ME – PhD Thesis Colloquium

Development of two new schemes of Cryogenic Cooling

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ABSTRACT

The scope of cryogenics for industrial applications has been expanding in recent times. This spurred efforts to develop cooling mechanisms customized for specific applications apart from the relevant fundamental research. Two such schemes of cooling are the subject of the present work. They are: (i) Development of in-situ system to cool the Charpy V-Notch (CVN) specimen for an Impact test and, (ii) Development of an Integral Cold Transportation system. These schemes provide a better solution to the difficulties faced in the conventional methods of cooling. The first scheme is developed to cool a Charpy V- Notch Impact test specimen at the anvil of the impact test machine. CVN Impact test is used to determine the Ductile to Brittle Transition Temperature (DBBT) which is carried out by testing a specific material specimen at various temperatures. Conventionally, these specimens are being thermally conditioned in an external chamber and then transferred onto the anvil of the impact test machine. To avoid the lag time and uncertainties associated with the transfer of specimen, an in-situ cooling system was developed. It uses a method of mixing of two streams of nitrogen, a vapor at saturated state at 77 K and a gaseous phase at 300 K. The flow rates of the two streams are determined by the required temperature and adjusted by a set of PID controlled cryogenic valves. A computational analysis was carried out to evaluate the thermo-hydraulics of the transfer system, and an experimental system was developed to realize the in-situ cooling system. Another scheme of cooling is designed to cool the sensors and other electronic equipment using a cryocooler remotely on a satellite or other space missions. The remote placement provides the vibration isolation of the electronic equipment from the compressor of the cryocooler. A thermal design of the system was first carried out with focus on the precooler. In the experimental test rig, the cold head was simulated with a liquid nitrogen bath and the load, with a resistance heater. The entire test rig was placed in a cryostat which is maintained at high vacuum condition. Different experiments were performed at both room and cryogenic temperatures. The cooling schemes discussed above were successful in meeting the desired requirement. The results of the computational/numerical work and the experimental work were compared, and the experimental investigations validated the design. This marks a significant and a successful development in the cooling schemes customized to the industrial requirement, and these schemes of cooling can be implemented where required.

ABOUT THE SPEAKER

Addala Sandeep is a Regular Ph. D. Research Scholar in the Department of Mechanical Engineering, IISc, Bengaluru under the supervision of Prof. Raghuraman N. Govardhan and Dr. G. S. V. L. Narasimham. He completed his B. Tech from GMR Institute of Technology, Rajam, Andhra Pradesh (Affiliated to Jawaharlal Nehru Technological University Kakinada, Andhra Pradesh) in 2013. He pursued his Master's degree M. Tech. from National Institute of Technology, Rourkela in 2015.His research interests are broadly in Cryogenics, Refrigeration and Air Conditioning, Heat Transfer.