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# Improvement in Performance of closed loop Thermosyphon

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***Abstract:** Complementary computational and experimental investigations of steady, laminar, fluid flow and heat transfer in a vertical closed-loop thermosyphon operating with slurries of a microencapsulated phase-change material (MCPCM) suspended in distilled water are presented. The MCPCM particles consisted of a solid-liquid phase-change material (PCM) encapsulated in a polymer resin shell. Their effective diameter was in the range 0.5 □m to 12.5 □m, and had a mean value of 2.5 m. Tests conducted with a differential scanning calorimeter (DSC) yielded the following data: starting with the PCM in its solid state, during monotonic heating, its melting starts gradually at about 20.0 °C, occurs mainly between 25.8 °C to 28.6 °C, and is completed by about 32.5 °C; during cooling after complete melting, super cooling of the liquid PCM to a temperature of about 18.1 °C is required for the initiation of freezing, which is then completed by about 15.0 °C; if cooling is started after only partial melting, no super cooling is required to start the freezing process; and the latent heat of fusion of the encapsulated PCM is 129.5 kJ/kg. The DSC data were used to deduce the variation of the effective specific heat of the MCPCM with temperature during both heating (melting) and cooling (freezing) processes. The effective density of the MCPCM during these processes was also determined, and the rheological behavior of the slurries was characterized. In the range of parameters considered, the slurries exhibited non-Newtonian behavior. The effective thermal conductivity of the slurries was determined using a correlation available in the literature.*

***Keywords:*** **Nanofluids; Pool boiling; Two-phase closed thermosyphon and Wettability.**

## I. INTRODUCTION

Liquid-vapor and solid-liquid phase-change phenomena are the basis of a wide range of energy conversion, storage, exchange, and control systems. For example, liquidvapor phase-change phenomena are pivotal to the Rankine cycle which is the basis of the majority of large thermal power plants in use today; ice-water phase-change is used in so called ice boxes to keep food products cool; salt- and paraffin-based solid-liquid latent heat storage devices are used to enhance the efficiency of solar energy systems and thermal-control systems for buildings [Lee et al. (2006); Shilei et al. (2007)]; liquid-vapor and solid-liquid phase-change phenomena are employed for the thermal management of high-heat-flux devices in electronics [Mudawar (2003); Bergles (2003)]; and in heat pipes, capillary pumped loops, and loop heat pipes, liquid-vapor phase-change phenomena are used to achieve very high rates of heat transfer with relatively low temperature drops over large distances [Maydanik (2005)].

Also, over the last 40 years, there has been increasing research interest in the enhancement of convective heat transfer using slurries of solid-liquid phase-change materials (PCMs) suspended in a carrier liquid. The work presented in this thesis involves investigations of a closed-loop thermosyphon operating with slurries of a microencapsulated solid-liquid phase-change material suspended in distilled water. The tasks undertaken in this work include the formulation and implementation of a cost-effective mathematical model of such closed loop thermosyphons, improvements to a numerical method for solving this model, experiments to determine the effective properties of the aforementioned slurries, and a complementary experimental study of the above-mentioned closed-loop thermosyphon. The main benefit of introducing a PCM in a carrier or conveying liquid is the following: when the PCM undergoes melting or freezing, the effective specific heat of the resulting suspension or slurry is increased due to the latent heat of fusion. As a result, the rate of convective heat transfer can also be increased (relative to that obtained with just the conveying liquid with no change of phase) if the PCM and the slurry are suitably chosen for the application of interest. It is advantageous in practice to use slurries of microencapsulated phase-change materials (MCPCMs) suspended in the conveying liquid, as they provide the following desirable characteristics: no drastic changes in the effective viscosity of the slurry during the phase-change process; no mixing of the molten PCM with the conveying liquid; no clumping or agglomeration of the PCM; and, with the proper choice of the encapsulation material and size of the particles, no agglomeration and no significant separation of the MCPCM from the conveying liquid. aging and only 2% of the Japanese population is engaged in production agriculture now. This resulted in a severe lack of human labor for farming operations. In these circumstances, harvest work has been a bottle-neck of cost reduction and acreage expanding for lettuce production in Shizuoka prefecture.

