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HUMAN SPACE ENDEAVOURS SYMPOSIUM (B3)
New Technologies, Processes and Operating Modes Enabling Future Human Missions (7)

Author: Mr. Mansu Navaneethan
Vikram Sarabhai Space Centre (VSSC), India

THEORETICAL PERFORMANCE PREDICTION FOR COMPACT PLATE-FIN HEAT EXCHANGERS FOR INDIAN HUMAN SPACEFLIGHT PROJECT (HSP)

Abstract

Environmental control and life support system (ECLSS) is one of the most critical systems devised for Human Spaceflight Project as its primary function involves maintaining the crew cabin at a habitable environment for the full duration of the mission. For ensuring the required temperature level, it has been decided to incorporate heat exchangers with a stipulated heat removal capacity. Since space and mass optimization is essential for a flight, it was decided to propose compact heat exchangers for temperature requirements. This report aims at designing a compact plate-fin heat exchanger for transferring the required heat load. For a given volume, plate fin heat exchangers can provide more area enhancement on both sides and thus resulting in increased thermal performance. We develop a generalized algorithm for the performance prediction of compact plate fin heat exchangers by assuming counter flow, parallel flow and cross flow arrangements. In connection with this, a numerical study is carried out to determine the temperature distribution for working fluids and the separating plate for the plate fin heat exchangers by considering the energy equations for fluid and solid domain. The approach involves two dimensional heat conduction effects for the separating wall and also the axial heat conduction for the fluids by considering the effects of Peclet number. The effect of temperature nonuniformity at inlet is also considered as it may affect the performance of the heat exchanger during flow regulation. In the first stage, the conjugate heat transfer problem was solved for steady state conditions and then the governing equations were modified for obtaining the transient temperature variations. The results are also compared by varying grid size and time step. In the second phase, an attempt is also made to extend the current study for the performance prediction for multi-pass heat exchangers, by assuming that the adiabatic plane or plane of symmetry exists at the location corresponding to half fin length. The governing equations are discretized using finite difference scheme wherein central difference is applied for second order spatial derivatives are and upwind scheme is used for the first order spatial derivatives. Transient problem is solved using implicit method coupled with Gauss-Seidal iterative technique.