National Exams Dec 2010

04-Agric-A4, Fluid Flow

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM.
   Any non-communicating calculator is permitted.

3. Four (4) questions constitute a complete exam paper.

4. Each question is of equal value.

5. All questions require calculation.

Choose either 1a or 1b

1a. A blower delivers air (For air take ρ=1.2 kg/m^3 and μ= 1.8E-5 kg/m·s) at 3000 m^3/hr to the duct circuit in the figure below. Each duct is commercial steel and of square cross section, with side lengths a_1=a_3=20 cm and a_2=a_4=12 cm. Assuming sea level air conditions, estimate the power required if the blower has an efficiency of 75%. Neglect minor losses.
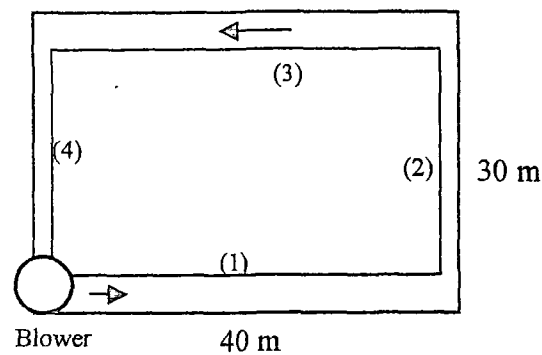

Figure for Question 1a.

1b. Uniform water flow in a wide brick(For brickwork, take n = 0.015) channel of slope 0.02° moves over a 10 cm bump as in the figure below. A slight depression in the water surface results. If the minimum water depth over the bump is 50 cm, compute (a) the velocity over the bump and (b) the flow rate per meter of width.
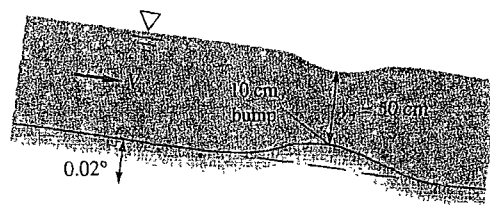

Figure for Question 1b.

2. The three arm lawn sprinkler shown below receives water at 20°C through the center at a volume of 2.7 m³/hr. If collar friction is negligible, what is the steady rotation rate in rev/min for:

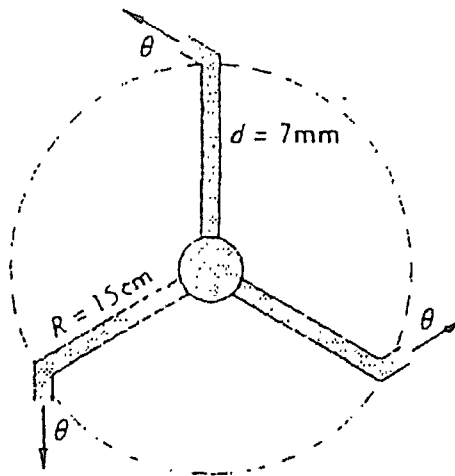a) $\theta=0°$
b) $\theta=40°$

Figure for Question 2.

3. What would be the technical classification of the following turbomachines: (a) a household fan, (b) a windmill, (c) an aircraft propeller, (d) a fuel pump in a car, (e) a fluid-coupling transmission, and (f) a power plant steam turbine?

