Load case - gas kick

Oliasoft

Abstract

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

Introduction

Gas kick 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 is circulated out using driller's method. A typical example is a kick at the bottom of the next open hole section, i.e. the total depth. It is the maximum pressure experienced at every depth that is reported, which occurs when the top of the gas column reaches that depth. It is possible to enable *Limit to frac at shoe*, and then the excess pressure is bleed off to the formation at the shoe, and the internal pressure in the casing is just the hydrostatic pressure from mud, with the fracture pressure at the shoe.

Inputs The following inputs define the gas kick 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, $\text{TVD}_{\text{influx}}$.
3) The fracture pressure profile from hanger to influx depth.
4) The kick volume and kick intensity, v_{kick} and ρ_{kick}, respectively.
5) The temperature profile of the wellbore, T.
6) The mud weight/density, ρ_{mud}.
7) The gas gravity, sg_{gas}.
8) Tubing and open hole dimensions.
9) 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.

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

Calculations The internal pressure profile of the tubing is calculated by following the front of the gas column, from shoe to hanger. The algorithm goes as follows

1) Calculate the pressure at the influx depth

$$p_{\text{influx}} = g(\rho_{\text{mud}} + \rho_{\text{kick}})\text{TVD}_{\text{influx}}, \tag{1}$$

   where g is the gravitational constant. This pressure is assumed constant throughout the kick.

2) Calculate the height of the gas column as it rises upwards, using the tubing and open hole dimensions, and the corresponding gas density from Sutton correlations [1].

3) Calculate the internal pressure, $p_{\text{gas kick}}$, from influx depth to hanger, as the hydrostatic pressure from mud and gas.

4) If 'Limit to frac at shoe' is enabled, calculate the fracture pressure at the shoe of the tubing, $p_{\text{f, shoe}}$. If in addition, $p_{\text{f, shoe}} < p_{\text{gas kick}}$, calculate the hydrostatic pressure from shoe to hanger as if the tubing is filled with mud, p_{f}.

5) The internal pressure of the tubing is then

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

   reported from shoe to hanger.

References

[1] Curtis H. Whitson and Michael R. Brulé. *Phase behavior*, volume 20 of *Henry L. Doherty series*. SPE Monograph series, 2000.