Rocket Nozzle Equations

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Contents

Nomenclature

A	Area
C_f	Vacuum thrust coefficient
c_s	Speed of sound
$\dot{m}$	Mass flow rate
M	Molar mass
Ma	Mach number
$mol\%$	Mole percentage
P	Pressure
R	Gas constant
R_s	Specific gas constant
T	Temperature
v	Velocity
ϵ	Nozzle area ratio
γ	Ratio of specific heats
ρ	Density

Subscripts

a	Ambient
c	Chamber
e	Exit
t	Throat
x,y	Given Position
0	Stagnation

1 Thermodynamic Relations [1]

1.1 Isentropic Flow Relation

$$\frac{T_x}{T_y} = \left(\frac{P_x}{P_y}\right)^{\frac{\gamma}{\gamma-1}} \tag{1.1}$$

1.2 Isentropic Total To Static Temperature Relation

$$0 = \frac{T}{T_0}\left[1 + \frac{1}{2}(\gamma - 1)\,Ma^2\right] \tag{1.2}$$

1.3 Isentropic Total To Static Pressure Relation

$$0 = \frac{P}{P_0}\left[1 + \frac{1}{2}(\gamma - 1)\,Ma^2\right]^{\frac{\gamma}{\gamma-1}} \tag{1.3}$$

References

[1] O. B. George P. Sutton, *Rocket Propulsion Elements*, 9th ed. Wiley, 2017.