Researchers study salt's potential to store energy

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(PhysOrg.com) -- When the wind blows, it blows — sometimes to a fault. The same is true for the sun: It can beat down relentlessly, scorching everything — and everyone-beneath its intense rays.

Yet, like the flip of a light switch, the breeze stills and the sun slips under the clouds, often for days.

This unpredictability is, perhaps, the greatest barrier in researchers' quest to integrate wind and solar as mainstream energy-generation technologies. "The current administration, I think, has properly characterized that energy storage, in some fashion, whether it be with batteries, thermal storage or some new technologies, is the only way to get renewables to grow, because they're fundamentally an intermittent energy source," says Michael Corradini, a University of Wisconsin-Madison professor of engineering physics.

At UW-Madison, researchers see potential for storing heat in a mineral found on kitchen counters and restaurant tables worldwide.

They're studying salt.

Heated to temperatures sometimes far exceeding 1,500 degrees Fahrenheit, salt liquefies. Despite this red-hot temperature, molten salt can act as both a coolant and as an agent for storing heat.

"Molten salts have many advantages," says Kumar Sridharan, UW-

Madison distinguished research professor of engineering physics. "Why they have these great heat-storage and heat-transfer capabilities is that they have very good conductivity, they have good specific heat and high density — compared to gases, at least — and those are the properties that dictate how a given volume of material will hold heat or transfer heat from one location to another. So it has all these attractive properties."

As a result, salts could gain a foothold in applications ranging from concentrating solar towers and nuclear reactors to oil recovery and biomass breakdown.

"It's just been in the recent few years that people have really started looking at the salts again for a bunch of these applications, and starting to look at different combinations of ternary and binary — and even multiple constituents of the salts — for different advantages," says Mark Anderson, a UW-Madison engineering physics senior scientist.

Anderson, Sridharan and Todd Allen, a UW-Madison engineering physics assistant professor, have been studying molten salt for about five years. Their research, which stretches into three separate laboratories, includes experiments to measure salt heat-transfer properties, determine the best salt mixtures for different applications, and develop materials and coatings able to withstand salt corrosion at extremely high temperatures.

Similar to table salt, molten salt starts as pea-sized granules. The researchers are working with a salt that melts at around 220 degrees Fahrenheit, and one goal is to find salts that melt at low temperatures, but are still stable up to very high temperatures. "It seems weird to talk about something that melts at 212 degrees Fahrenheit as a coolant, but a reactor and a solar energy system can operate more efficiently at 1,600 degrees Fahrenheit, so a melting point of 212 degrees Fahrenheit is still low compared to that," says Anderson.

Applied to solar-energy towers, molten salt in the collector heats up as sunlight focuses on it. An exchanger converts heat in the salt into steam or a high-temperature gas, which spins a turbine for generating electricity. In nuclear energy, liquid salts are more versatile, acting as a coolant to strip heat from the fuel and generate electricity or serve as an environmentally friendly form of high-temperature process heat for chemical and industrial products. In addition, molten salt is useful in an electrochemical process for separating nuclear waste, enabling nuclear power plants to recycle fuel components.

For oil extraction, some companies are studying the feasibility of more environmentally friendly in-ground refineries, where they could use the heat in molten salt from a power plant to super-heat the earth around oil shale. "They can actually heat up the oil shale and try to remove the valuable petroleum products deep in the ground, without having to disrupt the surface by digging down and processing the oil shale above ground," says Anderson.

The researchers also are studying how high-temperature sodium chloride can break down biomass to form syngas, a synthetic natural gas that forms the basis for bio-petroleum products. "The biomass would be used for alternative energy," he says. "So instead of oil, you make biogas, biodiesel."

Anderson and Sridharan say molten salt can help alternative-energy sources grow. "I think it's going to increase in popularity," says Anderson. "And we have to understand the materials, we have to understand the heat transfer properties and we have to understand how the salt chemistry works. And once we understand that, I think it's going to take off and be used in a lot of different energy applications."

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