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A Review On Nanofluid Heat Pipe

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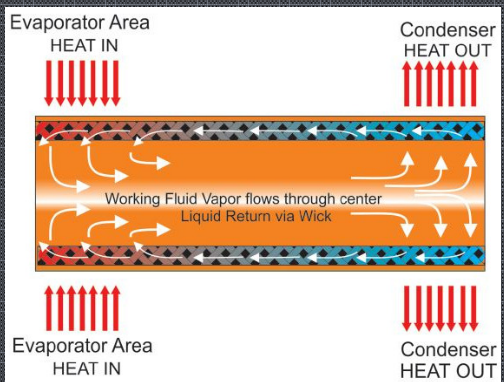
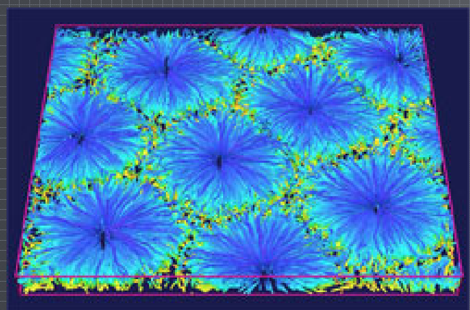
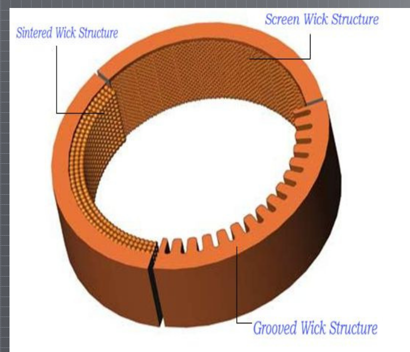






Layout

What is a heat pipe?

What is Nanofluid?

Why nanofluid heat pipe?

