Engineering Nanofluids

Stable Suspensions of Nanoparticles in Fluids Provide Advanced Heat Transfer

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Opportunity

In an age of increasing heat fluxes and power loads in applications as diverse as medical equipment, power electronics, renewable energy, and transportation, liquid cooling systems are necessary to enhance heat dissipation, improve energy efficiency, and lengthen device lifetime. To satisfy these increasing thermal management needs, the heat transfer efficiency of conventional fluids must be improved.

Nanofluids are nanotechnology-based heat transfer fluids that are engineered by stably dispersing nanometer-sized solid particles (such as ceramics, metals, alloys, semiconductors, nanotubes, and composite particles) in conventional heat transfer fluids (such as water, ethylene glycol, oil, and mixtures) at low particle volume concentrations.

Solution

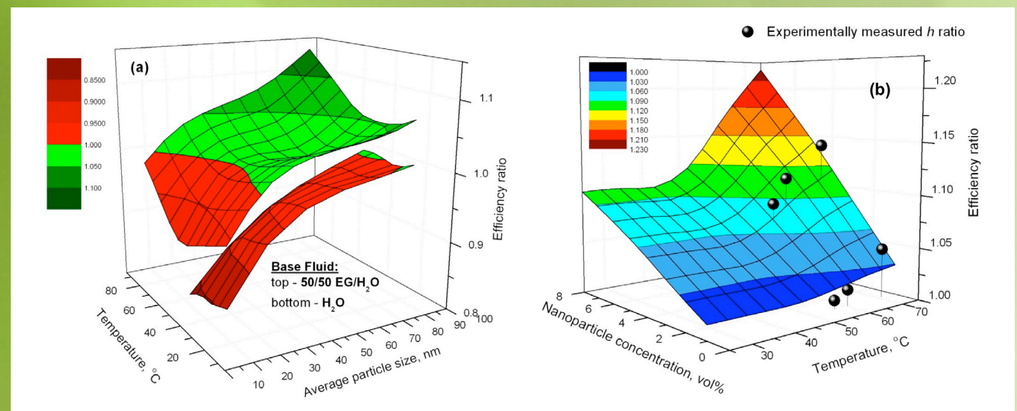
Argonne's approach to nanofluid engineering integrates individual system parameters and allows estimating and comparing the heat transfer performance of various fluids on a common basis by measuring the relevant thermo-physical properties. Argonne researchers have conducted systematic studies of multivariable nanofluid systems to optimize the efficiency of the heat transfer in nanofluids.

Argonne's Systematic Approach

What We've Achieved

With the guidelines for nanofluids engineering formulated, Argonne researchers were able to produce a competitive and commercially viable nanofluid (see diagram below). Industrial partners Saint Gobain Inc., Valvoline, and PACCAR are assisting in the technology transfer process.

Efficiency of Nanofluids in Turbulent Flow



(a) Temperature, Particle Size and **Base Fluid Effects** (4 vol.% SiC Nanofluid). Red – less efficient than base fluid, green – enhancement in efficiency.

(b) Temperature and **Particle Concentration Effects** (SiC Nanofluid in EG/H_2O); property-estimated values are compared to experimental heat transfer coefficients.

Benefits

With the improved cooling efficiency of nanofluids over conventional heat transfer fluids, the demonstration of nanofluids as engine and industrial process coolants will result in:

- Smaller cooling systems and lighter vehicles
- Less aerodynamic drag
- Reduced parasitic losses in other areas
- Reduced fuel consumption

Future Work

- Test the prospective nanofluids in a compact heat exchanger
- Conduct extensive erosion tests
- Expand nanofluid engineering into new applications (power electronics, high-temperature heat transfer fluids)

This work is funded by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, Industrial Technology and Vehicle Technologies Programs. Industry partners include Saint Gobain Inc., Valvoline, and PACCAR. The work was done at Argonne's Heat Transfer Testing Facility (ES), with supporting research conducted at the Advanced Photon Source and Electron Microscopy Center.