National Institute of Technology Rourkela

Registration Seminar

Seminar Title	: Design and Analysis of Cryocooler for Space Application
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Venue	: ME-Seminar Hall
Date and Time	: 11 Apr 2025 (12:00 PM)
Abstract	: Cryocoolers are essential in numerous advanced applications, where ensuring effective and accurate cooling continues to be a major challenge. The second-order analysis of Stirling cryocoolers (SC) involves idealistic predictions of the cooling effect and coefficient of performance (COP) using the equation of state, ideal isentropic compression, and isothermal expansions. The previous analyses incorporated several unrealistic approximations to aggregate the temperature variations. For example, the temperature variation in a regenerative heat exchanger is expressed as a logarithmic mean of the compressor and expansion temperatures. As a result, the previous second-order studies over-predict the ideal COP of the cryocooler. The regenerative heat exchanger is one of the critical components in SC design. Therefore, a comprehensive model for the regenerator temperature variations is necessary to make the predictions accurate. The present approach incorporates the one-dimensional temperature variation of the regenerator's mesh matrix into the second-order analysis, which is obtained by solving the heat balance equation. The model incorporates variations in mass flow rate and thermophysical properties of the working fluid, which previous studies have ignored. The current approach predicts a lesser cooling effect (1.38% less) and COP (0.34% less) than the earlier findings, which brings the prediction closer to reality. Further, the variations in the cooling effect and COP with different phase angles and expansion temperatures are explored, and the optimal phase angle for maximum COP is found between 80^{o} and 90^{o}.