

5. No heat transfer from the rocket engine.
6. Flow is isentropic except across the shock.
7. Uniform chamber conditions at the nozzle entrance; flow properties, namely, pressure, temperature, and density remain constant.
8. Velocity at the nozzle entrance is negligibly small as compared to its exit.
9. Gas composition across the nozzle remains constant. Frozen flow in the nozzle.
10. Gas leaves nozzle exit along axial direction only.

These simplifying assumptions are quite useful in deriving simplified performance parameters that are helpful in characterizing the chemical rocket engine. Subsequently, we will discuss the correction factors by which this idealized model can be improved further.

3.3 THRUST EQUATION OF ROCKET ENGINES

An expression for the thrust developed by a rocket engine under static condition can be obtained by applying the momentum equation. For this, let us consider a control volume (CV), as shown in [Figure 3.1](#). The propulsive thrust “ F ” acts in a direction opposite to V_e . The reaction to the thrust “ F ” on the CV is opposite to it. The momentum equation for such CV is given by [4]

$$\frac{d}{dt} \int_{CV} \rho V_x dV + \int_{CS} V_x (\rho V_x \cdot n) dA = \sum F_x \quad (3.1)$$

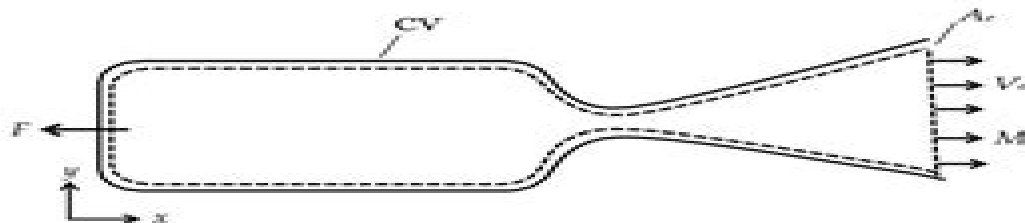


FIGURE 3.1 Control volume of rocket engine.

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Daniel F McAuley



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ELEMENTS THE DEFINITIVE INTRODUCTION TO ROCKET PROPULSION THEORY AND APPLICATIONS The recent upsurge in global government and private spending and in space flight events has resulted in many novel applications of rocket propulsion technology Rocket Propulsion Elements remains the definitive guide to the field providing a comprehensive introduction to essential concepts and applications Led by industry veteran George P Sutton and by Professor Oscar Biblarz this book provides interdisciplinary coverage including thermodynamics aerodynamics flight performance propellant chemistry and more This thoroughly revised ninth edition includes discussion and analysis of recent advances in the field representing an authoritative reference for students and working engineers alike In any engineering field theory is only as useful as it is practical this book emphasizes relevant real world applications of fundamental concepts to link thinking and doing This book will help readers Understand the physics of flight and the chemistry of propulsion Analyze liquid solid gas and hybrid propellants and the engines they fuel Consider high temperature combustion stability and the principles of electric and chemical propulsion Dissect the workings of systems in common use around the world today Delve into the latest advances in materials systems propellants and more Broad in scope rich in detail and clear in explanation this seminal work provides an unparalleled foundation in aerospace engineering topics Learning through the lens of modern applications untangles complex topics and helps students fully grasp the intricacies on a more intuitive level Rocket Propulsion Elements Ninth Edition merges information and utility building a solid foundation for innovation

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