

Differential pipe sticking

Pipe sticking:

A stuck pipe is a common worldwide drilling problem in terms of time and financial cost. It leads to significant increase in non-productive time and losses of million dollars each year in the petroleum industry. There are many factors affecting stuck pipe occurrence such as:

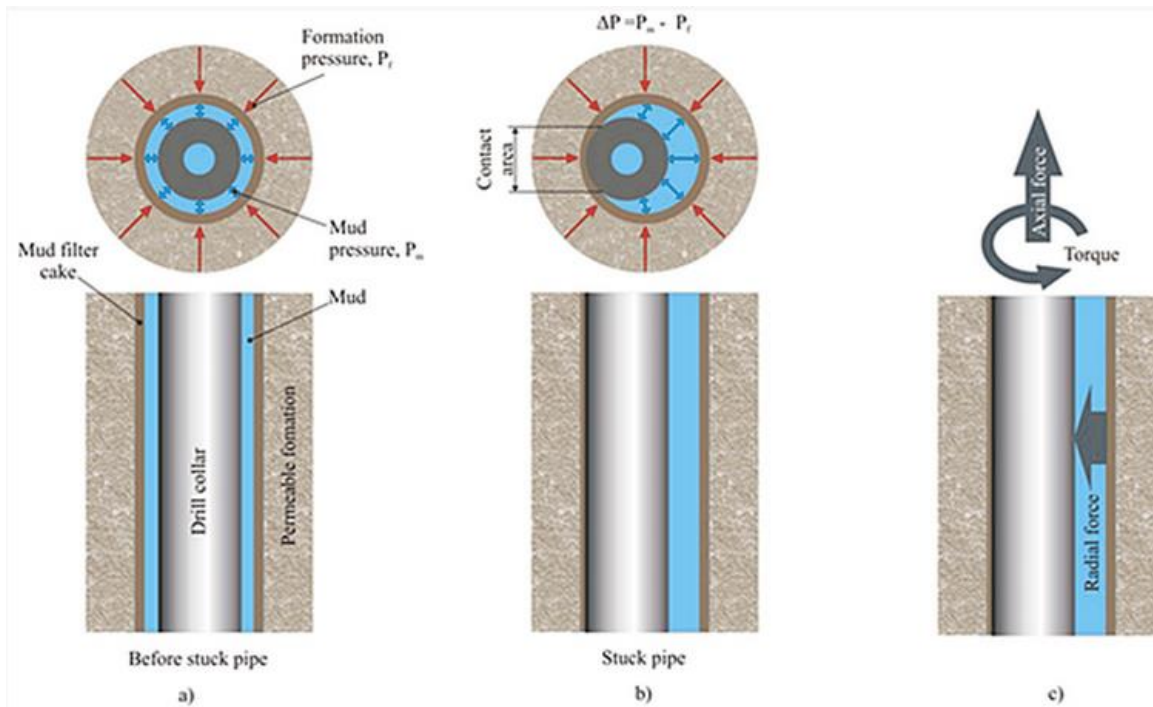
- i. Improper mud design.*
- ii. Poor hole cleaning.*
- iii. Differential pressure.*
- iv. Key seating.*
- v. Accumulations of cuttings.*
- vi. Balling up of bit ... etc.*

Pipe sticking is divided into two categories:

- i. Differential pipe sticking* (due to wall sticking).
- ii. Mechanical pipe sticking* (due to key seating, formation-related wellbore instability, wellbore geometry (deviations and ledges), inadequate hole cleaning, junk in a hole or a collapsed casing, cement related).

