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# The long-term response of geological setting to hydraulic fracturing in the presence of a leaky well

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Hydraulic fracturing operation (fracking) in shale/tight gas reservoirs could pose environmental risks to groundwater systems [1,2]. Fracking creates fracture systems that could intersect preexisting pathways, in the form of fractures, faults or compromised wells [3,4]. This paper studies the long-term (over 100 years) transport of fracturing fluid into overburden layers and groundwater aquifer through a leaky abandoned well using the geological setting of North German Basin. The three-dimensional model contains 15 sedimentary layers with three hydrostratigraphic units representing the hydrocarbon reservoir, overburden, and aquifer. The model considers one perforation location at the first part of the horizontal well, and a fully developed hydraulic fracture intersecting a leaky well. The mathematical model is implemented in a Finite Element Method (FEM) software. A benchmark study is conducted to select the proper approach for numerical modeling of the leaky well. To realistically represent the lifetime of a typical horizontal well, each simulation comprises six different stages namely: (1) reservoir initial condition prior to hydraulic fracturing; (2) injection of fracturing fluid into the reservoir; (3) shut-in period; (4) first production period; (5) second production period; and (6) continued migration of fracturing fluid into overlying layers. The aim is to identify the dominant key parameters and the main transport mechanisms governing upward movement of contaminants through a permeable pathway (i.e. leaky well). A sensitivity analysis is carried out to quantify and understand the influence of reservoir properties (i.e. overpressure), hydraulic fracture properties (i.e. permeability, porosity, and half-length), type of the abandoned well, and its proximity to induced fractures on transport of contaminants to shallower permeable strata. It was observed that the two-dimensional representation of the abandoned well reflects its spatial properties and addresses the upward leakage of fluids through the well with sufficient accuracy. The modeling results indicate the spatial properties of the abandoned well and its distance from hydraulic fracturing are the most important parameters influencing the transport of fracturing fluids to the shallow aquifer.

Bibliography

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