Heat pipe characteristics

Heat pipe limitations

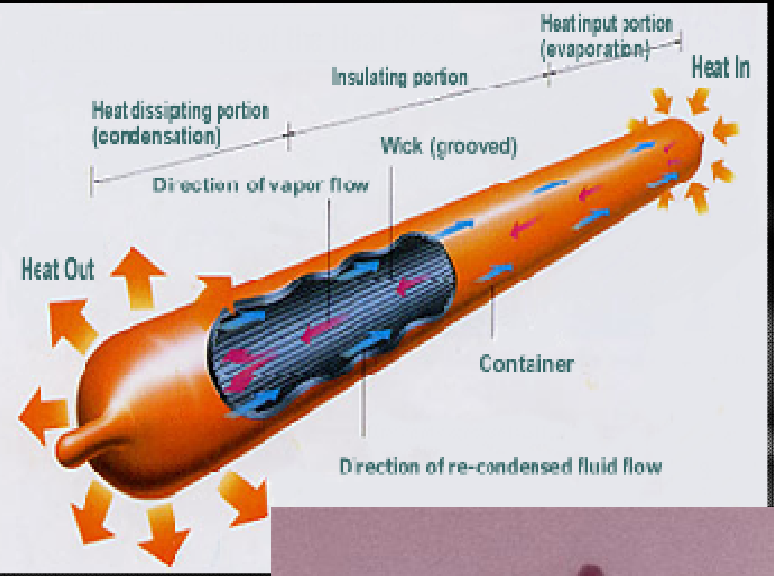
Wick design

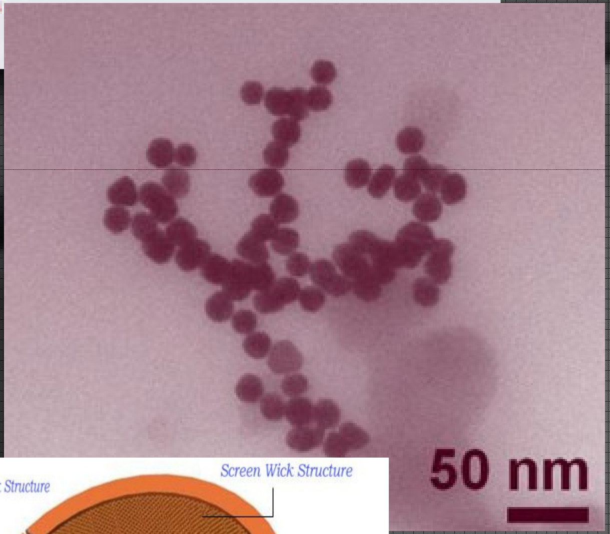
Working fluid

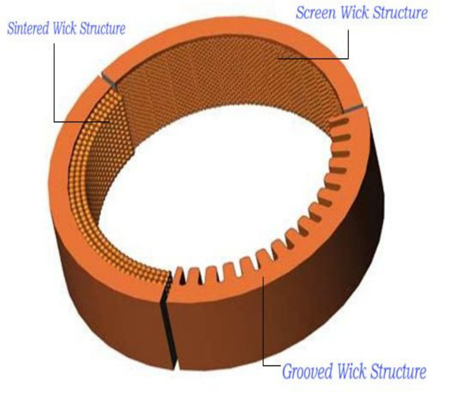
Thermophysical properties of nanofluids

Thermal conductivity

Viscosity and density







Layout

Electronics

Thermal syphon with nanofluid

Cylindrical Nanofluid Heat Pipe

Flat-SHaped Nanofluid Heat Pipe

Conclusion

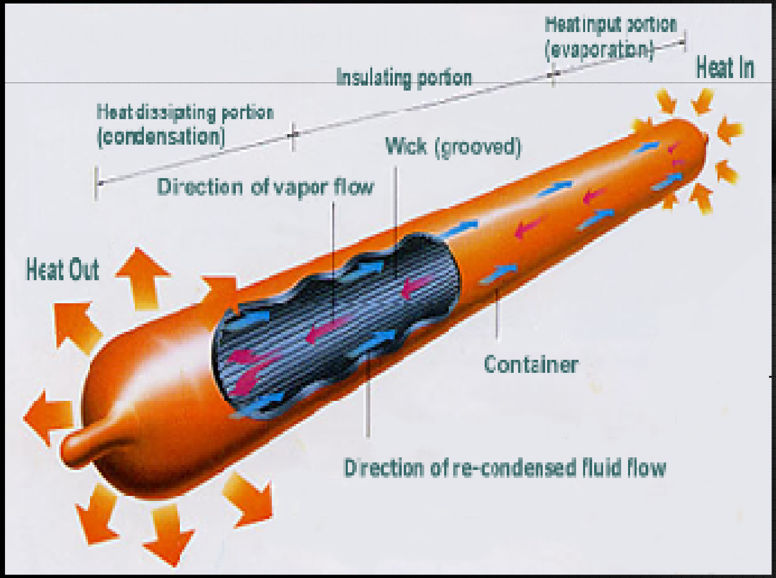
References

Questions

What Is A Heat Pipe?

Heat pipes are high capacity heat transfer devices that use evaporation, insulation and condensation as means to remove heat .

This device uses a wick, as a porous media, to pump the condensed liquid working fluid to evaporation section.



What is Nanofluid?

Nanofluid- "is a nanoparticle of solid metallic or nonmetallic materials dispersed in base fluids such as water, ethylene glycol and glycerol."

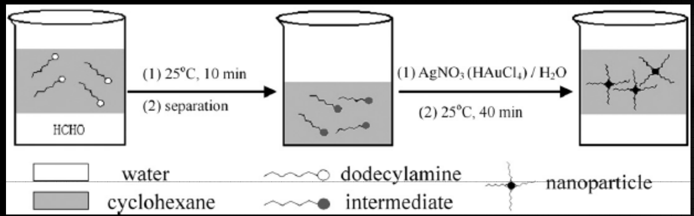
Typically made of chemically stable metals, metal oxides or carbon in various forms

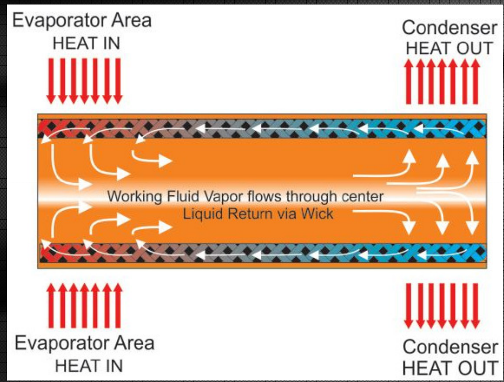
Base fluid usually water and organic fluids

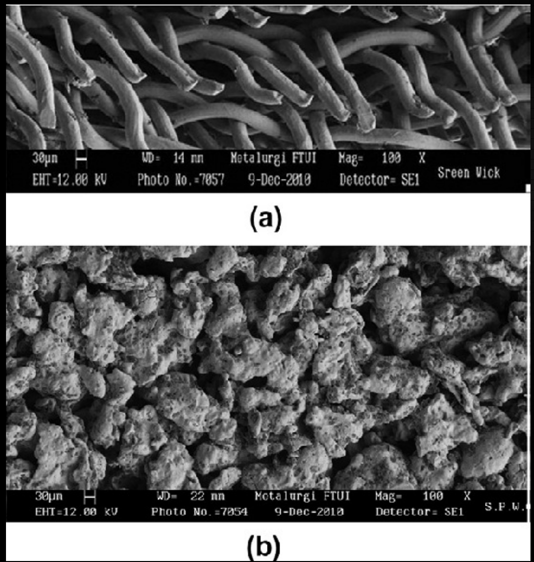
Range between 1-100nm

Why nanofluid heat pipe?

The use of nanofluid enhances heat transfer in the heat pipe due to its improved thermo-physical properties, such as a higher thermal conductivity.







Heat Pipe Applications

❖They are mainly used in cooling and thermal management in electronics, aerospace, and telecommunications.

❖Recent studies have shown that heat pipes can be used in military avionics. The LED monitors in the cockpit use very small components with very high energy and need to dissipate the heat generated very quickly.

