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Simulation Analysis and Optimization on Steady-state Characteristics of Cryogenic Distillation for Helium Isotope Separation

Wednesday 24 July 2024 14:00 (2 hours)

The helium isotope separation system based on cryogenic distillation represents a pivotal part in the purification of helium-3 (3He). In this study, we designed and simulated a cryogenic distillation column using the tridiagonal matrix algorithm. The liquid holdup and pressure drop for each theoretical stage were modeled using a general packed column model, with predictions based on known packing and fluid properties. We also predicted the steady-state separation characteristics of the column under various conditions. Our investigation focused on the impact of parameters such as the number of theoretical stages, feed location, flow rates, and feed composition on product quality, condenser duty, and liquid holdup. The optimal operating conditions were identified with a 4% mixture of 3He/(3He+4He) in saturated liquid condition, resulting in 99.9% yield of 3He at the top of the column. The current research significantly contributes to the guidance of complicated experiments involving cryogenic distillation of helium isotope.

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