Extended Evaluation of Primary Cement Jobs

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Extended Evaluation of Primary Cement Jobs

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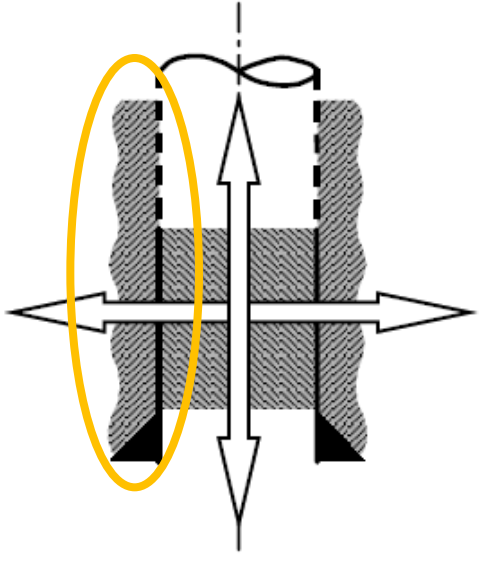


Extended Evaluation of Primary Cement Jobs – Background

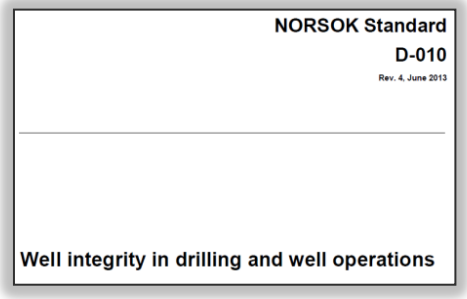
Project history:

- Feasibility study conducted by Oxand
- Contribution from the relevant Statoil disciplines, like:
  - Well Cementing
  - Well Integrity
  - Cased Hole Logging
  - PETEC/ Reservoir Technology
- The project has considered different methods & solutions

Extended Evaluation of Primary Cement Jobs – Requirements

- The Norsok requirements state fairly absolute values for cement heights
  - **30 meters** cement verified by log = **one barrier**
  - Requirements do not distinguish between typical HPHT- and low pressure/temp. conditions
  - Cased hole logging also generates fairly absolute values in **"meters of good cement"**

- The deviations are challenging to handle
  - Especially if the rig is waiting
  - Time consuming to consider actual well conditions



Objective: ⇨ «Effective assessment method that also considers actual well conditions as part of the cement evaluation process»

Extended Evaluation of Primary Cement Jobs – Hypothesis of model

“Good cement” from log interpretation, is used as a basis for the model:

- **Bonding** to casing and formation
- The formation is a **“perfect barrier”**
- **Microdarcy** cement permeability

No new assumptions compared to today’s verification practices

NOTE! Cement defects are not included in the model, might be possible the day cement defects can be quantified from logs

Extended Evaluation of Primary Cement Jobs – Model Comparison

Flow model	1D Numerical Modeling	Finite Element Modeling
Advantages	• Fast to run • Well adapted to standard geometry in 1D (or 2D axis) • Needs few parameters	• Well adapted to complex geometry in 2D and 3D • Ease to integrate defects and complex flow behavior
Drawbacks	• Do not allow strong heterogeneity • Do not consider complex mechanisms	• May be time consuming to run • May required a important number of parameters • Strongly dependant on the accuracy of the input data

- **Two 1D numerical models** developed: **1-phase- and 2-phase flow**
- **No defects modeled**
- **Hydrostatic pressure** at the top of the cement
- **Capillary effects neglected**, impermeable geology
- **Development of an numerical model (engineering approach):** can be performed with **more limited input data**

Extended Evaluation of Primary Cement Jobs – Cement permeability

- **Conservative approach –** due to the uncertainty
- What decides the cement permeability is fairly known in the industry:

Cmt-to-water ratio is important!	
+	**-**
I. **Pozzolans** (silica flour, fumed silica i.e. Microblock, Colloidal silica etc.) **II.** **Retarders** (Lignosulfonate, Hydroxy carboxylic acids, Cellulose derivates - all cause adsorbsion onto C-S-H phase layer) III. Latex **IV.** **Particle size distribution**	**I.** **Accelerators** (CaCl2, NaCl, Na and Ca formats, nitrates and nitrites)


BACK-UP SLIDES