Design of Twin Rod Assembly using Inventor

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Abstract - Conveyor system in automation technology is used worldwide to carry and transport various types of products to the different work stations. Twin rod assembly is designed to overcome the disabilities on the conveyor using INVENTOR software. Twin rod assembly is used as a sub-assembly in the conveyor to overcome the direction controlling issues. According to the product shape and size there are some disadvantages as well as advantages in a conveyor system. The main aim of the design is to eliminate the product losses by hitting in the conveyor while taking change in direction and to guide the product for dispatch. This newly designed assembly is cost effective and simple design where as it can be implemented in any automation system.

Keywords: Linear motion, rod coupler, design, pneumatic.

I. INTRODUCTION

Twin rod assembly is designed to improve the precision of the process by eliminating additional processes and structural changes. It consists of shafts, collars, rod couplers and linear bushes which are actuated using a pneumatic cylinder[5]. In this assembly there are two mounting plates provided of which one is fixed and the other is free to guide along the shaft. In the fixed plate, pneumatic cylinder and linear bushes are mounted. In the movable plate, piston rod, shaft and rod coupler are mounted where the rod coupler is used to mount the piston rod with the movable plate. Shaft collar is used at the end of shafts to prevent damage by hitting on linear bushes and misalignments. Through a flow control valve flow rate of air into the cylinder is controlled, which governs the velocity at which the piston moves. The cylinder is actuated through a piston in linear motion and shafts move along with the piston. Linear bushes consist of metal spheres which circulate in ball guides which in turn provide a continuous linear motion with minimal friction. Twin rod assembly is used in applications where low pressure and continuous motion is required.

II. MATERIAL SELECTION

Material selected to design the twin rod assembly model is high carbon chromium steel and EN8 steel. High carbon chromium steel is selected for linear bushes to perform continuous linear motion without any prompting or disturbances[8]. EN8 steel is selected for the fabricated parts such as mounting plates, shafts, rod coupler and shaft collar. EN8 steel is selected instead of having low carbon content and it is an unalloyed carbon steel with reasonable tensile strength. And EN8 should be used flame hardening to get high surface hardness with minimum wear resistance. Double acting cylinder and flow control valves are the standard elements selected for the requirement from FESTO.

EN8 chemical composition,

Level	Carbon	Manganese	Silicon	Phosphorous	Sulphur
Minimum	0.35	0.60	0.05	0.015	0.015
Maximum	0.45	1.00	0.35	0.06	0.6

Table no: 2.1 (EN8 composition)

III. DESIGN CONSIDERATION

Considering the design aspects, the specimen should be selected under the various selection processes and it is designed to the required part dimensions[10]. According to the conveyor size twin rod assembly is designed to fit in the conveyor assembly as a sub-assembly. [1]

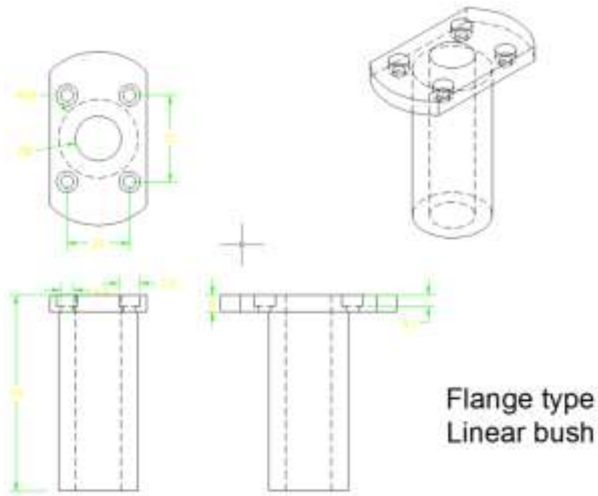
While designing twin rod assembly every specimen should be designed to evaluate the process[6]. Specimens selected to the required part dimensions as shown below,

LINEAR BUSH

Flanged type linear motion bush type is selected to increase the process capability and to hold the mounting plate even at the high friction[6]. Linear bushes are selected by considering the below mentioned dimensions,

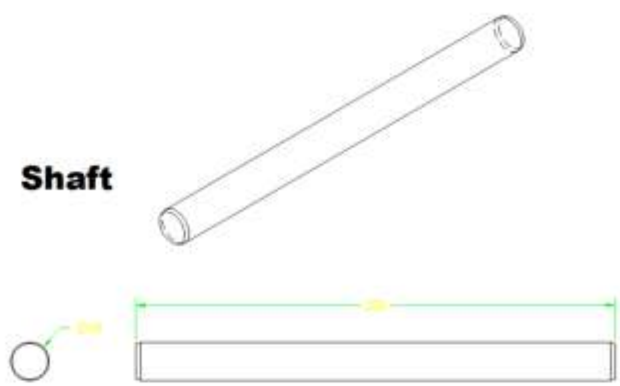
Outer diameter of the bush = 28mm
Inner diameter of the bush = 16mm
Height of the bush = 48mm
Length of the bush = 70mm
Thickness = 6mm

