# New challenges in drilling fluid selection and formation damage reduction in Algerian fields


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**Abstract :**
Formation damage in oil field during drilling is the major problem encountered by reservoir engineers. This damage often referred to as "skin" damage, results when the permeability of the producing formation is altered. Formation damage is caused by many factors and may occur from the moment the formation is penetrated by drilling to any time during the lifetime of a well. Solids invasion, clay swelling, fines migration, and wettability change are the main causes of skin damage.

This paper highlights the main challenges in developing this type of well sections of Cambrian age in Hassi Messaoud field, select the wells to be drilled and completion fluids with a major concern on non damaging fluids by :

- Testing conventional and alternative drilling fluids.
- Estimating the percentage of return of permeability for different types of cores with the use of a given drilling fluid

Using this process will reduce uncertainty regarding fluid selection and the impact of the fluids on productivity it is meant to assist in both increasing well productivity and reducing the requirement for expensive stimulation. It may lead to innovation, resulting in new system or products when designing workover and completion fluids or for drill-in fluids including overbalanced applications.



**Key word :** Formation damage, reservoir challenge, Hassi.Messaoud field, drilling fluid selection,


## I-INTRODUCTION

Formation damage is defined as any type of a process which results in a reduction of the flow capacity of an oil, water or gas bearing formation. Formation damage has long been recognized as a source of serious productivity reductions in many oil and gas reservoirs and as a cause of water injectivity problems in many waterflood projects. This paper provides a brief overview of many of the processes which can cause formation damage and discusses laboratory techniques which can be used to evaluate potential formation damage problems before they occur in the reservoir and result in substantial damage and/or costly stimulation or worf(over treatments. This work is a study of laboratory procedure when dealing with severe formation damage due to drilling fluid and solids invasion on several well Hassi-Messaoud one of the most important oil field in Algeria.

## II- FORMATION DAMAGE

### 1-Causes of Formation Damage

Formation damage can potentially occur any-time non-equilibrium or solid bearing fluids enter a reservoir, or when equilibria fluids are displaced at extrem velocities. Thus, most processes used to drill, corre, lete or stimulate reservoirs have the potential to cause formation damage. [2]

Some of these processes might include:
1. Drilling
2. Cementing
3. Completions/Stimulation
4. Workovers
a) Kill fluids
b) Hot oil treatments
5. Waterflooding or water disposal
6. Enhanced oil recovery processes
a) Miscible flooding
b) Chemical flooding
c) Thermal flooding (in-situ combustion/steamflood ing)
7. Excessive injection or production rates
a) Perforating
b) Acidizing
c) Fracturing

### 2-Mechanisms of Formation damage

Formation damage falls into four broad categories based upon the mechanism of it's origin, these being :

1. Mechanically Induced Formation Damage
- Fines migration
- Solids entrainment
- Relative permeability (trapping) effects

2. Chemically Induced Formation Damage
- Clay swelling and deflocculation
- Wax deposition
-Solids precipitation (asphaltens,hydrates... etc.
- Incompatible precipitates and scales
- Acid sludges and Stable emulsions
- Chemical adsorption
- Wettability alteration

3. Biologically Induced Formation Damage
- Bacterial growth and slimes
- Corrosion products due to H2S.

4. Thermally Induced Formation Damage
- Mineral transformations
- Rock solubility and dissolution phenomena
- Wettability alterations

It is not possible to discuss all these phenomena, this study will focuse on drilling fluids damage only. [3]

2-1 Mechanically Induced Damage

It has been long accepted that severe permeability impairment can occur when fluid velocities become large enough to physically shear interstitially bound particulates loose and move them to bridging/blocking locations at pore throats. Mungan, (1989) and Porter (1989) all provide more detailed descriptions on the problems associated with fines mobilization. The injection of fluids containing solids can also cause gradual plugging and loss of permeability. Damage can occur also when the near wellbore region is invaded by an aqueous based drilling fluid, resulting in a much high irreducible water saturation Sw, (due to capillary trapping phenomena).

