Chemical Engineering Department
College of Engineering
King Saud University

Chemical Engineering Principles (II) - ChE 202

Time : 2 hours **Final Examination** **Date: 6/7/1430**

Answer **ALL** questions.
ASSUME any missing data.
TAKE Cp=a + b.T
Specify clearly, your **REFERENCE** state for all problems .
Construct **ENTHALPY TABLES** for all problems.

Question # 1 (12 points).

(a, 6 points) Find the amount of heat needed to raise the temperature of 100 mol/s of steam from 290 °C to 600 °C at 60 bar.

(b, 6 points) Calculate the heat of reaction using the heat of combustion for the following gas phase reaction: $C_3H_8 \rightarrow C_2H_4 + CH_4$

Question # 24 (12 points).

100 mol/s of a vapor mixture containing 60 mol% benzene (C_6H_6) and 40 mol% Toluene (C_7H_8) at 120 ºC is fed continuously to a condenser in which the mixture is cooled to 80 ºC and is separated into two streams: a liquid and a vapor streams. The liquid product contains 10 mol% benzene and the vapor product is 90 mol% benzene. How much heat must be transferred to/from the mixture. Assume the operation to be at 1 atm. Use feed conditions as your reference for enthalpy calculations.

Question # 3 (13 points).

Consider the following gaseous system.

$$C_3H_8 + 0.5O_2 \rightarrow C_3H_6 + H_2O$$
$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

The feed to the reactor contains 50 mol/s propane (C_3H_8) and 100 mol/s oxygen (O_2) at 100 °C and 1 atm. In the reactor's outlet stream, the molar flow rate of the product stream is composed of C_3H_6=40 mol/s; CO_2=30 mol/s; H_2O=80 mol/s; and O_2=30 mol/s. The temperature of the reactor's product stream is 500 °C.

Using the **heat of reaction method**, Calculate the amount of heat that must added to or removed from the system.

Question # 4 (13 points).

Calculate the amount of heat that must transeferred if 200 mol/s of methane (CH_4) entering at 25 °C is burnt with air (21% oxygen and 79% nitrogen) flowing at 1000 mol/s at 200 °C according to the following reaction.

$$CH_{4(g)} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(g)}$$

The conversion of methane is 40%. The products exit the reactor at 400 °C.