Design and Development of Integral Cold Transportation System

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A new cold transportation system for a pulse tube refrigerator (PTR) that allows remote placement of the DTC (Device To be Cooled) with respect to the PTR is investigated. Such a system has practical applications in onboard space vehicles for cooling of sensors. The system works on the principle of a DC flow circuit and consists of a pressure wave generator, precooler, check valves and heat exchangers at the cold head of the PTR and the load (DTC). The precooler is a regenerator while the other heat exchangers are recuperators. All the heat exchangers are analyzed and designed to match the heat transfer requirement. In the experimental test rig, the cold head is simulated with a liquid nitrogen bath and the load, with a resistance heater. The entire test rig is placed in a cryostat which is maintained at high vacuum condition. Different experiments are performed at both room and cryogenic temperatures. The experiments include pressure testing to observe the AC-DC conversion of flow across the check valves. The temperature variation at different points of the flow circuit is monitored in time to ensure steady state. The load on the cryocooler is estimated by measuring the boil-off rate of LN2 which plays the role of cryocooler in this experimental setup. The boil off is measured by using a series of PT-100 type temperature sensors placed on a Teflon rod. The sensors are wound with nichrome wire to give a small heat input. The time taken for the rise in temperature of two consecutive sensors is used to calculate the boil-off rate. Results for the quantities of interest such as DTC load and cold head load are presented.