MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Vehicles – Mechanical/Thermal/Fluidic Systems (7)

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THERMAL MODELING AND SIMULATION FOR 'PRATHAM' IIT BOMBAY STUDENT SATELLITE

Abstract

'Pratham' is the first satellite under IIT Bombay's Student Satellite Program. It will measure TEC (Total Electron Count) of the ionosphere using Faraday's rotation method. Performance of major electrical components like solar panels, battery, etc and structural integrity depends on the temperature. Complete knowledge of the temperature distribution is a must from the design perspective. The requirement of maintaining the temperature of various critical components of the satellite within its operating limits was placed on thermals subsystem by Power, On Board Computing (OBC) and Attitude Determination and Controls (ADC) subsystems. The brief overview of the temperature management to ensure safety of the satellite under different thermal loads, is discussed.

In the initial phase, finite element analysis using Mechanical APDL solver was used for the purpose of in-orbit simulations. Due to non-linearities in radiations and intricacies in the satellite model, the computation time was quite high and the results had poor convergence. Therefore, the team decided to use NX Space System Thermal Solver. To generate more accurate results in lesser computation time, advanced meshing methods like shell method and 2D surface method are used. Different conduction and radiation couplings has been taken into account for the analysis. After various iterative analyses, finally the team generated the complete finite element model of the satellite with all the boundary conditions applied on it and performed simulations in advanced space system thermal module, which automatically takes the orbital parameters into consideration for getting accurate solar heat flux on the satellite. Thermal analysis for various orbital altitudes in the range of 500 to 800 km has been performed to ensure the proper functioning of all the satellite components as the launch is going to be at an altitude between 500-800 km.

To verify the simulation's results thermo-vacuum testing was done at ISRO in Nov'15 to check the working of the satellite hardware under various thermal loads. In this testing, all the electronic components were kept ON and their working was monitored. To verify whether the temperature remained in the operating range, the team performed detailed simulations, varying the ambient temperature from -10^0C to +50^0C for different time intervals. Thus, the simulated results were completely verified by thermo-vacuum test. The temperatures of various electrical components were within their operating range with sufficient margin, and hence the results of the simulations was successfully verified.