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RESEARCH ARTICLE

DESIGN AND MANUFACTURING OF WASHING AND CLEANING UNIT FOR CONNECTING ROD

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ABSTRACT

Every component adds up to the machine's performance. For effective working of a machine, every component needs to have proper dimensions and without any kind of impurities on it. The main objective of this work is to design and manufacture washing and cleaning unit. Whenever a manufacturing process takes place, it includes contact with oil, coolant and some amount of burr will accumulate on the surface of the component. These things are not acceptable when the component goes for further operations. To minimize the errors due to the presence of these impurities, a machine is designed and manufactured to clean the connecting rod with the help of water and air nozzles. Pneumatic cylinders are used to achieve smooth and noise free operation.

INTRODUCTION

Connecting rod plays a vital role in the performance of an engine. It connects the piston with the crankshaft of the engine. Thus, imperfections in it will affect the engine's performance (Anusha Chintada, 2016). For a metal piece to transform into connecting rod, it needs to go through many manufacturing processes viz. forging, boring, facing, chamfering, honing, finishing etc. Whenever a manufacturing process takes place, a lot of heat is generated due to friction between the metal and the tool. To overcome this heat during the manufacturing process oil or coolant is generally used. But, because of this the burr sticks to the surface. This affects further manufacturing processes. So, to overcome this difficulty the machine is designed and manufactured.

Washing and cleaning unit

The washing and cleaning unit is designed and manufactured for cleaning the impurities on connecting rod. The main function this unit is to remove oil and burrs stuck on the connecting rod. The machine is fully automated. The important component of this machine includes Pneumatic Cylinder (for door and rest pad operations), Nozzles

(for water and air spray), Gripper Assembly (to hold the connecting rod) and Additive (Polyclean MT). Washing and cleaning unit is shown in Figure 1.

Working

Rest pad works at three positions viz. top, middle and bottom. Initially the robotic arm keeps the connecting rod on the rest pad in the unit where the rest pad is at its top position. Once the connecting rod is placed sensor senses the position of connecting rod and the door closes. Now, the actual washing and cleaning cycle starts wherein at the middle position, gripper holds the connecting rod placed on the rest pad for washing and cleaning. After gripping the connecting rod rest pad moves to the bottom position. Now the mixture of water and additive is sprayed by the nozzles on the connecting rod. The gripper flips the connecting rod by 180 degree. Again the mixture of water and additive is sprayed to wash the other face of connecting rod.

After removing the impurities on the connecting rod the excess water on the connecting rod are removed using air nozzles. Then the rest pad again returns to its middle position and gripper releases the connecting rod. Now the rest pad moves to its top position and sensor senses the position of connecting rod and the door opens. Here, the cycle is completed and for the next connecting rod same procedure is repeated.

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Figure 1. Washing and Cleaning Unit

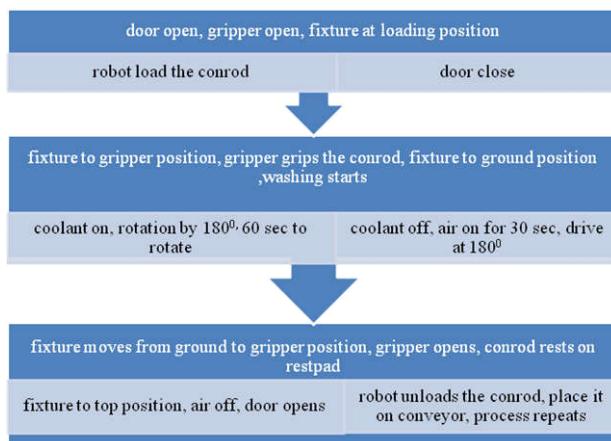


Figure 3. Flat Jet Spray Nozzle

Straight Jet Spray Nozzle: Straight jet spray nozzle provides with optimized flow and maximum jet power concentrated energy (Tao Zhang *et al.*,?). It gives away a narrow, concentrated stream jet with high impact force. A high efficiency and economical performance is obtained and is suitable for high pressure cleaning application shown in Figure 4.



