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3-D Numerical Simulation of Scraped Surface Heat Exchanger with Helical Screw

Authors : Rabeb Triki, Hassene Djemel, Mounir Baccar

Abstract : Surface scraping is a passive heat transfer enhancement technique that is directly used in scraped surface heat exchanger (SSHE). The scraping action prevents the accumulation of the product on the inner wall, which intensifies the heat transfer and avoids the formation of dead zones. SSHEs are widely used in industry for several applications such as crystallization, sterilization, freezing, gelatinization, and many other continuous processes. They are designed to deal with products that are viscous, sticky or that contain particulate matter. This research work presents a three-dimensional numerical simulation of the coupled thermal and hydrodynamic behavior within a SSHE which includes Archimedes’ screw instead of scraper blades. The finite volume Fluent 15.0 was used to solve continuity, momentum and energy equations using multiple reference frame formulation. The process fluid investigated under this study is the pure glycerin. Different geometrical parameters were studied in the case of steady, non-isothermal, laminar flow. In particular, attention is focused on the effect of the conicity of the rotor and the pitch of Archimedes’ screw on temperature and velocity distribution and heat transfer rate. Numerical investigations show that the increase of the number of turns in the screw from five to seven turns leads to amelioration of heat transfer coefficient, and the increase of the conicity of the rotor from 0.1 to 0.15 leads to an increase in the rate of heat transfer. Further studies should investigate the effect of different operating parameters (axial and rotational Reynolds number) on the hydrodynamic and thermal behavior of the SSHE.

Keywords : ANSYS-Fluent, hydrodynamic behavior, scraped surface heat exchange, thermal behavior
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