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Assessment of leak tightness for swellable packers under downhole conditions considering fluid-structure interaction

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Swellable elastomeric seal is a type of specifically engineered packer that swell upon contact with wellbore fluids. Assessment of leakage tightness is a fundamental aspect in the design of swellable packers, since they should guarantee a reliable sealing under extreme pressures of the downhole fluids (up to 10000 psi / 69 MPa). Numerical capability of the leakage pressure prediction would facilitate improvement in the packer design methodology. Previous work [1] was focused on investigation of the non-parametric optimisation capability seeking for an optimal external shape with a goal to maximise the grip of a packer with a borehole. The verification of an optimised design was done with a dynamic FE-simulation of packer's failure by extrusion under an excessive pressure. The downside of that type of analysis was that Abaqus/Explicit solver couldn't implement a realistic adaptive pressure application due to changing packer disposition and contact conditions. This simulation challenge was addressed in a later work [2] by application of the Coupled Eulerian-Lagrangian (CEL) approach in Abaqus/Explicit, which provided the multiphysics analysis capabilities with a proper consideration of fluid-structure interaction (FSI) within the single ABAQUS environment. The downside of that type of analysis was the FSI simulation with CEL was very computationally expensive requiring over 1000 CPU-hours. So current work is focused on the acoustic type of analysis as a form of FSI available for both dynamic solvers (implicit and explicit), which would provide an optimal balance between realism of simulation and computational performance.

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