Components of unit

Pneumatic cylinder: It is primarily used to control the movement of door and provides reciprocating motion to the rest pad in desired time interval (Jun Lia *et al.*, 2013). Schematic diagram of pneumatic cylinder shown in Figure 2.



Figure 2. Pneumatic Cylinder

Flat Jet Spray Nozzle: Flat jet spray nozzles are designed for high pressure washing application. Their specially designed inner profile allows for even jet distribution, which results in effective and uniform cleaning action over the surface being processed (John Durkee, 2009). It is ideal for Degreasing and Rinsing in industrial washing machine. Jet spray nozzle is shown in Figure 3.

Specifications of the machine

- The system is fully automated.
- Water and additive mixture to ensure proper removal of oil on connecting rod.
- Additive- Polyclean Mt 218, Flow rate- 32 LPM at pressure 2-5 bar.
- Nozzles used are –Straight Jet and Flat Jet.
- Sensors used are- Photoelectric and Proximity.
- Photoelectric sensors are used to make sure the connecting is placed or not.
- Proximity sensors are used to sense the position of connecting rod.

Calculations for Pneumatic Cylinder

Factors considered for selection of the pneumatic cylinder

- Force on it (weight of the material mounted)
- Factor of safety = 4
- Operating pressure $P = 4\text{bar}$
- Bore diameter d (to be calculated)
- Available bore diameter i.e. $d = 32, 40, 50, 63, 80, 100, 125$ The mass of components to be lifted for cylinder 1 are calculated using CATIA software which is shown in Table 1.

Table 1. Mass of Components for Cylinder 1 (200 mm)

Components	Mass (Kg)
Brackets	8.33
Shaft	10.80
Locator	0.5192
Side Butting Pad	0.264
Spacer	0.988
Cover 1	1.08
Adapter	0.793
Rest Pad	0.377
Cover 2	1.102

From Table 1 total mass to be lifted is

$$8.33 + 10.80 + 0.5192 + 0.264 + 0.988 + 1.08 + 0.793 + 0.377 + 1.102 = 24.2532 \text{ kg}$$

$$\text{Force } F = 237.924 \text{ N}$$

Now we have,

$$A = F / P$$

$$\pi d^2 / 4 = 951.6955 / 400$$

$$d = 55 \text{ mm}$$

Therefore calculated bore diameter for cylinder 1 is 55 mm. As per the design catalog of SMC cylinder the available diameter is 63mm. Hence the final diameter which is selected for cylinder 1 is 63mm. The mass of components to be lifted for cylinder 1 are calculated using CATIA software which is shown in Table 2.

Table 2. Mass of Components for Cylinder 2 (250 mm)

Components	Mass (Kg)
Cover	29.211
Adapter	0.793

From Table 2 total mass to be lifted is

Total mass to be lifted is:

$$29.211 + 0.793 = 30.004 \text{ kg}$$

$$\text{Force } F = 294.34 \text{ N}$$

Now we have,

$$A = F / P$$

$$\pi d^2 / 4 = 1177.357 / 400$$

$$d = 61.12 \text{ mm}$$

Therefore calculated bore diameter for cylinder 1 is 61.12 mm. As per the design catalog of SMC cylinder the available diameter is 63mm. Hence the final diameter which is selected for cylinder 1 is 63mm.

Application and Future Scope

The applications of washing and cleaning unit for connecting rod are as follows

- It is used to clean the connecting rod for quality improvement.
- It is used on a robotic line as it is fully automatic.
- Can be used for multiple application by changing the fixtures.
- Changes can be done in the time cycle and also the number of nozzles can be increased or decreased as per requirement.
- The gripper assembly can be changed as per the component to be washed.

Conclusion

From the study of cleaning unit following conclusions are made

- The use of air and water nozzle resulted in 100% cleaning of connecting rod.
- The solution of water and Polyclean MT has led to effective cleaning of connecting rod.
- The use of Pneumatic Cylinder has helped in reduction of noise and it also keeps the working area oil free.
- Pneumatic cylinder helps to reduce process time.
- The machine being fully automatic, it is compatible with the robotic line.

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