International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor (2018): 7.426

Designing for Belt and Drive Rolls for Belt Conveyor System for Raw Material in Briquetting Plant in Ferrochrome Industry

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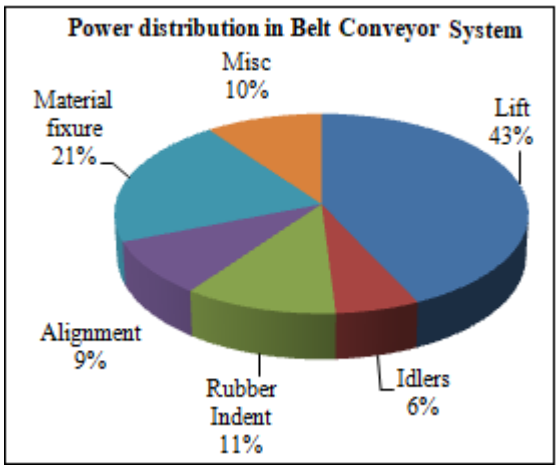
Abstract: ***In most of the industries (Process/ Manufacturing) raw materials need to be transported from one destination to another. Material handling equipment are needed to be designed such that transportation of material / products must be easy, cheap, fast and safe loading and unloading with least 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 paper discusses the design calculations and considerations of belt conveyor system in association with drive rolls, in order to ensure fast, continuous and efficient movement of raw material. The successful completion of this research work has generated design data for industrial uses application.***

1. Introduction

Efficient belt conveyor systems that will reduce cost and enhance productivity while simultaneously reducing dangers to workers operating them. Conveyor system is a mechanical system used in moving materials from one place to another and finds application in most processing and manufacturing industries such as: chemical, mechanical, automotive, mineral, pharmaceutical, electronics etc.

It is easier, safer, faster, more efficient and cheaper to transport materials from one processing stage to another with the aid of material handling equipment devoid of manual handling. Handling of materials which is an important factor in manufacturing is an integral part of facilities design and the efficiency of material handling equipment add to the performance level of an industry. Conveyor systems are durable and reliable in materials transportation and warehousing. Based on different principles of operation, there are different conveyor systems namely: gravity, belt, screw, bucket, vibrating, pneumatic/hydraulic, chain, spiral, grain conveyor systems etc. The choice however depends on the volume to be transported, speed of transportation, size and weight of materials to be transported, height or distance of transportation, nature of material, method of production employed. Material handling equipment ranges from those that are operated manually to semi-automatic systems and to the ones with high degree of automation. The degree of automation however depends on handling requirements.

Material handling involves movement of material in a manufacturing section. It includes loading, moving and unloading of materials from one stage of manufacturing process to another. A belt conveyor consists of an endless and flexible belt of high strength with two end pulleys (driver and driven) at fixed positions supported by rollers. Pulleys are used for providing the drive to the belt through a drive unit gear box powered by an electric motor. It also helps in maintaining the proper tension to the belt. The drive imparts power to one or more pulleys to move the belt and its loads. Materials are transported over the required distance as a result of friction generated between the roller surface and the moving belt set in motion by a rotating pulley (drive pulley). The other pulley (driven or idler pulley) acts as a wheel around which the material rotates and returns in a continuous process. Continuous processes are characterized by non-stop motion of bulk or unit loads along a path without halt for loading and unloading The peculiarities of a belt conveyor is that it is easy and cheap to maintain, it has high loading and unloading capacity and can transport dense materials economically and at very high efficiency over long distance allowing relative movement of material. Belt conveyor can also be used for diverse materials: abrasive, wet, dry, sticky or dirty material. Only a single roller needs to be powered by driver pulley and the roller will constantly spin causing the materials to be propelled by the driving roller. Material handling equipment such as belt conveyors are designed to load and unload materials from one stage of processing to another in the fastest, smoothest, most judicious, safest, and most economical way with minimum spillage. 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. A belt conveyor can be horizontal, incline or decline or combination of all. With the aid of pneumatic cylinder, the height of the conveyor is adjustable so as to load and unload at different height.



2. Indentations and Equations

The paper consists of design of following elements for a belt conveyor system:
a) Dimension, capacity and speed
b) Drive Roller diameter

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 undue 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
Taking Plant capacity = 11664 MT per day per unit (One belt conveyor system)
Feeding rate = 135 Kg per second
Taking belt capacity = 175 Kg per second (Considering for 30% future expansion)
Belt material - Composite rubber (canvas with reinforced steel)
Strength of belt = 85 Kg per mm^2
Density of briquettes = 1115 Kg per m^3
Taking the width of the belt as 1200 mm.
Max height of raw material on the belt h = 85*1200/1115 = 91.4 mm
Taking h=90 mm
So Belt speed

$$V = \frac{V_{rm}}{h} \quad \text{----------} \quad (i)$$

$V_{rm} = Volume\ of\ raw\ material\ flowing\ per\ second$
$V_{rm} = .180\ m^3\ per\ second$
V=1.56 m per second

Size of drive rolls

$$V = \pi d \quad \text{----------} \quad (ii)$$

Where:
V= Belt speed;
d= diameters of drive rollers;
Diameter of rolls = 496 mm
Drive roll must be made up of material EN-31.

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

$$M_m = \frac{C}{3.6.V} \quad \text{----------} \quad (iii)$$

Where:
C= Conveyor capacity (630 tonnes/hr); and
V= belt speed (1.56 m/s).
M m=112.17 kg.

$$The\ conveyor\ length = \frac{Horizontal\ Distance}{Inclination\ angle} \quad (vi)$$

The inclination angle is 10°, the conveyor length is 100 m, and the conveyor height is 10 m.

$$Basic\ belt\ length = 2X Length\ along\ the\ conveying\ route \quad (viii)$$

So basic length = 2X100 = 200 m

3. Figures and Tables

Following design values are found for belt conveyor system

SN	Parameter	Value
1	Plant capacity	11664 MT per hour
2	Feeding rate	135 Kg per second
3	Belt capacity	175 Kg per second
4	Strength of belt	85 Kg per mm^2
5	Width of the belt	1200 mm
6	Density of Briquettes	1115 Kg per m^3
47	Max height of raw material on the belt	90 mm
8	Belt speed	1.56 m per second
9	Volumetric flow of material on Belt	.180 m^3 per second
10	Diameter of rolls	496 mm
11	Mass of live load	112.18 kg
12	Basic length of belt	200 m

4. Conclusions

Following conclusions are made
a) Conveyor belt can be used in raw material handling section of industry.
b) It is robust.
c) It is flexible.
d) Its maintenance is easy.
e) It is safe.
f) It has low set up cost and maintenance cost comparative to other drives.
g) Electric consumption is not so much.
h) There is adverse effect on environment.

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