Performance Analysis and Multi-Objective Optimization of a Kalina Cycle for Low-Temperature Applications

Authors : Sadegh Sadeghi, Negar Shabani

Abstract : From a thermal point of view, zeotropic mixtures are likely to be more efficient than azeotropic fluids in low-temperature thermodynamic cycles due to their suitable boiling characteristics. In this study, performance of a low-temperature Kalina cycle with R717/water working fluid used in different existing power plants is mathematically investigated. To analyze the behavior of the cycle, mass conservation, energy conservation, and exergy balance equations are presented. With regard to the similarity in molar mass of R717 (17.03 gr/mol) and water (18.01 gr/mol), there is no need to alter the size of Kalina system components such as turbine and pump. To optimize the cycle energy and exergy efficiencies simultaneously, a constrained multi-objective optimization is carried out applying an Artificial Bee Colony algorithm. The main motivation behind using this algorithm lies on its robustness, reliability, remarkable precision and high–speed convergence rate in dealing with complicated constrained multi-objective problems. Convergence rates of the algorithm for calculating the optimal energy and exergy efficiencies are presented. Subsequently, due to the importance of exergy concept in Kalina cycles, exergy destructions occurring in the components are computed. Finally, the impacts of pressure, temperature, mass fraction and mass flow rate on the energy and exergy efficiencies are elaborately studied.

Keywords : artificial bee colony algorithm, binary zeotropic mixture, constrained multi-objective optimization, energy efficiency, exergy efficiency, Kalina cycle
Conference Title : ICECE 2018 : International Conference on Energy Conversion Engineering
Conference Location : Sydney, Australia
Conference Dates : December 03-04, 2018