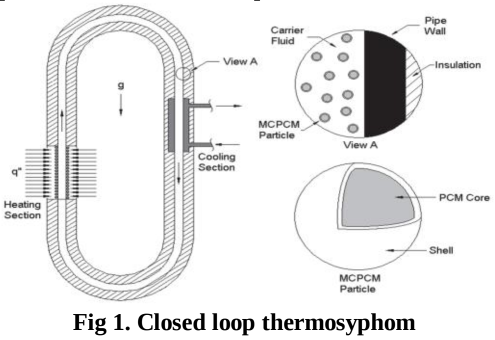


**Fig 1. Closed loop thermosyphom**

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## II. LITERATURE REVIEW

In this section the main experimental results on the Closed Loop Two Phase Thermosyphons (CLTPT) which have appeared in the technical literature in the last ten years are quoted and commented. The basic concepts related to the operation of vertical loop thermosyphons in connection with cooling systems can be originally found in works of the late nineties like Rossi and Polasek (1999), Chu et al. (1999), Garner and Patel (2001). They looked into the applications of loop thermosyphon in high-density electronic packaging and presented original test data for a traditional-design vertical loop thermosyphons with flat vertically oriented evaporators, using water as a working fluid, where the loop thermosyphons were intended for cooling of computers. Loop thermosyphons described in those publications, as well as in many others, had vertical transport lines and evaporators and did not have capillary structures in the evaporators. A summary of the experimental apparatus is provided in Fig.4.A first attempt to connect the heat flux removed from the evaporator section with the mass flow rate was carried out by Kyung and Lee (1996), which measured the mass flow rate with an orifice meter. They studied the instability in a loop applied to nuclear reactor plant, but the size and the heat load of the device are lower than those typical of high power loops. Their apparatus consists of a circular evaporator 1 m long (d=16.6 mm) which is connected with a vertical condenser. The con-denser is much wider than the evaporator (200 mm) and it is a real compensation tank, which is keep at atmospheric pressure. An orifice meter with a 9 mm

Microgravity Sci. Technol. (2012) 24:165–179171(Kyung and Lee, 1996)(Na et al., 2001)(Mudawar et al., 2003)(Honda et al., 2004)(Khodabandeh, 2005)(Hartenstine et al., 2007)Fig. 4A schematic report of some experimental devices analyzed centered hole was used to measure the mass flow rate with an accuracy of 1.5%. The working fluid was R113.They observed that the mass flow rate presented a maximum which was deeply influenced by the inlet sub-cooling. For heat fluxes higher than that of the maxi-mum flow rate, the boiling was not stable and a multimode periodic circulation was observed. For higher heat flux density wave instability was also observed. They observed a maximum flow rate which depended on the pressure drop, regulated by a valve, and the inlet sub cooling; the maximum flow rates observed were in the range 0.017–0.04 kg/s.Chu et al. (1999) tested a first thermosyphon heat loop test simulating a device for electronic equipment cooling. The apparatus consisted of an evaporator connected to an air-cooled finned-tube heat exchanger bya 25.4 mm outer diameter stainless steel pipe sewing as the vapour exhaust line and a 15.9 mm stainless steel pipe serving as the liquid return line with a finned-tube heat exchanger which functions as a condenser.

## III. ACTUAL SETUP

**Fig. 2. Set up of closed loop thermosyphon**

## IV. CONCLUSION

This section conclude the study of thermosyphon can be used large produce ejected heat in larger scale can be reuse with by using heat pipe and from the experiment thus we understand the lost heat can be reused for the various purposes instead of exhausting it to the atmosphere.

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