Characteristics of Heat Pipe

Heat pipe limitation

Capillary limit

Sonic Limit

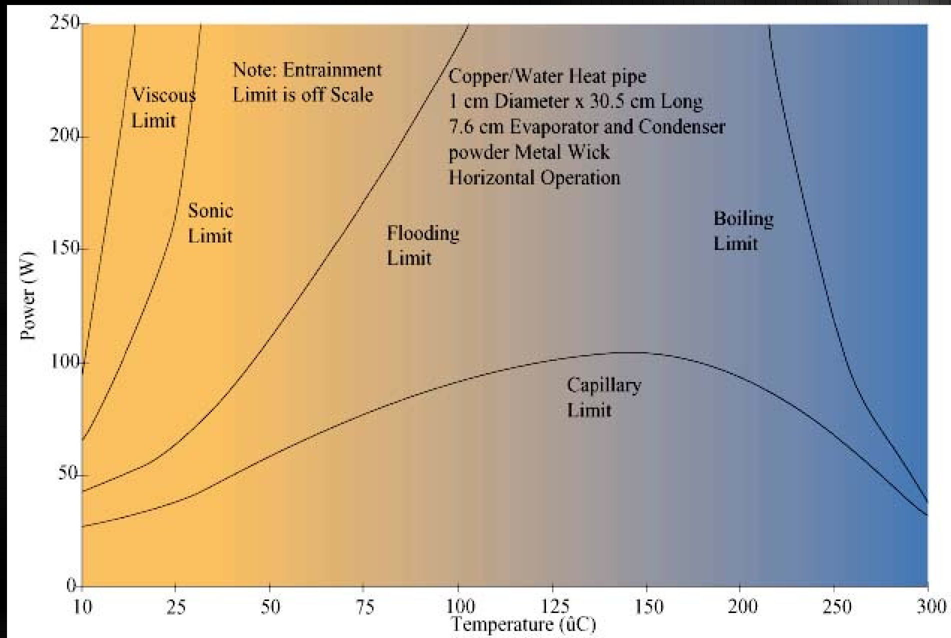
Entrainment limit

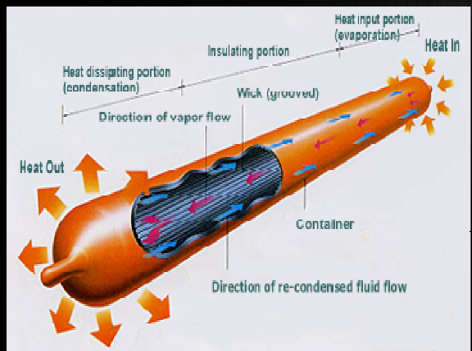
Viscous limit

Boiling limit

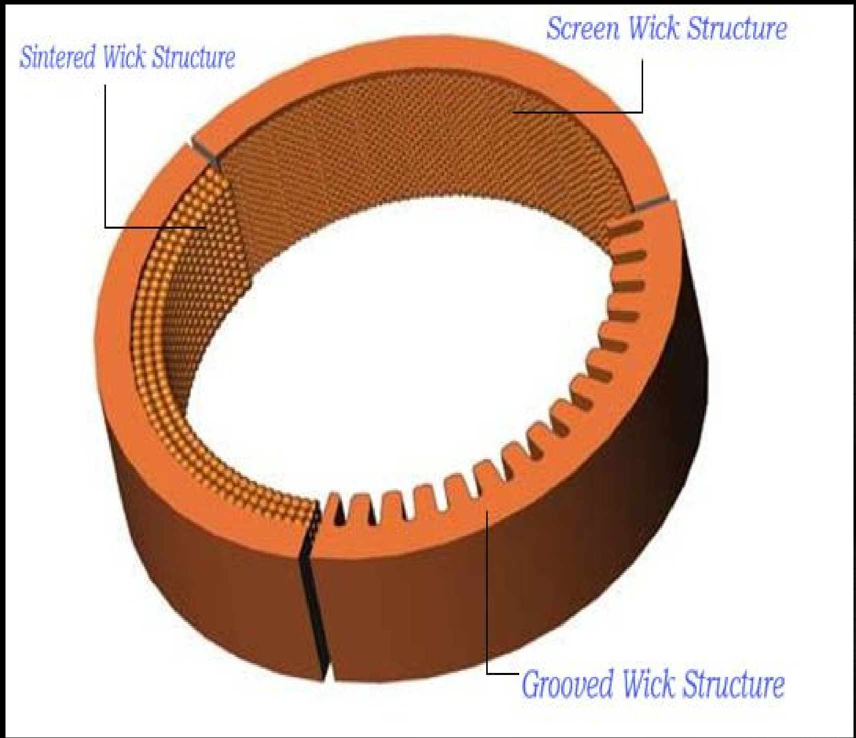
Flooding limit

Maximum Heat flux





Wick type



- The wick is in charge of the capillary action in the pipe, which traditionally is in forms of screens, wire meshes, sintered metal powders and woven fiberglass or grooves [13].
- According to Graham Rice, within an adiabatic uniform space of the heat pipe the wick structure would achieve a more stable boiling process, which provides a more uniform condensation and capillary action [7].

Working Fluid

❖Each heat pipe is used for a specific heat flux at a specific temperature range; therefore the working fluid is chosen based on the characteristics that will allow the heat pipe to work within the desired temperature range [15,16]

❖It is also important to point out that the working fluid should be compatible with the pipe itself and the wick around it .

