USING MACHINE LEARNING TO ADVANCE UNDERGROUND HYDROGEN STORAGE

Yuri Leonenko

Hydrogen gas may play a pivotal role in the global energy landscape as a sustainable, potentially carbon-neutral energy carrier. However, its high volatility and flammability pose significant challenges for safe, large-scale storage. To address this, researchers are investigating the feasibility of underground storage solutions.

Evaluating the storage capabilities of depleted hydrocarbon reservoirs, coal beds, or aquifers requires understanding the interactions between hydrogen gas and the brine typically present in these geological formations. This "interfacial tension" is crucial in determining how hydrogen disperses through the porosity and fractures of the subsurface structures, thereby affecting their overall storage capacity.

Quantifying this interfacial tension in laboratory settings is often costly and time-intensive. Therefore, modeling is employed not only to save time and reduce costs but also to enhance safety, simulate a wider range of environmental conditions, and enable flexible parametric analysis. So WISE researcher Yuri Leonenko and his University of Waterloo colleague Mostafa Hosseini set out to create computational models instead.

The duo developed four machine-learning models for predicting the interfacial tension between hydrogen gas and salt water across a broad range of pressures, temperatures and salt concentrations. Each model used a different decision-making approach: decision trees, random forests, support vector machines and multi-layer perceptron.

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Leonenko and Hosseini trained them using carefully vetted experimental datasets. When they subsequently tested the models with fresh sets of experimental data, the random forest method clearly stood out. Because it excels in capturing complex data relationships, it was able to deliver the greatest accuracy.

The result is a reliable, cost-effective tool for predicting interfacial tension. And because it's built on machine learning, its performance promises to continuously improve as new data becomes available.

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