Basic dynamic load = 1230N
Diameter of the bolt head = 7.5mm
Threaded diameter of the bolt = 4.5mm
Thickness of the bolt head = 4.1mm
Distance between bolts = 22mm
Area between bolts = 31mm



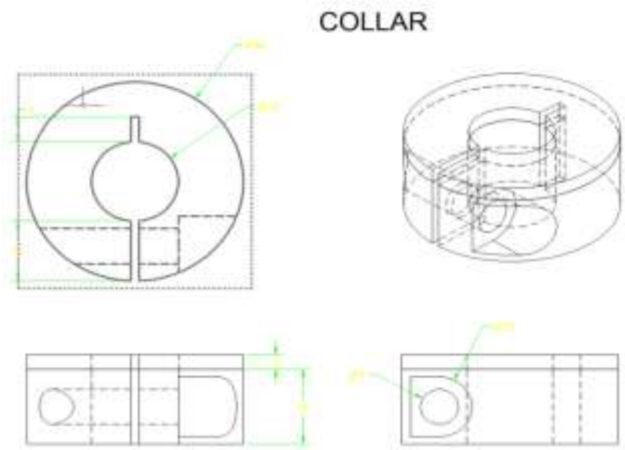
STEEL ROD or SHAFT

Diameter of the rod = 16mm
Length of the rod = 200mm
Pitch distance between pillars = 120mm



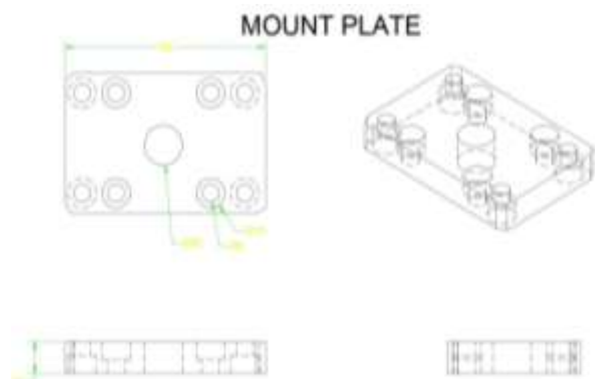
SHAFT COLLAR

Outer diameter = 40mm
Inner diameter = 16mm
Center key slot width = 1.5mm
Center key slot length = 26mm
Diameter of bolt = 7mm



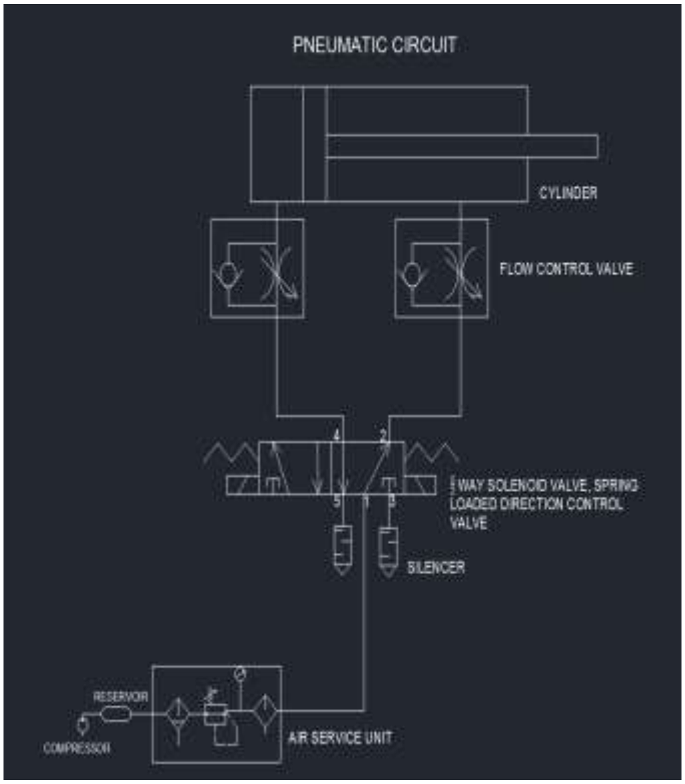
MOUNT PLATE

As per the dimensions mount plate is designed to hold the parts to form an assembly and to engage this assembly on a conveyor[9]. Mount plate is designed under the dimensions as shown below,
Area of mount plate = 106mm x 70mm
Plate thickness = 16mm



