A review on Testing and Commissioning of Electric Pump

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Abstract— **In this paper, the basics of Electric pump was discussed. The electric pump is one of the important electrical loads used in Agriculture, Power plants and many Industries. In addition the construction and working principle of Reciprocating and Centrifugal pump was neatly explained with necessary diagram. This paper covers the basic testing and commissioning procedure of centrifugal electric pump. This paper would be helpful for the Mechanical Engineer to understand the basic testing and commissioning concepts in electric pump**

Index Terms— **Pump, Motor, Starter, Piston.**

I. INTRODUCTION

Electric Power Pump is used for pumping water and other fluid. A pump may be defined as a hydraulic machine which converts mechanical energy into hydraulic energy. The hydraulic energy is in the form of pressure energy. The pressure energy is obtained by increasing the height of liquid from lower level. The pump lifts any liquid from lower level to higher level. They are used in agriculture, power plants, municipal water and many other services. The following section neatly explains the different types of pump and testing and commissioning of electric pump.

1.1 Classification of pumps

According to the design and principle of operation, they are classified as follows.

1. Dynamic pumps
i. Centrifugal pump
ii. Turbine pump
iii. Jet pump

2. Positive displacement pumps

(a) Reciprocating pumps
i. Piston pump
ii. Plunger pump
iii. Diaphragm pump

(b) Rotary pumps
i. Gear pump
ii. Vane pump
iii. Rotary pump

II. CENTRIFUGAL PUMP

2.1 Classification of Centrifugal pump

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(a) According to the type of casing
i. Volute
ii. Vortex
iii. Diffuser

(b) According to the number of impellers
i. Single stage pump
ii. Multistage pump

(c) According to the construction of impellers
i. Closed impeller pump
ii. Semi closed impeller pump
iii. Open impeller pump

(d) According to the direction of flow through impeller
i. Radial flow impeller
ii. Mixed flow impeller
iii. Axial flow impeller

(e) According to the number of entrances to the impeller
i. Single suction pump
ii. Double suction pump

(f) According to the position of the shaft
i. Horizontal pump
ii. Vertical pump

(g) According to the working head
i. Low head pump
ii. Medium head pump
iii. High head pump

2.2 Construction of Centrifugal pump

It consists of two main parts
(i)Casing
(ii) Impeller.

In Centrifugal Pumps the liquid is admitted at the centre of the Impeller and is pumped towards the outlet by Centrifugal action. The following Figure 1 shows Centrifugal Pump.

The impeller rotates and creates centrifugal flow of water. The Casing directs the water flow towards the outlet.

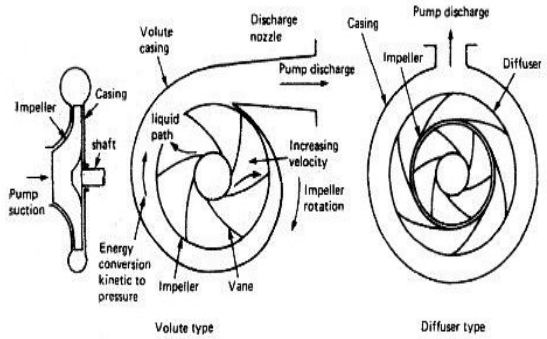

Figure 1 Centrifugal Pump

Displacement Pump can creates its own suction and does not need priming. But the Centrifugal Pumps needs Priming before starting. The suction piping and the casing should be filled with water or fluid. This is called Priming. The Centrifugal Pumps installed above water source must be primed (by using auxiliary device or foot-value) before the starting the pump.

2.3 Working principle of Centrifugal pump

i. Before starting the pump, the delivery valve is closed and the pump is initially primed.
ii. By starting the electric motor, rapid motion is imparted to the impeller which builds up centrifugal force.
iii. This centrifugal force throws the liquid towards the impeller periphery. It causes a partial vacuum exists at the impeller eye which sucks the liquid in the sump towards the impeller eye.
iv. After the pump attains a constant speed, the delivery valve is opened and the water flows radially outward.
v. Once the flow of fluid commenced, a partial vacuum is created continuously at the eye of the impeller. It sucks the liquid from the well or sump.
vi. The liquid leaves the impeller with a high velocity and pressure.

