

Load case - gas over mud

Oliasoft

Abstract

In this document we describe the load case *Gas over mud* available in the Oliasoft™ application.

Introduction

Gas over mud is a burst load case, where the unknown is the internal pressure profile of the tubing¹. The scenario is a gas kick somewhere below the shoe of the tubing, i.e. in the open hole of the next section, which moves upwards to the hanger and displace the mud. This load case can be viewed as the equilibrium of the load case *Displacement to gas*, although some of the inputs are different. This load case comes with two additional choices. It is possible to enable *Limit to frac at shoe*, which effectively limits the maximum pressure at the shoe to the fracture pressure there, and also to enable MASP/MAWP (Maximum Anticipated Surface/Wellhead Pressure), which then gives the internal pressure as the interpolated pressure between MASP/MAWP and fracture pressure at shoe. If both are enabled, then MASP/MAWP takes precedence.

Inputs The following inputs define the gas over mud load case

- 1) The true vertical depth (TVD) along the wellbore as a function of measured depth. Alternatively, the wellbore described by a set of survey stations, with complete information about measured depth, inclination, and azimuth.
- 2) The true vertical depth/TVD of
 - a) The hanger of the tubing, TVD_{hanger} .
 - b) The shoe of the tubing, TVD_{shoe} .
 - c) The influx depth of the gas, TVD_{influx} .
- 3) The pore- and fracture- pressure profile from hanger to influx depth.
- 4) The gas over mud ratio, q_{gm} .
- 5) The mud weight/density, ρ_{mud} .
- 6) The gas density, ρ_{gas} .
- 7) Whether or not to limit the pressure at shoe by the fracture pressure there. If this is enabled, it is also possible to give a fracture margin of error, which is added to the fracture pressure.
- 8) Whether or not to enable MASP/MAWP.

¹We denote any tubular by tubing. All calculations encompass both tubings and casings.

Calculations The internal pressure profile of the tubing is calculated as the hydrostatic pressure from hanger to shoe. The algorithm goes as follows

- 1) Calculate the true vertical depth of the gas-mud interface, $TVD_{interface}$. This interface is then either above the tubing shoe, or below it.
- 2) Calculate the pore pressure at influx depth, $p_{p,influx}$, and the fracture pressure at the shoe, $p_{f, shoe}$.
- 3) Calculate the hydrostatic pressure at the shoe, from p_{influx} and up

$$p_{h,shoe} = \begin{cases} p_{p,influx} - \rho_{mud} g(TVD_{influx} - TVD_{shoe}), & \text{if } TVD_{shoe} \geq TVD_{interface} \\ p_{p,influx} - \rho_{mud} g(TVD_{influx} - TVD_{interface}) - \rho_{gas} g(TVD_{interface} - TVD_{shoe}), & \text{otherwise,} \end{cases} \quad (1)$$

where g is the gravitational constant

- 4) Calculate the pressure at the shoe as

$$p_{shoe} = \begin{cases} \text{minimum}(p_{f, shoe}, p_{h, shoe}), & \text{if 'Limit to frac at shoe' is true,} \\ p_{h, shoe}, & \text{otherwise.} \end{cases} \quad (2)$$

- 5) Calculate the internal pressure of the tubing as the hydrostatic pressure from hanger to shoe.
- 6) If MASP/MAWP is enabled, this take precedence, and then the internal pressure profile of the tubing is given by the interpolated pressure of the MASP/MAWP, i.e.

$$p_{MASP/MAWP} = p_{p, influx} - \rho_{gas} g(TVD_{influx} - TVD_{hanger}), \quad (3)$$

and the fracture pressure at the shoe, $p_{f, shoe}$.