

ME-314 Homework 1: Dimensional Analysis

Due March 22

1. Electrically heated wires and pipes with the diameter, d , are mounted horizontally and are cooled by an air stream. The parameters involved in the process are:

Geometric variables: diameter, d , of the wire or pipe.

Process variables: flow velocity, v of the gas

Physical or material properties: density, ρ , kinematic viscosity, ν , heat conductivity, k , volume related heat capacity, ρC_p , of the gas, heat transfer coefficient, h .

- a. Setup the dimensional matrix and rearrange it to form the core and residual matrices.
 - b. Solve for the dimensionless numbers. Can you name these dimensionless numbers?
2. A common way to produce small droplets is to let them drip slowly from a capillary. The size of the droplet, D_d , depends on surface tension, σ_s , the diameter of the capillary, D , gravity, g , and density of the liquid. Perform a dimensional analysis to determine the dimensionless groups that govern this process.
 - a. Set-up the dimensional matrix and rearrange it to form the core and residual matrices.
 - b. Solve for the dimensionless numbers. Can you name these dimensionless numbers?
 - c. Derive an expression that predicts drop size and relate this equation to the dimensionless numbers.

