Experiment 1 - EFFECTS OF BLADE SHAPE ON THE PERFORMANCE OF A RADIAL FLOW PUMP

OBJECTIVE OF THE EXPERIMENT

The object of the experiment is to investigate the principle of energy transfer between the impeller and the fluid, and the effect of the blade shape on the performance characteristics of the pump.

EXPERIMENTAL PROCEDURE

1. Before the experiment, check that valve B and A are closed and **valve C is opened** completely.
2. Beware that air prèssure on the water tank is **0.4 atm** by filling the tank with water.
3. Open the switch which operates motor and set the selector switch to pump operation.
4. When the water issues from the open ended pipe which is connected to discharge side of the pump, close the switch and close the vent.
5. Release the air in the pipes of the U-tube manometer to adjust the air pressure again to 0.4 atm.
6. Calibrate the torquemeter as '0'. Start the motor and adjust the speed of the pump.
7. Read the values of the pressure inlet and across the pump, i.e. P_{ref} and $P-P_{ref}$),volumetric flow rate and torque from required metering equipment.
8. Read and record them in 6 different operating points of valve A.
9. Repeat all the steps for another rotational speed of the pump.

CALCULATIONS

1. Calculate head developed by the pump, (b) shaft and hydraulic powers, (c) efficiency of the pump, (d) the specific speed.
2. Using the calculations and data taken, plot for the selected type of impeller, H-Q, η-Q and P_s-Q characteristics on the same graph paper.
3. For the selected impeller type (straight, backward or forward) at maximum efficiency point, determine actual inlet and exit velocity from data and draw the actual velocity polygon for maximum efficiency point.
4. Determine inlet and exit meridional velocities and draw the theoretical velocity polygon for maximum efficiency point.

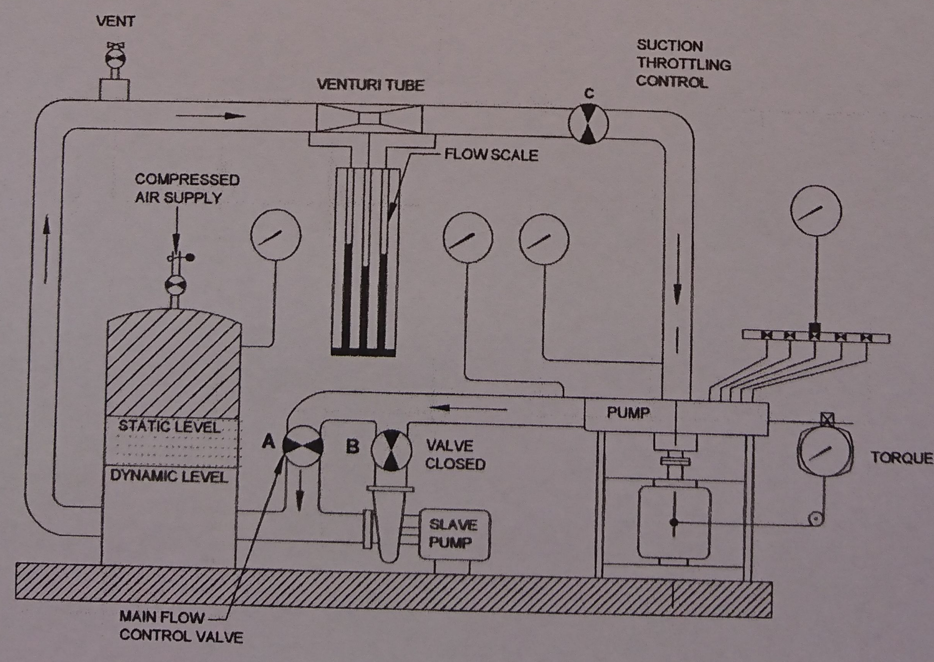

Figure 1. Radial flow water pump flow diagram

$P_{hyd} = \rho g Q H$ $\qquad$ $P_s = \tau \times \omega$ $\qquad$ $N_{SQ} = \frac{N\sqrt{Q}}{H^{3/4}}$

For all impeller types:

No of blades: 8 mm
Blade height: 15 mm
Outside diameter: 200 mm
Inside diameter: 100 mm

	Angle from radial	
	Inlet angle	Outlet angle
Straight	0°	0°
Forward	70°	0°
Backward	70°	65°

Impeller type (Circle the selected one)	N (rpm)	τ (N-m)	P_s-P_{ref} (mm Hg)	P_{ref} (m- Wc)	P-P_{ref} (ΔH) (m-Wc)	P_o (W)	P_{hyd} (W)	η %	Q (kg/s)	Dynamic head for exit velocity (mm Hg)	Dynamic head for inlet velocity (mm Hg)
Straight backward forward	N_2:										
	N_1:										

Experiment 2 - SERIES AND PARALLEL PUMP

JECT OF THE EXPERIMENT

The aim of this experiment is to observe changes in the operational performance characteristics of two geometrically similar pumps.

EXPERIMENTAL PROCEDURE

1. Record P_1, P_2, and F values at 5 different flow rate at N_1 and N_2 rpm for Pump 1 valve operation.
2. Record P_4, P_5, and F values at 5 different flow rate at N_2 rpm for Pump 2 valve operation.
3. Record the P_6 and Q values for 5 different flow rate in series operation. Connect Pump 1 and 2 series operation and both running N_2 rpm.
4. Record the P_3 and Q values for 5 different flow rate in series operation. Connect Pump 1 and 2 series operation and both running N_2 rpm.

