# Hybrid Nanofluids Heat Transfer in Metal Foam and Comparison to Ordinary Nanofluids

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# Outline

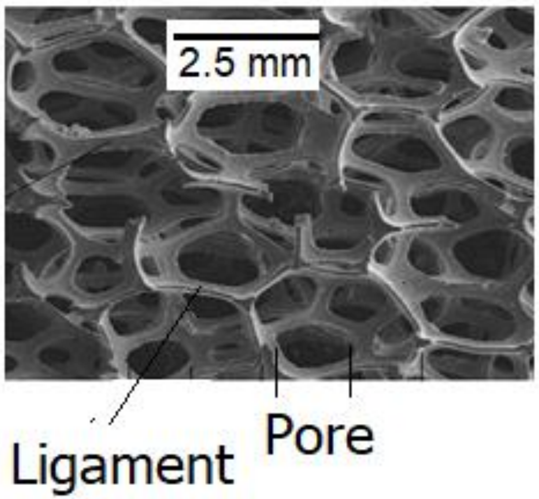
- Motivation
- Objective
- Problem Description
- Simulations
- Results
- Conclusion

# Motivation

- Hybrid Nanofluid
  - Nanofluids are better heat transfer fluids because they enhance thermal conductivity of base fluids.
  - A hybrid nanofluid (HNF) is a fluid that contains two or more chemically-distinct nanoparticles dispersed in a base liquid.
  - HNFs are the new generation of ordinary nanofluids (NFs)
  - They have great potential in many applications
  - Conflicting results on heat transfer enhancement are reported in the literature.
  - The authors have shown that HNFs outperform NFs in an open circular tube (*N. Dukhan and A.R. Radmanesh, "Comparison between Ordinary Nanofluids and Hybrid Nanofluid Heat Transfer in a Heated Tube," 14th International Conference on Thermal Engineering, Yalova, Turkiye, May 25- 27, 2023*.)

# Motivation

- Metal Foam
  – High thermal conductivity
  – Large surface area
  – Good permeability
  – Light-weight (High porosity)
  – Tailor-able and machine-able




Potential flow and thermal applications:

➢ Heat exchangers
➢ Heat sinks
➢ ……

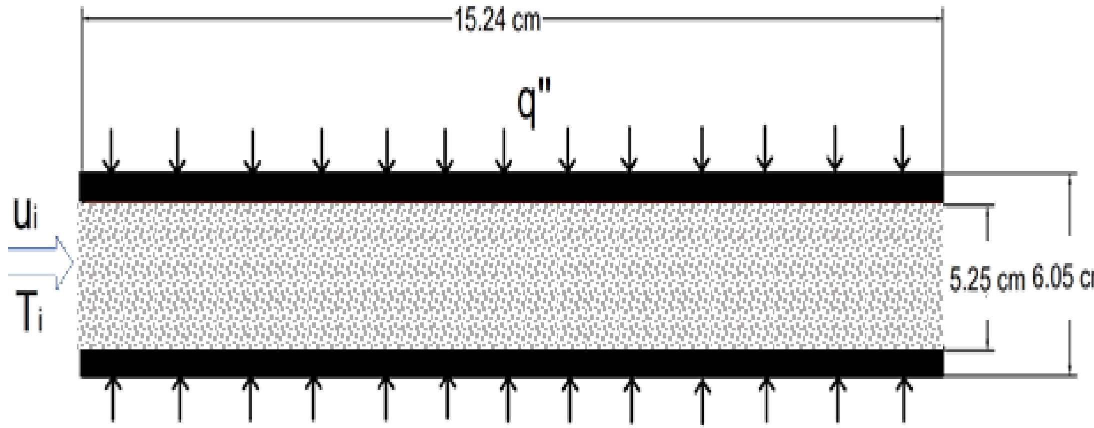
# Objective

- Investigate heat transfer due to flow of hybrid nanofluids in open-cell metal foam; compare to ordinary nanofluids.

# Problem Description

Circular pipe with uniform heat flux filled with aluminum foam:

- Open-cell aluminum foam:
  - ❑ Porosity: 95%
  - ❑ Pore density: 20 pores per inch
- Fluids:
  - ❑ DI water
  - ❑ $Al_2O_3$/Water, 1.5%
  - ❑ $TiO_2$/Water, 1.5%
  - ❑ $Al_2O_3$/$TiO_2$/Water, 1.5% (50:50)




- Boundary conditions:
  - ❑ Ti =298 K
  - ❑ ui = 0.029 m/s
  - ❑ q″ = 15518 W/m2

# Simulations

- Resources and Details
  - ANSYS Fluent 2021 R1
  - Local station AMD Ryzen 7 1st Gen - 8-Core 3.4 GHz, dual processor, 64 cores, and 32.0 GB RAM
  - Uniform square-shaped elements
  - Near-wall higher density to capture small variations
  - Even though the maximum Reynolds number was Re = 2125, which makes this pipe flow laminar, a k-ε turbulent model was adopted in the simulation, based on recommendation by Fluent.
  - Each run took approximately 25 minutes to converge.

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- Resources and Details
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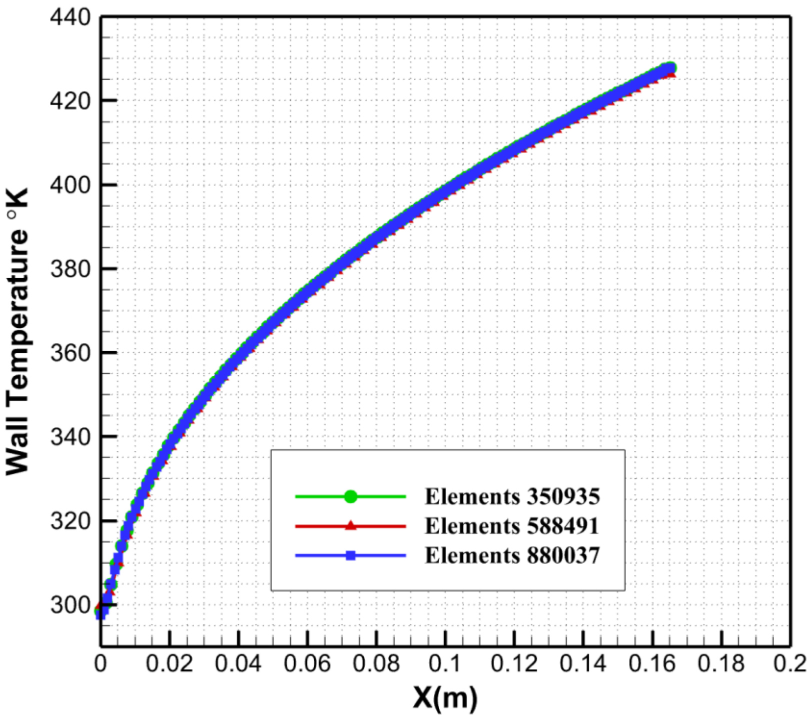
  - Uniform square-shaped elements
  - Near-wall higher density to capture small variations
  - Maximum Re = 2125, so laminar, k-ε turbulent model was adopted, based on recommendation by Fluent.
  - Run time 25 minutes.

- Mesh Independence
  - Total temperature across test section change less than 2%.
  - Final mesh:
    - 588491 elements
    - 600710 nodes



# Results

- Observations
  - Two mono nanofluids produce roughly same wall temperatures.
  - Hybrid nanofluid produces much lower wall temperature, up to 50%.
  - Thermal development
  - The gap between the surface temperature for all fluids is seen to increase along the pipe.