Load case - displacement to gas

Oliasoft

Abstract

In this document we describe the load case *Displacement to gas* available in the Oliasoft™ application.

Introduction

Displacement to gas is a burst load case, where the unknown is the internal pressure profile of the tubing[1]. The scenario is a gas kick somewhere below the shoe of the tubing, i.e. in the open hole of the next section, which eventually displaces the mud in the tubing, not necessarily all. If the gas only partly displace the mud, the fluid configuration inside the tubing is a mud cap, with gas underneath. Also, it is possible to specify *Limit to frac at shoe*, and if this is enabled, the maximum pressure at the shoe of the tubing is given by the fracture pressure there.

Inputs The following inputs define the displacement to gas 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 and inclination.
2) The true vertical depth/TVD of
   a) The hanger of the tubing, $\text{TVD}_{\text{hanger}}$.
   b) The shoe of the tubing, TVD_{shoe}.
   c) The influx depth of the gas, $\text{TVD}_{\text{influx}}$.
   d) The gas - mud interface, if the gas doesn't displace all the mud, $\text{TVD}_{\text{interface}}$.
3) The pore- and fracture- pressure profile from hanger to influx depth.
4) The mud weight/density.
5) The gas-oil gradient, i.e. the density of gas, ρ_{gas}.
6) 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.

Calculations The [hydrostatic] internal pressure profile of the tubing is calculated from the gas - mud interface down to the shoe and up to the hanger. The algorithm goes as follows

1) Calculate the pore pressure at influx depth, $p_{\text{p,influx}}$.
2) Calculate the fracture pressure at the shoe, $p_{\text{f,shoe}}$.

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

3) Calculate the hydrostatic pressure at the shoe from the pore pressure at influx depth and the gas-oil gradient, i.e.

$$p_{\text{shoe, h}} = p_{\text{p,influx}} - \rho_{\text{gas}} g \left(\text{TVD}_{\text{influx}} - \text{TVD}_{\text{shoe}} \right), \tag{1}$$

where g is the gravitational constant.

4) The pressure at the shoe depends on whether 'Limit to frac at shoe' is enabled, and whether the hydrostatic pressure at the shoe, $p_{\text{shoe, h}}$ is greater than or equal to the fracture pressure at the shoe, $p_{\text{f,shoe}}$. Precisely, the pressure at the shoe is

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

5) Calculate the internal pressure profile of the tubing, as the hydrostatic pressure from shoe to hanger.