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Development of a CFD Model for PCM Based Energy Storage in a Vertical Triplex Tube Heat Exchanger

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Abstract : Energy demands are increasing whereas energy sources, especially non-renewable sources are limited. Due to the intermittent nature of renewable energy sources, it has become the need of the hour to find new ways to store energy. Out of various energy storage methods, latent heat thermal storage devices are becoming popular due to their high energy density per unit mass and volume at nearly constant temperature. This work presents a computational fluid dynamics (CFD) model using ANSYS FLUENT 19.0 for energy storage characteristics of a phase change material (PCM) filled in a vertical triplex tube thermal energy storage system. A vertical triplex tube heat exchanger, just like its name consists of three concentric tubes (pipe sections) for parting the device into three fluid domains. The PCM is filled in the middle domain with heat transfer fluids flowing in the outer and innermost domains. To enhance the heat transfer inside the PCM, eight fins have been incorporated between the internal and external tubes. These fins run radially outwards from the outer-wall of innermost tube to the inner-wall of the middle tube dividing the middle domain (between innermost and middle tube) into eight sections. These eight sections are then filled with a PCM. The validation is carried with earlier work and a grid independence test is also presented. Further studies on freezing and melting process were carried out. The results are presented in terms of pictorial representation of isotherms and liquid fraction

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