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FEM analysis of multifluid heat exchangers

Abstract

Heat exchangers are devices for exchanging energy between two or more fluids. They find applications in various industries like power, process, electronics, refining, cryogenics, chemicals, metals and manufacturing sector. Even though heat exchanger designs have been reported quite extensively, they are generally limited to steady-state performance, single phase fluids, a few of the many possible flow arrangements and only two fluid heat exchangers. While these designs encompass the majority of the heat exchanger applications, there are some designs, which involve several fluids such as in cryogenics or fault-tolerant heat exchangers. The governing differential equations for a three-fluid heat exchanger are written based on the. conservation of energy. The finite element method is used to solve the governing differential equations along with the appropriate boundary conditions. The case of a Buoyonet heat exchanger (used for pasteurizing milk) is analysed and the results are compared with the analytical solution available in the literature. The Buoyonet heat exchanger, treated as a three-fluid heat exchanger is also analysed. The effect of heat loss to the ambient from a parallel flow double pipe heat exchanger is also investigated and the results are compared with those available in the literature. The results are presented both in terms of the temperature distribution along the length of the heat exchanger and the variation of effectiveness with NTU. The methodology presented in this paper can be extended to heat exchangers with any number of streams and any combination of the flow arrangements.

Keywords — Finite element analysis, heat exchangers, performance testing