

Multi-pump test

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1. Objectives

1. Study characteristics of a turbine pump in various flow rates.
2. Find and plot performance curve of a turbine pump.
3. Find the effects of pump speed on input power and pump efficiency

2. Theory

2.1 Input power from motor to pump,

$$\begin{aligned}
 P_{in} &= T [N.m] \times 2\pi N \left[\frac{\text{radian}}{\text{min}} \right] \times \frac{\text{min}}{60 \text{sec}} \\
 &= T \left(\frac{2\pi N}{60} \right) [W], \tag{1}
 \end{aligned}$$

where

T is torque, which is read from dial [N.m]

N is rotational speed of pump [rpm]

2.2 Output power of pump to water

$$\begin{aligned}
 P_{out} &= \Delta P \left[\frac{\text{kg}}{\text{cm}^2} \right] \times Q \left[\frac{\text{liter}}{\text{min}} \right] \times 9.81 \left[\frac{\text{N}}{\text{kg}} \right] \times 10^4 \left[\frac{\text{cm}^2}{\text{m}^2} \right] \times \left[\frac{\text{m}^3}{10^3 \text{ liter}} \right] \times \left[\frac{\text{min}}{60 \text{s}} \right] \\
 &= 1.635(\Delta P)Q [W], \tag{2}
 \end{aligned}$$

where

ΔP is different pressure between discharge and suction pressure [kg/cm²]

Q is flow rate of water [liter/min]

2.3 Pump efficiency is defined as the ratio of output power to input power,

$$\eta_{pump} = \frac{P_{out}}{P_{in}} \times 100 [\%] \tag{3}$$

3. Apparatus

This multi-pump test rig can be used to find characteristics of two pump types; 1 turbine pump and two centrifugal pumps, which test operation of pump when they are

connected in serial and parallel types. The apparatus are shown in the Figure 1, and they compose of the following units;

1. Controller and display unit

This unit composes of inverter, which is used for controlling frequency of power supply to turbine and centrifugal pumps, display of torque and speed of pumps, which vary with flow rate and head of pump. Controlling the pump operation is performed by the selecting switch, “1” for centrifugal pump and “2” for turbine pump.

2. Pressure display unit

Static pressures of system, which is measured from each position, such as inlet and outlet of pump.

3. Pump network

This unit composes of pumps, valves, water meter, pipe network, load cell, which is used to measure torque of each pump motor, and water tanks. The amount of water varying with time can be known through water meter and measuring the level of water in tank from investigating a sight glass.

