1189881 Growth of Steam Chambers in CSS Operations Assessed through Microseismic Monitoring

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Cyclic steam operations in oil reservoirs seek to reduce the viscosity of the hydrocarbons to facilitate production. Injection of steam at pressure also has the effect of inducing deformation in the reservoir, which gives rise to microseismic signals when deformation rates are rapid. Therefore, accurate location of these seismic sources can be used to track the deforming reservoir and the steam front. Microseismic monitoring arrays can be deployed downhole to record the induced deformations and highlight the steam chamber growth.

In the first case study, we examine the microseismic response observed based on about 10 years of development in a Canadian heavy oil reservoir. The growth of the steam chamber is demonstrated through the microseismicity. Because lower magnitude events are only seen near the microseismic array, a magnitude of completeness for the dataset is determined by considering the lowest magnitudes from the regions of the pad furthest from the array; all events with magnitudes lower than this magnitude of completeness are not considered. With this homogenized dataset, we examine the seismic deformation, which considers the total seismic moment of a number of events in the vicinity of a grid point, as viewed over a number of time steps and used to show the growth of the steam chamber. Another parameter that shows the progression of the deformation is apparent stress, which is the stress imparted to the medium represented in the seismic waveforms. These parameters will show how well the steam chamber is growing and also highlights potential problems like out-of-zone growth.

A second case study examines seismicity associated with a Huff and Puff steaming of a diatomite reservoir where much of the hydrocarbon is contained in a high porosity but low permeability matrix. Because diatomite strongly attenuates P-wave energy, a monitoring array was installed in three vertical wells surrounding a number of treatment wells. Because of this array coverage, the minimum detectable magnitude is relatively stable throughout the treatment zone. The growth of the steam chambers from a number of injection ports has been monitored for a number of steam cycles and related to the injection parameters.

In general, it can be surmised, that in steaming operations, microseismic monitoring offers the ability to identify the growth and development of a steam chamber and provides an effective approach to monitoring life of the field operations.

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