## III- LABORATORY APPROCH

Recent advances in laboratory testing procedures allow for the in-depth simulation and evaluation of almost any type of drilling, completion or stimulation program considered for use in a horizontal well.

This allows for considerable screening and optimization to be conducted, prior to implementing an expensive and potentially unsuccessful program in the reservoir. Several analysis are run in order to characterize rock samples and evaluate damage.

**1. Mineralogical analysis**
Several minerals are identified by RX diffraction technic.

**2. Petrophysical analysis**
Roch properties such as permeability, porosity are evaluated in order to optimize samples selection.

**3. Petrographic Analysis**
Rock samples are analysed with optic microscopy technic to identify type and distribution of minerals into the rock matrix.

**4.Scanning electronic microscopy Visualization**
This technic allows visualization of the rock framework with pore spaces and throats.

## IV- DAMAGE TESTS

### 1. Test description

The test series was performed on the Automated Return Permeameter (ARP). This permeameter was primarily designed to be able to perform return permeability tests on core samples to find the least damaging fluid for drilling and/or completion for a particular application. The unit was designed with several ideas in mind: it's capable of tests at 275ºF, with a pressure limitation of 10,000 psi on overburden pressure with a 5000 psi limit on mud overbalance pressure and pore pressure. Once the test sequence is programmed in and the test started, time required from the operator is minimal. All data acquisition is automatic. Even the clean up of the unit following the test can be set up in advance and carried out automatically.[3]

### 2.Samples saturation

Samples are saturated with brine in order to restaure original water saturation of the rock.

### 3.Flow tests

- Determination of the initial permeability to with a reference oil (Ki).
- Drilling fluids injection trhough rock during 3 hours
- Determination of the final de la permeability (Kf) : The return permeability gain is given by .

**Gain=Kf/Ki %**

## IV- RESULTS

1.Petrographic description

Figure 1 shows intercristalline porosity with great aptitude to solids invasion damage when drilling.

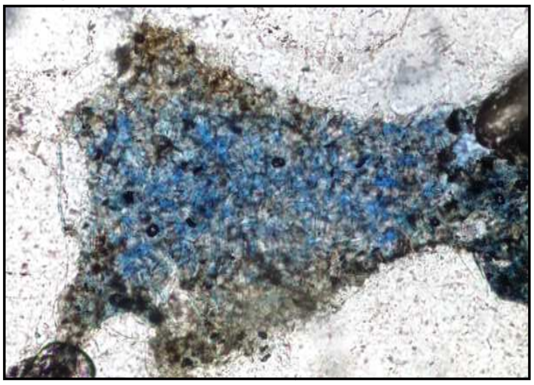

**Figure 1. Intercristalline porosity**

2- SEM visualization

Samples were taken from the testes rock with system I and shows a layer due to drillling fluids solids.

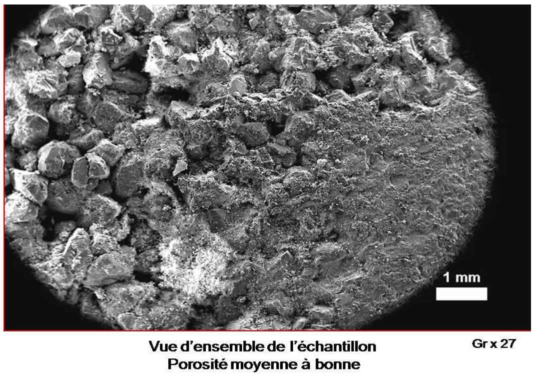


**Figure 2. SEM visualization of rock sample.**

3- Damage tests results

Three oil base mud drilling fluids systems from 03 companies were choosen for damage tests. Obtained permeability curves vs filtrate volume are given below (see figures 3, 4 and 5).