PNEUMATIC CIRCUIT

Pneumatic circuit should be the power system of the twin rod assembly. The assembly actuation is possible only by using a pneumatic system[5]. Double acting cylinder in the assembly performs the task which the twin rod assembly is designed to do[4]. Hence considering the pneumatic unit in the twin rod assembly is essential to design this assembly. [5]



IV. FORMULA

DOUBLE ACTING CYLINDER

- Force = (F) = $\pi/4$ P x ($D^2 - d^2$)
- Forward stroke = ($F_{forward}$) = (A x P) - F_R
- Return stroke = ($F_{reverse}$) = (A` x P) - F_R
- Area = ($\pi/4$ x D^2)
- Area` = ($D^2 - d^2$) x $\pi/4$

Where,
F = Effective piston force (N)
A = Useful piston surface (m^2)
A` = Useful annular surface (m^2)
D = Cylinder bore diameter (mm)
d = Piston rod diameter (mm)
p = Working pressure (pa)
F_{Th} = Theoretical force (N)
F_R = Frictional force (approximately 10% of F_{Th}) (N)

- Air consumption = compression ratio x piston surface x stroke x number of stroke/minute
- Compression ratio = (101.3 + operating pressure in (Kpa)/101.3)

LINEAR BUSH

- Life span = (L_h) = L x 10^3 / (2 x l_s x n_1 x 60)
- Rated life span = (L) = $(C / P)^3$ x 50

Where,
L_h= Life span hours (hr)
L_s = Stroke length (m)
L = Rated life span (Km)
N_1 = Reciprocating times per minute (cpm)
c = Basic dynamic load (N)
P = Load acting (N)

V. CALCULATION

DOUBLE ACTING CYLINDER

- Force = (F) = $\pi/4$ P x ($D^2 - d^2$)
  F = 6 x 10^5 x $\pi/4$ ($0.032^2 - 0.010^2$)
  [F = 435.43 N]
  10% of theoretical force = 43.54 N = F_R
- Area = ($\pi/4$ x D^2)
  A = ($\pi/4$ x 0.032^2)
  [A = 8.042x10^{-4} m]
- Area ` = ($D^2 - d^2$) x $\pi/4$
  A` = ($0.032^2 - 0.010^2$) x $\pi/4$
  [A`= 7.257x10^{-4} m]
- Forward stroke = ($F_{forward}$) = (A x P) - F_R
  = (8.042 x 10^{-4} x (6x10^5)) – 43.54
  = 482.549 – 43.54
  [$F_{forward}$= 439.01 N]
- Return stroke = ($F_{reverse}$) = (A` x P) - F_R
  = (7.257x10^{-4} x (6x10^5)) – 43.54
  = (228.079 – 43.54)
  [$F_{reverse}$=184.54 N]
- Compression ratio = (101.3 + operating pressure in (Kpa)/101.3)
  = (101.3 + 600) / 101.3
  [Compression ratio = 6.923]
- Air consumption = compression ratio x piston surface x stroke x number of stroke/minute
  = 6.923 x 8.042x10^{-4} x 100 x 12
  [Air consumption = 6.681x$10^{-3}$$m^3$/min]
  [Air consumption = 0.235 cfm]

LINEAR BUSH

Assuming load condition as 40kg,

- Rated life span = (L) = $(C / P)^3$ x 50
  = $(1230 / (40x9.81))^3$ x 50
  [L = 1.526 x 10^3 Km]
- Life span = (L_h) = L x 10^3 / (2 x l_s x n_1 x 60)

$= 1.539 \times 10^3 \times 10^3 / (2 \times 0.1 \times 12 \times 60)$

$[L_h = 10.687 \times 10^3 hr]$

VI. 3D MODELS OF TWIN ROD ASSEMBLY

By using inventor software twin rod assembly is designed as per the mentioned part dimensions,

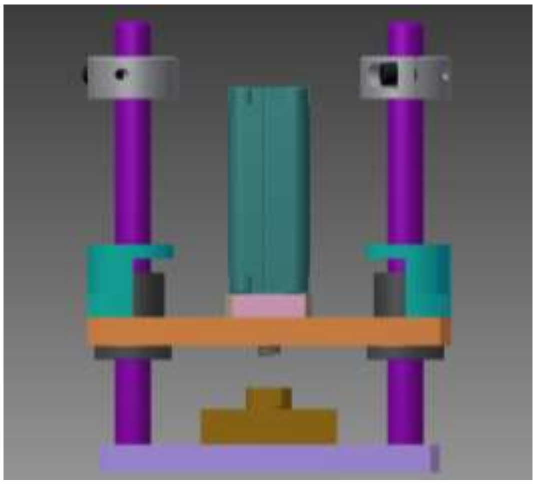


Figure no: 6.1 (FRONT VIEW)