4. Use a stopwatch to measure time period of changing the water level in Tank 2.

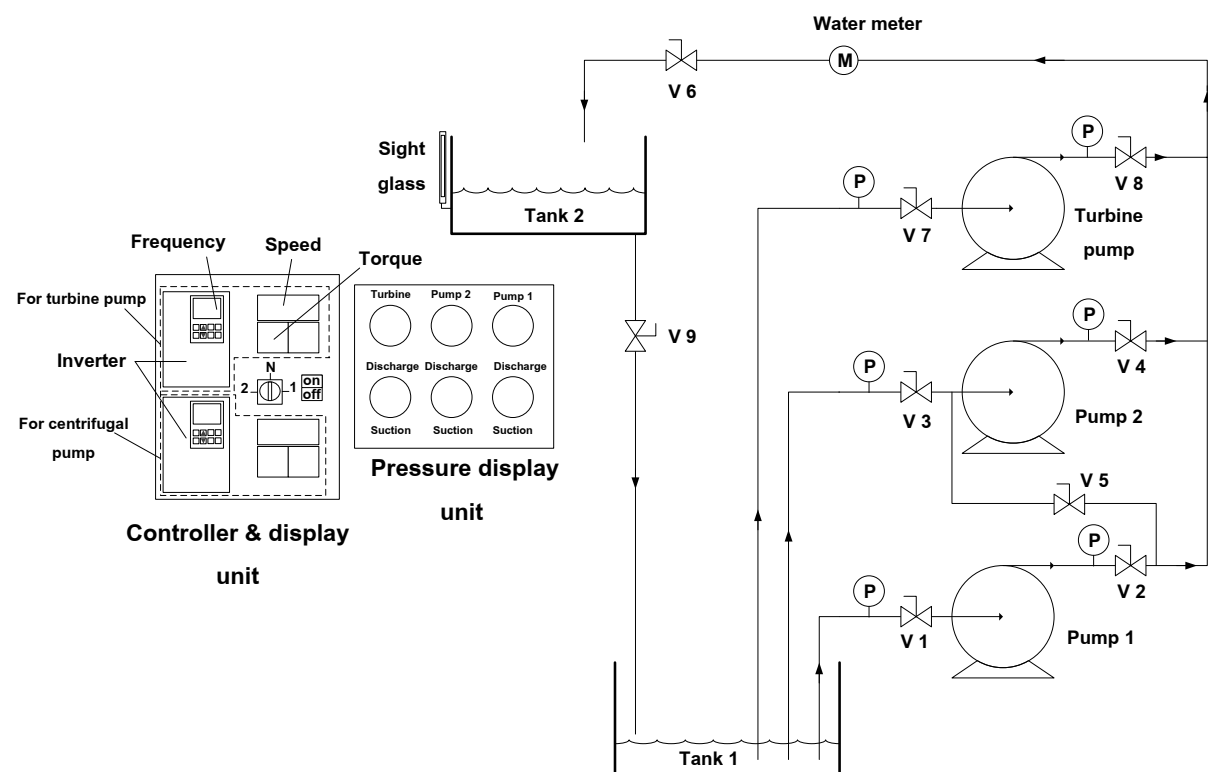


Figure 1. Schematic diagram of multi-pump test rig

4. Experimental procedure

4.1 Experimental setup before starting experiments

- (1) Fill water in the tank 1 (below the upper edge of tank about 5 – 10 cm)
- (2) Open a bleed plug of turbine pump and fill water into this plug. Afterwards, close this plug. In case of the plug can not be opened, do the following step:
 - 2.1 Close all valves and open valves "V1", "V2", "V3", "V4", "V6", and "V8"
 - 2.2 Run switch on the main switch of control & display unit
 - 2.3 Turn the selector on the control & display unit to position of "1" for running pump 1 and 2.
 - 2.4 Run the pumps (1 and 2) for a few minute
 - 2.5 Switch off the main switch.
 - 2.6 Close valve "V1", "V2", "V3", and "V4".
- (3) Switch "ON" the main switch on control & display unit. And move selector to position "2" for running turbine pump
- (4) Open valve "V7".

4.2 Procedure of starting turbine pump

4.2.1 Experiment 1

- (1) Control the speed of turbine pump at 3000 rpm by pressing button (select forward) at inverter of turbine pump
- (2) Record data (such as rpm, discharge and suction pressures, number on water meter dial, level of water in tank 2 and its time, torque) in the data sheet No.1
- (3) Adjust the flow control valve "V6" at the pressure of 0.4 kg/cm²
- (4) Record data, which is same as in (3) in the data sheet No.1
- (5) Narrow the flow control valve "V6" in order to increase discharge pressure to next pressure and record data, which is as same as (4)
- (6) Do step (5) until the discharge pressure reaches the maximum pressure (~2.0 kg/cm²)
- (7) Fully open the outlet valve "V6" and control the speed to the other rpm (2500, and 2000). Follow step (3) to (6).

5. Discussions

- a. Plot H-Q curve and torque in various speeds, as shown in Figure 2
- b. Plot rpm and head and rpm and torque (Shaft power), as shown in Figure 3.

- c. Discuss the effects of speed on head, flow rate, pump efficiency, and shaft power.

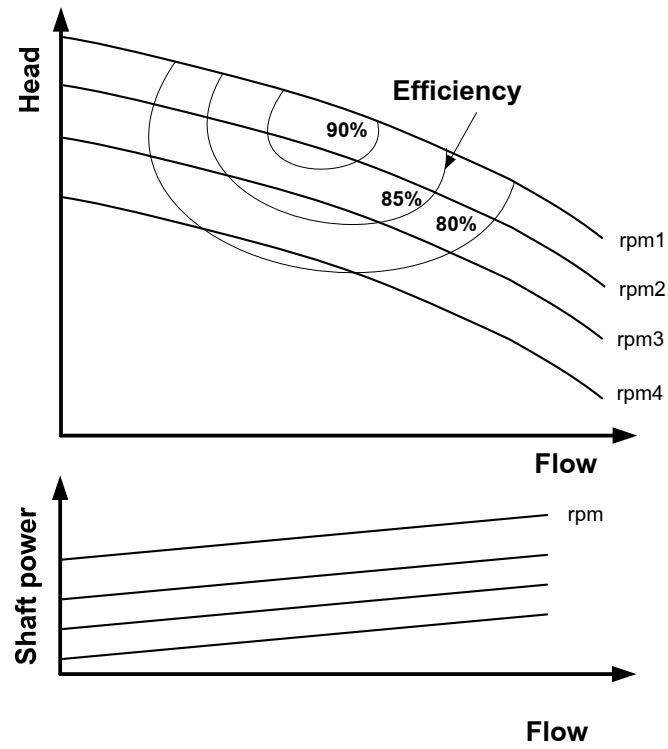


Figure 2 H-Q curve and input power

