Thermodynamic and Economic Analysis of Organic Rankine Cycle: Effect of Working Fluid Critical Temperature on the Optimal Evaporator Mass Velocity

Zhong Ge [S], Jian Li, Fufang Yang, Yuanyuan Duan [C] and Zhen Yang
Key Laboratory for Thermal Science and Power Engineering of MOE, Beijing Key Laboratory for CO2 Utilization and Reduction Technology, Beijing, Beijing, China
yyduan@mail.tsinghua.edu.cn

Organic Rankine cycle (ORC) is a promising technology for medium and low temperature geothermal water power generation due to its simple structure, good applicability, and user-friendliness. The evaporator absorbs heat from a heat source and facilitates the evaporation of working fluid; the performance of it has an important influence on ORC system. The working fluid mass velocity is the key parameter for the evaporator. A large mass velocity will enhance heat transfer but also increase pressure drop. Both the heat transfer and pressure drop will affect ORC performance. There have been few studies on the working fluid mass velocity for an ORC evaporator. Furthermore, the working fluid critical temperature also has a crucial impact on the ORC performance. The thermodynamic and economic performance of a geothermal water ORC system using 9 working fluids (R227ea, R236ea, R245fa, R600, R600a, R601, R601a, R1234yf, R1234ze(E)) with different critical temperatures are analyzed. The working fluid mass velocity effects of shell-and-tube heat exchanger on geothermal water outlet temperature, system power net output, heat transfer area, and electricity generation cost (EGC) are analyzed. The optimal mass velocities of the evaporator for obtained maximal power net output and lowest EGC of each working fluid are obtained respectively, and the influences of the working fluid critical temperature on optimal mass velocity, maximal power net output, and lowest EGC are discussed.