Starting fire with water

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This is the rack onboard the ISS where the Super Critical Water Mixture experiment takes place.

When firefighters want to extinguish a blaze, they often douse it with water. Astronauts on board the ISS, however, are experimenting with a form of water that does the opposite. Instead of stopping fire, this water helps start it.

"We call it 'supercritical water,'" says Mike Hicks of the Glenn Research Center in Ohio. "And it has some interesting properties."

Water becomes supercritical when it compressed to a pressure of 217 atmospheres and heated above 373o C. Above that so-called critical point, ordinary H2O transforms into something that is neither solid, liquid, nor gas. It's more of a "liquid-like gas."

"When supercritical water is mixed with organic material, a chemical reaction takes place—oxidation." Says Hicks. "It's a form of burning without flames."

This really comes in handy when you want to get rid of certain unpleasant materials—like sewage. Cities, corporate farms, ships at sea and manned spacecraft accumulate waste materials that could benefit from this kind of treatment.

"When we push a wet waste stream above the critical point, supercritical water breaks the bonds of the hydrocarbons. Then, they can react with oxygen." In other words, the slurry ignites. Sometimes, hotspots in the slurry produce visible flame, but usually not. "This is a relatively clean form of burning that produces pure water and carbon dioxide, but none of the toxic products of ordinary fire."

What does all of this have to do with the ISS? "The International Space Station provides a unique microgravity lab for studying the properties of supercritical water," explains Hicks.

One of the problems with supercritical water has to do with salt. Above the critical point, any salts dissolved in water quickly precipitate out. If this happens in a reactor vessel, the metallic components of the vessel become coated with salt and they begin to corrode.

"In any realistic waste stream, we have to learn how to deal with salt. It's a major technological hurdle."

Dealing with salt is the ultimate goal of the Super Critical Water Mixture experiment on the ISS, a joint effort between NASA and CNES, the French space agency.

"By studying supercritical water without the complicating effects of gravity, we can learn how precipitating salts behave on a very fundamental level," says Hicks, who is the principal investigator of the experiment. "We might even be able to figure out how to draw salt away from corrosion-sensitive components."

The experiment, which uses French-built hardware (DECLIC) located in the station's Japanese Experiment Module (JEM), began during the first week of July 2013. It will continue for a full year in a series of six test runs, each lasting approximately 15 days.

The results could have down-to-Earth applications. The US Navy has already started using supercritical water technologies to purify waste streams onboard some of their ships, while the City of Orlando has started a supercritical treatment plant for processing municipal sludge.

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