

## B.CHEM.ENGG.FINAL EXAMINATION, 2017

(2<sup>nd</sup> Semester)

### ENERGY CONSERVATION AND MANAGEMENT

(Elective III)

Time: Three hours

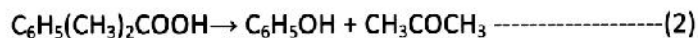
Full Marks: 100

Answer any Five Questions

1. a) What is meant by energy conservation Index? 3  
 b) Give an organisation chart for an energy conservation program in a large Chemical process plant. 6  
 c) Discuss the duties and responsibilities of the plant energy conservation co-ordinator 6  
 d) State the composition and functions of the plant energy conservation committee. 5
  
2. Discuss about resources flows and management process in industrial systems. 20
  
3. a) Discuss the factors to be considered for forecasting energy requirements of a chemical plant. 10  
 b) What are the principal phases of energy audit process? State the purposes of each phase. 4+6=10
  
4. a) It is desired to manufacture phenol with a co-product acetone from cumene and oxygen. The process consists of two reactions in sequence. In the first stage cumene hydroperoxide [C<sub>6</sub>H<sub>5</sub>(CH<sub>3</sub>)<sub>2</sub>COOH] is formed from the peroxidation of cumene (C<sub>6</sub>H<sub>5</sub>C<sub>3</sub>H<sub>7</sub>) with oxygen by the reaction (1)  

$$\text{C}_6\text{H}_5\text{C}_3\text{H}_7 + \text{O}_2 \rightarrow \text{C}_6\text{H}_5(\text{CH}_3)_2\text{COOH} \text{ -----(1)}$$
 This reaction is followed by the decomposition of cumene hydroperoxide into phenol (C<sub>6</sub>H<sub>5</sub>OH) and acetone (CH<sub>3</sub>COCH<sub>3</sub>) by the reaction (2)

[ Turn over



Calculate the specific energy consumption (SEC) for the production of phenol in kcal/kg product.

The following correlation may be used.

$$\text{SEC} = 5088 + 3.356(\Delta H_R^0) + 0.00025(\Delta H_R^0)^2$$

Where SEC is expressed in Btu/lb product  $\Delta H_R^0$  is standard heat of reaction in Btu/lb. Given data: The standard heat of formation at 298K of cumene, cumene hydroperoxide, phenol and acetone are -9.84, 12.26, 37.8, and -97.99 kcal/gm mole respectively.

( 1 Btu=252 cal=0.252 kcals; 1kJ/g mole=430.6 Btu/lb mole=0.239 kcal/g mole)

b. How SEC is related to standard heat of reaction **14+6=20**

5. a) Write a note on utility bill **8**

b) The table below shows the billing data on consumption of electricity in a fire-brick manufacturing factory based on three on three consecutive billing periods. **12**

Billing Period	Bill received in the month of	Emergency consumption koh
15-01-2014 to 20-02-2014	February,2014	30000
20-02-2014 to 10-03-2014	March,2014	17000
10-03-2014 to 02-04-2014	April,2014	21000

Calculate the energy consumption for calendar month of March.2014 using linear interpolation formula.

6. To compare the advantages of high temperature water versus steam processes heating assuming 22650 kg/h of steam at 150 psig are to be produced to deliver heat to equipment 350 m away. Further assume that the saturation temperature of the 150 psig steam =182°C ; Sp. Vol=2.75; enthalpy of vapour 479 kcal/kg; enthalpy of saturated vapour= 610 kcal/kg; ambient temperature 22°C; velocity=27 m/s and density of water at 172°C=850 kg/m<sup>3</sup>.

Pipe line heat losses can be calculated using

$$q = \frac{\pi(t_f - t_0)l}{\frac{1}{h_f \cdot D_1} + \frac{2.3}{2K_{12}} \log \frac{D_2}{D_1} + \frac{2.3}{2K_{2,3}} \log \frac{D_3}{D_2} + \frac{1}{h_a \cdot D_3}}$$

Steam	condensate	HTW
10" dia		10" dia. Pipe
2inch insulation		2inch insulation
$t_1=185^\circ\text{C}$	$t_1=100\text{C}$	$t_1=171\text{C}$
$t_2=21\text{C}$	$t_2=21\text{C}$	$t_2=21\text{C}$
$D_1=25.45\text{ cm}$	$D_1=12.80\text{cm}$	$D_1=25.42$
$D_2=27.31\text{cm}$	$D_2=14.12\text{cm}$	$D_2=27.31\text{cm}$
$D_3=37.47\text{cm}(\text{pipe}+\text{insulation})$		$D_3=37.47\text{cm}$
$K_{1,2}=12\text{kcal/hr.m.}^\circ\text{C}$	$t_3=36^\circ\text{C}$	$t_3=37^\circ\text{C}$
$K_{2,3}=0.0034\text{ kcal/hr.m.}^\circ\text{C}$	$L=305\text{m}$	$L=310\text{m}$
$h_a=1.57\text{kcal/hr.m}^2.\text{C}$		
$t_3=39^\circ\text{C}$		
$L=305\text{m}$		