Exergy and thermo-economic analysis of solar thermal cycles powered multi-stage flash desalination process

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ABSTRACT
Solar thermal power cycles assisted multi-stage flash brine recycle (MSF-BR) distillation process are thermo-economically analyzed and evaluated. In this work, the analyses are compared according to three different configurations via two techniques of solar thermal power cycles. The first technique is considered for only desalination process; however, the second is considered for desalination and electric power generation via organic Rankine cycle. Solar parabolic trough concentrator (PTC) field is considered to dominate sufficient thermal power for MSF plant. Water steam working fluid is used for a direct vapor generation (DVG); however, Therminol-VP1 working substance is used for an indirect vapor generation (IDVG) through the PTC field. Moreover, the optimized configuration from the first technique is compared with the power generation and desalination (the second technique). The comparisons are proceeding for the MSF-BR desalination plant with total productivity in the range of 5,000m3/d which the gain ratio is increased up to 12 with 40 stages. The thermo-economic results reveal that first technique achieves remarkable results related to the PTC area, the SPC, kWh/m3, and the thermo-economic product cost, $/GJ.

Keywords: Solar organic Rankine cycle; Thermo-economic; MSF-BR

1. Introduction
The water problem in the Mediterranean region is not limited to the shortage but is being extended to the low quality of water and its conversion to non-consumption purposes for specific reasons. These countries usually have abundant seawater resources and a good level of solar radiation, which could be used to produce drinking water from seawater. Although everybody recognizes the strong potential of solar thermal energy to seawater desalination, the process is not yet developed at the commercial level [1]. Cost-effective desalination, and particularly solar-powered desalination technology, can play an important role toward helping to solve the water supply problems of this region and other regions of the world [2]. Among different kinds of thermal desalination processes, multi-stage flash (MSF) evaporation process is the powerhouse of the desalination industry. MSF process has also a possibility for use with solar thermal power. Operating conditions of multi-stage flash distillation systems allow the use of different solar collectors in solar powered plants [3]. The solar MSF desalination system tested in Kuwait [4]...