



ME PhD Thesis Colloquium



Analysis and Modelling of Small Scale Organic Rankine Cycle System with Scroll Expander

ABSTRACT

In this thesis work, a comprehensive effort has been made to evaluate the efficacy of organic Rankine cycle (ORC) for microscale solar thermal power plant applications. As a first step, appropriate working fluids have been identified, which are suitable for the parameters corresponding to typical insolation and ambient conditions prevalent in most part of India. Various options for expander designs are evaluated, and it is determined that positive displacement expanders are best suited for these small scale operations, as turbines become inefficient at these scales. Also, among the positive displacement expanders, studies in literature indicate that scroll expander has a good potential for efficient operation as part of a micro scale solar application. Next, detailed thermodynamic analyses with respect to first and second laws of thermodynamics are performed with selected organic working fluids, mainly to determine the optimum process parameters and ORC configuration for each fluid. Further thermodynamic analysis of the expansion process alone is also carried out to identify the fluids most suitable for heat source temperature range corresponding to moderate insolation. Variation of sound velocity and the product $p v$ along the expander passage is examined for each fluid under various operating parameters, and these outcomes are used as inputs towards the scroll's geometric and structural design. Subsequently, a semi-empirical method is used to design and analyse various scroll geometries, and a methodology for design optimization with respect to appropriate working fluid choice is presented through non-dimensional parameters. Finally, a CFD model is developed to understand the detailed distribution of thermodynamic variables (such as pressure, temperature, density and enthalpy) during scroll expander operation.

ABOUT THE SPEAKER

Avinash Dash is a PhD scholar in the department of Mechanical Engineering at IISc Bangalore, working with Prof. Pradip Dutta in the field of thermal science. He graduated in Mechanical Engineering from Indian School of Mines, Dhanbad. He did his M.Tech in Computational and Data Science from IISc Bangalore. His research focuses on numerical thermal-fluid science and data driven research.



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