



Contribution ID: 72

Type: **Poster presentation (105min)**

Cold & Black Environment Design of Large Space Simulator

Thursday 10 July 2014 10:30 (2h 15m)

Abstract: The environment for a thermal vacuum test is created by a space simulator, of which cold & black is the important technical specification for spacecrafts' thermal test. The objects of the paper are shrouds and nitrogen system to simulate the cold & black environment with the effective volume $\varnothing 8500\text{mm}\times 9000\text{mm}$. As for the shroud design of a large horizontal space simulator, not only the heat transfer and temperature uniformity should be considered, but also the feasibility of manufacture, transportation and installation. Based on the computation model of shrouds' distribution, numerical simulation is conducted for flow and heat transfer in shrouds. The nitrogen system adopts a single-phase loop cycling to provide a cold source for shrouds. Sub-cooling cycling is driven by a liquid nitrogen pump in single-phase closed cycling which can absorb more heat load and sustain a stable working pressure. Given above characteristics of single-phase closed cycling, it has a common application in space simulator. The results of thermal tests show that the test data is the same as the numerical simulation, of which the shroud temperature is in the range of -191°C to -194°C . Hence, the temperature and temperature uniformity of shrouds meet the requirement of thermal vacuum test.

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Session Classification: Thu-Mo-Posters Session 3.4

Track Classification: C-14: New devices and novel concepts