EXPERIMENTAL PERMEABILITY OF SINTERED POROUS MEDIA MULTILAYER

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Abstract. *Mini heat pipes (MHP) are employed in thermal control of electronic components, such as notebook processors and video display boards. Sintered porous media is used in mini heat pipes to perform the capillary transport of the working fluid from the condenser to the evaporator section. In this matter, there has been a development in porous media, such as the sintered multilayer, to intensify the heat transfer capacity in mini heat pipes. The measurement of permeability is an important parameter for modeling the mini heat pipes behavior. This paper presents an experimental measurement of the permeability of sintered porous multilayer using argon as the working gas. The measurement equipment was developed at LABTUCAL/UFSC. This apparatus measures the gas flux trough the sample, while recording the pressure drop. Atomized copper powder was selected to build cylindrical samples of 0.020m in diameter and 0.025m in length. Commercial powder PAC and PAM, produced by METALPÓ Ind., was used for this study. The porous media is composed of two layers with a different particle size range (average size 20 and 50µm to PAC and PAM respectively) and a third central layer as the interface of those layers. The interfacial characteristic length was determined by applying statistical images analyses using the software IMAGO®. Porosity and frequency correlations were employed as parameters of evaluation. A possible relationship between the measured interfacial characteristic length and the particle average size was identified. The experimental results were compared to models presented in literature, relating the influence of each layer to the total effective permeability.*

Keywords*: multilayer porous media, mini heat pipes, effective permeability.*

1. INTRODUCTION

Mini heat pipes (MHP) basically consist of small heat pipes that are able to efficiently transport relatively high amounts of thermal energy. They can be employed as thermal control devices in the aerospace industry, for cooling of electronic equipment, in the automotive industry, and among other applications (Faghri, 1995). The behavior of MHP with sintered wick structure has been studied by LABTUCAL (Heat pipe laboratory).

For instance, with portable computers the increase of their data processing capacity together with the decrease of their size and weight lead to the development of small processors and other electronic components that dissipate high amounts of concentrated heat. Actually, the heat dissipation of electronic components is a major limitation for the development of faster and smaller computers. Computational development has increased the data processing and reduced the components size. MHP are, basically, an evacuated metal case with a capillary structure in it to transport the working fluid. Like a classic heat pipe, the mini heat pipe can be divided into three sections: the evaporator section, an adiabatic section, and a condenser section. MHP with a sintered wick structure have been studied in the Heat Pipe Laboratory since 2005.

The main objective of the present work is to study and measure the effective permeability in multilayer porous media. Porous media permeability is an important factor to consider in the MHP project, particularly to preview the fluid pressure drop in the condenser section and the pressure distribution in the whole MHP. According to Faghri (1995) permeability can be defined as a parameter that describes the relationship between pressure drop and the mass transfer through a porous media. It is usual to use semi-empirical correlations based on experimental data to presume the system permeability. These correlations depend on the particle size, diameter, and porosity of the sintered porous media. However, employing correlations to model the permeability of MHP proves not so accurate (Faghri, 1995). Experimental measurements are indicated for precision. Homogeneous porous media that show a low effective permeability generally indicates that this material has a tiny porous ratio, and usually a low porosity. This aspect indicates a high capillary pressure, which increases the capillary pumping and the thermal resistance of the whole