FLUID FACILITIES AND MACHINERY

GUIDE TO LABORATORY PRACTICALS

University of the Basque Country (UPV/EHU)

Energy Engineering Department

PRACTICAL P1: PUMPS 1: CONNECTIONS

1. EXPERIMENTAL PROCEDURE: PRACTICAL DEVELOPMENT.

The following procedure must be followed to complete the practical:

Obtaining the characteristic curve of B.1.

1. The valve located on the suction line MUST NOT BE TOUCHED. The water level must be checked.
2. Turn on the facility.
3. Correctly position the red shut-off valves to operate only with pump B.1.
4. The flow regulation valve, must be CLOSED.
5. Turn on pump B.1 (clockwise).
6. Verify that the frequency controller is set at 44 [Hz].
7. Record the pressure value reading for the suction and discharge sections (vacuum gauge-manometer and manometer) of pump B.1 at zero flow. Open the regulation valve until cavitation is heard in the impeller. Record the pressure and flow-rate values (head, in [mm W.C.]) of pump B.1.
8. Close the flow regulation valve again. Then, open it progressively (increasing the flow) and record the pressure values at the suction (inlet) and impulse (outlet) valves, as well as the flow-rate values at FIVE points between zero flow and the flow corresponding to the start of cavitation.
9. Close the flow regulation valve again.
10. Turn off pump B.1.

Obtaining the characteristic curve of B.2.

Repeat steps 3 to 10, with pump B.2 operating at 50 [Hz].

Obtaining the characteristic curve of pumps B.1 and B.2 connected in series.

1. Correctly position the red shut-off valves to obtain a SERIES connection pump circuit.

2. The flow regulation valve must be CLOSED.
3. Turn on pumps B.1 and B.2 (clockwise) at the same time.
4. Verify that the frequency controller is set at a value of 44 [Hz].
5. Record the pressure value readings at the suction (inlet) and impulse (outlet) valves (vacuum gauge-manometer and manometer) of pumps B.1 and B.2 at zero flow. Open the outlet valve until cavitation can be heard within the impeller. Record the pressure and flow-rate values (head, in [mm W.C.]), of B.1 and B.2.
6. Close the flow regulation valve again. Then, open it progressively (increasing the flow rate) and record the pressure values at the suction (inlet) and impulse (outlet) valves, as well as the flow-rate values at THREE points between zero flow and the flow rate that corresponds to the onset of cavitation.
7. Close the flow regulation valve.
8. Turn off pumps B.1 and B.2.

Obtaining the characteristic curve of pumps B.1 and B.2 with a parallel connection.

1. Correctly position the red shut-off valves to obtain a PARALLEL connection pump circuit.
2. The flow regulation valve must be CLOSED.
3. Turn on pumps B.1 and B.2 (clockwise) at the same time.
4. Verify that the frequency controller is set at 44 [Hz].
5. Record the pressure values at the suction (inlet) and impulse (outlet) valves (vacuum gauge-manometer and manometer) of pumps B.1 and B.2 at zero flow. Open the outlet valve until cavitation can be heard in the impeller. Record the pressure and flow-rate values (head, in [mm W.C.]) of pumps B.1 and B.2.
6. Close the flow regulation valve again. Then, open it progressively (increasing the flow rate) and record the pressure values at the suction (inlet) and impulse (outlet) valves, as well as the flow-rate values at THREE points between zero flow and the point that corresponds to cavitation.
7. Close the flow regulation valve.
8. Turn off pumps B.1 and B.2.

9. Switch off the facility.

Table 1: *Experimental data.*

PUMPS 1: Connections		Z_1	Z_2	Manometer		Vacuum gauge-manometer	
	Units	[mm]	[mm]	B.1 [m W.C.]	B.2 [kg/cm^2]	B.1 [cm Hg]	B.2 [cm Hg / kg/cm^2]
Pump B.*i*	Points X						
B.1-Series-B.2 – B.1-Parallel-B.2	Points Y						

2. RESULTS

The student will fill in a table of results in an EXCEL file. This table will show the experimental data collected in the laboratory, which will justify the experimental results. Following the analysis of the experimental results, the following graphs will be prepared:

- **Graph 1:** *H-Q* characteristic curve of pump B.1 with the corresponding polynomial adjustment.
- **Graph 2:** *H-Q* characteristic curve of pump B.2 with the corresponding polynomial adjustment.
- **Graph 3:** Theoretical *H-Q* characteristic curve, calculated from the individual curves of B.1 and B.2, for series connection. The same graph must show the experimental points obtained in the laboratory for the series connection.
- **Graph 4:** Theoretical *H-Q* characteristic curve, calculated from the individual curves of B.1 and B.2, for a parallel connection. The same graph must show the experimental points obtained in the laboratory for the parallel connection.

The *H-Q* characteristic curves corresponding to graphs 1 and 2 must be fitted to the corresponding polynomial degree, and both the regression and the corresponding equation must be shown. All graphs must have a title and each (*x*,*y*) axis must be labelled

with the corresponding units. These graphs will be presented in the report and must specify the primary source of the data that are represented in the graph.

3. CONCLUSIONS

In the Excel file, the main conclusions must be written, based on the objectives of the practical, and on an analysis of the possible differences between the experimental and the theoretical results noted in the pump connections section.

4. EXPERIMENTAL DATA

Pump B.1

Pump B.1		Z_1 (mm)	Z_2 (mm)	Manometer B.1 (m W.C.)	Vacuum gauge-manometer B.1 (cm Hg)
Q = 0	1	207	207	18,5	-7
	2	202	215	16,0	-9
	3	195	228	14,0	-13
	4	185	245	11,5	-19
	5	180	253	10,0	-22
	6	170	268	8,0	-27
Cavitation	7	165	280	6,0	-30

Pump B.2

Pump B.2		Z_1 (mm)	Z_2 (mm)	Manometer B.2 (m W.C.)	Vacuum gauge-manometer B.2 (cm Hg)
Q = 0	1	207	207	2,35	-2
	2	200	217	2,1	-5
	3	190	235	1,9	-8
	4	178	253	1,7	-10
	5	168	272	1,5	-11

	6	158	292	1,3	-13
Cavitation	7	147	303	1,1	-15

B.1 – series - B.2

B.1 – series- B.2		Z_1 (mm)	Z_2 (mm)	Manometer B.1 (m C.A.)	Vacuum gauge-manometer B.1 (cm Hg)	Manometer B.2 (m C.A.)	Vacuum gauge-manometer B.2 (cm Hg)
Q = 0	1	205	205	18,4	-8	4,3	1,75
	2	195	223	15,0	-11	3,7	1,43
	3	183	242	11,0	-20	3,0	1,01
	4	170	266	8,0	-27	2,4	0,71
Cavitation	5	165	275	6,7	-29	2,2	0,58

B.1 – parallel- B.2

B.1 – parallel- B.2		Z_1 (mm)	Z_2 (mm)	Manometer B.1 (m C.A.)	Vacuum gauge-manometer B.1 (cm Hg)	Manometer B.2 (m C.A.)	Vacuum gauge-manometer B.2 (cm Hg)
Q = 0	1	205	205	18,4	-8	4,3	1,75
	2	195	223	15,0	-11	3,7	1,43
	3	183	242	11,0	-20	3,0	1,01
	4	170	266	8,0	-27	2,4	0,71

Cavitation	**5**	165	275	6,7	-29	2,2	0,58