FABER-CASTELL
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Required booster initial thrust → 3.1×10^6 lbf = 13.8 MN
Initial chamber pressure = 700 PSI = 4.8 MPa
mixture ratio = 2.0
C_F = 1.75
C^* = 5912 ft sec^{-1} = ~~1801~~ 1801.9776 ms^{-1}

$$\dot{m}_{propellent} = \frac{P_0 A^*}{\sqrt{T_0}} \left[\gamma / R \left(\frac{2}{\gamma+1} \right)^{\gamma+1 / \gamma-1} \right]^{1/2}$$

assuming the combustion efficiency to be 0.9
the $C^*_{real} = C^* \cdot 0.9 = 1801.9776 \times (0.9)$
$= 1621.779$ ms^{-1}

$C_F (\dot{m}_{prop}) (C^*) = F$
$\Rightarrow 1.75 (\dot{m}_{prop}) (1621.779) = 13.8 \times 10^6$
$\dot{m}_{prop}$ = ~~1802.885~~ 48.6472 kgs^{-1}

In the chamber we can assume the mixture to be following ideal gas law.

for calculating throat radius
HR = 2
$C_{12} H_{20} O_2 + 16 O_2 \longrightarrow 12 CO_2 + 10 H_2O$
$\therefore$ HR stoichiometric = 16/1
$\therefore$ EAR = $\frac{2}{16} = 1/8$

$$P_t = P_c \left(1 + \frac{(\gamma-1)}{2} ER\right)^{\gamma/\gamma-1}$$

assuming $\gamma = 1.4$ $\quad \gamma/\gamma-1 = 1.4/0.4$

$$P_t = 4.8\ MPa \left[1 + \frac{0.4}{16}\right]$$

$$= 5.23\ MPa$$

$$\therefore A_t = \frac{13.8 \times 10^6\ N}{5.23 \times 10^6\ Pa} = 2.63\ m^2$$

$$\frac{\pi d^2}{4} = 2.63$$

$$\boxed{d = 1.83\ m}$$

- $\dot{M}_{ox} + \dot{M}_F = \dot{M}_{prop}$

  $\dot{M}_{ox} / \dot{M}_F = 2$

$$\Rightarrow \dot{M}_{ox} + \frac{\dot{M}_{ox}}{2} = \dot{M}_{prop}$$

$$\Rightarrow \frac{3\dot{M}_{ox}}{2} = \dot{M}_{prop}$$

$$\Rightarrow \dot{M}_{ox} = \frac{2(48.64)}{3} = 32.42\ kg\,s^{-1}$$