Load case - tubing leak

Oliasoft

Abstract

In this document we describe the load case *Tubing leak* available in the Oliasoft™ application.

Introduction

Tubing leak is a burst load case, where the unknown is the internal pressure profile of the tubing[1]. This load case is used in connection with production- and injection- operations, and represents a surface pressure on top of a completion fluid due to a tubing leak.

Inputs The following inputs define the tubing leak 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 packer depth, $\text{TVD}_{\text{packer}}$
   d) The perforation depth, $\text{TVD}_{\text{perforation}}$.
3) The pore pressure profile from hanger to influx depth.
4) The packer fluid density, ρ_{packer}.
5) The temperature at the perforation depth, $T_{\text{perforation}}$.
6) The gas gravity, sg_{gas}.

Calculations The internal pressure profile of the tubing is calculated as follows

1) Calculate the pore pressure at perforation depth, $p_{\text{p, perforation}}$.
2) Calculate the gas density at perforation depth from gas gravity, using Sutton correlations [1], $\rho_{\text{gas, perforation}}$.
3) Calculate the pressure at the hanger

$$p_{\text{hanger}} = p_{\text{p, perforation}} - \rho_{\text{gas, perforation}}\, g\, (\text{TVD}_{\text{perforation}} - \text{TVD}_{\text{hanger}}), \tag{1}$$

   where g is the gravitational constant.
4) The internal pressure of the tubing depends on where the packer- and perforation- depth are related to each other and the shoe of the tubing. Explicitly, parametrize the tubing by TVD

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

a) If $\mathrm{TVD}_{\mathrm{shoe}} \leq \mathrm{TVD}_{\mathrm{packer}} \leq \mathrm{TVD}_{\mathrm{perforation}}$, or if $\mathrm{TVD}_{\mathrm{shoe}} \leq \mathrm{TVD}_{\mathrm{perforation}} \leq \mathrm{TVD}_{\mathrm{packer}}$, then

$$p_i = p_{\mathrm{hanger}} + \rho_{\mathrm{packer}}\, g\, (\mathrm{TVD} - \mathrm{TVD}_{\mathrm{hanger}}) \tag{2}$$

b) If $\mathrm{TVD}_{\mathrm{packer}} \leq \mathrm{TVD}_{\mathrm{shoe}} \leq \mathrm{TVD}_{\mathrm{perforation}}$, then from hanger to packer

$$p_i = p_{\mathrm{hanger}} + \rho_{\mathrm{packer}}\, g\, (\mathrm{TVD} - \mathrm{TVD}_{\mathrm{hanger}}), \tag{3}$$

and from packer to shoe

$$p_i = p_{\mathrm{perforation}} - \rho_{\mathrm{gas,\ perforation}}\, g\, (\mathrm{TVD}_{\mathrm{perforation}} - \mathrm{TVD}). \tag{4}$$

c) If $\mathrm{TVD}_{\mathrm{packer}} \leq \mathrm{TVD}_{\mathrm{perforation}} \leq \mathrm{TVD}_{\mathrm{shoe}}$, then from hanger to packer

$$p_i = p_{\mathrm{hanger}} + \rho_{\mathrm{packer}}\, g\, (\mathrm{TVD} - \mathrm{TVD}_{\mathrm{hanger}}), \tag{5}$$

from packer to perforation

$$p_i = p_{\mathrm{perforation}} - \rho_{\mathrm{gas,\ perforation}}\, g\, (\mathrm{TVD}_{\mathrm{perforation}} - \mathrm{TVD}), \tag{6}$$

and finally, from perforation to shoe

$$p_i = p_{\mathrm{perforation}} + \rho_{\mathrm{packer}}\, g\, (\mathrm{TVD} - \mathrm{TVD}_{\mathrm{perforation}}). \tag{7}$$

d) If $\mathrm{TVD}_{\mathrm{perforation}} \leq \mathrm{TVD}_{\mathrm{shoe}} \leq \mathrm{TVD}_{\mathrm{packer}}$, then from hanger to perforation

$$p_i = p_{\mathrm{hanger}} + \rho_{\mathrm{packer}}\, g\, (\mathrm{TVD} - \mathrm{TVD}_{\mathrm{hanger}}), \tag{8}$$

and from perforation to shoe

$$p_i = p_{\mathrm{perforation}} + \rho_{\mathrm{packer}}\, g\, (\mathrm{TVD} - \mathrm{TVD}_{\mathrm{perforation}}). \tag{9}$$

e) The last scenario, $\mathrm{TVD}_{\mathrm{perforation}} \leq \mathrm{TVD}_{\mathrm{packer}} \leq \mathrm{TVD}_{\mathrm{shoe}}$, is physically impossible.

References

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