

## Test Rig Development for Up-to-Date Experimental Study of Multi-Stage Flash Distillation Process

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**Abstract :** Vacuum evaporation is a reliable and well-proven technology with a wide application range which is frequently used in food, chemical or pharmaceutical industries. Recently, numerous remarkable studies have been carried out to investigate utilization of this technology in the area of wastewater treatment. One of the most successful applications of vacuum evaporation principal is connected with seawater desalination. Since 1950's, multi-stage flash distillation (MSF) has been the leading technology in this field and it is still irreplaceable in many respects, despite a rapid increase in cheaper reverse-osmosis-based installations in recent decades. MSF plants are conveniently operated in countries with a fluctuating seawater quality and at locations where a sufficient amount of waste heat is available. Nowadays, most of the MSF research is connected with alternative heat sources utilization and with hybridization, i.e. merging of different types of desalination technologies. Some of the studies are concerned with basic principles of the static flash phenomenon, but only few scientists have lately focused on the fundamentals of continuous multi-stage evaporation. Limited measurement possibilities at operating plants and insufficiently equipped experimental facilities may be the reasons. The aim of the presented study was to design, construct and test an up-to-date test rig with an advanced measurement system which will provide real time monitoring options of all the important operational parameters under various conditions. The whole system consists of a conventionally designed MSF unit with 8 evaporation chambers, versatile heating circuit for different kinds of feed water (e.g. seawater, waste water), sophisticated system for acquisition and real-time visualization of all the related quantities (temperature, pressure, flow rate, weight, conductivity, pH, water level, power input), access to a wide spectrum of operational media (salt, fresh and softened water, steam, natural gas, compressed air, electrical energy) and integrated transparent features which enable a direct visual control of selected physical mechanisms (water evaporation in chambers, water level right before brine and distillate pumps). Thanks to the adjustable process parameters, it is possible to operate the test unit at desired operational conditions. This allows researchers to carry out statistical design and analysis of experiments. Valuable results obtained in this manner could be further employed in simulations and process modeling. First experimental tests confirm correctness of the presented approach and promise interesting outputs in the future. The presented experimental apparatus enables flexible and efficient research of the whole MSF process.

**Keywords :** design of experiment, multi-stage flash distillation, test rig, vacuum evaporation

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