

ENGINEERING

Organic Rankine Cycle Analysis: Finding the Best Way to Utilize Waste Heat

Student researcher: Nadim Chakroun, Senior

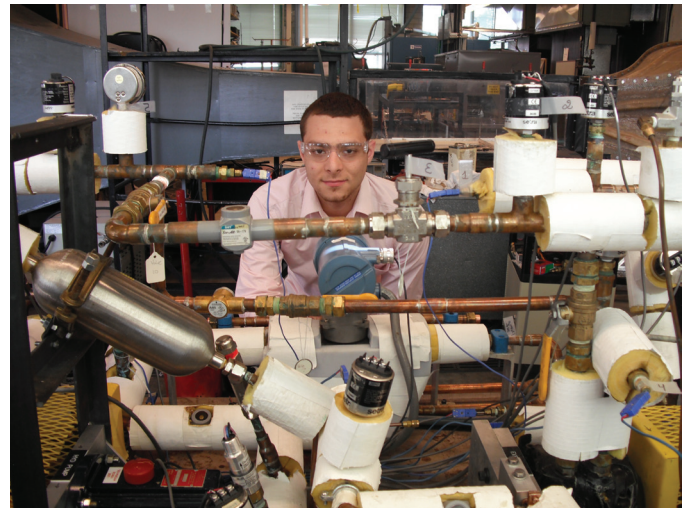
An Organic Rankine Cycle (ORC) is a type of power cycle that uses organic substances such as hydrocarbons or refrigerants as the working fluid. ORC technology is used to generate electricity in waste heat recovery applications, because the available heat is not at a high enough temperature to operate with other types of cycles. The optimum amount of working fluid required for the cycle (i.e., optimum charge level) was investigated. Three charge levels (13, 15, and 18 lb_m) were tested, and their effect on efficiency and performance of the system was analyzed.

The heat source for the fluid was waste steam from the Purdue Power Plant, which had an average temperature of 120°C. Regular city tap water at a temperature of 15°C was used as the heat sink. For each charge level, multiple tests were performed by measuring the temperatures and pressures at all state points in the cycle, in order to understand any overarching patterns within the data.

An important parameter that was analyzed is the 2nd law efficiency. This efficiency is a measure of the effectiveness of the energy utilization compared to that of an ideal case. The peak efficiency increased from 24% to 27% as the charge in the system decreased. Therefore, moving forward, this research suggests that a lower charge level

in the system will increase efficiency. However, testing below 13 lb_m might cause mechanical complications in the equipment as there may not be enough fluid to flow around; thus, a compromise had to be made.

Research advisor Professor Eckhard Groll states, “The increasing cost of energy, coupled with the recent drive for energy security and climate change mitigation, have provided the impetus for harnessing renewable energy sources, as viable alternatives to conventional fossil fuels. Organic Rankine Cycles provide the best available technology to convert this renewable energy to produce electricity.”



Chakroun with the Organic Rankine Cycle experimental setup.