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Conveyor Belt Machine Power Analysis

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ABSTRACT

Everyone would want convenience in completing the work in his life, be it light work or high-risk heavy work. As we all know, today's technology is so fast that it can replace human jobs where all human work wants to be completed with the results we want.In designing this Portable Belt Conveyor, the author first understands the methods in planning in the preparation stage as well as in theory, namely by analyzing the design, because planning also requires the ability to analyze planning to get performance on this Portable Belt Conveyor. From the calculation results of the analysis of the motor power on the conveyor belt against the resistances contained on the conveyor and also on the variation of the load being transported, it is known that the variation of load and resistance on the conveyor belt plane greatly affects some performance and motor power. So from the results of the discussion conducted, several conclusions can be drawn. The elevation angle that occurs on the conveyor belt also affects the tensile stress received by the belt, the greater the elevation angle that occurs, the greater the tensile stress received by the belt, but on the conveyor belt there is no elevation angle because the conveyor belt is a conveyor belt used in a flat position so that the elevation angle is 00. (3) Based on load variations, motor power was very influential on the load to be transported. The heavier the load being transported, the greater the motor power required.

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1. INTRODUCTION

Everyone certainly wants convenience in completing the work in his life (Fabriar, 2020), whether it's light work or heavy work that is high risk (Kasmarani, 2012). As we all know, today's technology is so fast that it can replace human jobs (Wijaya et al., 2016) where all human work wants to be completed with the results we want (Pradana, 2014).

Machines are one example of the application of technology that has a major role in our lives (Suryadi, 2015), where an energy, such as electrical energy is converted into motion energy that produces work in its use (Haryati, 2006). Machines are always evolving because the types of work that are increasingly diverse are always looking for new alternatives in an effort to make the job easier (Saripah, 2001).

Of the many types of construction, a conveying machine or conveyor is one of the equipment that plays an important role in industries (Kusuma, 2018). Conveyor machines generally work by conveying loads from one place to another (Prabowo, 2017). Conveyors according to the direction of movement of the movers are divided into two types, namely shifters in an up and down direction

(vertical) and in a horizontal direction (horizontal) (Candrabuana, n.d.). Seeing how important the conveyor machine is, there is a desire to raise it as an object of discussion for the Final Work report. The other reason is because conveyors have various disciplines that have been studied during lectures (Harsanto, 2017).

The purposes of this Final Project are: (1) Completing the lecture period of the Diploma IV Study Program, Department of Industrial Mechanical Technology, Faculty of Engineering, University of North Sumatra (Akhir & Ubi, n.d.) (2) Knowing the work of the Conveyor Belt Machine. (3) Developing knowledge, both theory and practice, which are obtained in lectures (Arifin, 2014) (4) Adding and deepening knowledge about conveyor systems (Nayakapraja D, 2021) (5) To calculate the transmission system, reducer speed, and calculation of the transmission shaft. (Ilhamsyah, 2020) (6) Apply the knowledge gained during lectures to be used in the process of designing a belt conveyor machine as a prototype of the Final Work later (Rian, 2021) (1) For students: (1) As a medium to get to know or get the opportunity to train themselves in carrying out various types of work in the field (Amiran, 2016) (2) As material to get to know various aspects of company science, either directly or indirectly (Daniar et al., 2020) (3) Get the opportunity to practice skills in doing work or field activities (Bangun, 2019) (2) For Study Programs (1) As a means to introduce the Diploma-IV Study Program of the Department of Industrial Mechanical Technology, Faculty of Engineering, University of North Sumatra, to the community and companies (Huriani et al., 2021) (2) As a means to obtain cooperation between the faculty and the company. (3) As input from the application of the disciplines of the curriculum, is it still relevant to the situation in the field? (Siagian et al., 2019) (3) For Companies/Agencies. (1) As a material for comparison or proposal for companies in an effort to resolve problems in the company (Lailiyah, 2020) (2) As a material to know the existence of the company from the perspective of the community, especially students who do the Final Project (Narda, 2022) (3) As a company partner in the form of scientific theory that is useful for improving a better work system. (4) As a contribution from the company in its role to advance development in the field of development (Sulaiman, 1984).

