Thermodynamic Analysis of Ultra-Pure Water Production Plants

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Abstract

Water and Energy are strongly linked. Water purification processes are becoming increasingly necessary to meet different qualities of water. As a result, energy consumed during these purification processes is a huge and become a concern. Giving the attention to energy conservation is increase, the use of the exergy analysis to evaluate the performance of the system is also increase. This concept is recognized widely as a powerful tool to quantify the thermodynamic losses in a given process or system. One important application of exergy analysis concept is the seawater desalination in which there is a large difference between the theoretical minimum energy required for seawater desalination and the practical requirements, owing to the irreversible losses in real systems. As a result, several exergy analyses studies have been carried out to determine these inefficiencies and to give relevant recommendations for improving the desalination systems.

In this study, the three predominant Desalination Exergy Analysis Models which are; Cerci Model (Model A), Drioli Model (Model B) and Electrolyte Solution Model (Model C), had been applied on Al Ghubrah Reverse Osmosis (RO) Desalination Plant. The models have been assessed, compared and analyzed. The major exergy destruction sites in Al Ghubrah Desalination Plant had been identified, and the exergetic efficiency of the plant had been calculated. An alternative design had been proposed to increase the efficiency of the plant.

Then an exergy analysis was applied on an Ultra-pure water (UPW) production plant using the Electrolyte Solution Model (Model C). Exergy analysis was carried out on the UPW production plant which is operated under Oman climate and fed by Al Ghubrah Desalination Plant product. The exergies rates of the major elements in the UPW production plant have been calculated. Then, the top ten processes in terms of exergy destruction have been identified. Finally, the exergetic efficiency have been calculated for the highest sites of exergy destruction using the rational exergetic efficiency approach. Finally, recommendations for further researches on UPW systems have been suggested.