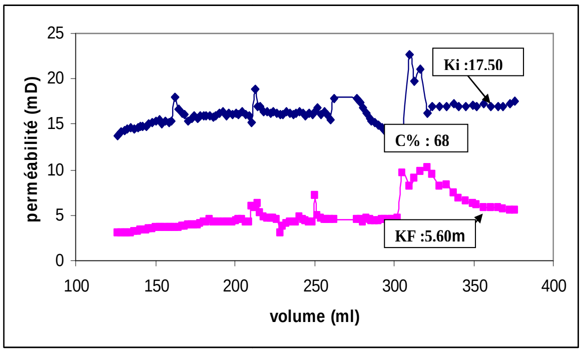


**Figure 3. Permability vs filtrate systemI.**

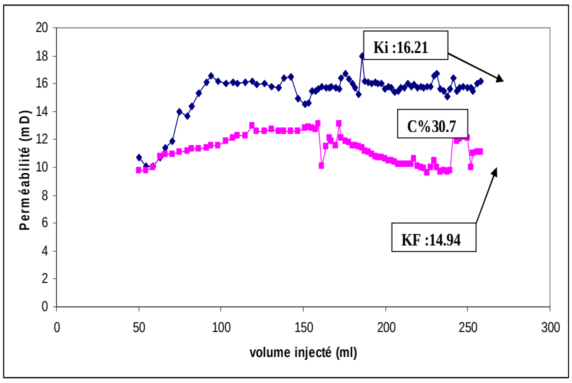


**Figure 4.Permeability vs filtrate system II.**

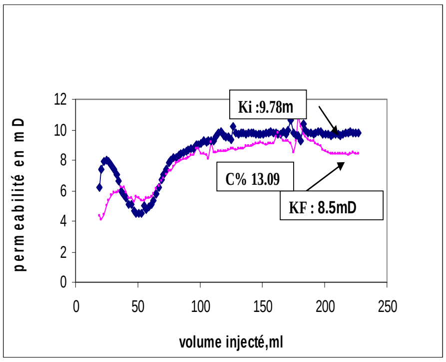


**Figure 5. .Permeability vs filtrate system III.**

- Skin Damage Attributable to Drilling or Completion Occurs from 3 mechanisms: [4] Krueger, A.F.: "An Overview of Formation Damage and Well Productivity in Oilfield Operations", JPT, Feb. 1986).

1. Particulate invasion which blocks the formation pores.

2. Filter cake can fill up and plug large cracks and fractures. (This is difficult to remove by flowing the well or acid treatment, see figure below).

**Figure 6. Filter cake on front of sample rock.**

3. Filtrate invasion can interact in various ways with solids or liquids in the pores to cause a reduction in permeability.

The results shows that designing formulations can reduce damage from 68% to 13.5% because :
Non-Damaging systems have been developed due to formation damage observed in past wells; those damages have lead to the evolution of completion,
workover and stimulation systems that can greatly reduce the impairment often incurred when using traditional drilling fluids and techniques

**Recommendations**
Damage occurs when drilling can be resolved by several operational interventions Filter Cake Removal.

• It is very important to ensure that the filter cake formed by dynamic and static filtration can easily be removed when the well is brought into production.

• The filter cake may be removed by washing or acid treatment, or simply through the application of formation back pressure.

• The use of well-sized material, able to build up a thin, easily removable filter cake is the desirable solution.

## CONCLUSION

Formation damage is a significant problem that has the potential for reducing productivity in horizontal wells in oil and gas reservoirs during almost any type of drilling, completion or stimulation operation.
Through the use of high technology laboratory studies, the effects and benefits or disadvantages of various proposed drilling, completion or stimulation programs can be examined and weighed in the laboratory, prior to the expense and risk of implementing them in the reservoir.
The careful use of well designed laboratory programs can thus reduce costs and increase productivity in many oil and gas reservoirs.

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