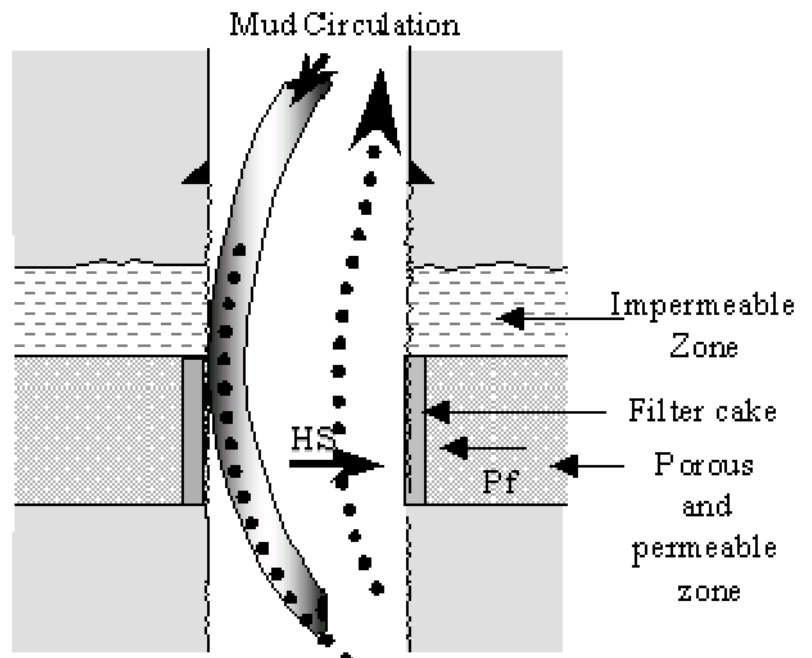
Differential sticking:

Differential sticking is a situation in which the drilling assembly (pipe, drill collars and bottom hole assembly) is stuck in a filter cake that was previously deposited on a permeable zone. The pipe is held in the cake by difference in pressure (ΔP) between the hydrostatic pressure of the mud P_m and the formation pore pressure P_f .



Causes of differential pipe sticking:

The hydrostatic pressure resulting from drilling fluid is maintained at a level which exceeds the pore pressure of formations by usually about 200 psi. In a permeable formation this pressure differential results in the flow of drilling fluid filtrate from the well to the formation. As the filtrate enters the formations the solids in the mud are screened out and a filter cake is deposited on the walls of the hole. The pressure differential across the filter cake. When the drill string comes in contact with the filter cake, the portion of the pipe which becomes embedded in the filter cake is subjected to a lower pressure than the part which remains in contact with the drilling fluid due to this overbalance the pipe is stuck.



Differential pipe sticking can be realized when:

- ✚ *The drill string can't be rotated, raised or lowered.*
- ✚ *Circulation is normal.*

Differential sticking force:

Once sticking is established a significant force is required to free the pipe. In some cases the pipe can't be freed and the well has to be side tracked or abandoned. Pull force needed to free a stuck pipe is equal to:

$$F = \Delta P \cdot A \cdot \mu$$

F: pull force (N).

ΔP : differential pressure (Pa).

A: contact area (m²).

μ : coefficient of friction (-).

The differential sticking force depends on:

- ✚ *The magnitude of overbalance and the area of contact between the drill pipe and the porous zone.*
- ✚ *The coefficient of friction between the pipe and the filter cake.*
- ✚ *Thickness of the filter cake and pipe diameter.*

Freeing differentially stuck pipe:

There are two ways in which a stuck pipe can be released:

- ✚ *Reduction of hydrostatic pressure.*
- ✚ *Spotting pipe release agents.*

Reduction of hydrostatic pressure:

The reduction of hydrostatic pressure is the obvious and most successful method in releasing a differentially stuck pipe. The lowering of hydrostatic pressure reduces the side loading forces on the pipe and therefore reduces the force needed to free the pipe from filter cake. This can be achieved by several methods:

- ✚ *Circulating and reducing mud weight.*
- ✚ *Displacing the choke.*
- ✚ *The "U" tube method.*

Spotting fluid release agents.

Pipe release agents are a blend of surfactants and emulsifiers mixed with base oil or diesel oil and water to form a stable emulsion. They function by penetrating the filter cake making it easier to remove and at the same time they reduce the surface tension between the pipe and the filter cake.

Methods of reducing the risks of differential sticking:

- ✚ *Minimize the overbalance (by decreasing the mud weight).*
- ✚ *Keep the solids in the mud to minimum.*
- ✚ *Try to keep the drill string moving all the time (minimize the stationary time) as the coefficient of friction for a moving drill pipe is about half of that for the stationary one.*
- ✚ *Increase the drill collar and drill string stabilization.*
- ✚ *Select the drilling fluid that will yield a smooth filter cake with low coefficient of friction.*