Fundamentals of combustion (ME608)

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Group assignment

Due date: 25/11/2021

Instructions

1. Submit a code written by the group
2. Each group members should submit a well written report comprising of results, interpretation of results and conclusions/comments
3. You are required to mention your contribution for the completion of the project.

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1. A mixture of ethane (C_2H_6) and air $\phi = 0.6$ enters a plug flow reactor of constant cross-section having diameter 3 cm at T = 1000 K, P = 1 atm and $\dot{m} = 0.2$ kg/s. Determine the length required to take the reaction to 80 % completion under steady state. Assume single-step reaction mechanism. Neglect pressure drop, radiation effects, wall mass transfer and work transfer. Consider $\Delta H_c = 4 \times 10^7$ J/Kg and $c_p = 0.122 \times 10^4$ J/Kg K

   (**Note**: Please refer to the lecture video 15 for the given quantities)

2. Propane (C_3H_8) enters a spherical (d = 8 cm) adiabatic well stirred reactor at T_1 = 298 K and P_1 = 1 atm with $\phi = 1$. Under steady state conditions determine the exit conditions from this reactor for different mass flow rates starting from $\dot{m} = 0.1$ kg/s and identify the blow-off limits.

   (**Note**: Please refer to the lecture video 17 for the given quantities)

3. In spark-ignition engines, knock occurs when the unburned fuel-air mixture ahead of the flame reacts homogeneously i.e. it auto ignites. The rate of pressure rise is a key parameter in determining knock intensity and propensity for mechanical damage to the piston-crank assembly. Now create a simple constant-volume model of the autoignition process and determine the temperature and the fuel and product concentration histories. Also, determine

dP/dt as a function of time. Assume initial conditions corresponding to compression of a fuel-air mixture from 300 K and 1 atm to top-dead-center for a compression ratio of 10:1. The initial volume before compression is 3.68×10^{-4} m^3, which corresponds to an engine with both a bore and a stroke of 75 mm. Use ethane as fuel.

(**Note**: Please refer to Example 6.1 in S.R. Turns for the given quantities)