CASING DESIGN IN HORIZONTAL WELLS
OUTLINE

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INTRODUCTION

- Horizontal Drilling is a well established technique that allows one wellbore to exploit reservoirs that have an extensive lateral dimension.

- An Horizontal well could be long, medium, or short radius based on the build-up rate.

- Short radius wells could be 3°/ft – from Vertical wellbore geometry to Horizontal in 20 ft. Most of these Horizontal sections are completed as open hole because of the challenges of unknowns of casing design and cementing.

- Horizontal wells with open hole completion have restricted production rate due to possible hole stability problem and borehole failure.

- Open hole completion limits bottom hole pressure that can be applied and also the pressure drawdown.

- Pumping technique for production from an open horizontal wellbore poses problems.

- Lots of casing failures and inability to get casing down to final TD have been reported in horizontal wells.

- Our objective is to prevent all these challenges with some special casing design consideration in horizontal wells.
Anticipated Casing Loads

Introduction

There are a number of areas horizontal well casing design requires a distinct difference in load magnitude compared to conventional wells. These areas include:

Anticipated casing loads

- Formation stability and overburden load (i.e. formation subsidence)
- Bending load

Design strategies

- Torque and Drag

Design Procedures

- Perforation load

Conclusion
Design strategies

- Divide your well trajectory into 3 different sections: vertical, build and horizontal sections.
- Define all the anticipated loads and their magnitudes for each of the sections.
- Clarify the effects of these loads on the resistance of the casing strings.
- Select casing strings that meet all the loads considering also corrosions and wear.
Design strategies (cont’d)

In Horizontal Section

Besides the traditional loads of conventional procedures, this section is subjected to Torque & Drag, formation subsidence, and perforation effects on collapse resistance.

1. Torque & Drag
   This is the sliding friction forces caused by the contact of the casing with the borehole wall.
   
   Magnitude depends on:
   Normal contact force (i.e. effect of Casing weight; and tension and compression e.g. buoyancy force applied on the casing)

   Coefficient of friction (i.e. effect of contact materials e.g. mud, and its degree of lubrication on the casing. It varies from 0.2 – 0.4 depending in the mud and formation type.)
Design strategies (cont’d)

Drag Force
Use computer program to generate the Drag Force (lbs) Vs. Horizontal distance

Anticipated casing loads

Design strategies

Design Procedures

Conclusion

Fig: Running load applied at the heel of the horizontal section
This load can actually cause casing damage, and should be considered in the axial load of casing design.
Design strategies (cont’d)

**Torque:**
Use a computer model to generate the maximum Torque Vs. Running Depth

This is critical in selecting the torque rating of your casing and connection in casing design.
Design strategies (cont’d)

2. Formation Subsidence

This is simply the settling of the overlaying formation on the casing string.

It results in a non-uniform load equivalent to the overburden on the casing especially, where there’s poor cement job.

Collapse rating of the pipe under overburden load can reduce to as low as 25%.

To avoid collapse failure due to this, proposed Collapse (formation subsidence) design factor of 2.0 should be used in casing design.

Fig: Collapsed casing
Design strategies (cont’d)

3. Perforation Intensity

- This is the number of perforations per longitudinal foot

- Perforation intensity higher than 4 perforations per foot has been shown to reduce the collapse resistance of a casing by 10 – 60% of the original rating.

- Based on the perforation intensity, Perforation (Collapse) design factor should be applied to casing design to correct for the collapse resistance in the horizontal section
Design strategies (cont’d)

In Build-up Section

The loads at the section could be modeled as a convention load using application like StressCheck™ or WellCat™. Such Critical loads include:

- Running load: 1 – 3ft/sec is ideal for the running speed simulation.

- Bending Load: The curve section of the wellbore generates compression load on the convex side of the pipe, and tension load on the concave side, especially when reciprocating the casing string.

- Overpull: 100,000 lbs is adopted for conventional casing design, 150,000 lbs should be considered for a build rate section of 20/100 ft or above.
Design procedures

- The design method should be based on Triaxial collapse resistance of the casing string, which incorporates the conventional loads, and the loads due to the horizontal configuration.

- **Anticipated casing loads**
  1. Calculate the overburden load at the bottom of the well. Overburden gradient of 1.0psi/ft is commonly used in salt.
  2. Apply a collapse design factor of 2 for the horizontal section of the pipe due to overburden; 1.25 collapse design factor due to perforation.
  3. Plot the correct value of triaxial relationship curve i.e. Collapse load Vs Burst and axial loads.

- **Design procedures**
  4. Calculate the bending load through the build-up section.
  5. Use the conventional loads for the vertical section.
  6. Choose the grades and connections that posses a resistance curve and torque covering each section.

- **Conclusion**
The drag force, formation subsidence, effects of perforations, and bending loads as well as the conventional loads are major loads applied on casing strings in the horizontal section. These loads can cause major failures if they are ignored in casing design.

Formation subsidence produces non-uniform overburden load acting as a point line load on the pipe and reduce the collapse resistance drastically.

Perforation intensity results in a reduction of 10 – 60% of the collapse (crushing) resistance of the casing string depending on the number of perforations per longitudinal foot.

This presentation proposes that special considerations should be given to horizontal casing string design with design factor of 2.0 for formation subsidence, and 1.10 for perforation effect.
Thank You!