Novel Heat Exchanger Design Based on Porous Materials (CRADA Baltimore Air Coil)

Kashif Nawaz, Sr. R&D Staff, nawazk@ornl.gov

Summary Statement

The evaporative cooling process has been successfully deployed in multiple energy conversion processes such as power generation, process cooling, HVAC, and commercial and industrial refrigeration.

- Key to the performance of direct and indirect evaporative coolers is the packing media:
  - Increase in surface area and residence time
  - Enhancement of flow mixing—Increased heat and mass transfer
  - Conventional technologies rely on *nonmetallic* structures
  - Carry-over is unavoidable owing to structure (5%–10% loss owing to carry-over)
- A novel heat exchanger design based on porous materials was proposed as a next-generation hybrid solution for direct/indirect evaporative cooling processes

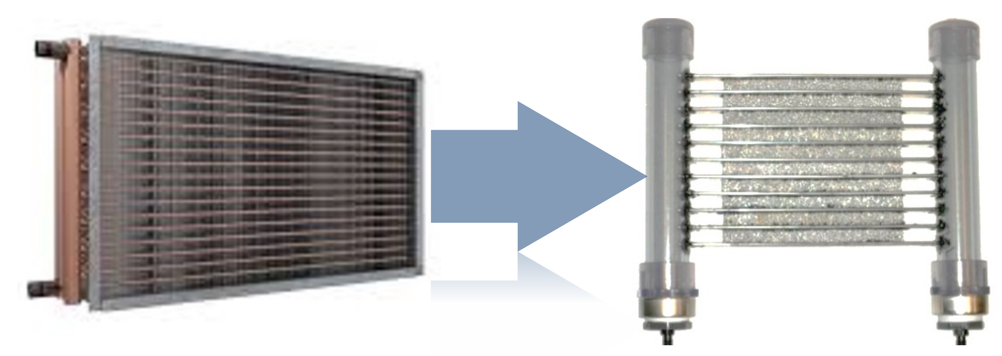

Figure 1: Replacement of conventional heat exchanger with novel design.

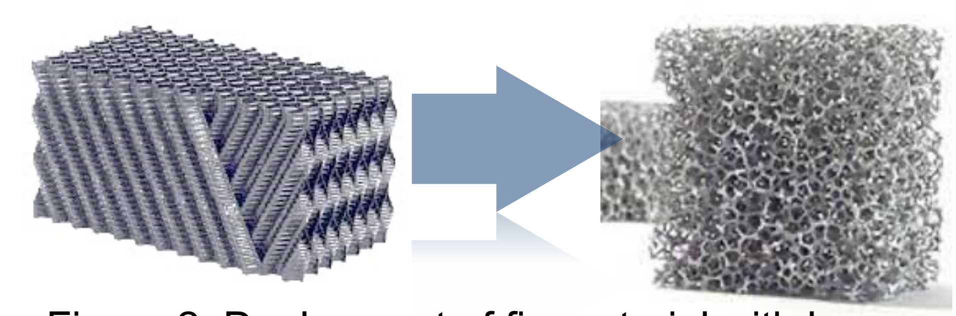

Figure 2: Deployment of fin material with large surface area.

