ES 202 - Exam III | Spring 1999-2000 | Richards

Name:_______________________________________ Campus Mail Box ____________

Problem 1 (100) __________

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TOTAL (100) __________

EXTRA CREDIT
Problem (15) __________

Water Properties:	Density	$\rho = 999$ kg/m^3	Dynamic viscosity	$\mu = 1.12 \times 10^{-3}$ N·s/m^2
	Specific weight	$\gamma = 9.80$ kN/m^3	Kinematic viscosity	$\nu = 1.12 \times 10^{-6}$ m^2/s
	Specific heat	$c_p = 4.18$ kJ/(kg·K)		

General Comments

(1) Anytime you apply conservation or accounting principles in solving a problem, sketch and clearly identify the system you have selected. In addition, clearly indicate how your assumptions or given information simplifies the general equations. Numbered-symbols, e.g. P_1 ,in equations must make sense for the problem in question, i.e. they must match you figure and communicate information accurately.

(2) Closed book/notes; however, you may use any of the following:
- ... yellow equation pages provided by instructor
- ... unit conversion page
- ... material in Appendices and end flaps of Wark/Richards text
- ... your equation page (single side of 8-1/2 x 11 sheet of paper)

(3) For maximum credit,
- ... solve problems symbolically first showing logic and reasoning for solution,
- ... substitute numbers into the equations clearly showing any required unit conversion factors
- ... then and only then crunch numbers on your calculator.

If I only have to punch your numbers into a calculator to get a correct answer (including units) you will receive full credit. **Don't make me guess what you are doing and why you chose to do this.**

(4) Watch the time and feel free to remove the staple and take the test apart so that you don't have to keep flipping pages around.

PLEASE REMOVE THE STAPLE AND USE EXTRA PAPER *INSTEAD* OF WRITING ON THE BACK OF PAGES AND THEN HAVING TO FLIP BACK AND FORTH TO FINISH THE PROBLEM. I'LL GLADLY RESTAPLE YOUR TEST!

Problem 1 (100 points)

Fuel oil (*S.G.*= 0.94) is pumped between two reservoirs, as shown in the figure. The average velocity in the pipe is 3.5 m/s. The pipe is commercial steel with a diameter of 60 cm. The piping connections with the reservoirs are both sharp-edged openings.

Fuel oil properties:	specific gravity	$SG = 0.94$;	kinematic viscosity	$\nu = 5.0 \times 10^{-5}$ m^2/s,
			dynamic viscosity	$\mu = 4.7 \times 10^{-2}$ N·s/m^2

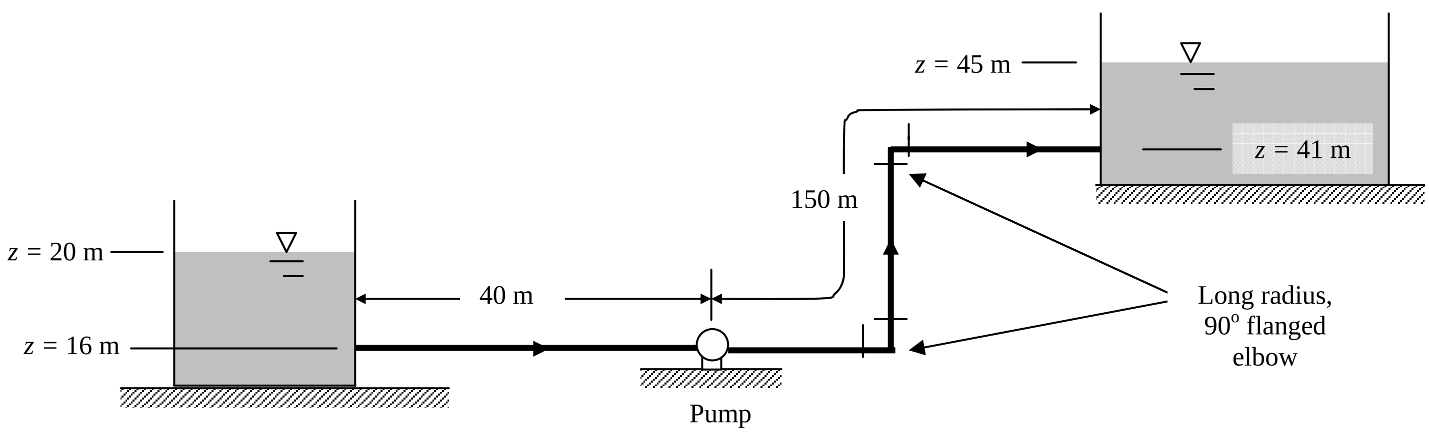
(a) Determine the **actual pump power**, in kilowatts, assuming a 76% efficient pump.

(b) Determine the **pressure in the lower reservoir just before the oil enters the piping system,** i.e. just before the oil flows through the sharp-edged entrance to the piping system, in kPa absolute or gage.

(c) Determine the **pressure at the pump inlet** (immediately upstream of the pump), kPa absolute or gage.

(d) Determine the **pressure at the outlet of the piping system**, i.e. the point where the fuel oil *enters* the upper reservoir, in kPa absolute or gage.

(e) Some individuals have suggested that the commercial steel pipe should be replaced with galvanized iron pipe in the future as repairs are necessary. How will this change affect the head loss of the system? More specifically will the volumetric flow rate increase, decrease, or stay the same? Briefly explain your reasoning.



EXTRA CREDIT PROBLEM (15 points)

Part of the Jordan River water system in Israel consists of a 275-cm diameter pre-stressed concrete pipe that conveys water with an average velocity of 3.0 m/s. Experiments have shown that the friction factor for the pipe at this flow rate is $f = 0.02$.

Use the energy balance and the mechanical energy balance, as required, to predict the temperature rise of the water, in ^{o}C, as it flows through a 1000-m long length of pipe with negligible change in elevation. You may assume that the fluid is incompressible and that the flow is adiabatic.