Permeability Prediction and its Impact in Reservoir Modeling. Postle Field, Oklahoma

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Permeability is one of the most important attributes to estimate in a producing field because is a measure of how the fluid will flow through the reservoir. A permeability model was developed for a thin reservoir located at Postle Field, Oklahoma, with the objective of accurately predict fluid flow under a CO_2 injection framework. Postle Field is located in the Texas Country, Oklahoma, and it is comprised of the Pennsylvanian age Morrow A sandstone of the Morrow Formation. The presence of high permeability zones represented the greatest challenge to overcome. This project became more challenging because reservoir thickness is under resolution (average thickness is 30 ft). This is not uncommon in the oil and gas industry since the average reservoir thickness in North America is 17ft (5m). It is of the utmost importance to understand the influence of permeability and the role of heterogeneity in fluid flow. High permeability zones have the potential to cause early breakthrough and poor sweep efficiency.

A permeability model was developed for Postle Field with the main focus in characterizing these permeability zones. The repercussions of this in terms of field performance under a CO_2 injection framework need to be analyzed in detail because the miscible oil will flow through the path of least resistance represented by these high permeability zones.

Core data are available from the study area. In these data, sandstone petrofacies within the reservoir were identified and distinguished by the use of petrophysical attributes from the well logs. A multiclass classification using Support Vector Machines (SVM) was performed to breakdown the Morrow A sandstone into sandstone petrofacies data. It was demonstrated that each petrofacies behaved as a hydraulic flow unit therefore possessing a specific permeability distribution.

Modeling permeability based on multiple permeability distributions to characterize the Morrow A Sandstone gave a more reliable reservoir model to simulate CO_2 flooding. A multivariate regression was performed to create pseudo-permeability logs for all wells in the study area. This permeability information was populated throughout the study area using the predicted petrofacies as a guideline.

P-wave time-lapse seismic reflects changes in fluid and pressure within a reservoir through time. Both these changes are expected in Postle Field because of the injection of CO_2 into the subsurface. With the use of P-wave time-lapse seismic we were able to identify areas of high sweep within the reservoir that correlated to the high permeability zones obtained from the permeability model. These zones were not captured by means of our initial binary model, sandstone-shale, used for fluid flow simulation. This was shown by the lack of agreement between our initial simulation results and time-lapse seismic data. The integrated permeability model; however, showed better agreement in areas were high permeability zones were present demonstrating that an accurate characterization of high permeability zones leads to a more reliable reservoir model for CO_2 flow prediction.

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