LABORATORY MANUAL

ON

RECIPROCATING PUMP TEST RIG

Prepared

By

Prof. (Dr.) M. K. Roul

Professor and Principal

Department of Mechanical Engineering

Gandhi Institute for Technological Advancement (GITA),

Bhubaneswar-752054

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1. OBJECTIVE:

Study of Reciprocating pump characteristics (with A.C. motor, 3 speed with step cone pulley)

2. AIM: To determine:

- Total head
- Discharg
- Power input
- Shaft output
- Pump efficiency
- Overall efficiency
- Volumetric efficiency
- To plot the following performance characteristics;
  - i) Head vs Discharge
  - ii) Pump efficiency vs Discharge

3. INTRODUCTION:

A pump is a device, which lifts water from a lower level to a higher level at the expense of mechanical energy. Pump can be broadly classified

into two categories, positive displacement & rotodynamic or dynamic pressure pump. In a positive displacement pump, a small quantity of liquid is taken inside the pump and is displaced and forced out of the pump under pressure. The liquid inside a positive displacement pump may be subjected either to a reciprocating motion (reciprocating pump) or to a rotary/circular motion (gear pump, screw pumps etc.).

4. THEORY:

Reciprocating pump consists a piston having a reciprocatory motion inside a cylinder with the help of connecting rod and a crank rotated by an electric motor, I.C. engine, or any another suitable means. The cylinder is connected to the sump by the suction pipe and to the reservoir by the delivery pipe. Valves are provided at suction and delivery side and are non-returnable so that to allow the fluid in direction only.

These pumps are applied where the fluid is required in a small quantity but at a higher pressure. Reciprocating pumps are applied for vehicle washing, water supply for the multi-stories buildings, industries etc.

5. DESCRIPTION:

The apparatus consists of a double acting-single cylinder reciprocating pump is operated on closed circuit basis. An AC motor with 3 speeds is provided to regulate the rpm of the pump. Suction and delivery head can be varied by the valves provided and Pressure & Vacuum Gauges can measure it. Flow of water is measured by using measuring tank and stopwatch.

6. UTILITIES REQUIRED:

Electricity Supply: Single Phase, 220 VAC, 50 Hz, 5-15 amp socket with earth connection.

Water Supply (Initial fill).

Drain Required.

Floor Area Required : 1.5 m x 0.75 m

Tachometer to measure RPM

7. EXPERIMENTAL PROCEDURE

STARTING PROCEDURE:

1. Clean the apparatus and make tanks free from dust.
2. Close the drain valves provided.

3. Fill Sump tank .th with clean water and ensure that no foreign particles are there.

4. Open flow control valve given on the water discharge line and control valve given on suction line.

5. Ensure that all ON/OFF switches given on the panel are at OFF position.

6. Set the speed of pump with the help of 3 speed step cone pulley.

7. Now switch ON the main power supply and switch ON the Pump.

8. Operate the flow control valve to regulate the flow of water discharged by the pump.

9. Operate the control valve to regulate the suction of the pump.

10. Record discharge pressure by means of pressure gauge, provided on discharge line.

11. Record suction pressure by means of vacuum gauge, provided at suction of the pump.

12. Note down the time required for 10 pulses with the help of stop watch to calculate the power consumption.

13. Note down the RPM.

14. Measure the flow of water, discharged by the pump, using stop watch and measuring tank.

15. Repeat the same procedure for different pressure head.

16. Repeat the same procedure for different RPM with the help of step cone pulley.

CLOSING PROCEDURE:

1. When experiment is over, properly open the gate valve provided on discharge line.

2. Switch OFF the pump first.

3. Switch OFF power supply to panel (MCB).

8. NOMENCLATURE:

A = Area of measuring tank, ^{m2}

a = Area of cylinder, m^2

EMC = Energy meter constant, Pulses/kW hr

E_i = Power input, kW

E_o = Pump output, kW

E_S = Shaft output, kW

g = Acceleration due to gravity, m/s^2

H = Total head, m

h_{pg} = Height of pressure gauge from vacuum gauge, m

L = Length of stroke, m

N = Speed of pump, R.P.M

P = Number of pulses, m

P_d = Delivery pressure, kg/cm^2

P_S = Suction pressure, mmHg

Q_{act} = Actual discharge, m^3/sec

Q_{theo} = Theoretical discharge, m^3/sec

R = Rise of water level in measuring tank, m

R_1 = Final level of water in measuring tank, cm

R_2 = Initial level of water in measuring tank, cm

t_P = Time required for P pulses, sec

t = Time for R, sec

ρ = Density of water, kg/m^3

η_m = Efficiency of motor %

η_t = Efficiency of transmission %

η_p = Pump efficiency %

η_o = Overall efficiency %

η_{vol} = Volumetric efficiency %

9. PRECAUTIONS & MAINTENANCE INSTRUCTIONS:

1. Never run the apparatus if power supply is less than 180 Volts and above 230 Volts.
2. Never fully close, the Delivery line and By-Pass line Valves simultaneously.
3. To prevent clogging of moving parts, Run Pump at least once in a fortnight.
4. Always use clean water.
5. If apparatus will not in use for more than half month, drain the apparatus completely.
6. Always keep apparatus free from dust.

10. TROUBLESHOOTING:

1. If water is not lifted, the revolution of the AC motor may be reverse. Change the electric connection of motor to change the revolutions.

2. If panel is not showing input, check the fuse and main supply.

11. OBSERVATION & CALCULATIONS:

DATA:

d = 0.055 m

L = 0.04 m

A = 0.077 m^2

EMC = 3200 Pulses/kW hr

ρ = 1000 kg/m^3

g = 9.81 m/s^2

η_m = 0.8

η_t = 0.7

h_{pg} = 0.65 m

OBSERVATION TABLE

S.NO.	**N,** ***RPM***	**P_d,** ***Kg/cm2***	**P_s,** ***mmHg***	**R_1,** ***cm***	**R_2,** ***cm***	**t,** ***sec***	**P**	**t_p,** **sec**

To plot head vs discharge & Pump efficiency vs Discharge

CALCULATIONS:

$E_i = \frac{P}{t_p}$ x $\frac{3600}{EMC}$ kW= ---------- Kw

$E_s = E_i \times n_m \times n_t$, kW = ---------- Kw

$R = \frac{R_1 - R_2}{100}$ m = ---------- m

$Q_{act} = \frac{A \times R}{t}$, m^3/sec = ---------- m^3/sec

$Q_{theo} = \frac{2 \times a \times L \times N}{60}$, m^3/sec = ---------- m^3/sec

$a = \frac{\pi}{4} d^2$, m^2 = ---------- m^2

$H = 10 \times \left[P_d + \frac{P_s}{760}\right] + h_{pg}$, m of water = ---------- m of water

$E_o = \frac{\rho \times g \times Q \times H}{1000}$, kW= ---------- kW

$\eta_0 = \frac{E_o}{E_i} \times 100\%$ = ---------- %

$\eta_p = \frac{E_o}{E_s} \times 100\%$ = ---------- %

$\eta_{vol} = \frac{Q_{act}}{Q_{theo}} \times 100\%$ = ---------- %

12. Conclusions: The experiment on Reciprocating Pump was performed. The pump efficiency, volumetric efficiency and overall efficiency of the pump was calculated. The efficiency of the pump was found to be _____.