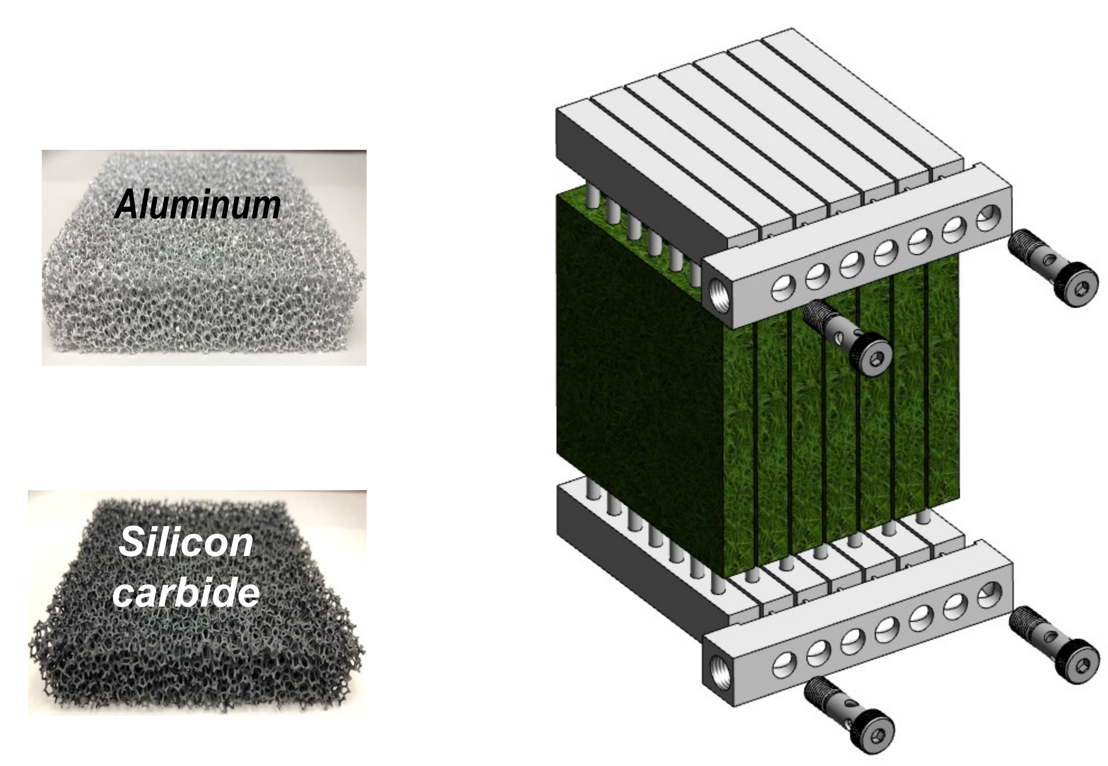

Figure 3: Prototype development using porous media.

Key Activities

- Development of prototype heat exchangers
- Thermal-hydraulic performance evaluation and comparison to the baseline design
- Development of performance models for operation under various conditions
- Durability assessment under field operating conditions
- Development of cost model and life cycle cost analysis
- Risk mitigation strategy for scaled-up solutions
- Field deployment and performance analysis over extended period