2.4 Cavitations

Defined as the phenomenon of formation of water bubbles at low pressure side and collapsing of these water bubbles at high pressure side is called cavitations.

2.4.1 Precautions

The following precautions should be taken against cavitations.
i. The pressure of the flowing fluid at any point should not be allowed to fall below its vapour pressure.
ii. Cavitations resistant materials such as aluminum- bronze and stainless steel materials should be used to make the impeller.

2.4.2 Effects of cavitations

The following are the effects of cavitations
i. The metallic surfaces of the impellers are damaged and cavities are formed on the surfaces.
ii. Due to the sudden collapse of vapour bubbles, considerable noise and vibrations are produced.
iii. Due to pitting action on the surface of blades, the force exerted by water on blade decreases and hence efficiency also decreases.

2.5 Merits Centrifugal Pumps

i. Provides uniform flow.
ii. If Delivery wall closed condition – No danger.
iii. Suitable for High Speed operation.
iv. Low maintenance.
v. Low floor-area.
vi. Provides silent operation.

III. RECIPROCATING PUMP

3.1 Classification of Reciprocating Pump

(a) According to the water being in contact

i. Single acting pump
ii. Double acting pump

(b) According to the number of cylinders

i. Single cylinder pump
ii. Double cylinder pump
iii. Triple cylinder pump
iv. Duplex cylinder pump

3.2 Construction of Reciprocating Pump

A reciprocating pump is appositive displacement pump. This means, the liquid is first sucked into a cylinder and then displaced or pushed by the reciprocating motion of a piston or plunger. It can be obtained by connecting the piston rod to a crank by means of connecting rod. The discharge of these pumps is almost fully dependent on the speed of the pump.

3.2.1 Single acting Reciprocating Pump

The following figure 2 shows the Single acting Reciprocating Pump. It consists of Piston or Plunger, Cylinder, Crank and connecting rod mechanism and Suction and delivery.

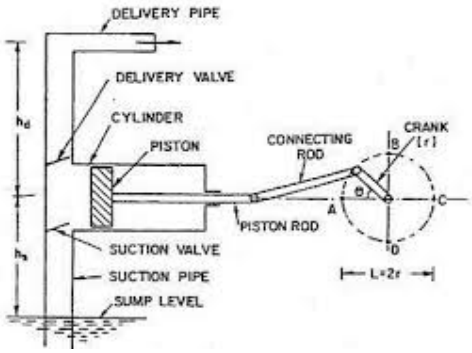

Figure 2 Single acting Reciprocal Pump

3.2.2 Double acting Reciprocal Pump

The pump is said to be double acting, when the liquid pressure acts on both sides of the piston or plunger. For this two suction and delivery pipes with non return valves are provided on each end of the cylinder as shown in the following figure 3.

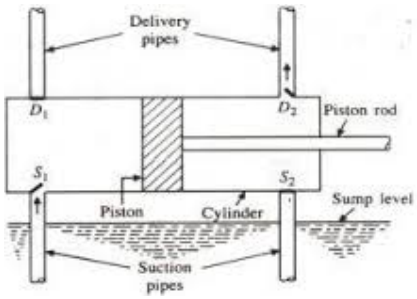

Figure 3 Double acting Reciprocal Pump

3.3 Working principle of Single acting Reciprocating Pump

3.3.1 Suction stroke

When the crank starts rotating, the piston or plunger moves to and fro in the cylinder. During the suction stroke, the piston or plunger moves from left to right in the cylinder. It creates a partial vaccum in the cylinder. Therefore the atmospheric pressure acting on the liquid surface the liquid to the suction pipe from the sump. By that way, the liquid is entering into cylinder till the suction stroke is completed.

