Layered wicks enable passive transport of condensation out of cooling systems

Nhicolas Aponte

Jordan Morrow

Gennifer Riley

Partha P. Chakraborty

Melanie M. Derby

See next page for additional authors

Recommended Citation

Presenter Information

Nhicolas Aponte, Jordan Morrow, Gennifer Riley, Partha P. Chakraborty, and Melanie M. Derby

Layered wicks enable passive transport of condensation out of cooling systems

Nhicolas Aponte, Jordan Morrow, Gennifer Riley, Partha Chakraborty, Dr. Melanie Derby
Department of Mechanical and Nuclear Engineering, Kansas State University

Motivation

- The cooling process that occurs in systems like condensers or the cooling towers of a power plant often occurs through the condensation of water, which forms a liquid film
- This liquid film reduces heat transfer, making the cooling system less efficient
- In this work, we use the capillary/surface tension forces to passively transport water. This is applicable for removing liquid films from condensers

https://pixabay.com/photos/power-plant-industry-chimney-2411932/

Hypothesis

- Wicks can be used to passively transport condensation out of condensers (i.e., power plant cooling systems)

Methodology

- SOLIDWORKS was used to design wicking structures which were then sent to WSU to be 3-D printed
- The wicks used in these experiments are an array of layered spheres bridged by cylindrical columns
- Porosity was calculated using the following equation

$$\varepsilon = \frac{V_{total} - V_{solid}}{V_{total}}$$

- The interactions between the wick and the water are observed under a high speed camera

Rate-of-rise Test

Wick — Wick

Water front

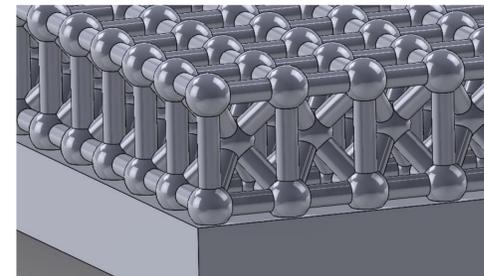Water Reservoir — Water Reservoir
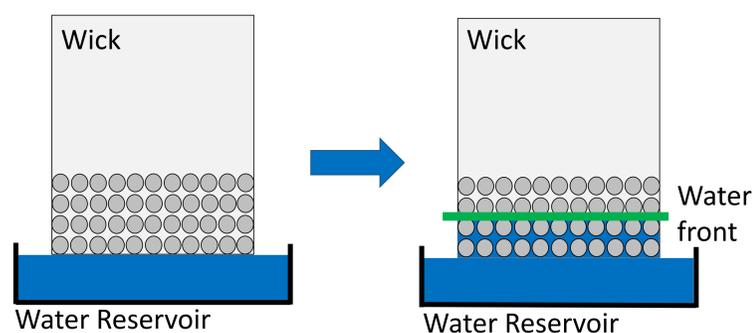
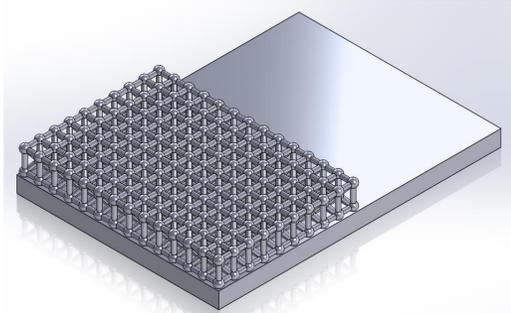## Wick Designs

Wick A:
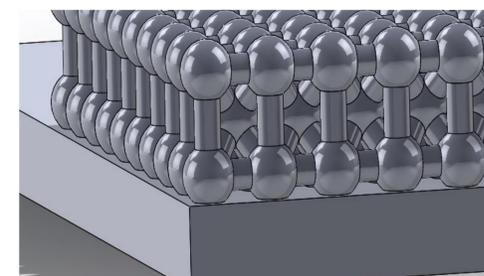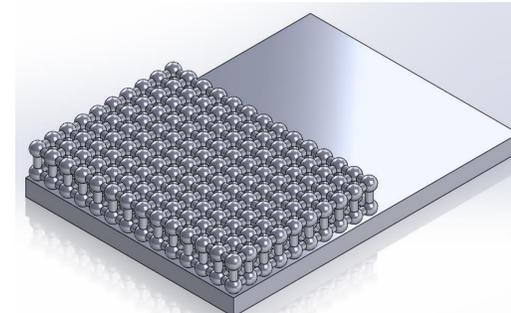Sphere Diameter: 1.00 mm   Bridge Diameter: 0.5 mm   Porosity: 0.66

