LABORATORY MANUAL

ON

CENTRIFUGAL PUMP TEST RIG

(WITH A.C MOTOR, 3 SPEED WITH STEP CONE PULLEY)

Prepared

By

Prof. (Dr.) M. K. Roul

Professor and Principal

Department of Mechanical Engineering

Gandhi Institute for Technological Advancement (GITA),

Bhubaneswar-752054

June 2014

1. **OBJECTIVE:** Study of Centrifugal pump characteristics.

2. **AIM:**

To determine:

- Power input
- Shaft output
- Discharge
- Total head
- Pump Output
- Overall efficiency
- Pump efficiency

To plot the following performance characteristics:-

- Head Vs Discharge
- Pump efficiency Vs Discharge

3. **INTRODUCTION:**

The hydraulic machines, which convert the mechanical energy into hydraulic energy, are called pumps. The hydraulic energy is in the form of pressure energy. If the mechanical energy is converted into pressure energy by means of centrifugal force acting on the fluid, the hydraulic machine is called centrifugal pump.

4. THEORY:

The centrifugal pump acts as a reversed of an inward radial flow reaction turbine. This means that the flow in centrifugal pumps is in the radial outward directions. The centrifugal pump works on the principle of forced vortex flow, which means that when an external torque rotates a certain mass of liquid, the rise in pressure head of the rotating liquid takes place. The rise in pressure head at any point of the rotating liquid is proportional to the square of tangential velocity of (i.e. rise in pressure head = $V^2/ 2g$ or $\omega^2r^2/2g$) the liquid at that point. Thus, at the outlet of the impeller where radius is more, the rise in pressure head will be more and the liquid will be discharged at the outlet with a high- pressure head. Due to this high-pressure head, the liquid can be lifted to a high level.

Centrifugal Pump is a mechanical device, which consists of a body, impeller and a rotating mean i.e. motor, engine etc. Impeller rotates in a stationary body, sucks the fluid through its axes, and delivers through its periphery. Impeller has an inlet angle, outlet angle and peripheral speed, which affect the head and discharge. Impeller is rotated by motor or i.e. Engine or any other device.

5. DESCRIPTION:

Centrifugal Pump Test Rig consists of a sump, a centrifugal pump, an AC motor and measuring tank. To measure the head, pressure and vacuum gauges are provided. To measure the discharge, a measuring tank is provided. Flow

diversion system is provided to divert flow from sump tank to measuring tank and from measuring tank to sump tank. A valve is provided in pipeline to change the rate of flow.

6. UTILITIES REQUIRED:

1. Electricity Supply: Single Phase, 220 V AC, 50 Hz, 5-15 amp socket with earth connection.
2. Water Supply.
3. Drain required.
4. Bench Area Required: 1.5 m x 0.75 m\
5. Tachometer for RPM measurement.

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 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 desired speed of pump with the help of step cone pulley arrangement.

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

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

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

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

11. Record the power consumption by means of energy meter, provided in panel.

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

13. Repeat the same procedure for rest of the two speeds of motor / pump.

CLOSING PROCEDURE:

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

2. Reduce the RPM of the pump with the help of DC drive.

3. Switch OFF the pump first.

4. Switch OFF power supply to panel.

8. NOMENCLATURE:

A = Area of measuring tank, m^2

EMC = Energy meter constant, Pulses/kW hr

E_i = Pump input, kW

E_S = Shaft output, kW

E_o = Pump output, kW

g = Acc. due to gravity, m/s^2

H = Total Head, m of water

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

N = Speed of Pump, r.p.m.

P = Pulses of energy meter

P_d = Delivery pressure, kg/cm^2

P_S = Suction pressure, mmHg

Q = Discharge, m^3/s

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 = Time taken by R, sec

t_p = Time taken by P, sec

ρ = Density of fluid, kg/ m^3

η_p = Pump efficiency %

η_o = overall efficiency %

9. PRECAUTIONS & MAINTENANCE:

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 be in use for more than one month, drain the apparatus completely.
6. Always keep apparatus free from dust.

10. TROUBLESHOOTING:

1. If rpm indicator is not displaying the rpm, check the distance of proximity switch and adjust it to 2-3 mm.

2. If pump does not lift the water, open the air vent provided on the pump to remove the air from pump.

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

11. OBSERVATION & CALCULATION:

DATA:

EMC = 3200 Pulses/kW hr

A = 0.128 m^2

ρ = 1000 kg/m^3

η_m = 0.8 (assumed)

g = 9.81 m/s^2

h_{pg} = 1 m

OBSERVATION TABLE:

S.NO.	N, RPM	$P_{d,}$ kg/cm^2	Ps, 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

Es = E_i x η_m kW = ---------- kW

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

$Q = \frac{A \; x \; R}{t}$ m^3/sec = ---------- m^3/sec

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

$E_0 = \frac{p \; X \; g \; X \; Q \; X \; H}{1000}$ kW = ---------- kW

$\eta_0 = \frac{E_0}{E_i} \; x \; 100\%$ = ---------- %

$\eta_p = \frac{E_0}{E_s} \; x \; 100\%$ = ---------- %

Conclusions: Experiment on Centrifugal Pump test rig was performed successfully. Input power, output power and efficiency of the centrifugal pump was calculated. The efficiency of the pump was found to be _____.