Abstract

Well integrity is crucial for sustainable hydrocarbon production from oil and gas reservoirs. The number of new wells can be minimized by maintaining the integrity of existing wells. Also, oil and gas leakage due to compromised well integrity can be curtailed through proactive well integrity management. The present research focuses on well integrity analysis and monitoring for methane hydrate reservoirs. Methane hydrate reservoirs are susceptible to large deformation due to their unconsolidated nature, which could substantially compromise well integrity during well construction as well as gas production periods. Therefore, in the present research, finite element analyses (FEA) and laboratory experiments of well integrity are carried out for the case of the Nankai Trough methane hydrate reservoir in Japan, in order to contribute to a better well integrity management. FEA on well construction and reservoir compaction processes as well as cement shrinkage process is conducted. Laboratory experiments are carried out with a distributed fibre optic monitoring technique called Brillouin optical time domain reflectometry/analysis (BOTDR/A) on the strain development of laboratory-scale well specimens subjected to tensile and bending loading. The primary contributions of the present research are as follows. First, cement shrinkage volumes for the Nankai Trough formation case are estimated to be up to 0.7%. Second, cement shrinkage of 0.7% during well construction induces stress concentrations in the high hydrate saturation layers of the Nankai Trough formation. Third, the well is found to become most vulnerable to damage in the initial stages of hydrate dissociation under large depressurisation. Forth, fibre optic cables with minimal number of coating layers and tight interlayer buffering will be effective for accurate in-well integrity monitoring with BOTDR/A. Fifth, fibre optic cables should be attached on the casing rather than in the cement in the well to facilitate accurate bending curvature monitoring with BOTDR/A.