3.3.2 Delivery stroke

During this stroke, the piston or plunger moves from right to left. The liquid is compressed and its pressure is increased. Due to the increment of pressure, the suction valve closes and the delivery valve opens. Then, the liquid is forced into delivery pipe and raised to the required height. By that way, the liquid is discharged till the delivery stroke is completed.

3.4 Comparison of Reciprocating and Centrifugal Pump

The following Table 1 shows the Comparison of Reciprocating and Centrifugal pump.

Table 1 Comparison of Reciprocating and Centrifugal pump.

S. No.	Reciprocating Pump	Centrifugal Pump
1	Complicated in construction	Simple in construction
2	It has more efficiency	It has less efficiency
3	More wear and tear	Less wear and tear
4	Maintenance cost is More	Maintenance cost is less
5	It cannot handle dirty water	It can handle dirty water
6	Total weight of the pump is more for a given discharge	Total weight of the pump is less for a given discharge
7	Suitable for less discharge and higher heads	Suitable for large discharge and smaller heads
8	Required large floor area and heavy foundation	Required less floor area and simple foundation
9	It cannot run at higher speed	It can run at higher speed
10	Its delivery is pulsating	Its delivery is continuous
11	Air vessels are required	No air vessels are required
12	Thrust on the crankshaft is not uniform	Thrust on the crankshaft is uniform
13	Much care is required	Operation is simple
14	Maintenance cost is more	Maintenance cost is less

4. ROTARY PUMPS

A rotary vane pump is a positive-displacement pump that consists of vanes mounted to a rotor that rotates inside of a cavity. In some cases these vanes can be variable length or tensioned to maintain contact with the walls as the pump rotates.

Note:

Not suitable for pumping liquids carrying solid, abrasive material, objects.

4.1 Advantages of Rotary Pumps

i. Do not need Priming
ii. Provides Continuous flow
iii. Simple Construction
iv. Required no values
v. Smaller size
vi. Requires less Space
vii. Easy to install
viii. Little maintenance
ix. Suitable for handling thick viscous fluids.

4.2 Application of Rotary Pumps

i. Have positive displacement action.
ii. Used for Pumping thick viscous liquids, slurries such as oils, grease, soap, fuels.
iii. Used for pumping lighter liquids such as gasoline, benzene, petrol, diesel, volatile liquids.

5. TESTING AND COMMISSIONING OF RECIPROCATING PUMP

The following figure 4 shows Water not delivered Trouble – Possible Causes and Remedies.

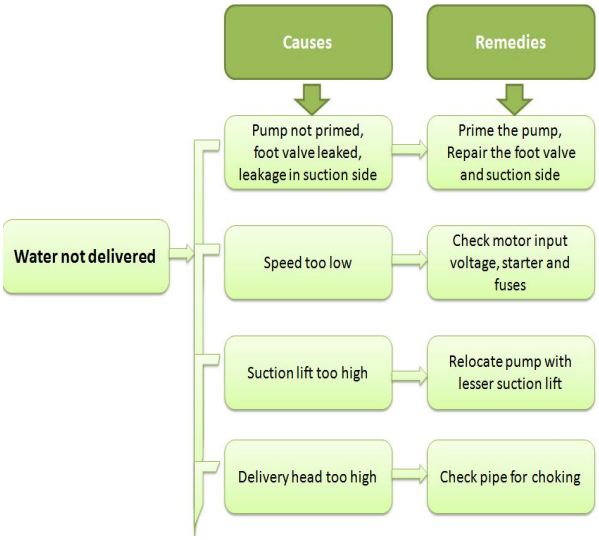

Figure 4 Water not delivered Trouble – Possible Causes and Remedies

The following figure 5 shows Delivery of water at lesser rate Trouble – Possible Causes and Remedies.

