

Seat No.



King Mongkut' University of Technology Thonburi
Final Examination—1/2009
ChE 103 Material and Energy Balances (Bilingual program)

Date: Tuesday 6, October 2009, 13:00-16:00

Notes:

1. This exam paper includes 6 problems (100 points) in a total of 8 pages.
2. It is an open-book/notes examination.
3. A calculator and a dictionary/talking dictionary are allowed.
4. Students are not allowed to take any exam materials/papers out of the exam room.

Student Name _____ Student ID _____

Written by

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This exam paper has been evaluated and approved by the Department of Chemical Engineering's Committee.

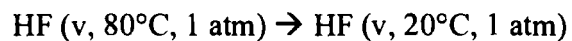
Anawat Sungpet

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Interim Departmental Chair

Student Name _____

Student ID _____

1. (10 points) Given liquid HF at 20°C and 1 atm as a reference state, the enthalpy of a vapor hydrogen fluoride (HF) is 2,500 J/mol at 20°C and 1 atm, and 6,000 J/mol at 80°C and 1 atm.
 - a. Determine the approximate value of \hat{H} for the vapor HF at 20°C and 4 atm
 - b. Determine the $\Delta\hat{H}$ for the process indicated below:



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2. (15 points) In an adiabatic heat exchanger, saturated steam at 170°C is used to heat a counter-currently flowing stream of acetone vapor from 60°C to 160°C . The flow rate of the acetone is 1,000 standard liters (STP) per minute, and the steam condenses and leaves the heat exchanger as liquid water at 80°C . Calculate the rate of heat transfer from the water to the acetone in kilo-watts.

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3. (15 points) 100 mol/h of methanol vapor at 250°C is condensed to a liquid methanol at 25°C in a condenser. Calculate the rate of heat (kW) that must be transferred from the methanol in the condenser.

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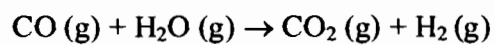
4. (10 points) Calculate the standard heat of formation of liquid nitrobenzene, $\text{C}_6\text{H}_5\text{O}_2\text{N}$.

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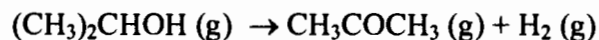
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5. Determine the standard heat of reaction of the following reaction by

- a. Heats of formation (4 points)
- b. Heats of combustion (6 points)



6. (40 points) The production of isopropyl alcohol from acetone is shown below.



100 mol/s of isopropyl alcohol vapor is fed to a reactor at 500°C with 90% conversion of isopropyl alcohol. The gas products exit the reactor at 500°C. Determine the heat that must be transferred to or from the reactor. (Assuming a constant pressure at 1 atm; given $\Delta\hat{H}_f^\circ(\text{isopropyl alcohol (g)}) = -272.8 \text{ kJ/mol}$)

Table 1 Specific heat capacities of isopropyl alcohol vapor

Temperature (K)	C _p , gas (J/mol·K)
273.15	83.72
298.15	89.32
300.	89.74
400.	112.15
500.	131.96
600.	148.30
700.	161.75
800.	173.04
900.	182.67
1000.	190.97