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A Review of Atomization Mechanisms Used for Spray Flash Evaporation: Their Effectiveness and Proposal of Rotary Bell Atomizer for Flashing Application

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Abstract : Considering the severity of water scarcity around the world and its widening at an alarming rate, practical improvements in desalination techniques need to be engineered at the earliest. Atomization is the major aspect of flashing phenomena, yet it has been paid less attention to until now. There is a need to test efficient ways of atomization for the flashing process. Flash evaporation together with reverse osmosis is also a commercially matured desalination technique commonly famous as Multi-stage Flash (MSF). Even though reverse osmosis is massively practical, it is not economical or sustainable compared to flash evaporation. However, flashing evaporation has its drawbacks as well such as lower efficiency of water production per higher consumption of power and time. Flash evaporation is simply the instant boiling of a subcooled liquid which is introduced as droplets in a well-maintained negative environment. This negative pressure inside the vacuum increases the temperature of the liquid droplets far above their boiling point, which results in the release of latent heat, and the liquid droplets turn into vapor which is collected to be condensed back into an impurity-free liquid in a condenser. Atomization is the main difference between pool and spray flash evaporation. Atomization is the heart of the flash evaporation process as it increases the evaporating surface area per drop atomized. Atomization can be categorized into many levels depending on its drop size, which again becomes crucial for increasing the droplet density (drop count) per given flow rate. This review comprehensively summarizes the selective results relating to the methods of atomization and their effectiveness on the evaporation rate from earlier works to date. In addition, the reviewers propose using centrifugal atomization for the flashing application, which brings several advantages viz ultra-fine droplets, uniform droplet density, and the swirling geometry of the spray with kinetically more energetic sprays during their flight. Finally, several challenges of using rotary bell atomizer (RBA) and RBA Sprays inside the chamber have been identified which will be explored in detail. A schematic of rotary bell atomizer (RBA) integration with the chamber has been designed. This powerful centrifugal atomization has the potential to increase potable water production in commercial multi-stage flash evaporators, where it would be preferably advantageous.

Keywords : atomization, desalination, flash evaporation, rotary bell atomizer
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