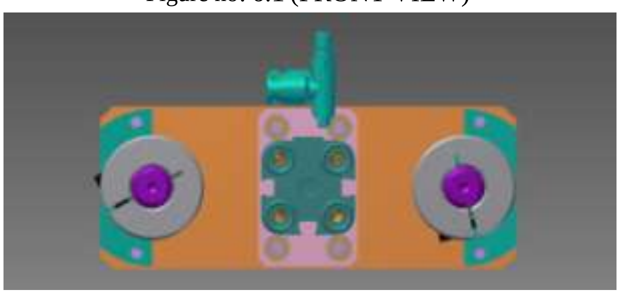


Figure no: 6.2 (TOP VIEW)

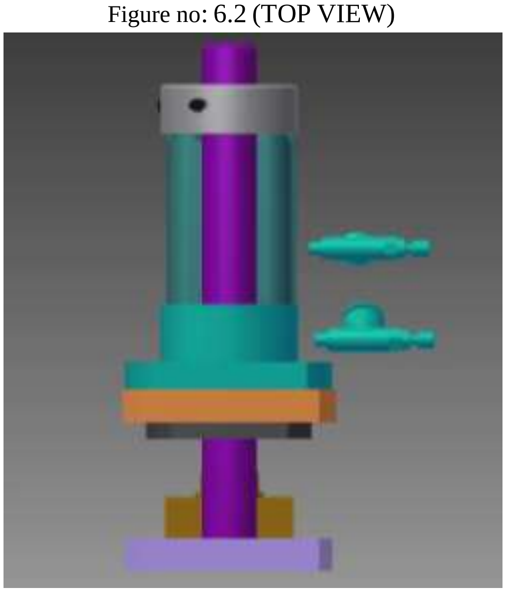


Figure no: 6.3 (SIDE VIEW)

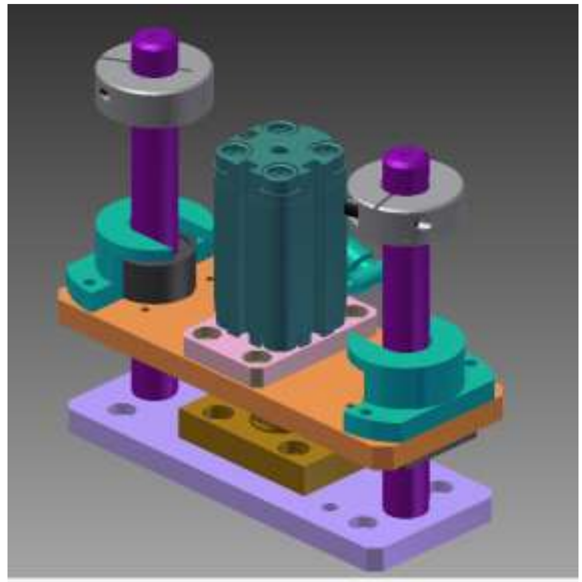


Figure no: 6.4 (ISOMETRIC VIEW)

VII. WORKING

Twin rod assembly works on the basis of pneumatic system to enable a process by actuating the double acting cylinder to provide continuous linear motion to the assembly[5]. While some other parts to be assembled on the piston to make sure that the assembly should fulfil the requirement with minimal product losses. When the system energized it starts working by the double actingcylinder to produce continuous linear motion by the piston at 6 bar pressure of compressed air [5]. Flow control valve is used to control the flow rate of the air and it governs the velocity at which the piston moves. Linear motion bushes are provided for the guidance of the shaft to attain continuous linear motion. It consists of metal spheres which circulate in ball guides which in turn provide a continuous linear motion with minimal friction. Cylinder rod coupler holds the piston end surface to move the movable base plate in a linear motion. Shaft is provided to move the product by the help of double acting piston to achieve continuous precision cycle. By the double acting cylinder source of linear movement is forwarded to the movable base plate under the guidance of linear bushes and shafts to prevent the misalignments and to maintain the precision of the process. Twin rod assembly is used in applications where low pressure and break free motion is required.

VIII. APPLICATIONS

- Twin rod assembly is applicable to conveyor automation system for direction controlling.
- It can be used to eject the product at the end of the cycle or to remove it from the line if it's rejected in any station.
- It can also be used to singulate components coming from any part feeding units.
- For the material which requires low pressing capacity twin rod assembly is used.
- Lifting of components.

IX. CONCLUSION

The design of the twin rod assembly will ultimately result in reduction of total number of process stations required in the assembly line of a conveyor[11]. Previously, the operations which required an exclusive station for removing the rejected or processed components but now it can be carried out while the component is in motion on the conveyor. This will lead to a substantial reduction of costs as there is no need of designing any additional station with exclusive pneumatic pick and place units. This will also result in reduction of process time as the operation would be carried out while transferring the components[2]. Improvisations on our present design could be made which can make this design resourceful for many other applications as is listed. All these functional aspects make it an economical choice in any automation industry.[3]

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