TU Delft

Offshore & Dredging Engineering

Technische Universiteit Delft

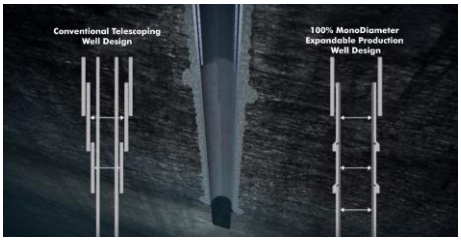
Measurement and mitigation of swab pressures due to cone pop-out

The discovery of oil and gas reservoirs remains the most important factor in the oil and gas industry. Every year new reservoirs are discovered, but their accessibility is becoming more challenging. In order to make the deep and hard-to-reach reservoirs more economic or even technologically accessible, oil companies are looking for improved ways to drill wells. The technique Shell developed is called Mono-diameter Drilling (MOD), which allows minimal diameter change along the casing lengths installed using the expansion process. This is in contrast to a telescopic design used in conventional drilling operations. MOD allows larger inner liner diameters in deeper wells, enabling higher flow rates per well in deeper areas. Such technology is necessary for wells that are too deep or hard-to-reach for conventional technologies.

During MOD expandable casings with a smaller diameter are run through the host pipe with an expansion cone underneath. At the aimed location of the new casing, the volume between casing and formation is cemented. Before the cement is cured the cone is pulled through the casing by the drill string operated from the rig, expanding the casing. At the location of the bottom of the host pipe and the top of the installed casing, an overlap exists between the casing and the host pipe. During the expansion at the overlap, the casing, host pipe, cured cement of previous section, and the formation need to be expanded by the cone. This requires an increase in expansion force from the tower on the rig, and simultaneously the drill string is stretched (further) elastically and potential energy is stored in the form of strain.

When the cone reaches the end of the overlap, the contact area delivering frictional resistance between cone and casing decreases, the friction on the cone reduces, and a gradual acceleration due to strain in the drill string initiates. As soon as the cone has passed the overlap section, no contact area is left and the cone undergoes an enormous increase in acceleration; this is referred to as the cone pop-out. During cone pop-out, a void is created by the displacement of the cone. In order to fill this void, fluids flow from the top of the bottom hole (decompression of this region), flow through the clearance between cone and host pipe, and flow through the drill string. The decompression is initiated at the bottom of the cone and fluid interface and propagates as a negative pressure wave (swab pressure wave) down hole. This wave reflects at the bottom of the hole, increasing the swab pressure. When the pressure difference between the inside and outside of the installed casing becomes too large, the casing collapses. Swab pressures are therefore very dangerous and need to be taken into account in well design.

In this research, an experiment has been designed in order to validate existing numerical models that predict swab pressures. The experiment is designed to validate the effect of four factors: the force required to expand the casing, the clearance between the expansion cone and the host pipe, the geometry of the tail of the cone, and the fluid properties in the well. In addition, two opportunities to mitigate the swab pressure problem have been investigated: flow ports in the drill string and sudden additional flow injection in the system. The flow ports show promising numerical behaviour. It is advised to conduct the experiment to validate the previously developed numerical models and implement the flow ports in the design of the drill string. In the 10.2"/10.0" (host pipe/expanded liner) configuration a short pressure peak larger than the collapse pressure remains, therefore researching the dynamics of the pipe collapse is advised as well.



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