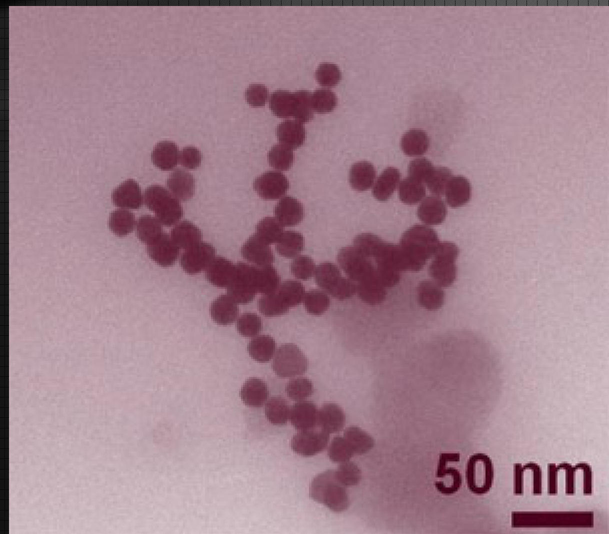
Nanofluid Characteristics

Advantages

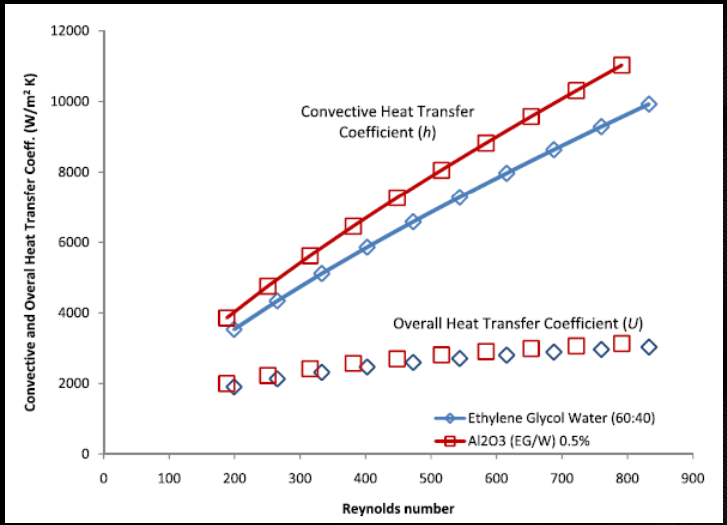
- *enhancement of thermal conductivity*
- Maintains *Newtonian behavior of fluid*
- Small Concentration

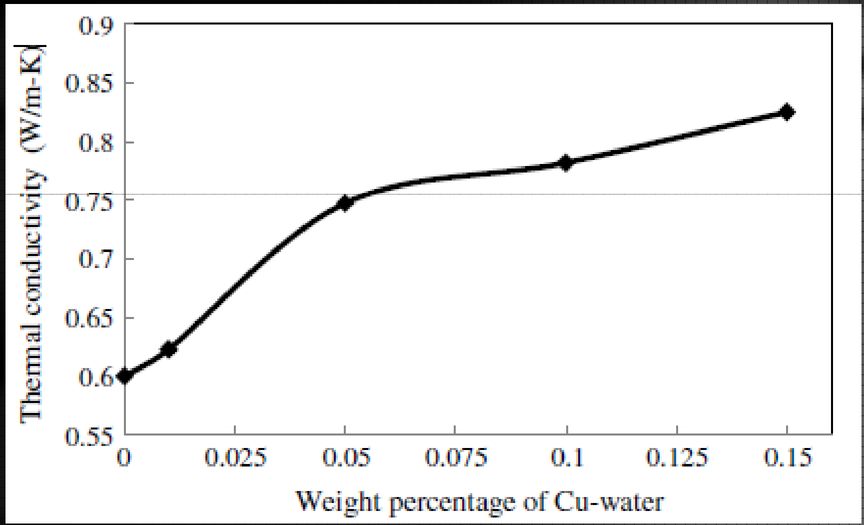
Disadvantages

- Agglomeration could cause clogging of channels
- Instability
- Increased viscosity and density
- High cost



Thermal conductivity and convection coefficient enhancement





Viscosity and Density

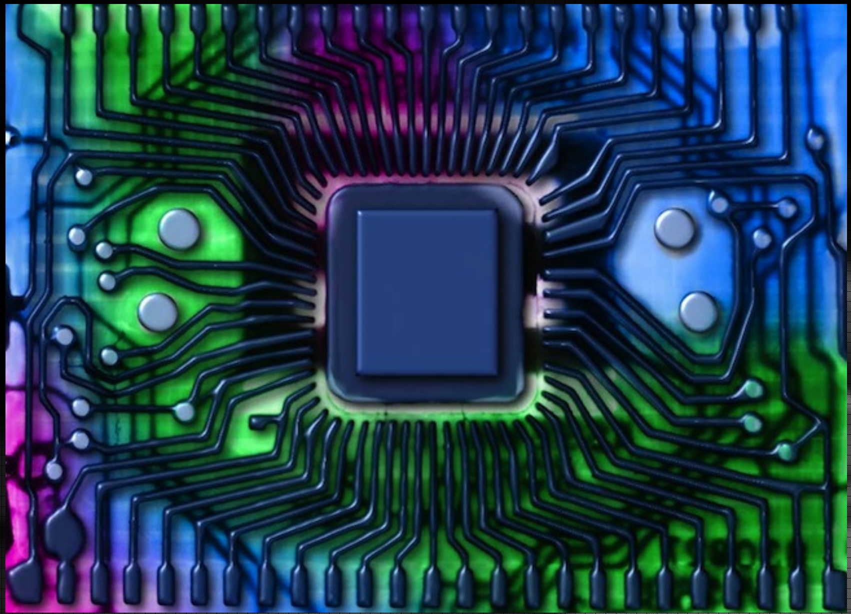
$$\rho_{nf} = \rho_p \phi + (1 - \phi)\rho_{bf}$$

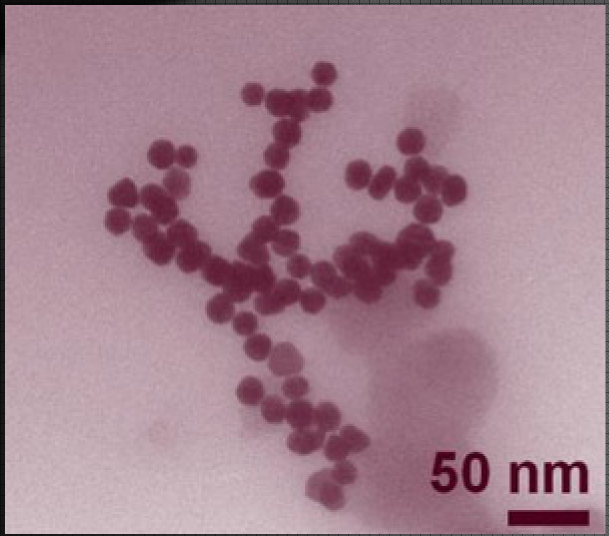
$$\mu_{nf} = \frac{\mu_{bf}}{(1 - \phi)^{2.5}}$$

Electronics

More compact and smaller electrical components, more challenge are faced to dissipate heat.