2. RESEARCH METHOD

2.1 Preliminary Data

In designing this Portable Belt Conveyor, the author first understands the methods in planning in the preparation stage as well as in theory, namely by analyzing the design, because planning also requires the ability to analyze planning to get performance on this Portable Belt Conveyor (Fauzi, 2020).

2.2 Conveyor Belt Capacity Determination

The capacity of the belt conveyor machine is planned to be able to transport 17.3 tons/hour of material to be transported using a belt (belt).

2.3 Transmission System Planning

To move the motor rotation to the drive shaft, it is planned to use a shaft and reducer transmission system (using gears) and be adjusted to their needs (Al Qadim, 2021). In planning this conveyor belt machine, it is planned that the final rotation is 37 rpm and the belt speed is 0.11 m/s.

2.4 Planning Specification

Material Type : Unit load includes crates, sacks, boxes.
Capacity: 17.3 tons/hour
Transmission system: Shaft and reducer

3. RESULTS AND DISCUSSIONS

A review of the material being transported needs to be done in the discussion of conveyors. This review aims to obtain data regarding the characteristics of the transported material and the variables carried out in this discussion.

3.1. Characteristics of Transported Materials

The material transported by this belt conveyor is material that is included in the unit classification (unit load), which is a unit load that can usually be lifted one by one or in groups, including bulk loads that have been packaged into a single unit, for example cement in sacks, grains in burlap, or oil in a can.

3.1.1. Specific Properties of Transported Materials

The specific properties of the material being transported are the same temperature and humidity as the environment, non abrasive, not explosive or flammable, does not contain hazardous chemicals and is assumed to be easily torn or broken.

3.1.2. The shape and size of the material transported

The shape and size of the material are material characteristics that are directly related to the size of the conveyor. The material with the maximum size that can be transported is beverage crates which are a type of material in the form of units, from the results of a survey study conducted in the field it is found that for ease of moving the material. So one of the sizes of material to be transported is length = 350 mm, width = 400 mm, height = 300 mm

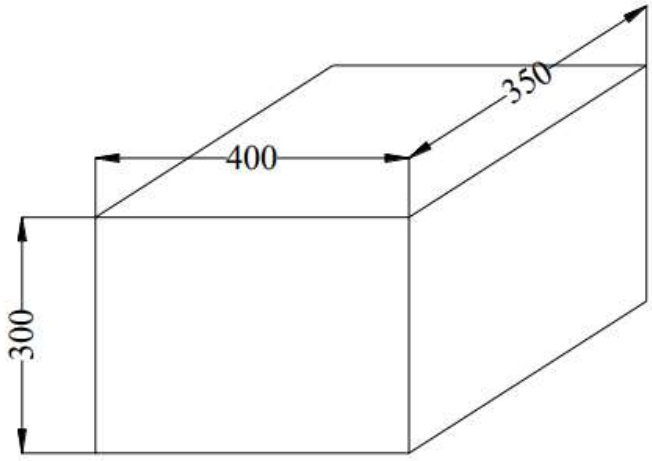


Figure 1. Dimensions of Transported Materials

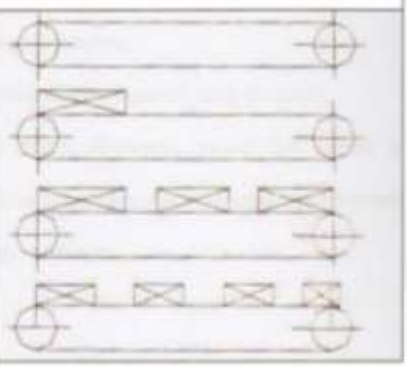
3.1.3. Weight of Transported Material

The weight of the material transported by the belt conveyor is very important to know, because these characteristics greatly affect the strength and ability of the belt conveyor to operate. From the results of the tests carried out, the efficient load that can be transported by this conveyor belt is 20 kg. If a load above 20 kg is used, the motor can carry the load, but the motor temperature becomes high or the motor overheats, so for safety purposes only a load of 20 kg and below is used. Thus the weight of the load (G) is 20 kg, and the weight is determined as the maximum weight to be carried by the conveyor.

