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# Prediction of Pressure Increase during Waste Water Injection to Prevent Seismic Events

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## Abstract

A considerable increase of seismicity has occurred in the USA in the last decade (2009–2020) with an annual average of 345 M3+ earthquakes. Numerous field cases have shown that excessive well pressure due to a high injection rate may have triggered seismic events. This study defines conditions for inducing a seismic event by excessive injection in the well's pressure that may cause geomechanical damage to the rock. Introduced here is an analytical model and method for predicting pressure increase during injection of produced water contaminated with oil. The model calculates time-dependent advancement of the captured oil saturation causing the well's injectivity damage and pressure increase. Critical conditions for a seismic event are set by defining rock failure when well pressure exceeds the fracturing pressure of the wellbore or when the increased pore pressure reduces the effective normal stress at the "weak" interface inside the rock, computed with a geomechanical model. This concept is demonstrated in three field case studies using data from geological formations in areas of petroleum operations. The results confirm field observations of the initial rapid increase of oil invasion and injection pressure that could only be controlled by reducing the rate of injection to assure continuing long-time operation.

**Keywords:** [injection wells \(/search?q=injection%20wells\)](#); [induced seismicity \(/search?q=induced%20seismicity\)](#); [produced water injection \(/search?q=produced%20water%20injection\)](#); [injection pressure model \(/search?q=injection%20pressure%20model\)](#); [rock slippage diagram \(/search?q=rock%20slippage%20diagram\)](#)