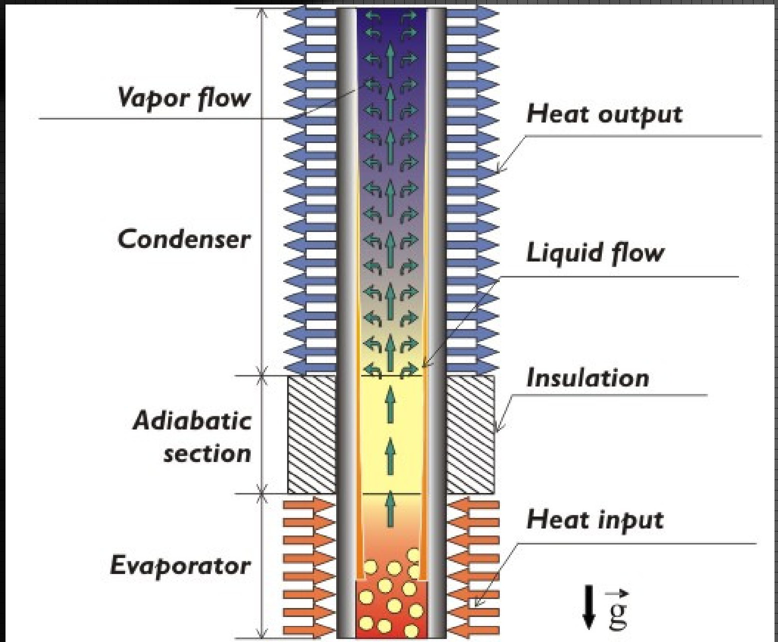
Researchers show the use of nanofluid to be more of an ideal base fluid increasing thermal conductivity and the overall heat transfer of a liquid coolant. In a study by Shokouhmand et al. on the performance analysis of microchannel heat sinks, nanofluid containing Cu nanoparticles was used for a silicon microchannel heat sink. Compared with the pure water, experimentation showed that nanofluid could enhance the performance of the heat sink by increasing both the thermal conductivity of the coolant and the nanoparticle thermal dispersion effect.





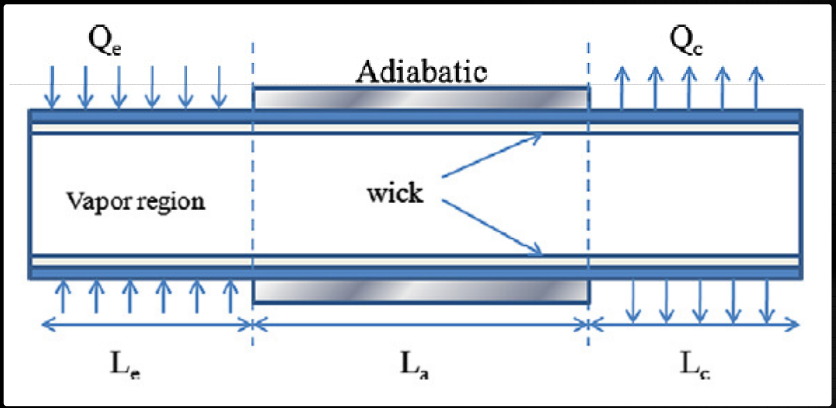
Thermal syphon with nanofluid

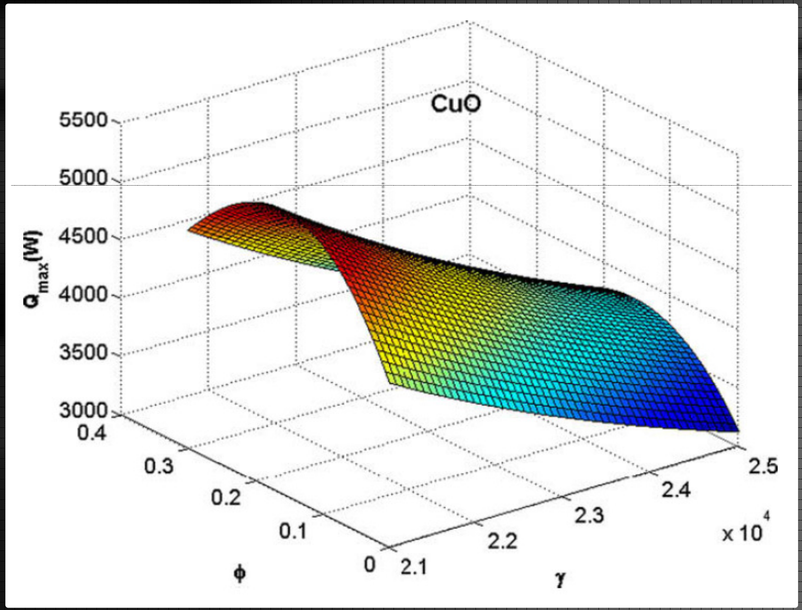
Another heat pipe model was done by Asmaie et al. with a closed two-phase thermo syphon, using CFD modeling. Because the system lacked a capillary and wicking structure, the model was mounted vertically to allow gravity to return the condensed fluid back to the evaporator section. Their study showed that the maximum heat fluxes of the thermosyphon had a remarkable increase upon substituting of the nanofluid with water as the working fluid. Under the same conditions, the maximum heat flux of nanofluid was about 46 % higher than water.