3.1.4. Loading Condition

Loading conditions are the ways in which material is loaded onto the conveyor. Is the load/material made manually, i.e. lifting the load by hand and placing it on a conveyor belt, or the load received from another conveyor or also the load that is loaded onto the conveyor using other equipment such as cranes or robots. The distance between the charges is also the scope of this characteristic. In addition, it is also about how to lay or arrange the load on the belt. The following are the loading conditions on the belt conveyor handling unit load in table 4.1.

Table 1. Loading Conditions Unit Load

Kondisi Pemuatan	
Tanpa Muatan	
Muatan Minimal	
Muatan Normal	
Muatan Maksimal	

In the belt conveyor discussed, it is determined that the loading condition is maximum loading, the load is loaded on the conveyor manually and should not be stacked increasing that the designed conveyor has a slope of 100–300 which will cause the transported load to fall and break while the distance between loads depends on the amount loads that the conveyor can serve at the same time. This will be discussed in the following discussion.

3.2. Conveyor Capacity Design

3.2.1. Belt Width (Weight Belt)

In general, the belt width sizes according to ASTM are 14, 20, 24, 30, 36, 42, 48, 50, 54, 60, and 108 inches. Meanwhile, the belt widths produced in Europe are 400, 500, 650, 800, 1000, 1200, 1400, 1600, 1800, 2200, 2400, 2600, 2800, and 3000 mm. There are several things to consider in choosing the width of the belt, namely: 1. The width of the belt of a conveyor system is a determining factor for the speed and capacity of the conveyor. 2. The width of the belt is determined by the size of the material being transported. Taking into account the economic factors, solutions and situations of the conveyor as well as the shape and size of the dimensions of the load, from the existing data the width of the conveyor belt and the shape and size of the dimensions of the load, from the existing data the width of the conveyor belt (b) used is: 500 mm.

3.2.2. Conveyor Track Length

To determine the length of the belt conveyor, it is necessary to consider the loading conditions around the conveyor and its development in the future. Considering this conveyor can be used anywhere during the horizontal transportation process without any tilt angle. Then used a conveyor with a belt track length of 1375 mm.

3.2.3. Belt Conveyor Speed Setting

According to Spivakovsky, 1996, the conveyor belt speed (v) serving the unit load is generally set at 0.1 – 0.7 m/s. This is intended to facilitate the loading and unloading of loads from the conveyor,

and it must also be taken into account that the load can be picked up before it reaches the end of the conveyor, so the conveyor belt speed (v) for transporting the unit loads is set: 0.11 m/s.

3.2.4. Conveyor Capacity Determination

The determination of the conveyor capacity depends on the length of the conveyor path, the number of loads that can be served at the same time and the distance between the loads. The length of the conveyor track used is 1375 mm. From the conditions for loading the conveyor, it is known that the length of the load in relation to the width of the conveyor track used is: 500 mm. Therefore
Based on equation 2.1, the number of units of load that can be served by the conveyor at the same time is:

$$Z = \frac{PanjangLint\ asan}{PanjangMuatan} = \frac{1375mm}{350mm} = 3{,}9$$

To get the distance between the unit loads (a), it is assumed that Z = 3 units, so a conveyor plane is needed along: 3 x 350 = 1050 mm Means the length of the conveyor plane used is left along: 1375 – 1050 = 325 mm This distance of 325 mm is used as the distance between unit loads (a), according to equation 2.2. then the unit load distance obtained is:

