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ABSTRACT

As per the data of international energy efficiency two-third of the world's energy demand is fulfilled by the burning of fossil fuel. The fossil fuels have been excessively exploited in order to meet the increasing world's energy demand. There are Several grievous consequences have been noticed due to overexploitation of fossil fuels such as Depletion of fossil fuel resources, increase in global warming, stratosphere ozone layer depletion, perturbation in climate change, acid rain, air pollutions etc.

Therefore, it is mandatory to explore new energy sources which are not only energy efficient but are also environmentally friendly. Various energy sources are available including Solar. Solar thermal is best energy source among various energy sources because it is naturally abundant, long lasting and environment-friendly.

As per the statistical data 50% of the total energy which is developed from fossil fuels generally goes waste into the environment in the form of low-grade heat (Temperature<370°C). It is difficult and uneconomical to develop power when the temperature of the working fluid falls below 370°C.

Various thermodynamic power cycles are available to generate the power from the low-grade heat source: Goswami cycle, Kalina cycle, Organic Rankine cycle, Transcritical cycle, Trilateral flash cycle. Organic Rankine cycle based system is simple to operate, easily maintainable, highly reliable. Organic Rankine cycle (ORC) is a mature method to develop the power from the low-grade heat source. However, the cycle efficiency of the low-grade heat source powered organic Rankine cycle is not up to mark using pure working fluid, owing to higher exergy loss in the evaporator.

The important limitation of using pure working fluid in the ORC system is higher exergy destruction in evaporator caused by finite temperature difference between heat source and working fluid. The performance of ORC system can be improved by using the zeotropic mixture in place of pure working fluid modification in ORC configurations and optimization of cyclic parameters by various technique (i.e. Taguchi, Analysis of variance, Grey relational analysis integrated with principal components analysis and Genetic algorithm (GA)).

In this thesis work, a Thermodynamic Analysis of solar driven Organic Rankine cycle (ORC) has been carried out using the zeotropic mixture as working. The mathematical expressions are required to evaluate the system performance of ORC have been coded in MATLAB 2015a interfaced by REFPROP 9.0. Furthermore, various optimization technique such as Taguchi, Anova, Grey relational analysis, Principal component analysis, Genetic algorithm have been applied in order to optimize the further system performances.

Results indicate that using zeotropic mixture thermal performance of ORC is better than pure fluid whereas the economy of the zeotropic mixture is poorer. The modified ORC shows better performance than a basic ORC

KEYWORDS: Low-grade solar Thermal power generation, Solar concentrator, Organic Rankine cycle, Zeotropic mixture, Thermo-economic and multi-objective optimization