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Evaluation of Non-Staggered Body-Fitted Grid Based Solution Method in Application to Supercritical Fluid Flows

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Abstract : The efforts to understand the heat transfer behavior of supercritical water in supercritical water cooled reactor (SCWR) are ongoing worldwide to fulfill the future energy demand. The higher thermal efficiency of these reactors compared to a conventional nuclear reactor is one of the driving forces for attracting the attention of nuclear scientists. In this work, a solution procedure has been described for solving supercritical fluid flow problems in complex geometries. The solution procedure is based on non-staggered grid. All governing equations are discretized by finite volume method (FVM) in curvilinear coordinate system. Convective terms are discretized by first-order upwind scheme and central difference approximation has been used to discretize the diffusive parts. k-ε turbulence model with standard wall function has been employed. SIMPLE solution procedure has been implemented for the curvilinear coordinate system. Based on this solution method, 3-D Computational Fluid Dynamics (CFD) code has been developed. In order to demonstrate the capability of this CFD code in supercritical fluid flows, heat transfer to supercritical water in circular tubes has been considered as a test problem. Results obtained by code have been compared with experimental results reported in literature.

Keywords : curvilinear coordinate, body-fitted mesh, momentum interpolation, non-staggered grid, supercritical fluids
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