Indian Institute of Technology Kanpur
ESO 201 A: Thermodynamics
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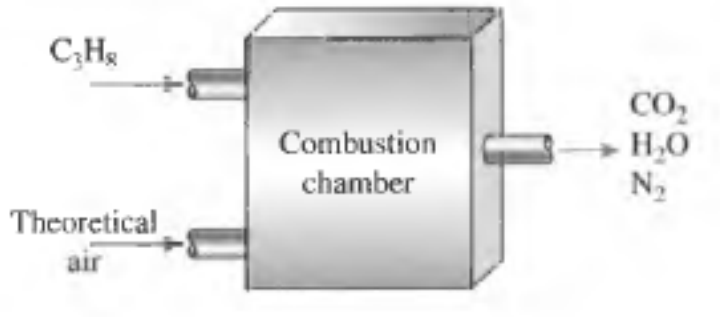
Tutorial- 13

Q.15-14

Propane fuel (C_3H_8) is burned in the presence of air. Assuming that the combustion is theoretical—that is, only nitrogen (N_2), water vapour (H_2O), and carbon dioxide (CO_2) are present in the products—determine **(a)** the mass fraction of carbon dioxide and **(b)** the mole and mass fractions of the water vapour in the products.

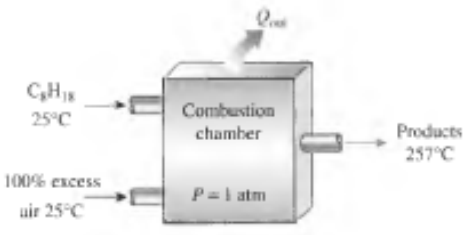


Q.15-26

Propylene (C_3H_6) is burned with 50 percent excess air during a combustion process. Assuming complete combustion and a total pressure of 105 kPa, determine **(a)** the air-fuel ratio and **(h)** the temperature at which the water vapor in the products will start condensing.

Q.15-58

n-Octane gas (C_8H_{18}) is burned with 100 percent excess air in a constant pressure burner. The air and fuel enter this burner steadily at standard conditions and the products of combustion leave at 257°C. Calculate the heat transfer, in kJ/kg fuel, during this combustion.



Q.15-71

A constant-volume tank contains a mixture of 1 kmol of benzene (C_6H_6) gas and 30 percent excess air at 25°C and 1 atm. The contents of the tank are now ignited, and all the hydrogen in the fuel burns to H_2O but only 92 percent of the carbon burns to CO_2, the remaining 8 percent forming CO. If the final temperature in the tank is 1000 K, determine the heat transfer from the combustion chamber during this process.

Homework-13

Q 15-20

n-Butane fuel (C_4H_{10}) is burned with a 100 percent excess air. Determine the mole fractions of each of the products. Also, calculate the mass of carbon dioxide in the products per unit mass of the fuel and the air-fuel ratio.

Q 15-28

A fuel mixture of 60 percent by mass methane (CH_4) and 40 percent by mass ethanol (C_2H_6O), is burned completely with theoretical air. If the total flow rate of the fuel is 10 kg/s, determine the required flow rate of air.

Q 15-60

Methane (CH4) is burned completely with the stoichiometric amount of air during a steady-flow combustion process. If both the reactants and the products are maintained at 25°C and 1 atm and the water in the products exists in the liquid form, determine the heat transfer from the combustion chamber during this process. What would your answer be if combustion were achieved with 100 percent excess air?

Q 15-62

A coal from Texas which has an ultimate analysis(by mass) as 39.25 percent C, 6.93 percent H_2, 41.11 percent0 2, 0.72 percent N2, 0.79 percent S, and 11.20 percent ash(non-combustibles) is burned steadily with 40 percent excess air in a power plant boiler. The coal and air enter this boiler at standard conditions and the products of combustion in the smokestack are at 127°C. Calculate the heat transfer, in kJ/kg fuel, in this boiler. Include the effect of the sulfur in the energy analysis by noting that sulfur dioxide has an enthalpy of formation of —297,100 kJ/kmol and an average specific heat at constant pressure of $\boldsymbol{cp}$ = 41.7 kJ/kmol-K.

Q 15-79

Estimate the adiabatic flame temperature of an acetylene (C_2H_2) cutting torch, in °C, which uses a stoichiometric amount of pure oxygen.