

大同大學 104 學年度研究所碩士班入學考試試題

考試科目:單操與輸送 所別:化學工程研究所(甲組) 第 1/1 頁

註:本次考試 不可以參考自己的書籍及筆記; 不可以使用字典; 可以使用計算器。

Useful formula:

$$\frac{\partial \rho}{\partial t} + \frac{\partial}{\partial x}(\rho v_x) + \frac{\partial}{\partial y}(\rho v_y) + \frac{\partial}{\partial z}(\rho v_z) = 0 \qquad \frac{\partial \rho}{\partial t} + \frac{1}{r} \frac{\partial}{\partial r}(\rho r v_r) + \frac{1}{r} \frac{\partial}{\partial \theta}(\rho v_\theta) + \frac{\partial}{\partial z}(\rho v_z) = 0$$

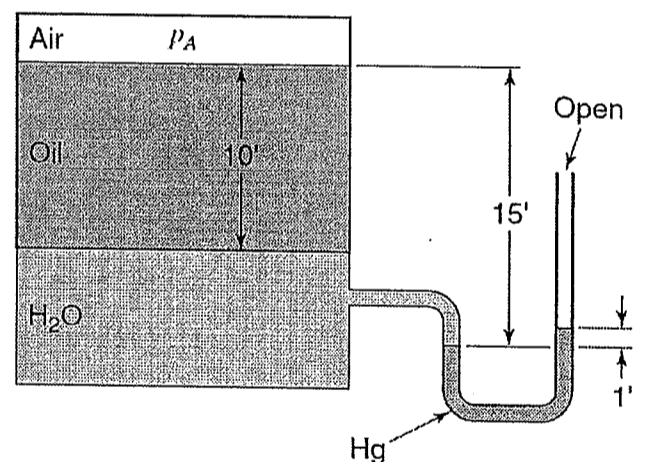
$$\rho \left(\frac{\partial v_x}{\partial t} + v_x \frac{\partial v_x}{\partial x} + v_y \frac{\partial v_x}{\partial y} + v_z \frac{\partial v_x}{\partial z} \right) = -\frac{\partial p}{\partial x} + \mu \left[\frac{\partial^2 v_x}{\partial x^2} + \frac{\partial^2 v_x}{\partial y^2} + \frac{\partial^2 v_x}{\partial z^2} \right] + \rho g_x$$

$$\rho \left(\frac{\partial v_y}{\partial t} + v_x \frac{\partial v_y}{\partial x} + v_y \frac{\partial v_y}{\partial y} + v_z \frac{\partial v_y}{\partial z} \right) = -\frac{\partial p}{\partial y} + \mu \left[\frac{\partial^2 v_y}{\partial x^2} + \frac{\partial^2 v_y}{\partial y^2} + \frac{\partial^2 v_y}{\partial z^2} \right] + \rho g_y$$

$$\rho \left(\frac{\partial v_z}{\partial t} + v_x \frac{\partial v_z}{\partial x} + v_y \frac{\partial v_z}{\partial y} + v_z \frac{\partial v_z}{\partial z} \right) = -\frac{\partial p}{\partial z} + \mu \left[\frac{\partial^2 v_z}{\partial x^2} + \frac{\partial^2 v_z}{\partial y^2} + \frac{\partial^2 v_z}{\partial z^2} \right] + \rho g_z$$

1. Analyze flow between two horizontal(水平)parallel(平行)plates separated by a distance 2h under constant pressure drop. 30%
- 1.1 Draw a schematic diagram showing coordinate and important parameters. (3%)
- 1.2 Make necessary assumptions. (5%)
- 1.3 Check equation of continuity. (2%)
- 1.4 Simply the equation of motion for x-, y-, and z-direction. (3%)
- 1.5 Specify two appropriate boundary conditions. (2%)
- 1.6 Solve for the velocity profile. (6%)
- 1.7 Find the maximal flow velocity. (2%)
- 1.8 Find the volumetric flow rate. (5%)
- 1.9 Find the average flow velocity. (2%)

2. What is the pressure P_A ? The specific gravity of the water, oil, and mercury are 1, 0.8, and 13.6, respectively. (15%)



3. 250°C steam flows in a 100-meter long steel pipeline with inside diameter of 0.1m. Estimate the heat loss rate to atmospheric air at 25°C and the temperature at the outside surface of the pipeline. Clearly state your assumptions and use the following data: pipeline thickness = 0.006m, steel thermal conductivity = 43W/m-K, steam convective heat transfer coefficient = 9000 W/m²-K, and air convective heat transfer coefficient = 200 W/m²-K. Is the outside surface of the pipeline safe to touch? (15%)
4. In order to prevent heat loss from the pipeline in Problem 3, an insulation material with thermal conductivity = 0.05 W/m-K is wrapped around the pipeline. Estimate the heat loss rate to atmospheric air and the temperature at the outside surface of the pipeline insulation when the insulation layer thickness is 2 cm. What is the percentage of heat loss? Is the insulation surface safe to touch? (15%)
5. 某化工製程排放的廢氣中含有 100 ppm(by volume)的苯, 其餘為空氣, 廢氣壓力為 1atm、溫度為 30°C、流量為 5000 L/min。欲以 30°C 的水吸收廢氣之苯, 使其排放濃度低於 0.5 ppm(by volume), 廢氣由板式吸收塔底進入, 不含苯的水由塔頂進入, 假設每一板的氣液接觸都達到平衡且為等溫操作, 在 30°C 水中苯的亨利係數為 6.49 bar.m³/kgmol, 請在答案卷上作圖, 以圖解法計算
 - 5.1 吸收塔所需之最低水的流量(mol/min) (5%)
 - 5.2 如果水的流量使用 1.5 倍的最低流量, 請估算
 - 吸收塔所需之板數 (10%)
 - 吸收塔廢氣出口中之苯的濃度(ppm) (5%)
 - 吸收塔廢水出口中之苯的濃度(mg/L) (5%)