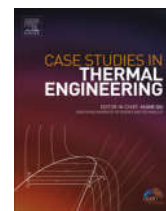




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Thermodynamic and economic performance improvement of ORCs through using zeotropic mixtures: Case of waste heat recovery in an offshore platform



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ABSTRACT

This paper presents a comparative thermodynamic and economic analysis of two kinds of organic Rankine cycles (ORCs) with pure and zeotropic mixtures for recovering waste heat from the exhaust gases of large diesel engines used in the offshore platforms of phase 12 of South Pars Gas on Persian Gulf. The mixtures of three hydrocarbons with two refrigerants in two cycle arrangements (simple ORC and ORC with internal heat exchanger) at different evaporation temperatures are investigated to optimize three indicators. The results showed that both the energy and exergy efficiencies are maximized at particular mass fractions of refrigerants. The ORC with mixture of R236ea/Cyclohexane (with a ratio of 0.6/0.4) has the best performance as its energy and exergy efficiency are 14.57% and 37.84%, respectively. These values are increased to 16.81% and 40.75%, respectively by adding IHE to system. The minimum amount of the specific investment cost for the most cases is achieved at the mass fractions of 0.1 and 0.5 and it is greater for the ORC with IHE. Also the payback period of investment is calculated for comparison of economic value of systems and it is observed that its amounts for the ORC with IHE are greater than simple one.

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1. Introduction

By the growing industrialization over the last decades, global energy consumption has increased to a level never reached before, which has led to many serious environmental problems such as climate changes, air pollution, acid rain and ozone layer depletion. Due to the energy shortage and emission problems, the issues of energy saving and energy efficiency improvement has received more attention recently and has become a field of intense research and development. Utilization of Organic Rankine Cycle (ORC) is one of the proposed solutions to increase the energy usage and to reduce environmental emissions. Waste heat recovery is one of the applications of this system. As an example, by recovering waste heat from exhaust gases of an engine, the efficiency of the engine will be greatly enhanced.

In an ORC, the working fluid is an organic compound instead of water in the traditional steam cycle. Lower boiling point temperature and higher vapor pressure of organic fluids make better conformity with low and medium temperature heat sources compared to water. Also the ORC technology has many other advantages such as possibility of local and small scale power generation, simplicity of components and startup procedure, no need to operator attendance, easy maintenance

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