A high-fidelity simulation model for the precise characterization of a solar air-cooled ammonia-water absorption chiller at part load operation

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Environmental concerns lead to the need for highly energy efficient systems powered by renewable energy, including solar energy. However, solar cooling systems are complex, both in terms of design, control, and cost. In this framework, solar concentrators provide high efficiency at high driving temperatures, favorable for thermally driven chillers. Therefore, they can be applied in industrial process integration, especially if combined with ammonia-water chillers, capable of generating temperatures below zero. The European ASTEP project is being developed to demonstrate the feasibility of the application of solar thermal energy at industrial site. Within that project, the present work aims to study the coupling between a commercial air-cooled ammonia/water absorption chiller driven by a patented solar concentrator (SunDial) to meet the cooling demand of a dairy industry located in Greece (Mandrekas) at different outdoor conditions.

The operating conditions of the air-cooled solar chiller vary greatly over time. Therefore, the performance of the chiller at part-load is key. Several strategies are found in literature to address this issue. In order to improve the control of the chiller, in this work a high-fidelity simulation model has been developed and implemented. It has been found that an essential parameter is the circulation ratio. The results show that for a desorber coupling temperature of 160 ºC and a variation in outside temperature between 10 and 45 ºC, optimum chiller performance is achieved for circulation ratios ranging from 3.03 to 39.