ARTICLE NAVIGATION

APPLICATIONS | FEBRUARY 14 2024

Blowout-Capping-Fracturing-Relief Well: A Full Cycle Workflow

Special Collection: Drilling & Completion

Youssuf Elnoamany; Andreas Michael; Ipsita Gupta; Tej Bhinde; Steve Todman; Paulo J. Waltrich; Yuanhang Chen

SPE J. 29 (02): 780–797.
Paper Number: SPE-217462-PA

https://doi.org/10.2118/217462-PA Article history

Summary

Failed well-capping attempts following offshore-well blowouts undergoing worst case discharge (WCD) can lead to fluid-driven tensile failures (de facto hydraulic fracture initiations). Subsequent propagation of these fractures may lead to broaching of overburden-rock-formation layers and even the seafloor, providing pathways for reservoir hydrocarbons to escape into the seawater. After capping stack shut-in, the pressure buildup in the fluid column inside the wellbore exposes vulnerable locations to tensile (Mode I) failure. If this shut-in wellbore pressure exceeds the formation breakdown pressure (FBP) in any of the exposed-rock-formation layers, a fracture will initiate and will continue to propagate as long as sufficient energy is provided by the reservoir. Scenarios where the propagating fracture(s) broached the seafloor in the past led to severe environmental impacts, disturbing the local ecology. The quintessential example is Union Oil's 1969 "A-21 Well" blowout in California's Santa Barbara Channel, where subsequent well-capping attempts led to multiple broaching instances on the seafloor near the well with thousands of hydrocarbon gallons gushing into the seawater (observable from the sea surface as "oil boilups").

In this paper, numerical modeling is performed on a hypothetical case study using deepwater Gulf of Mexico parameters in order to evaluate the likelihood of a similar scenario by modeling a planar-fracture propagation longitudinally-to-the-wellbore, upon well capping. A workflow is developed that integrates post-blowout WCD flowrate and volume estimations, fracture initiation and propagation modeling following the capping stack shut-in, pertaining to a "cap-and-contain" strategy (including predictions in regard to seafloor broaching), along with relief-well intersection followed by kill-weight-mud injection. The casing-shoe depth is the presumed location of fracture initiation, assuming perfect integrity of all casedhole sections above it. Several sensitivity analyses are performed to investigate the impact of the casing-shoe depth, along with the stiffness of the overburden-rock-formation layer, and the post-blowout-discharge duration on the resultant fracture growth. Finally, the mud density and pump flowrate necessary to compensate the oil column to successfully kill the blown well are quantitatively assessed.

Keywords: fluid dynamics, geologist, sedimentary rock, casing and cementing, annular pressure drilling, contingency planning, operational safety, artificial intelligence, structural geology, asia government

Subjects: Casing and Cementing, Casing design, Contingency planning and emergency response, Environment, Exploration, development, structural geology, Flow in porous media, Fluid Characterization, HSSE & Social Responsibility Management, Hydraulic Fracturing, Oil and chemical spills