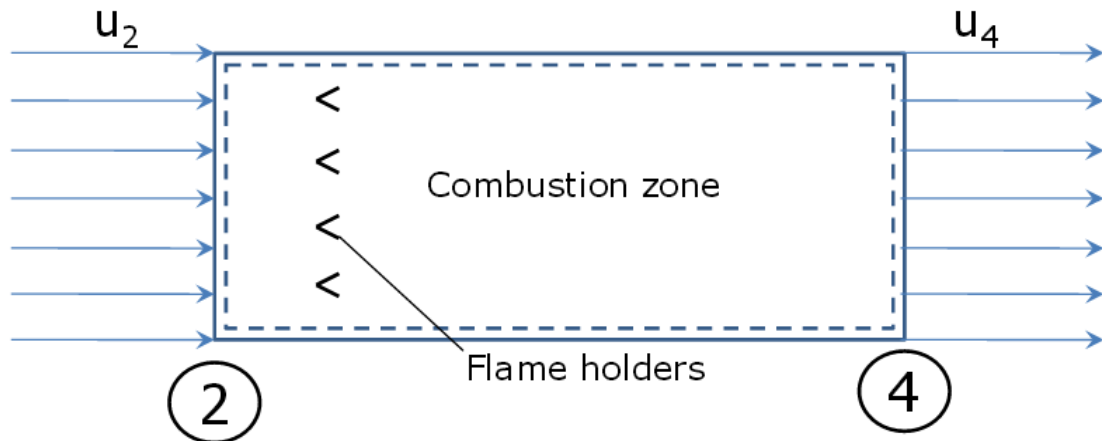


۱- محفظه احتراق رمجتی را به صورت زیر در نظر بگیرید



اگر رابطه زیر برقرار باشد:

$$P_2 - P_4 = \rho_4 u_4^2 - \rho_2 u_2^2 + K \left( \frac{1}{2} \rho_2 u_2^2 \right)$$

که در آن k نسبت افت فشار ناشی از اصطکاک است، روابط زیر را اثبات نمایید:

$$\frac{P_2}{P_4} = \frac{1 + \gamma M_4^2}{1 + \gamma M_2^2 \left( 1 - \frac{K}{2} \right)}$$

$$\frac{P_{04}}{P_{02}} = \frac{1 + \gamma M_2^2 \left( 1 - \frac{K}{2} \right)}{1 + \gamma M_4^2} \left[ \frac{1 + \frac{\gamma-1}{2} \gamma M_4^2}{1 + \frac{\gamma-1}{2} \gamma M_2^2} \right]^{\gamma / (\gamma-1)}$$

$$\frac{T_{04}}{T_{02}} = \frac{M_4^2}{M_2^2} \frac{1 + \frac{\gamma-1}{2} \gamma M_4^2}{1 + \frac{\gamma-1}{2} \gamma M_2^2} \frac{\left[ 1 + \gamma M_2^2 \left( 1 - \frac{K}{2} \right) \right]^2}{[1 + \gamma M_4^2]^2}$$

2- A ramjet is flying at Mach 1.818 at an altitude 16.750 km ( $P_a = 9.122$  kPa,  $T_a = -56.50$  C = 216.5 K., sonic speed,  $a = 295$  m/s). The flow is assumed to enter the intake of the ramjet through a normal shock standing at the intake face. No pre-entry loss or friction loss inside the engine is assumed to exist. Combustion delivery temperature is 1280 K, and the fuel –air ratio is 1:40. The area at the intake face is  $A_1 = 0.0929$  m<sup>2</sup> and at the Combustion chamber,  $A_3 = 0.1858$  m<sup>2</sup>

Calculate:

- i) Mass flow rate through the engine
- ii) Throat area in the nozzle,  $A_5$
- iii) Combustion related pressure drop in the combustion chamber
- iv) If the nozzle expands to ambient pressure –find the thrust produced
- v) If the nozzle expands only in a convergent nozzle –find the thrust produced
- vi) Calculate the propulsive efficiencies for (iv) and (v)
- vii) Calculate TSFC in both the cases
- viii) Complete and draw the cycles for the cases (a) with C-D nozzle and (b) Convergent nozzle