TechBriefs

Savannah River National Laboratory

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At a glance

- Higher heat capacity, volumetric density, and volumetric heat capacity
- More energy stored per volumetric unit
- Greater efficiency in increased steam pressure
- Lack of vapor pressure; no volatilization
- More simplistic design of heat transfer fluid system
- U.S. Patent 8,801,957 B2

Contact Information

Partnering Opportunities

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Nanoparticle-enhanced Ionic Liquids as Heat Transfer Fluids

As the demand for renewable energy sources is on the rise, scientists at the Savannah River National Laboratory (SRNL) have explored ways to improve solar energy technology, specifically a method known as concentrating solar power (CSP). CSP involves the use of a heat transfer fluid (HTF) to collect and convert energy from the sun to steam for electricity generation. Finding a HTF with high volumetric heat capacity as well as favorable physical properties has the potential to substantially improve the efficiency of CSP systems.

Background

A good HTF must be able to absorb a substantial amount of energy in a given volume, a property known as volumetric heat capacity. Physical properties such as viscosity, thermal stability, and thermal conductivity must also be considered. Ionic liquids (IL) were discovered more than 30 years ago and are organic compounds with negligible vapor pressure. ILs are molten salts with low melting points below 100°C, high liquid range above 400°C, in some cases, freezing points below 0°C. Experiments conducted at SRNL examined the ionic liquid known as $[C_4mmim][NTf_2]$ due to commercial availability, good thermal stability, and tolerable viscosity. The studies indicate that the addition of Al_2O_3 nanoparticles to the ionic liquid can increase density of the liquid by 10%, and increase volumetric heat capacity by 40% compared to neat ILs and 70% compared to traditional volatile organic fluids, such as commercially used Therminol (VP-1). The incorporation of nanoparticles into ILs, which can potentially increase thermal conductivity by 7%, forms suspensions known as a nanoparticle-enhanced ionic liquids (NEILS).

How it works

CSP systems function by first using mirrors to direct sunlight into a collector filled with HTF. Once in the collector, the HTF converts the concentrated energy into steam, which is used to generate power. Because the electrical energy production efficiency hinges on the properties of the HTF,

Technology transfer

The Savannah River National Laboratory (SRNL) is the U.S. Department of Energy's (DOE) applied research and development laboratory at the Savannah River Site (SRS).

With its wide spectrum and expertise in areas such as homeland security, hydrogen technology, materials, sensors, and environmental science, SRNL's cutting edge technology delivers high dividends to its customers.

The management and operating contractor for SRS and SRNL is Savannah River Nuclear Solutions, LLC. SRNS is responsible for transferring its technologies to the private sector so that these technologies may have the collateral benefit of enhancing U.S. economic competitiveness.

finding a liquid than can store more energy per volumetric unit will improve the CSP system. SRNL has investigated an alternative to conventional organic liquids used as HTF in the CSP process. In experiments conducted at SRNL, NEILs were used in the solar concentrating section of the system chiefly due to their higher heat capacity, higher volumetric density, and higher volumetric heat capacity. The process is complemented by the lack of appreciable vapor pressure and volatilization of NEILs, which allows for simplification of the system design that typically requires engineering to prevent phase change of traditional liquids. Careful material selection of both the IL but particularly the incorporated nanoparticle is vital to optimization of the nanofluid properties.

Stage of development

This technology is in early stage research and development with ongoing testing underway. Early tests have demonstrated that the NEIL did not have an adverse effect on the thermal stability in a non-pressurized system. Both ILs and NEILS demonstrated great improvement in thermal stability without volatilization, and could be used to replace traditional HTFs and enhance the CSP process. The advantage to NEILs over ILs is an increased heat capacity and nonvolatility. A patent has been filed with the U. S. Patent and Trademark Office.

Partnering opportunities

SRNS invites interested companies with proven capabilities in this area of expertise to develop commercial applications for this process or product under a cooperative research and development agreement or licensing agreement. Interested companies will be requested to submit a business plan setting forth company qualifications, strategies, activities, and milestones for commercializing this invention. Qualifications should include past experience at bringing similar products to market, reasonable schedule for product launch, sufficient manufacturing capacity, established distribution networks, and evidence of sufficient financial resources for product development and launch.

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