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Deep learning-assisted technology transition in natural hydrogen development

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Although the global energy sector is shifting from the fossil-based energy systems to the renewable energy resources, the conventional energy development techniques has received increasing attentions with the mature development and the recharge by AI. With the help of AI techniques, drawing lessons from thousands of years of traditional energy development in the technology transition into the next-generation energy is an effective approach to accelerate energy transition and avoid repeated research causing unnecessary wasting. In this talk, we will introduce an iterative flash calculation scheme and a deep learning algorithm using a thermodynamics-informed neural network (TINN) to perform accurate, robust, and fast phase equilibrium calculations for realistic fluid mixtures of natural hydrogen. The development of natural hydrogen is an emerging topic in the current energy transition trend. The production process involves compositional multiphase flow via subsurface porous media. This makes studying the compositional phase equilibrium behavior essential for reliable reservoir simulation and prediction. The application of TINN architecture can accelerate the calculations for nearly 20 times. The effect of capillarity on phase equilibrium states is demonstrated. Based on simulation results, suggestions for the natural hydrogen industry chain are provided to control the possible phase transitions under certain environmental conditions that may be observed in the natural hydrogen reservoirs, storage and transportation facilities. The extremely low critical temperature of hydrogen challenges the robustness of flash calculations but facilitates the separation of impurities by liquefying certain undesired species. Moreover, phase transitions under control can be an effective approach for carbon dioxide capture and sequestration with optimized operating conditions over the phase equilibrium analysis.

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