Project Work

LH_2-LO_2 Cryogenic Rocket Performance Predictions

1. Determine the products of combustion and adiabatic flame temperature in the combustion chamber of a cryogenic rocket using Liquid Oxygen at a temperature of 80 K and Liquid Hydrogen at a temperature of 20 K. The chamber pressure of the rocket is 10 MPa. The mixture ratio is 4.5.

2. If the dissociated products of combustion are expanded in a convergent divergent nozzle of area ratio 200, plot the temperature, specific heat at constant pressure of the mixture of gases, the molecular mass, the specific heat ratio, the laminar Prandtl number and heat generation along the length of the nozzle from the recombination reactions assuming the following:

   i. Equilibrium flow in the nozzle
   ii. Frozen flow in the nozzle
   iii. Equilibrium flow up to the throat and frozen flow thereafter.

3. Calculate the exit jet velocity corresponding to:

   i. Equilibrium flow in the nozzle
   ii. Frozen flow in the nozzle
   iii. Equilibrium flow up to the throat and frozen flow thereafter.

4. Does the water condense in the nozzle under frozen flow and equilibrium flow assumptions? Is there a contribution to the Jet Velocity from the condensation? If so, comment on the availability of this energy.

You can assume the products of combustion to be dissociated at the high temperature of combustion. The dissociated products are O, OH, H, while the un-dissociated products are H_2, O_2, and H_2O. You can include $H_2O(l)$ in the expanded combustion products.

You can get the thermodynamic properties such as the Gibbs Free Energy from any book in thermodynamics or books on Combustion or in JANAF Tables. The heats of formation are available in the net and also in any standard book on Combustion.