameter of pulley, the size of geared coupling is decided by using elecon catalog. [12]

Sizes of geared couplings are as follows:

ED 500- geared motor to gear box

ED 4500- gear box to drum

To reduce the jerk we are reducing the speed by using geared motor and gear box.

In the geared motor the speed reduction ratio is 1500/48

i. e. 31. The maximum speed reduction is carried out in geared motor. The remaining speed reduction is carried out by using gear box. As the belt speed is 0. 1m/s and pulley diameter is 636mm, the required rpm is 3.

Hence the speed reduction in geared box is 48/3 i. e., 16.

The bearing selected from the shaft diameter and thrust is SN 230 spiral roller bearing (ZKL bearing). [13]

From ergonomic consideration and human safety some advanced control switches can be used such as

(i) Pull Cord Switch: Pull cord switch is also known as Rope operated emergency switch is used as a safety switch to stop the conveyor belt in case of emergency by pulling the rope.

(ii) Belt Sway Switch: The switch allows the smooth running of the conveyor and protects it from damages by over swaying which can occur due to uneven loading of material, worn out idler roller bearings etc.

(iii) Zero Speed Switch: when any problem occurs in the system it will sense the signal and machine automatically stops using this type of switch.

4. MANUFACTURING ASPECTS:

After design, proper profile of belt conveyor is finalised. Geometrical parameters and material selection are choosen from the design. The conveying material is mould which is at 180 degree centigrade. Therefore

material used for belt is pyroshield KEP/800/4 ply. The pulley and idlers are made up of mild steel material and shaft material is EN 8 AISI 1040.

From the design, components are procured such as geared motor, gear box, geared coupling etc. as per requirement.

5. RESULTS AND DISCUSSION:

The major components and its parameters in the conveyor system are finalised. The designed parameters are calculated by using standard practice.

The belt width is 1200 mm. The belt tension is 47. 908 KN The drive is having power of 10HP with 1500 rpm. The shaft and pulley diameters are 165 and 636mm respectively. The spacing between the idler is 1 meter.

By using the advanced control switches like pull cord switch, belt sway switch, zero speed switch one can control the motion, reduce the frequency of accidents in belt conveyor system.

6. NOMENCLATURE:

Cbelt capacity in tons/hr

v

L

Hheight of conveyor in m

Fe, Fl

W

Wm

Wb

tf

Te

Si

P

Mt

Mbbending moment in Nmm

D

coefficient of friction

F

ggravitational acceleration in m/s2

N

d

Kb

bending moment

Kt

torsional moment

shear stress in N/mm2

ut: ultimate tensile strength in N/mm2

yt: yield strength in N/mm2

S

i

ic

VLD: Vertical load diagram

HLD: Horizontal load diagram.

VBMD: Vertical bending moment diagram

HBMD: Horizontal bending moment diagram

RBMD: Resultant bending moment diagram