UNIVERSITY OF GHANA

FACULTY OF ENGINEERING SCIENCES

DEPARTMENT OF FOOD PROCESS ENGINEERING

B.Sc SECOND SEMESTER FINAL EXAMINATION, 2012/2013

FPEN 202: FOOD PROCESS ENGINEERING CALCULATIONS (2 Credits)

Answer ALL questions Time: 2 hours

Question 1

Methane is burned in a furnace with 100% excess dry air to generate steam in a boiler. Both the air and the methane enter the combustion chamber at 600°F and 1 atm, and the products leave the furnace at 1000°F and 1 atm. If the effluent gases contain only CO_2, H_2O, O_2 and N_2, calculate the amount of heat absorbed by the water to make steam per pound of methane burned.

Enthalpy Data: (Btu/lb mol; Reference - 77°F)

Temp (°F)	CH_4	N_2	O_2	CO_2	H_2O
77	378.5	312.2	315.1	392.2	359.9
600	6051.6	4145.4	4293.1	5945.3	4877.0
1000	11030.4	6775.1	7122.5	10195.3	8093.9

Compound	Heat of formation (Btu/lb mol)
CH_4	-32,208.9
CO_2	-169,441.1
H_2O	-104,119.1

Question 2

For each of the process below, write down the general energy balance (include all terms). Based on the data given and any reasonable assumptions you make, simplify the balances as much as possible.

(a) Milk flows through a tiny orifice from a region where its pressure is 1300kPa and 600K to a pipe where the pressure is 275 kPa

(b) A turbine directly connected to an electric generator operates adiabatically. The working fluid enters the turbine at 250 psia and 600°F, and leaves at 50 psia and 400°F. The entrance and exit velocities of the fluid area negligible.
(c) A fluid leaves the nozzle of a hose at 200 kPa and 400°C, and is brought to rest by passing it through the blades of an adiabatic turbine rotor. The fluid leaves the blades at 50 psia and 250°F.
(d) A fluid flows steadily through a poorly designed coil in which it is heated from 70°F to 250°F. The pressure at the coil inlet is 120 psia, and at the coil outlet is 70 psia. The coil is uniform cross-section, and the fluid enters with a velocity of 2 ft/sec

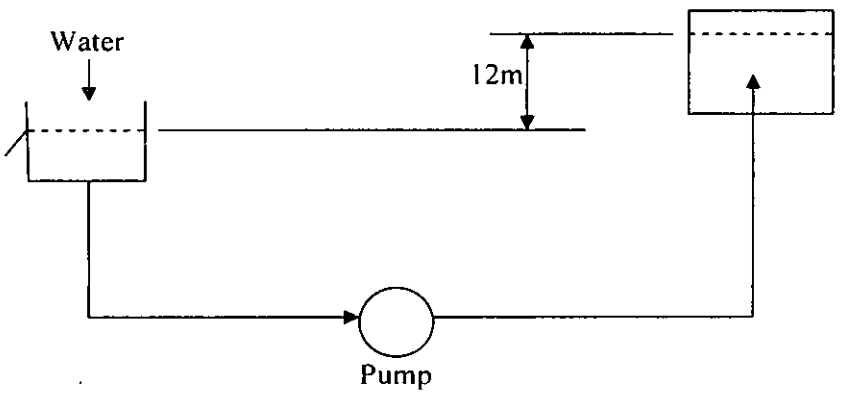
Question 3

Water at 20°C is being pumped from a constant-head tank open to the atmosphere to an elevation kept at a constant pressure of 1250 kPa in an experiment as shown in the figure below. If water is flowing in the 5-cm line at a rate of 0.50 m^3/min, find

a) the rating of the pump in joules per kilogram being pumped
b) the rating of the pump in joules per minute

The pump and the motor have an overall efficiency of 60% and the energy loss in the line can be determined to be 70.0 J/kg flowing.

Data:
Specific volume of water= 1.694 m^3/kg
g =9.81 m/s^2



Question 4

In a processing plant, milk flows from a storage tank maintained at 6°C through a valve to a pasteurizer via an insulated 12-cm-diameter pipe at the rate of 1000 litre/min. The upstream pressure is 220 kPa and downstream pressure is 120 kPa. Determine the lost work (F) in J/min and the temperature change which occurs in the milk as a result of this throttling process. (Milk and water are sufficiently equivalent in properties for you to use those of water.)

(Density of water=1000 kg/m^3; Specific heat of water=4.2 kJ/kg.K)