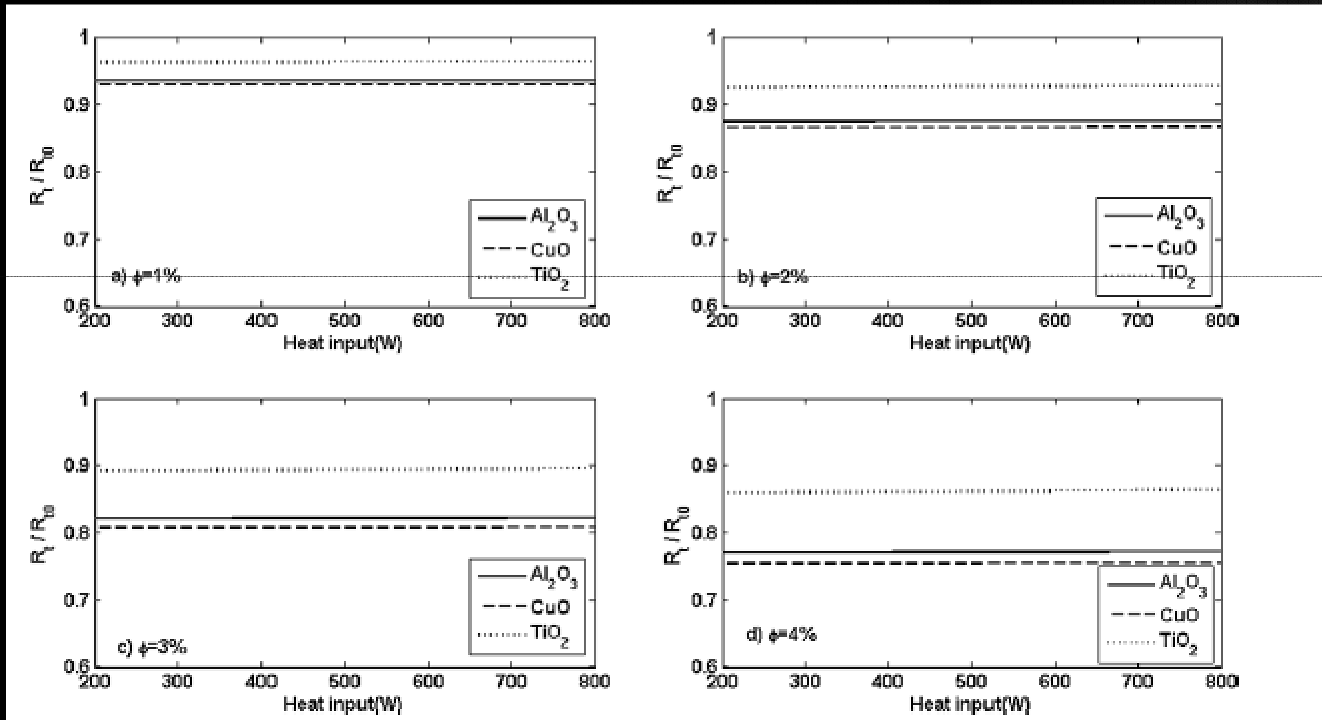
Cylindrical Nanofluid Heat Pipe

Cylindrical model assumes steady state, incompressible, and Newtonian fluid, and ignores radiative and gravitational effects. Overall, study shows improvement in thermal performance [22].

