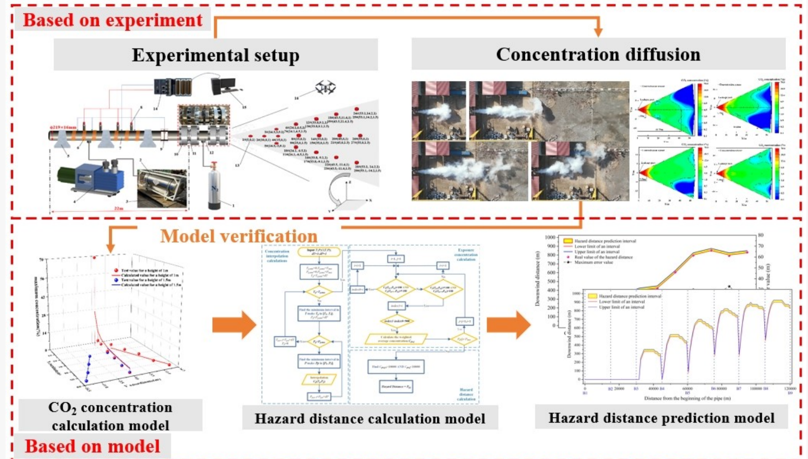
Method for Predicting Hazard Distance After CO2 Leakage Using Burst Test and Diffusion Modeling

GA, UNITED STATES, January 14, 2025 /EINPresswire.com/ -- Currently, there is no unified conclusion on the method of hazard distance delineation and calculation after CO2 pipeline leakage. The researchers propose a method for calculating and predicting hazard distance through a combination of experimental and modeling calculations.



Graphical Abstract

Carbon capture, storage and utilization (CCUS) is an important technology for meeting global carbon emission reduction targets. The development of CO2 transportation, as a link in the CCUS industry chain, is crucial for CCUS projects.

The supercritical or dense phase is widely recognized as the optimal phase state for carbon dioxide (CO2) transport. Therefore, it is of great value and significance to ensure the safe and efficient transportation of CO2 in this phase state.

In a study (doi: https://doi.org/10.1016/j.jpse.2024.100248) published in the KeAi journal Journal of Pipeline Science and Engineering, the PipeChina Group from China conducted the first full-size CO2 pipeline burst fracture test in China to evaluate the pipeline's fracture arrest performance.

“CO2 leaks caused by pipeline breaks can have more serious consequences than property damage,” says lead author Prof. Yuxing Li from the Key Laboratory of Oil and Gas Storage and Transportation Safety in Shandong Province, China University of Petroleum (East China)“ Due to the positive throttling effect of CO2 and the toxicity of high concentrations of CO2, it can frostbite or even cause asphyxiation of plants and animals near the leakage area. Therefore, it is meaningful to study the leakage characteristics of supercritical/concentrated-phase CO2 and predict its potential hazard distance.”

The team first carried out four sets of full-size burst tests with different initial conditions to clarify the effect of initial conditions on the CO_2 concentration in the near and far field of leakage. The researchers then verified the CO_2 concentration diffusion model through the measured concentration data, on the basis of which the CO_2 hazard distance calculation model was proposed.

“There are large temperature and pressure differences between the start and end points of industrial-grade CO_2 pipelines, and leakage at any location of the pipeline will lead to different leakage consequences,” shares Li. “Meanwhile, the relative distance between the leakage point and the cut-off valve will affect the CO_2 leakage characteristics and thus the delineation of the hazard distance.”

Taking into account these factors, it is therefore difficult to predict the hazard distance due to leakage at different locations. To that end, the team proposed a PSO-BP neural network to predict the hazard distance for leaks at any location, which is consistent with the results of the CO_2 concentration diffusion model but with greatly reduced computational demands.

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