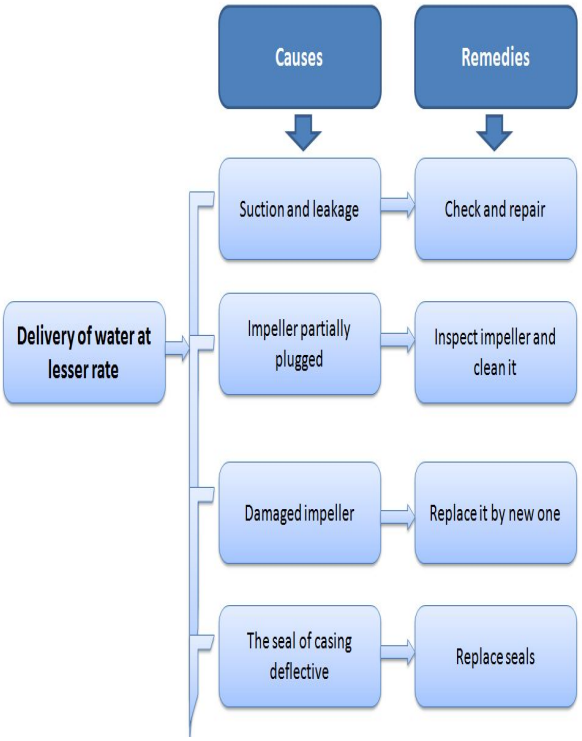

Figure 5 Delivery of water at lesser rate Trouble – Possible Causes and Remedies

The following figure 6 shows Pump works for a short period and stops delivery Trouble – Possible Causes and Remedies.

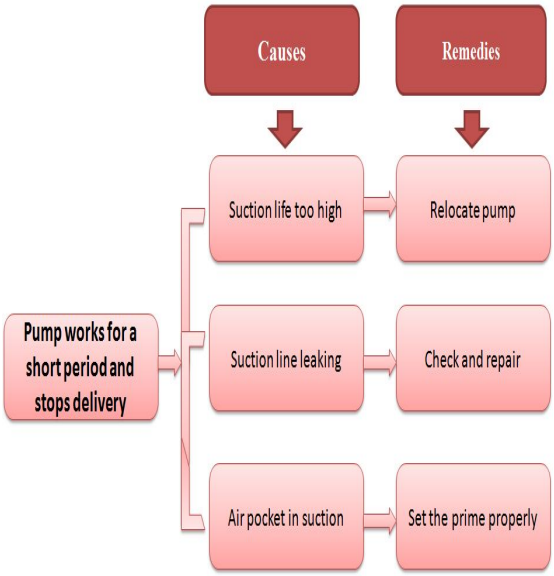

Figure 6 Pump works for a short period and stops delivery Trouble – Possible Causes and Remedies

The following figure 7 shows Pump takes high power Trouble – Possible Causes and Remedies

