

Thermal Response of a Pulsating Heat Pipe on Board the Rexus 18 Sounding Rocket: PHOS Experiment Chronicles

F. Creatini¹, G. Guidi¹, F. Belfi¹, G. Cicero¹, S. Piacquadio¹, D. Di Prizio¹, D. Fioriti¹, G. Becatti¹, G. Orlandini¹, A. Frigerio¹, S. Fontanesi¹, P. Nannipieri¹, M. Rognini¹, N. Morganti¹, A. Pasqui¹, S. Filippeschi¹, P. Di Marco¹, L. Fanucci¹, F. Baronti¹, M. Manzoni, M. Mameli^{2,*}, M. Marengo^{2,3}.

¹ Università di Pisa, DESTEC, Largo Lazzarino 2, 56122 Pisa,

² Università di Bergamo, Dept. of Eng. and Applied Science, Viale Marconi 5, 24044 Dalmine (BG), Italy

³ University of Brighton, School of Computing, Eng. and Maths, Lewes Road, BN2 4GJ, Brighton, UK

*Email: mauro.mameli@unibg.it

Abstract

This work presents the experimental results of two Pulsating Heat Pipes (PHP) with different internal tube diameter tested on board the REXUS 18 sounding rocket. As shown in Figure 1, both the test cell (experiment box containing the two PHPs) and the electronic hardware (battery pack, power management and data handling) are designed, developed and implemented by the team. The PHPs are both filled with FC-72, thus, being the critical diameter around 1.7mm at ambient temperature and on Earth gravity conditions, one PHP (1.6 mm I.D.) is around the critical diameter while the other one (3 mm I.D.) is larger. The acronym PHOS, Pulsating Heat pipe only for Space, indeed resume the concept of a two phase closed loop that is working as a PHP only in microgravity: surface tension prevails over buoyancy and the flow pattern should switch to the slug and plug PHPs typical operational regime also when the diameter is above the critical. The temperature and pressure trends are expected to reveal such a regime transition and provide further information for future space applications. The tested PHPs consist of a closed end-to-end aluminium tube with fourteen curves arranged on two planes constituting the evaporator or hot section. A heating cable wrapped around the tube in the evaporator section supplies the desired heat flux, while a phase change material allows dissipating the heat in the condenser section. A set of thirty thermocouples for each PHP is located in different tube positions and the local fluid pressure is recorded by means of a mini pressure transducer in the condenser section. Ground and flight results are compared in terms of temperature and pressure temporal trends.



Figure 1: Phos Experiment global layout