
Q.1. The standard heats of the following combustion reactions have been determined experimentally:

$$1.\ C_2H_6 + \tfrac{7}{2}O_2 \rightarrow 2\,CO_2 + 3\,H_2O: \quad \Delta\hat{H}^{\circ}_{r1} = -1559.8 \text{ kJ/mol}$$
$$2.\ C + O_2 \rightarrow CO_2: \quad \Delta\hat{H}^{\circ}_{r2} = -393.5 \text{ kJ/mol}$$
$$3.\ H_2 + \tfrac{1}{2}O_2 \rightarrow H_2O: \quad \Delta\hat{H}^{\circ}_{r3} = -285.8 \text{ kJ/mol}$$

Use Hess's law and the given heats of reaction to determine the standard heat of the reaction of following reaction no. 4:

$$2\,C + 3\,H_2 \rightarrow C_2H_6: \quad \Delta H^{\circ}_{r4} = ?$$

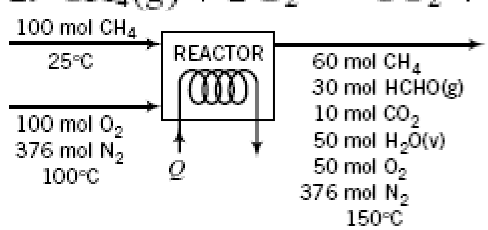
Anaswer: -48.6 kJ/mol

Steps: Obtain reaction 4 from the reactions 1, 2 & 3 by some manuplations on these reactions.

Perform the same amnuplations on the heat of reactions of reaction 1, 2, & 3 to get heat of reaction for reaction 4.

Q.2. Methane is oxidized with air to produce formaldehyde in a continuous reactor. A competing reaction is the combustion of methane to form CO. A flowchart of the process for an assumed basis of 100 mol of methane fed to the reactor is shown here.

$$1.\ CH_4(g) + O_2 \rightarrow HCHO(g) + H_2O(v)$$
$$2.\ CH_4(g) + 2\,O_2 \rightarrow CO_2 + 2\,H_2O(v)$$



Estimate the heat transfer *Q* of the process. Use following data: Standard enthalpy of formation of CH_4, HCHO, CO_2, and H_2O (v) are -74.85, -115.90, -393.5 and -241.83 kJ/mol. Use formula for C_p(kJ/mol ^{0}C) = a + bT. Assume for HCHO, $a = 34.28\times10^{-3}$ and $b = 4.268 \times10^{-5}$; for CH_4, $a = 34.31\times10^{-3}$ and $b = 5.469 \times10^{-5}$.

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

Answer: Q = -15300 kJ

Solutions Steps:

1. Write the appropriate E.B. for the given system, remove the terms, which are zero.

2. Use heat of formation data to obtain standard heat of reaction for the two reactions.

3. Obtain the enthalpies of inlet and outlet streams using the data given.

4. Obtain the value of Q from E.B. to get the answer.