Material and Energy Balances

Major Exam 11/01/2020

Time: 2Hour **M. Marks:50**

1. Examine Figure 1. What is the quantity of the recycle stream in kg/h? In stream C, the composition is 4 % water and 96 % KNO_3. **(12)**
2. If C_P of SO_2 is 10 cal/gmol.K, what is its value in FPS units? **(6)**
3. In an insulated storage room, 52 pallets, each containing 24 boxes of potatoes, are stacked. Each box corresponds to 2.1 kg of cardboard and 20 kg of potatoes. The respective specific heats are 1.7 kJ/(kg)(^{0}C) for the cardboard, and 3.05 kJ/(kg)(^{0}C) for the potatoes. If the potatoes are cooled at the rate of 0.3^{0}C/h, how much heat must be removed from the room in kW? Neglect the effect of air in the room. **(12)**
4. If CO at constant pressure was burned with excess air to achieve complete combustion and the measured temperature of the exit gases was 1000^{0}C. What was the percentage of excess air used? The reactants entered at 100^{0}C. **(20)**

   Standard Heat of Formation:

   CO_2 = - 393.5 kJ/mol.; CO = - 110.52 kJ/mol.

   Additional Data provided at the bottom.

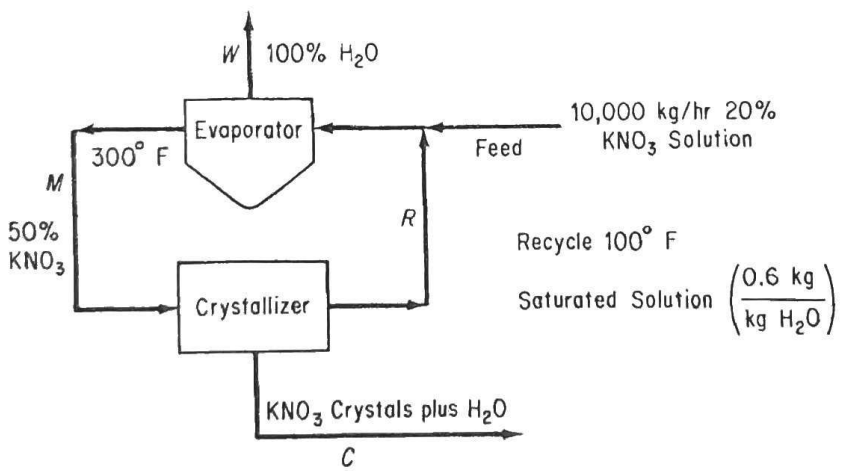

Figure 1

Table B.8 Specific Enthalpies of Selected Gases: SI Units

	$\hat{H}$(kJ/mol) Reference state: Gas, P_{ref} = 1 atm, T_{ref} = 25°C						
T	Air	O_2	N_2	H_2	CO	CO_2	H_2O
0	−0.72	−0.73	−0.73	−0.72	−0.73	−0.92	−0.84
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	2.19	2.24	2.19	2.16	2.19	2.90	2.54
200	5.15	5.31	5.13	5.06	5.16	7.08	6.01
300	8.17	8.47	8.12	7.96	8.17	11.58	9.57
400	11.24	11.72	11.15	10.89	11.25	16.35	13.23
500	14.37	15.03	14.24	13.83	14.38	21.34	17.01
600	17.55	18.41	17.39	16.81	17.57	26.53	20.91
700	20.80	21.86	20.59	19.81	20.82	31.88	24.92
800	24.10	25.35	23.86	22.85	24.13	37.36	29.05
900	27.46	28.89	27.19	25.93	27.49	42.94	33.32
1000	30.86	32.47	30.56	29.04	30.91	48.60	37.69
1100	34.31	36.07	33.99	32.19	34.37	54.33	42.18
1200	37.81	39.70	37.46	35.39	37.87	60.14	46.78
1300	41.34	43.38	40.97	38.62	41.40	65.98	51.47
1400	44.89	47.07	44.51	41.90	44.95	71.89	56.25
1500	48.45	50.77	48.06	45.22	48.51	77.84	61.09