

Geowell - Mechanical properties of casing materials up to 550°C and the impact on casing design

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TNO, Structural Dynamics

Keywords: Geothermal well high temperature casing material

In a geothermal well the casing is subjected to tremendous cyclic stresses and strains, particularly at temperatures above 200 °C. When anchored to the formation, the casing can easily exceed the yield stress locally. The associated plastic strain cycles during several well discharges can be such that the material's material properties deteriorates quickly and can lead to early casing failure. To meet the well integrity requirements needed for safe and prolonged operation, several solutions are proposed in the GeoWell project to lower the casing stresses and strains. One of the proposed solutions is the design of an axial compensator. Though the design it is intended to eliminate most axial stresses, there will still be locations left with high stresses. While the temperatures exceed 400 °C in the Icelandic Deep Drilling Project, the material's mechanical properties are compromised. Material data at such temperatures is not readily available for typical casing material candidates (K55, L80, T95 and Inconel 625). Therefore mechanical experiments were performed at room temperature, elevated (250 °C) and high temperatures (450 °C, 550 °C) for the proposed material candidates. Four casing materials were tested and revealed significant strength reductions with increasing temperature. Because high plastic straining is expected in the casing and compensator design direct use of the acquired engineering stress-strain data is not correct. The acquired engineering stress-strain data needs to be converted to true stress-strain relations to make it suitable for the use in Finite Element Analysis (FEA) when high plastic deformations are expected. A practical inverted method will be presented to make such conversions possible.