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Enhancing Pressure Transient Analysis Distortions Caused by Gas-Influx for Liquid Hydrogen Storage Well Testing Based On A LSTM Deep Learning Architecture

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Abstract

Liquid hydrogen performance assessment represents an important consideration in determining carbon sequestration operational performance. Liquid hydrogen storage requires a firm understanding of the reservoir formation, as well as the injection and pressure distribution derived from pressure transient analysis. A challenge in the pressure transient analysis is the abnormal behavior in a buildup curve caused by phase redistribution in a wellbore. This behavior may arise when both liquid and gaseous hydrogen penetrate the wellbore. Pressure transient analysis represents an important factor for effective liquid hydrogen storage, as it enables to analyze reservoir characteristics based on the pressure response data. Specifically, pressure formation tests enable to determine permeability, skin factor and distance to boundaries. This enables to determine additionally mobility of the liquid hydrogen phase as well any well damage. In order to model the PTA response subject to temperature and rate dependent liquid hydrogen production, a physics-based deep-learning model was developed to take into account temperature and rate effects into the pressure transient analysis and cope with the gas humping effect. We investigated the pressure response arising from temperatures effects dealing with the gas humping effect based on the Ahuroa aquifer in New Zealand. The deep learning model utilizes a time-series based adapted Long Short-Term Memory Network for the estimation of the pressure response during the buildup pressure transient analysis. Analysis of buildup curves for wells exhibiting this behavior can be difficult or impossible because the reservoir response is affected by a hump in the pressure distribution. The investigated Ahuroa aquifer is part of the Ahuroa gas reservoir that is located within the Urenui formation and has been utilized for the storage of natural gas. The aquifer is intersected by the Ahuroa-3 that is utilized for hydrogen storage. Several formation tests were simulated with different hydrogen production and injection rates, and temperature dependent effects. The results indicate that the temperature effects may impact the presence of the gas humping effect due to pressure maintenance challenge that may also cause near well phase changes affecting the wellbore environment. Specifically, the explainable model indicates that while temperature effects impact the pressure, the impact is limited as compared to that of rates, porosity and the viscosity of the hydrogen. Determining temperature and pressure effects for the gas humping effect to ensure adequate pressure transient analysis is critical in order to enhance hydrogen storage. The potential two-phase nature of liquid hydrogen storage requires a solid analysis of the various effects that have been outlined by the analytical deep learning model.