17.2.4 Thrust Calculations

Various formulae exist to calculate gross engine thrust (Fg). However, modern engines are too complex for standard textbook formulas to accurately predict thrust; this is normally left to complex computer algorithms. The current standard for new models is the Numerical Propulsion System Simulation (NPSS). Despite this, a control volume approach relying on conservation of momentum will provide gross engine thrust if the required parameters are known.

$$Thrust = \frac{(\dot{m}_9 + \dot{m}_{fuel})V_9 - \dot{m}_0 V_0}{g_c} + (P_9 - P_0)A_9$$

Where subscript 9 represents the nozzle exit and subscript 0 represents the freestream conditions. $\dot{m}$, V, and, P represent mass flow rate, velocity, and static pressure respectively.

Variations and simplifications of this formula exist:

Turbojet and Low Bypass Turbofan (Mixed Streams)

$$Thrust = \frac{\dot{m}_0(V_9 - V_0)}{g_c}$$

High Bypass Turbofan (Separate Streams)

$$Thrust = \frac{\dot{m}_{fan}}{g_c}(V_{fan} - V_0) + \frac{\dot{m}_{core}}{g_c}(V_9 - V_0)$$

Atmospheric temperature, Mach, and altitude also significantly affect engine thrust and efficiency.