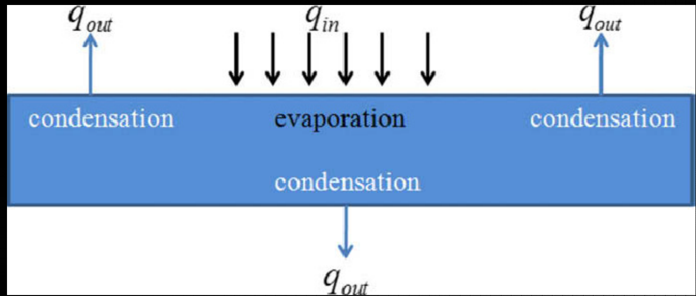


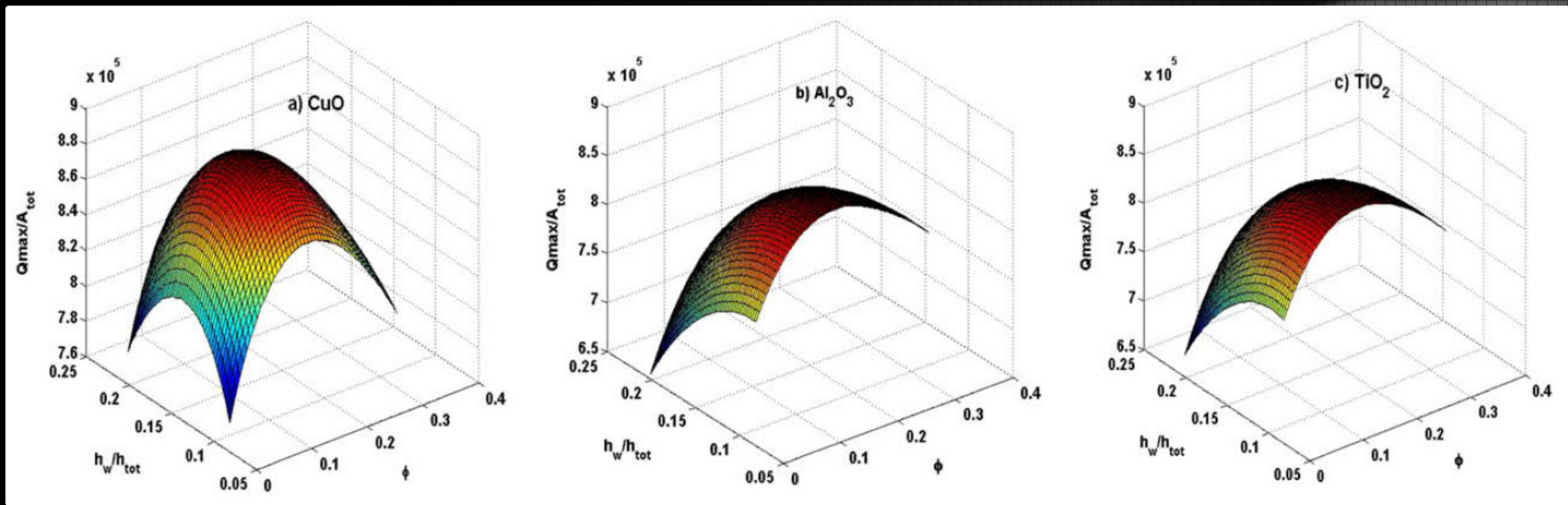


Cylindrical Heat Pipe Thermal Resistance Reduction

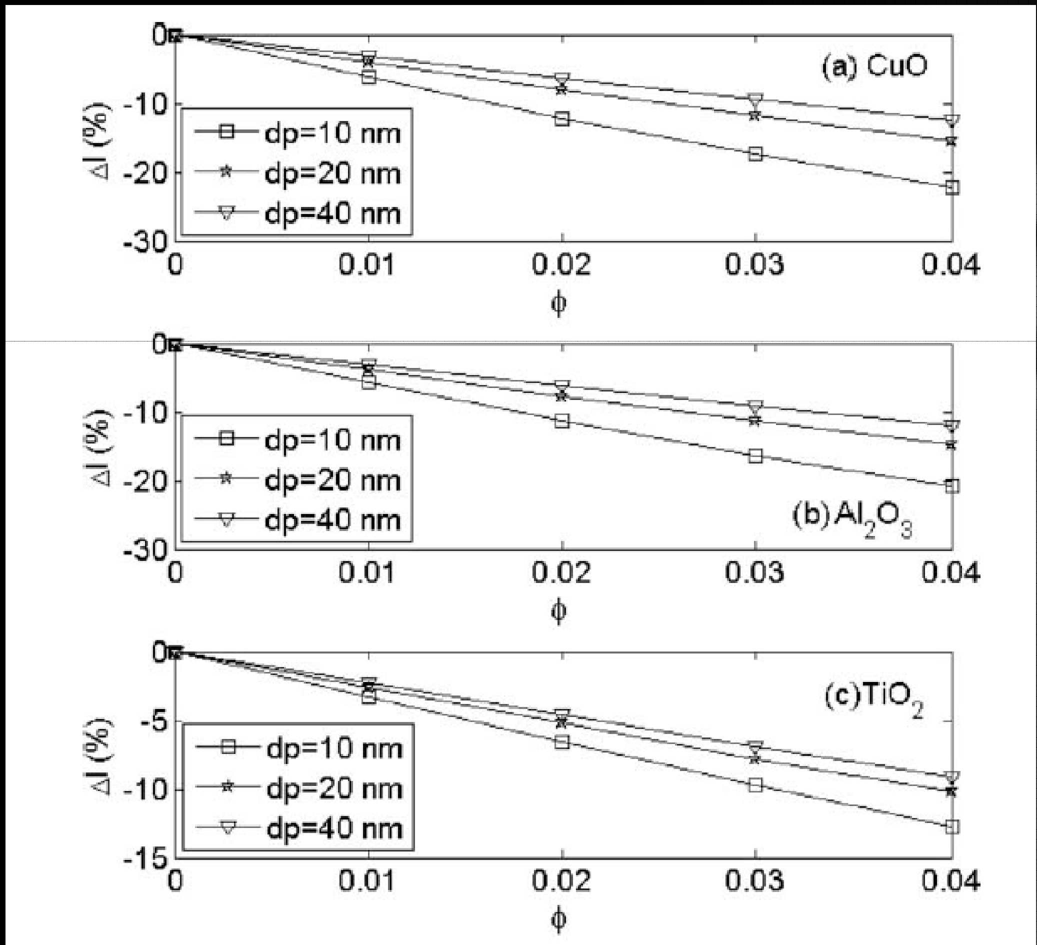


Flat Shaped Nanofluid Heat Pipe



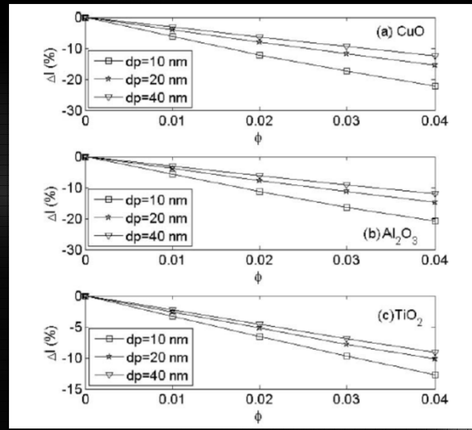


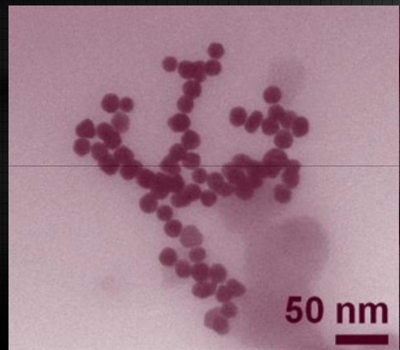
Flat Shaped Heat Pipe Size Reduction

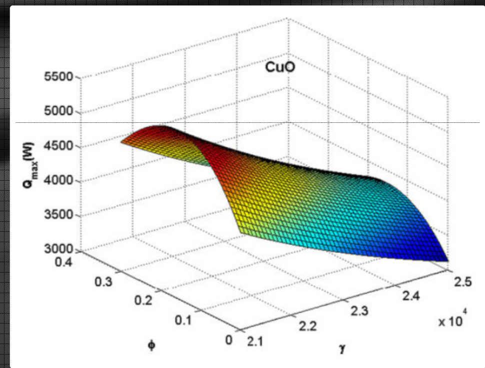


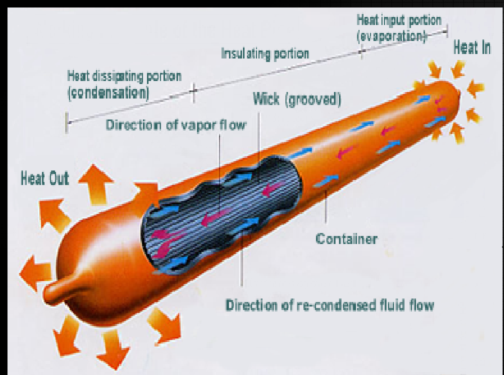
Conclusion

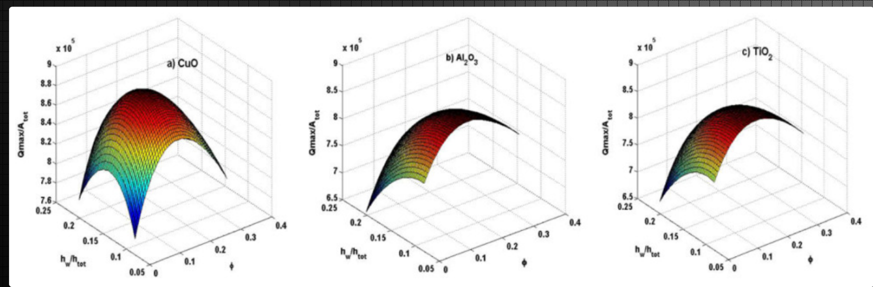
- Thermal conductivity
- Pressure drop
- Thermal resistance
- Maximum heat flux
- Heat pipe size











REFERENCES

M. Shafahi, V. Bianco, K. Vafai, O. Manca. An Investigation of the Thermal Performance of Cylindrical Heat Pipes Using Nanofluids. *International Journal of Heat and Mass Transfer,* vol. 53, pp 376-383, 2009. http://www.medgadget.com/2011/10/nanoparticle-measurement-breakthrough-could-lead-to-super-accurate-pregnancy-tests.html

M. Shafahi, V. Bianco, K. Vafai, O. Manca. Thermal Performance of Flat-Shaped Heat Pipes Using Nanofluids. International Journal of Heat and Mass Transfer, vol. 53, pp 1438-1445, 2010.

N. Zhu and K. Vafai. Analytical modeling of the startup characteristics of asymmetrical flat-shaped and disk-shaped heat pipes. International Jounral of Heat Mass Transfer, vol. 71, no. 17, pp. 2619-2637, 1998.

] L. Asmaie, M. Haghshenasfard, et al. Thermal Performance Analysis of Nanofluids in a Thermosyphon Heat Pipe Using CFD Modeling. Heat Mass Transfer, vol. 49, pp. 667-678, 2013.