CALCULATIONS

1. Calculate the net head across the pump, H, hydraulic power, (P_h), mechanical power, (P_s), and efficiency.
2. Plot the H-Q, P_s-Q on the same graph paper.
3. Using the similarity rules calculate and plot H and P_s vs Q for
   a) N_1 rpm using the data of pump 1 at N_2 rpm.
   b) 4000 rpm using the data of pump at N_2 rpm.
   c) Scale pump 2 running at N_2 rpm to pump 1 at N_2 rpm.
4. Calculate flow and head coefficients Q/ND^3 and gH/N^2 for pump 1 running at N_1 and N_2 rpm. Plot the results.
5. Calculate the N_{sq} for maximum efficiency points for N_1, N_2, and 4000 rpm rotational speed of pump 1.
6. Plot the parallel and series operational modes H-Q characteristics on the same graph paper. Also H-Q curves of pump 1 and 2 at N_2 rpm on the same graph paper.

OPERATION	VALVE POSITION						
	1	2	3	4	5	6	7
Pump 1 only	O	O	C	C	C	C	C
Pump 2 only	C	C	O	O	C	C	C
Parallel operation	O	O	O	C	C	O	C
Series operation	O	C	C	O	O	C	C
KEY	O:Open, C: Closed, ...:Control valve						

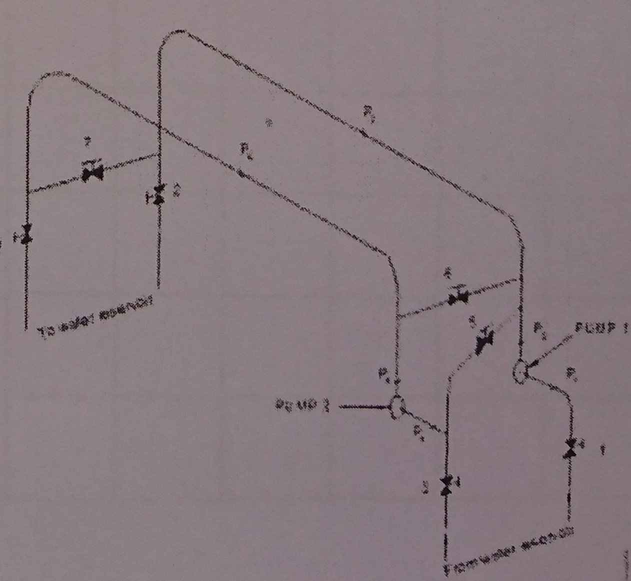

Figure 2. Schematic diagram of the test set-up

	EXPERIMENTAL									Calculated using similarity					
	Q (lt/sec)	P_1, P_4 (mWC)	P_2, P_5 (mWC)	F (N)	H (mWC)	T (Nm)	P_{hyd} (W)	P_{mech} (W)	η %	Q	H	P_{hyd}	P_{mech}	η %	
Pump 1 — N_1: rpm															Pump 1 at N_1 rpm using the data of Pump 1 at N_2 rpm
Pump 1 — N_2: rpm															Pump 1 at 4000 rpm using the data of Pump 1 at N_2 rpm
Pump 2 — N_2: rpm															Pump 2 at N_2 rpm using the data of Pump 1 at N_2 rpm

Series Operation

Pump 1 at rpm

Pump 2 at rpm

Q	P_6

Parallel Operation

Pump 1 at rpm

Pump 2 at rpm

Q (lt/sec)	P_3

Torque Arm = 0.165 m

$D_1 = 0.14\ m$

$D_2 = 0.076\ m$

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Experiment 4 - CAVITATION OF RADIAL FLOW PUMP

OBJECTIVE OF THE EXPERIMENT

The aim of this experiment is to observe changes in the cavitation characteristics of a radial flow pump.

EXPERIMENTAL PROCEDURE

1. Prime the pump 1.
2. Start pump with valve 2 fully closed and set pump rotational speed to N_1 rpm.
3. Fully open valve 1 slowly.
4. Partly open valve 2 so that Q_1 lt/sec flowrate passes through the pump.
5. Record P_1, P_2 and torque.
6. Decrease P_1 by throttling valve 1 and adjust valve 2 to maintain the constant flowrate Q_1. Take the values P_1, P_2, and T.
7. Repeat step 6 for different inlet throttling conditions.
8. Repeat steps 4 to 7 for a different value of pump discharge Q_2.

CALCULATIONS

1. Calculate NPSH
2. Plot NPSH versus ΔH and NPSH versus η.
3. Find critical NPSH.
4. Calculate σ_c and S.

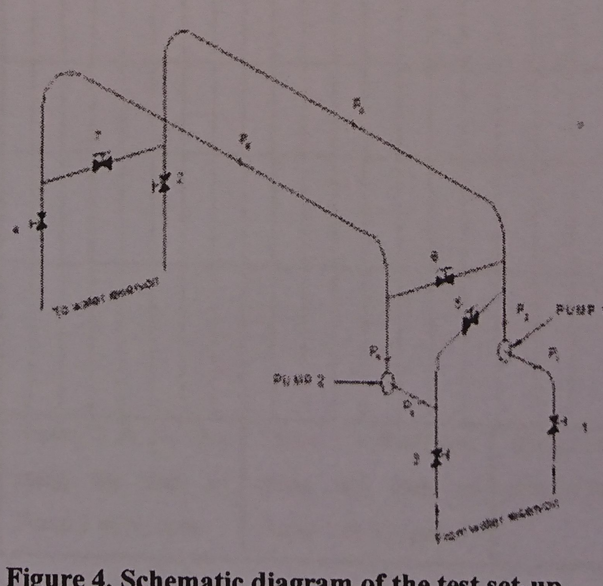

Figure 4. Schematic diagram of the test set-up