Thermal Performance of Microencapsulated Phase Material (MPCM) Slurry in a Coaxial Heat Exchanger

A thesis
By
Kun Yu

Submitted to the Office of Graduate Studies of Texas A&M University
In partial fulfillment of the requirements for the degree of MASTER OF SCIENCE

February 2014

Major Subject: Mechanical Engineering
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ABSTRACT

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Microencapsulated phase change material (MPCM) slurries and coil heat exchangers had been recently studied separately as enhancers of convective heat transfer processes. Due to the larger apparent heat related to the phase change process of the phase change material (PCM), MPCMs have shown improved heat capacity when compared with water. It has also shown better performance as heat storage and secondary heat transfer fluid. Coil heat exchangers had been already used in industrial applications due to their high heat transfer performance. This study explores the use of MPCM and coil heat exchanger in terms of heat transfer efficiency and pressure drop when these two enhancers work together.

The objective of this study is to understand the effects of microencapsulated phase change material (MPCM) slurries as heat transfer fluid (HTF) on coil heat exchangers. An in depth survey of the literature pertaining to both coil heat exchangers and MPCMs has been conducted in an effort to understand the effect of using MPCMs as HTFs in different heat exchangers. The review covers the basic understanding of heat exchangers under laminar and turbulent flow as well as a more in depth review of helical coil and coaxial heat exchangers and their flow and heat transfer characteristics. Previous research in the field of MPCM's is also
presented to help understand the effects of their thermal properties including density, viscosity, thermal conductivity, and specific heat on heat transfer performance. A detailed description of the present experimental setup is given, which includes physical dimensions as well as operating parameters. Steps taken during the data reduction process are included in order to facilitate the analysis of the results. Experiments were conducted using a fully instrumented heat transfer system under laminar and turbulent flow conditions of MPCM slurry at different flow rates and mass fractions. The results are compared to each other as well as to heat transfer correlations from previous studies. Heat exchanger effectiveness calculations and results are also presented. Using these analyses, conclusions have been made on the effects of using MPCM slurry in coaxial coil heat exchangers. Results show that MPCM flows are characterized by high pressure drop, but higher heat transfer rates at a certain mass fraction. Finally, future research directions are proposed based upon the present results.