Choose either 4a or 4b

4a. Figure below shows performance data for the Taco, Inc., model 4013 pump. Compute the ratios of measured shutoff head to the ideal value U^2/g for all seven impeller sizes(12.95 in, 12.50 in, 12.00 in, 11.50 in, 11.00 in, 10.50 in, 10.00 in). Determine the average and standard deviation of this ratio.
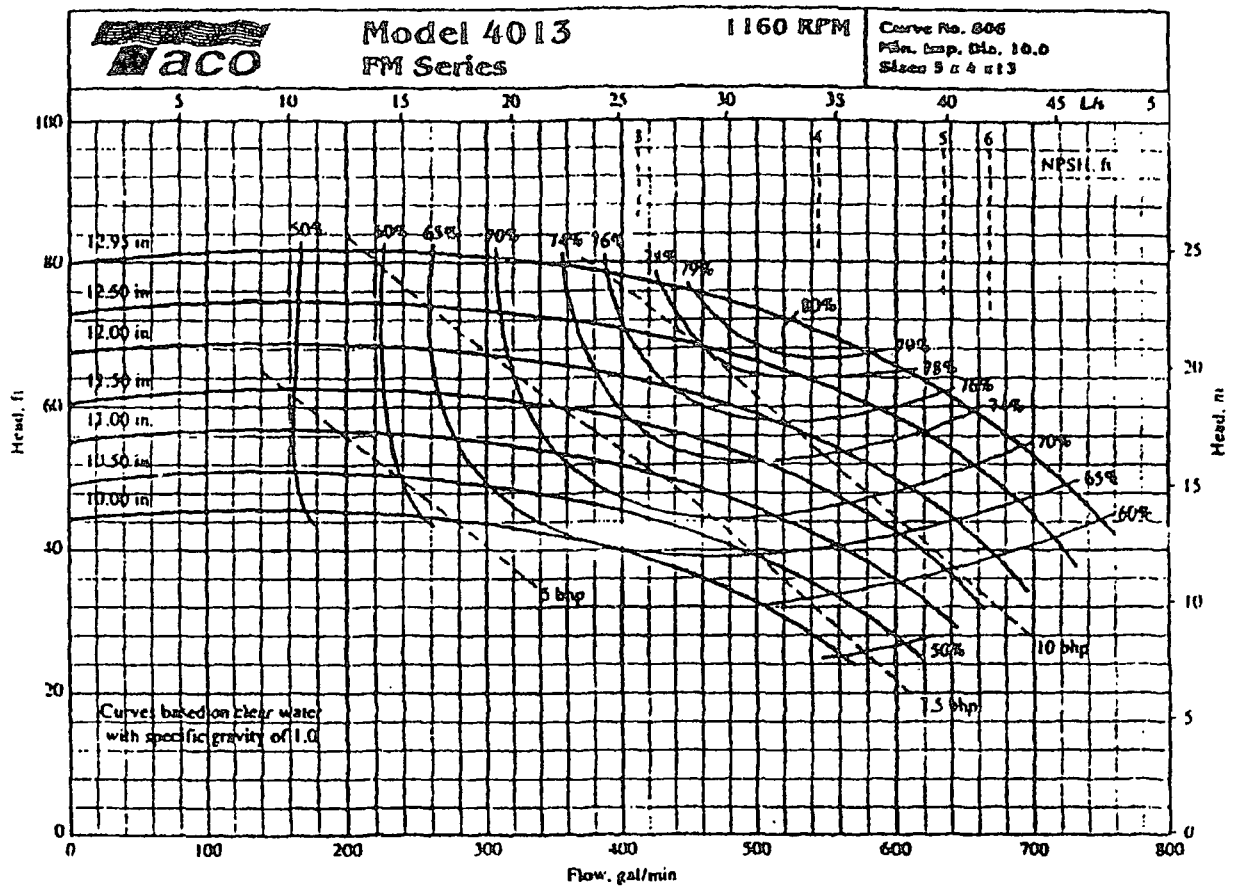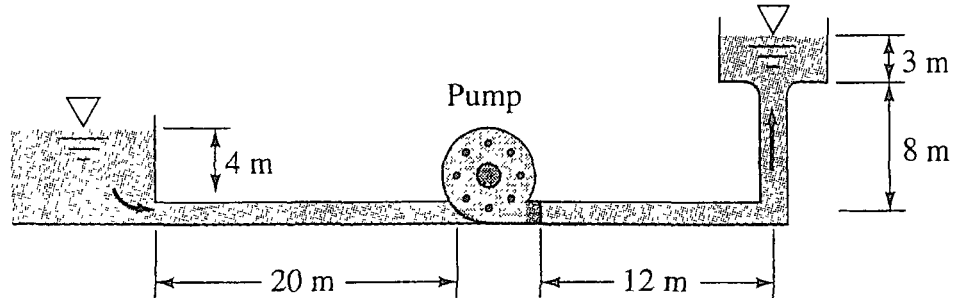

Figure for Question 4a.

4b. It is proposed to run the pump of the figure below at 880 r/min to pump water at 20°C through the system as shown in the below figure. The pipe is 20 cm diameter commercial steel. What flow rate in ft³/min? Is this an efficient application? For water, take ρ = 998 kg/m³ and μ = 0.0010 kg/m·s. For commercial steel, take ε = 0.046 mm.

Figure for Question 4b.