

Chapter 7

Equations of Fluid Motion

Abstract

The equations modeling conservation of mass (continuity equation) and momentum (Navier-Stokes equations) are derived using a simple control volume analysis. These derivations elucidate the physical mechanisms in each balance and connect these phenomena to the mathematical terms which represent them. No-slip, impermeable, and free surface boundary conditions are explained and illustrated in a practical example. Scaling these conservation equations in a channel flow shows the conditions under which treating certain configurations as external or internal flows. The practical utility of these governing equations is stressed throughout. Extensive use of scaling analysis, especially in the end-of-chapter problems, illustrates the importance of understanding their origin and the usefulness of the study of their behavior, even when not finding exact solutions.