$$a = \frac{SisaPanjangKonveyor}{Z} + PanjangMuatan \quad (1)$$

$$a = \frac{325mm}{3} + 350mm$$

= 458 mm
= 0.458 m
According to equation 2.3. to calculate the capacity of the conveyor can be known by using the following formula:

$$Q = 3{,}6x\frac{G}{a} \times V \quad (2)$$

Where:
G = Load weight = 20 kg
a = Charge distance = 0.458 m
v = belt speed = 0.11 m/s (appendix 5)

$$Q = 3{,}6x\frac{20kg}{0{,}458m} \times 0{,}11\,{}^{m}\!/_{s}$$

= 17.3 tons/hour
So the capacity of the conveyor is 17.3 tons/hour.

3.3. Main Component Calculation

The main components of portable belt conveyors analyzed include
1. Belt (belt)
2. Roller Idler
3. Drive Motor

3.3.1. Belt Calculation

In general, in choosing the type of belt, things that must be taken into account are: (a) Selection of belt material (b) Belt weight (c) Belt dimensions. According to Spivakovsky, 1996, the belt material used is a Nylon type belt, this material has a fracture tensile strength of 100 kg/cm per layer.

According to equation 2.4. To find the weight of the belt per unit length, the following formula can be used:

Wb = 1.1 x B (I x + 1 + 2) (3)

Where:

= thickness of the belt layer = 1.5 mm

i = Number of belt layers = 1 layer (attachment 3)

1 = Thickness of the bulky layer of the loaded belt = 1 mm (appendix 3)

2 = Unloaded belt layer thickness = 1.5 mm (appendix 3)

B = Belt width = 500 mm

Figure 2. Belt Used

Then obtained:

Wb = 1.1 x B (I x + 1 + 2) (4)

= 1.1 x 0.5 (1 x 1.5 + 1 mm + 1.5 mm)

= 2.2 kg/mx 9.81 m/s2

= 21.6 N/m

The mass of the belt is calculated using a scale weighing = 2 kg

3.3.2. Idler Roller Calculation

What needs to be considered in choosing an idler roller is to consider the shape of the material being transported, on the belt conveyor discussed the shape of the material being transported unit load is known, so on this belt conveyor a flat roller idler type roller is selected, as shown in Figure 4.3.

Figure 3. Flat Roller Idler

According to Spivakovsky, 1996, idler roller diameter D = 60 mm, for a belt width of 500 mm, but there is a stipulation that on conveyors serving a unit load, the load must be supported by at least two idler rollers at the same time, then by stipulating that the load is supported by two rollers. The inner diameter can be calculated using the equation 2.11

$$d = \frac{D_R}{2} \quad (5)$$

$$d = \frac{60}{2} = 30 \text{ mm}$$

However, when designing a portable Belt Conveyor tool, it does not use idler rollers of different sizes, the diameter of the idler roller used is the same as the diameter of the belt drive puller. Based on equation 2.13. To find the length of the Flat Roller Idler, you can use the formula: Lr = 1,2 . B, = 1.2 . 500 = 600mm.

3.3.3. Distance Between Roller Idler

The distance between the idler rollers (L) for the belt conveyor serving the unit load is related to the requirement that the load must be supported, at least two rollers at the same time, according to equation 2.14. then the distance between the idler rollers is:

$$L = \frac{PanjangMuatan}{2} \quad (6)$$

$$L = \frac{350}{2} = 175mm$$

This is adjusted to the existing literature references that for unit load transfers, for heavy loads above 10 kg – 50 kg, the roller bearing distance is set at 0.1 – 0.4 m, and must be supported by two idler rollers.