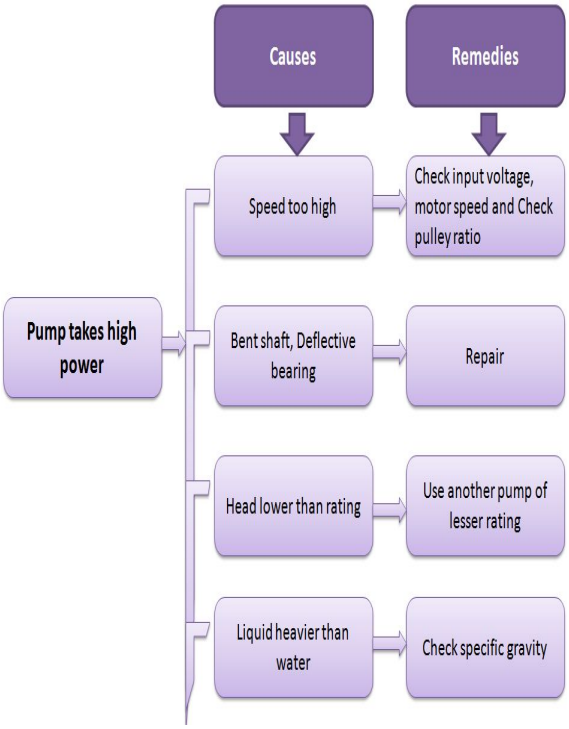

Figure 7 Pump takes high power Trouble – Possible Causes and Remedies

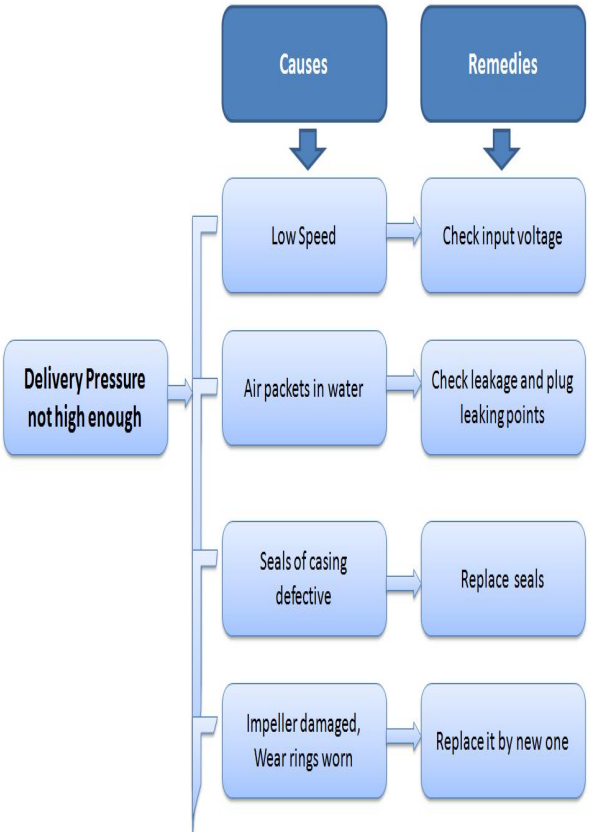

Figure 8 Delivery Pressure not high pressure Trouble – Possible Causes and Remedies

The following figure 8 shows the Procedure sequence of Commissioning a Centrifugal Pump.

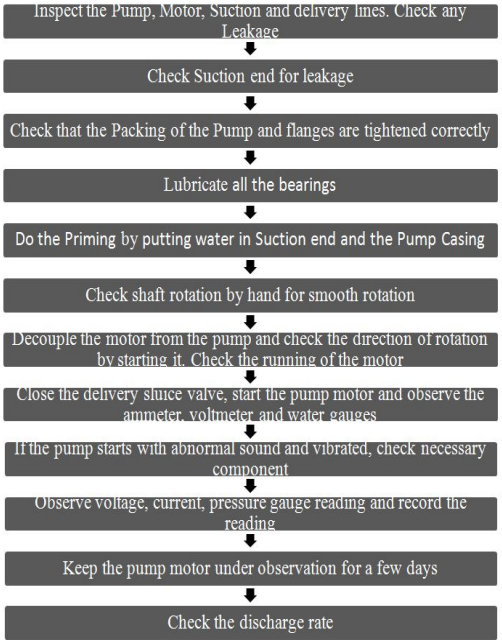

Figure 8 Procedure sequence of Commissioning a Centrifugal Pump

6. Applications of Electric Power Pumps

(a) Reciprocating Pump
- i. High Pressure, for feeding water into smaller boiler.
- ii. High Pressure, low speed Oil Pumps.

(b) Turbine Pumps
- i. Feeding small boilers with water.

(c) Centrifugal Pumps
- i. Used in Thermal Power Stations.
- ii. Can be used with High Speed motors.
- iii. Irrigation Pumping Process
- iv. Used for High viscosity fluid flow

Conclusion

The construction, working principle, classifications, testing and commissioning procedures was discussed in simple way. This paper would be helpful for the Mechanical Maintenance Engineer to enrich their knowledge in the field of electrical and mechanical engineering.

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