



Abnormal formation pressure encountered while drilling due to offset water injection wells

While drilling, abnormal formation pressures were encountered because offset water injection wells had not been correctly shut in ahead of drilling activity. It was further determined that the water injector wells had been operating in excess of their design limits which further impacted formation pressures encountered during the drilling operation. As a result, the predicted pore pressures were higher than expected causing a kick to be taken while drilling exceeding the Formation Integrity Test (FIT). The well was successfully killed using the Driller's Method.

The IOGP Wells Expert Committee/Well Control Incident Subcommittee believes that this incident description contains sufficient lessons to be shared with the industry. We further encourage the recipients of this mail to share it further within their organization.

What happened?

While drilling ahead on a water injector well at 3488m MD, a gain of 7 bbls was detected in the active system, a flow check was performed and a further 6.5bbls was gained in 8 min while flow checking the well. The well was shut in. Pressures stabilized at +/- 780 psi.

This exceeded the MAASP based on the FIT of 1.51sg at the shoe and the influx pressure exceeded the high side of the pore pressure estimate for the hole section.

Offset water injector wells were shut in however, no change was observed in the shut-in pressures on subject well.

The well was killed in two circulations using the driller's method, circulating to 1.57sg kill weight mud on the second circulation.

What Went Wrong?

- Offset injection well design and operating limits were exceeded.
- PPFPG prediction did not consider the potential impact from out-of-zone-injection on offset wells.
- Offset water injection wells were not correctly assessed for shut-in requirements ahead of drilling activity.
- Utilising the auto driller in constant ROP mode impeded the ability to identify a drilling break at 3480m, i.e. there was reduction in WOB and torque rather than increase in ROP.
- Flow paddle alarm setting point at +/- 5% was too wide to provide an alarm at the influx rate of 50 bph equivalent to an increase in flow out of 2%.
- The shut in of the well was delayed due to conducting an additional flow check adding to the influx volume. There were positive indications of an influx through the increase in PVT increase and flowback fingerprint when pumps were shut down.

Corrective Actions and Recommendations:

- Update guidance for operating injection wells including methodology for setting bottom hole injection pressure limits.
- Define how to identify a drilling break when drilling in "auto drill" mode with constant ROP.
- Perform flow paddle calibration at the casing shoe prior to drilling the hole section to define the appropriate minimum alarm setting at the planned flow rate.
- Revise Well Control Shut In procedures to prompt shutting-in the well without a flow check in the case of a positive indication of an influx.
- Review frequency and method of kick detection drills to verify the response of the driller, mud loggers and remote monitoring team.

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