

AS5020 Propulsion-- Exercise 1.

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1. For a given P_c and A_t , show that the thrust obtained by a Rocket is maximum when the exit pressure is equal to the ambient pressure of the rocket. Note that velocity or Mach number of the exit and the pressure at exit are related. (differentiate the thrust expression with respect to exit pressure or Mach number and look for maxima)
2. Consider the $H_2 O_2$ combustion system for rocket propulsion. If we start with temperatures of the order of 250K for both fuel and oxidiser, the final temperature after combustion is around T_c for various chamber pressures are given below along with product γ and M_w . Find the C^* for these cases.
 - a. $P_c=40$ bar, $T_c=3645K$, $\gamma=1.199$, $M_w=15.69$ g/mol
 - b. $P_c=60$ bar, $T_c=3700K$, $\gamma=1.197$, $M_w=15.78$ g/mol
 - c. $P_c=80$ bar, $T_c=3750K$, $\gamma=1.196$, $M_w=15.85$ g/mol
 - d. $P_c=100$ bar, $T_c=3780K$, $\gamma=1.195$, $M_w=15.90$ g/mol
 - e. $P_c=120$ bar, $T_c=3810K$, $\gamma=1.194$, $M_w=15.94$ g/mol
3. If C_{τ} for a given nozzle is around 1.7, find the Thrust for all the cases given in Q2. Assume $A_t=10 \text{ cm}^2$. Also find the I_{sp} .
4. Give the advantages and disadvantages of aerospike nozzle over conical nozzle.
5. Explain how the heat transfer to the nozzle is maximum at the throat.
6. What are the solutions for handling the problem of high heating in the throat, for solid and liquid propellant rockets?
7. When staging is used, how does the final velocity achieved by the payload increase?