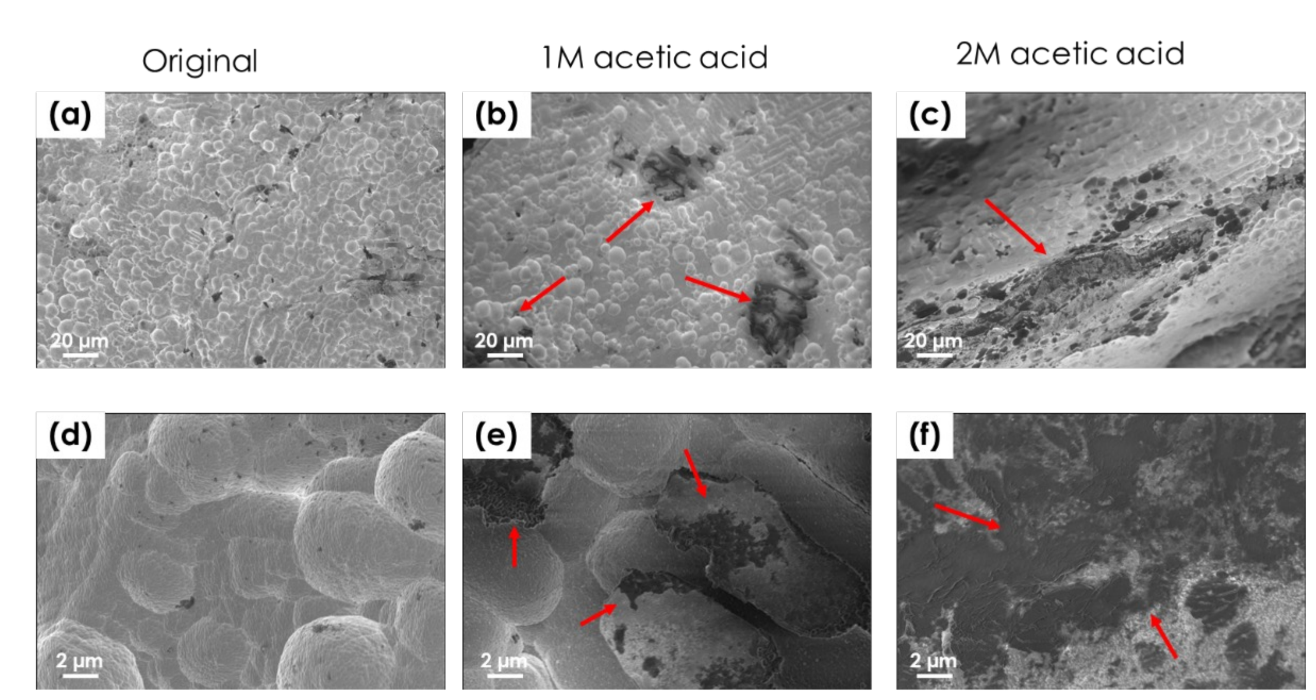

Figure 4: Scanning electron microscopy images of the Al foam before and after exposure to acetic acid. (a, d) Original sample, (b, e) exposure to 1 M acetic acid, (c, f) exposure to 2 M acetic acid.

Project Impact

- Ultracompact infrastructure to control the air temperature (>30% reduction in size)
- At least 30% reduction in water usage for competing capacity
- At least 50 Mt emissions reduction owing to improved performance
- Enabling development for deployment of application requiring smaller footprints
- Reduced cost of the working fluid (less replacement)
- At least 800 TBtu energy savings in air-conditioning technologies

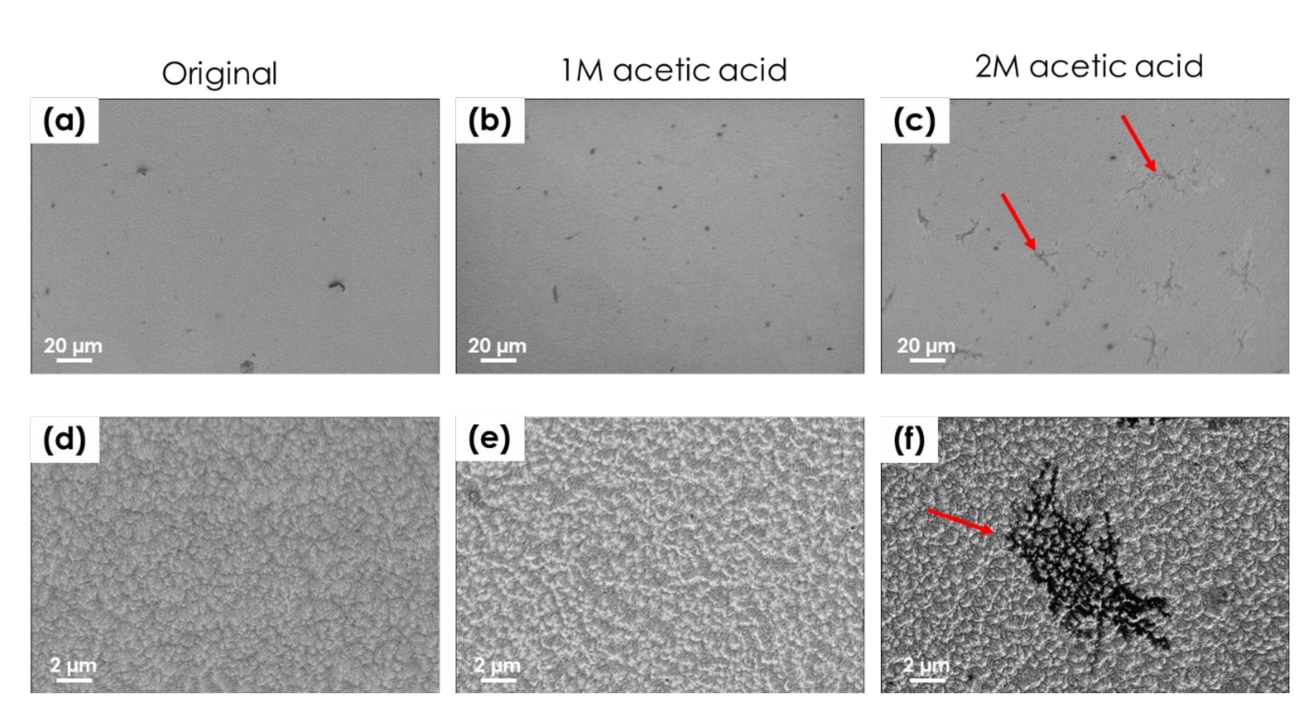

Figure 5: Scanning electron microscopy images of the SiC foam before and after exposure to acetic acid. (a, d) Original sample, (b, e) exposure to 1 M acetic acid, (c, f) exposure to 2 M acetic acid.

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