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Research Paper

# A 0D model for diesel engine simulation and employing a transcritical dual loop Organic Rankine Cycle (ORC) for waste heat recovery from its exhaust and coolant: Thermodynamic and economic analysis

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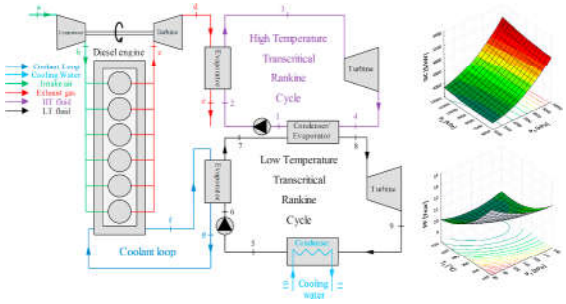
## HIGHLIGHTS

- Thermodynamic and economic analysis of waste heat recovery from an engine is done.
- Engine exhaust and coolant heats are considered for the recovery process.
- A transcritical dual loop ORC is used to produce power from the waste heats.
- A parametric study is performed to examine the effects of important parameters.
- The dual cycle produces 24.93 kW power which is 25% of the engine brake power.

## GRAPHICAL ABSTRACT




## ARTICLE INFO

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## ABSTRACT

A zero-dimensional simulation model is developed for a four-stroke turbocharged Diesel engine. In order to utilize the waste heat of exhaust and cooling water of the engine, a transcritical dual loop Organic Rankine Cycle (ORC) is employed. Temperature distributions and pinch point locations in heat exchangers are examined in detail, and performance parameters of the cycle are determined employing different working fluids, to achieve the best results. A comprehensive parametric study is also done to show the effects of engine speed and some other important parameters on the system performance. Thermodynamic properties of the engine exhaust gas and coolant are calculated using the developed simulation model for the engine which is validated with Diesel-RK software results. The simulation results show that the best performance is achieved using toluene and R143a as working fluids in high and low-temperature loops, respectively. In this case, net produced power of the transcritical dual loop ORC is determined to be 24.93 kW which is 25% of the engine brake power. The discounted payback period and specific investment cost are calculated to be 9.243 years and 4361 $/kW, respectively. The exergy analysis indicates that the highest exergy destruction rate in the cycle belongs to the condenser/evaporator.

## 1. Introduction

The world experiences many sustainability challenges. Energy is an important part of our lives and one of the key elements for achieving sustainable development in any country. Increasing living standards of people as well as technology improvements have increased energy

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