M.C.S. Reddy, V.V. Rao. Experimental Investigation of Heat Transfer Coefficient and Friction Factor of Ethylene Glycol Water Based TiO2 Nanofluid in Double Pipe Heat Exchanger With and Without Helical Coil Inserts. International Communications in Heat and Mass Transfer, vol. 50, pp.68-76, 2014.

[Wael I.A. Aly. Numerical Study on Turbulent Heat Transfer and Pressure Drop of Nanofluid in Coiled Tube-in-Tube Heat Exchangers. Energy Conversion and Management, vol. 79, pp. 304-316, 2014.

H. Shokouhmand, M. Ghazvini, J. Shabanian. Performance Analysis of Using Nanofluids in Microchannel Heat Sink in different Flow Regimes and its simulation using Artificial Neural Network. Proc. of the World Congress on Engineering, vol. 3, 2008.

W.N. Septiadi, N. Putra, M. Juarsa, I.P.A Putra, R. Sahmura. Characteristics of Screen Mesh Wick Heat Pipe with Nanofluid as Passive Cooling System. Atom Indonesia, vol. 39, no. 1, pp. 24-31, 2013.

L.G. Asirvatham, R. Nimmagadda, S. Wongwises. Heat transfer performance of screen mesh wick heat pipes using silver-water nanofluid. International Journal of Heat and Mass Transfer, vol. 60, pp. 201-209, 2013.

[54] K.H. Do, S.P. Jang. Effect of nanofluids on the thermal performance of a flat micro heat pipe with a rectangular grooved wick. International Journal of Heat and Mass Transfer, vol. 53, pp. 2183-2192, 2010.

R. Saleh, N. Putra, S.P. Prakoso, W.N. Septiadi. Experimental investigation of thermal conductivity and heat pipe thermal performance of ZnO nanofluids. International Journal of Thermal Sciences, vol. 63, pp. 125-132, 2013.

http://www.lepten.ufsc.br/english/research/tucal/presentation.html

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