Wick B:
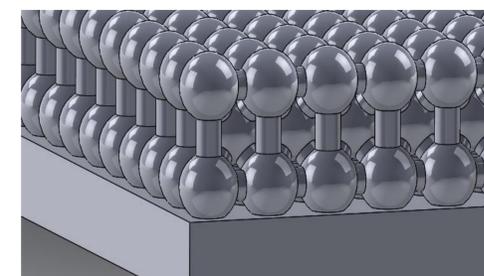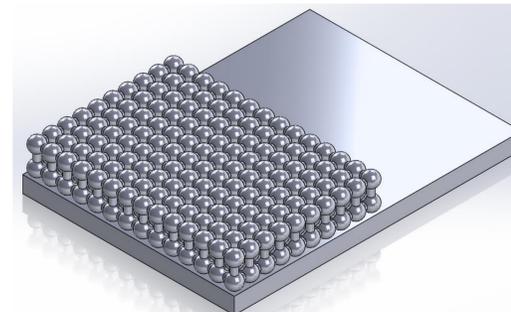Sphere Diameter: 1.50 mm   Bridge Diameter 0.75 mm   Porosity: 0.42

Wick C:
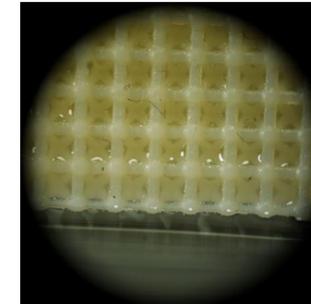Sphere Diameter: 1.75 mm   Bridge Diameter: 0.75 mm   Porosity: 0.35
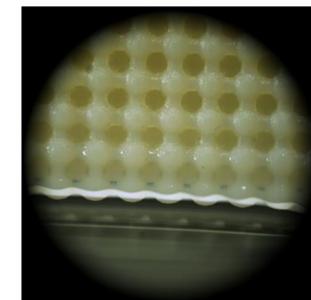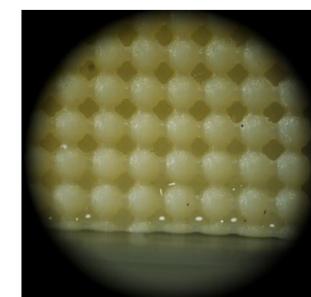
3-D Printed Wicks

- When the wicks were printed, due to the small pore volume of the wicks, the support material left debris between the layers of the wick

  - Wick A after further cleaning; debris left inside will make it difficult to quantify any measurements
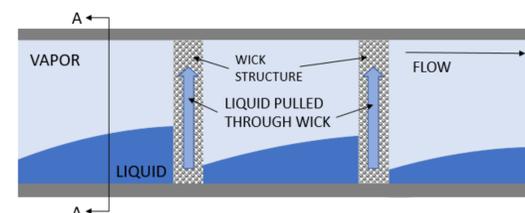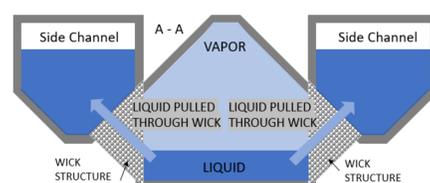
  - Wick B after further cleaning; due to low porosity, debris remains within structure

  - Wick C after further cleaning; due to low porosity, support material remains attached to structure – unusable for testing
  - Future wicks will be designed with a greater pore volume than wick C

Conclusions

- The design process for these wicks outlined various factors to be accounted for as this project moves forward. Wick A will serve as a point of reference for future wicks
- The success of this project could improve space cooling systems and power plants
- Below is a conceptual sketch of the application of this project

Side Channel   A – A   Side Channel

VAPOR

LIQUID PULLED THROUGH WICK   LIQUID PULLED THROUGH WICK

WICK STRUCTURE   LIQUID   WICK STRUCTURE

A

VAPOR   WICK STRUCTURE   FLOW

LIQUID PULLED THROUGH WICK

LIQUID

A

Acknowledgements