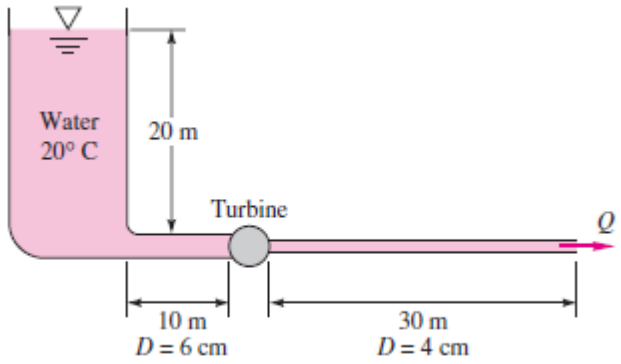
ESO204A: Fluid Mechanics and Rate Processes
TUTORIAL 7 PROBLEMS

August-November 2017

1. Review of Tutorial-6

2. The small turbine in Fig. P6.76 extracts 400 W of power from the water flow. Both pipes are wrought iron. Compute the flow rate $Q$ in $m^3/h$. Why are there two solutions? Which is better? Use the table below for surface roughness.

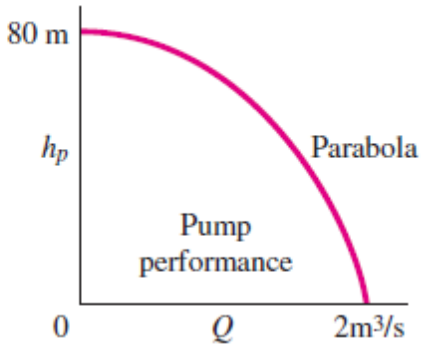



**P6.76**

**Table 6.1** Recommended Roughness Values for Commercial Ducts

| | | $\epsilon$ | | |
|---|---|---|---|---|
| **Material** | **Condition** | **ft** | **mm** | **Uncertainty, %** |
| Steel | Sheet metal, new | 0.00016 | 0.05 | ±60 |
| | Stainless, new | 0.000007 | 0.002 | ±50 |
| | Commercial, new | 0.00015 | 0.046 | ±30 |
| | Riveted | 0.01 | 3.0 | ±70 |
| | Rusted | 0.007 | 2.0 | ±50 |
| Iron | Cast, new | 0.00085 | 0.26 | ±50 |
| | Wrought, new | 0.00015 | 0.046 | ±20 |
| | Galvanized, new | 0.0005 | 0.15 | ±40 |
| | Asphalted cast | 0.0004 | 0.12 | ±50 |
| Brass | Drawn, new | 0.000007 | 0.002 | ±50 |
| Plastic | Drawn tubing | 0.000005 | 0.0015 | ±60 |
| Glass | — | Smooth | Smooth | |
| Concrete | Smoothed | 0.00013 | 0.04 | ±60 |
| | Rough | 0.007 | 2.0 | ±50 |
| Rubber | Smoothed | 0.000033 | 0.01 | ±60 |
| Wood | Stave | 0.0016 | 0.5 | ±40 |

3. The head-versus-flow-rate characteristics of a centrifugal pump are shown in Fig. P6.80. If this pump drives water at 20°C through 120 m of 30-cm diameter cast iron pipe, what will be the resulting flow rate, in $m^3/s$? Use surface roughness data from the table on page 1.




**P6.80**

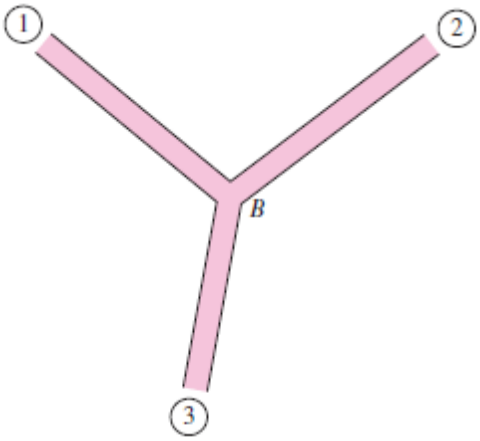
4. Three cast iron pipes are connected to meet smoothly at point *B*, as shown in Fig. P6.125. The cast iron pipes are with these dimensions:

| Pipe | Length, m | Diameter, cm |
|---|---|---|
| 1 | 800 | 12 |
| 2 | 600 | 8 |
| 3 | 900 | 10 |

The inlet pressures in each pipe are

$$p_1 = 200 \text{ kPa} \quad p_2 = 160 \text{ kPa} \quad p_3 = 100 \text{ kPa}$$

The fluid is water at 20°C. Neglect minor losses. Estimate the flow rate in each pipe and whether it is toward or away from point *B*.




**P6.125**