PhD Dissertation Defense Announcement Mechanical and Aerospace Engineering Department University of Texas at Arlington

EFFECT OF THERMAL CONDUCTIVITY, REYNOLDS NUMBER, ASPECT RATIO AND PACKING ARRANGEMENT ON RADIAL HEAT TRANSFER IN PACKED BEDS

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11 AM, Tuesday, Aug 3rd, 2021

Teams

Abstract

Flow tubes containing packed beds are utilized in many industrial applications including chemical manufacturing, gas purification/separation, and water filtration. Many applications of packed tubes involve heat transfer. Examples include drying, heat exchangers, endo/exothermic reactions, and solar thermal storage.

A packed bed is a typically a vertical tube filled with a packing material. The packing materials vary widely in material composition and shape. As packed beds have a wide range of applications in heat and mass transfer, there are many parameters to consider in their design.

The goal of this research is to use a computation model to quantify the impact of the packing material on the heat transfer performance as a function of non-dimensional parameters.

The study focuses on the impact of packing size, thermal conductivity, and arrangement on the radial heat transfer performance as a function of Reynolds number. A simple annular tube packed with circles (2D) and spheres (3D) is utilized for this study. The heat transfer performance is quantified by an Effective Thermal Conductivity (ETC), which indicates the overall effectiveness of the radial heat transfer performance. The studies focus on laminar flow since many applications using packed beds involve slow moving fluids to avoid large pressure drops.

Preliminary work focused on building an acceptable understanding of the problem in 2D before committing to time consuming 3D runs. A 2D rectangular packed bed is filled with different aspect ratios (tube to particle diameter ratio; $1 < \Lambda < 10$) and different porosity of circular particles to see how radial heat transfer is affected by these parameters. Two packing styles (regular & staggered) are designed to compare the effect of packing structure on ETC. Similarly, a 3D cylindrical packed bed is a packed bed filled with spherical particles of different aspect ratios ($2 < \Lambda < 10$), different heater temperatures and two packing structures (radial & hollow) to see how these parameters effect ETC.