Chapter 6

Mechanical Energy Balance in Fluid Flow

Abstract

This chapter introduces a simple model for estimating the behavior of a moving fluid in a conduit by deriving a mechanical energy balance, Bernoulli's equation, which represents the transfer of mechanical energy among the net work done on the fluid (in terms of pressure drop) and changes in kinetic and potential energy. This balance neglects the loss of mechanical energy due to friction, which transforms mechanical energy into heat and appears in a mechanical energy balance as a sink.) To account for friction losses, a modified Bernoulli equation is derived to model the interaction of friction with the average velocity in the conduit and the net work added (as a pressure drop or change in potential energy). Models of frictional effects are mostly empirical correlations for friction factors as functions of Reynolds numbers and surface roughness (shown in the Moody chart) and the energy losses caused by flow through bends, fittings, and expansions and contractions in the conduit. These models are used in steady state applications such as pumping metal between two melting furnaces to mix alloys and slag flow down a launder. Models of transient system include draining of vessels and the filling of molds.