3.4. Analysis of the Effect of Load Variations on Motor Power

The analysis is carried out on the motor power based on the variation of the load carried by the conveyor belt using the equation:

$$Pm = \frac{G.Vg}{75} \quad (7)$$

Where:
Pm = Motor power
G = Load
Vg = Load Speed
1. At Load 2 kg

$$Pm = \frac{2kg \times 0{,}11\,{}^{m}/_{s}}{75} = 0{,}003Hp$$

2. At 4 Kg . Load

$$Pm = \frac{4kg \times 0{,}11\,{}^{m}/_{s}}{75} = 0{,}006Hp$$

3. At 6 Kg . Load

$$Pm = \frac{6kg \times 0{,}11\,{}^{m}/_{s}}{75} = 0{,}009Hp$$

4. At 8 Kg . Load

$$Pm = \frac{10kg \times 0{,}11\,{}^{m}/_{s}}{75} = 0{,}015Hp$$

5. At 10 Kg . Load

$$Pm = \frac{10kg \times 0{,}11\,{}^{m}/_{s}}{75} = 0{,}015Hp$$

6. At 15 Kg . Load

$$Pm = \frac{10kg \times 0{,}11\,{}^{m}/_{s}}{75} = 0{,}022\,Hp$$

7. At 20 Kg . Load

$$Pm = \frac{20kg \times 0{,}11\,{}^{m}/_{s}}{75} = 0{,}03\,Hp$$

Table 2. Effect of Load Variation on Motor Power

No.	Beban (Kg)	Putaran Motor (Rpm)	Kecepatan Beban (Vg) (m/s)	Daya Motor (HP)
1	2	1480	0,11	0,003
2	4	1480	0,11	0,006
3	6	1480	0,11	0,009
4	8	1480	0,11	0,012
5	10	1480	0,11	0,015
6	15	1480	0,11	0,022
7	20	1480	0,11	0,03
8	25	1480	0,11	0,04
9	30	1480	0,11	0,044
10	35	1480	0,11	0,05
11	40	1480	0,11	0,06
12	45	1480	0,11	0,066
13	50	1480	0,11	0,073
14	55	1480	0,11	0,081
15	60	1480	0,11	0,088
16	65	1480	0,11	0,095
17	70	1480	0,11	0,103
18	75	1480	0,11	0,11
19	80	1480	0,11	0,117
20	85	1480	0,11	0,125
21	90	1480	0,11	0,132
22	95	1480	0,11	0,14
23	100	1480	0,11	0,15
24	110	1480	0,11	0,16
25	127	1480	0,11	0,19

4. CONCLUSION

From the calculation results of the analysis of the motor power on the conveyor belt against the resistances contained on the conveyor and also on the variation of the load being transported, it is known that the variation of load and resistance on the conveyor belt plane greatly affects some

performance and motor power. So from the results of the discussion conducted, several conclusions can be drawn: (1) The tension in the belt greatly affects the motor power to be used. The higher the tension in the belt, the greater the motor power used. (2) The elevation angle that occurs on the conveyor belt also affects the tensile stress received by the belt, the greater the elevation angle that occurs, the greater the tensile stress received by the belt, but on the conveyor belt there is no elevation angle because the conveyor belt is a conveyor belt used in a flat position so that the elevation angle is 00. (3) Based on variations in load, motor power is very influential on the load to be transported. The heavier the load being transported, the greater the motor power required. (4) The factor that greatly affects the tension on the belt, the strength of the belt on the conveyor belt, and on the electromotor power is the load being transported.

The suggestions that the author can convey in the Motor Power Calculation Analysis on Conveyor Belts are as follows: (1) To be able to achieve the desired capacity the material used must be appropriate and based on the requirements in the design criteria. (2) The formulation of the requirements must be determined based on its function, so that the construction and all elements of the conveyor belt plane can last a long time (life time). (3) The bearings on the idler rollers should be checked regularly, so that the conveyor belt plane can work properly. (4) Pay attention to the load to be transported in its operation because it greatly affects the tensile stress on the belt due to the reaction of the load to the tension on the belt.

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