

Analytical protocole for petroleum potential evaluation of the shales gas and completion parameters

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Abstract –

The shale gas plays exploration and development around the world represent from the starting of the twenty first century a capital aspect in oil and gas industry it is deduced, and according to the EIA (Energy International Agency), in the horizon of 2020, the United States of America will become the first oil and gas producer in the world and will be exporting just after.

These reversing situations conduct all the remaining countries which have significant reserves estimated as unconventional to prepare itself to this technical and technological challenge.

Algeria, by the intermediate of its national oil company SONATRACH started since 2012 to prepare its upstream structures to defy this challenge and where the first target assigned is the evaluation of the petroleum potential of the Algerian shale gas. This process can't be done without the direct implication of the evaluation structures even the indirect logging analysis, but also the laboratory core analysis as direct analysis.

The lab Division is totally related to this project from the starting. The Division continue to put in place during 2013 an upgrading program where is integrated these specific protocols totally dedicated to the non conventional reservoirs

We will expose in this communication all the necessary parameters, the very important one needed for the evaluation of the petroleum potential of the shale gas and the characterization of the completion of these specific wells. We will expose the technologies put in place for an accurate and efficient acquisition of these capitals information.

The implementation of these new analytical protocols, conduct us to follow the life progress of the shale gas wells starting by its preparation to its producing operation. This process is a tool where every potential operator and intervening can find answer to any question and interrogation in order to make the appropriate anticipated simulation of the actions to do and

avoid by the way any failure

Key words: Shale gas, analysis, petroleum, laboratory

1. Introduction

The evaluation of the non conventional reservoirs and especially the shales gas reservoirs require advanced technologies for the determination of the needed parameters necessary for the petroleum potential estimation and aptitude for completion

The shales gas reservoirs have the following particularities by report to conventional formations:

A highly spatial heterogeneity observed by the variation of the genetic parameters and very low reservoirs characteristics

A very pronounced anisotropy for a direction to other. The evaluation requires a spatial investigation and also according to many need directions. Correlations have to be done.

In our presentation, we will expose you a typical shale gas reservoirs analytical protocol, by précising the interest of each researched parameter and also the existing technological mean for the determination of this properties and which are instead of acquisition in the Technologies and Development Division.

2. Core extraction and preservation in the wellsite:

Le starting of the evaluation process begin from the wellsite. Since the special cores are carefully recovered in a timing which have to be less than (06) six hours in order to be preserved. In place the sample have to be immediately taken and put in an hermetic container connected with a pressure manometer. This allows the evaluation of depression along the time. These containers called canisters are conserved in stable temperature during about (60) days and depression is followed regularly. In the end a depression curve is dressed showing the variation of pressure in function of time

The freed gas from samples is also recovered and analyzed qualitatively and quantitatively by special gas chromatography in order to have the exact composition of the adsorbed gas

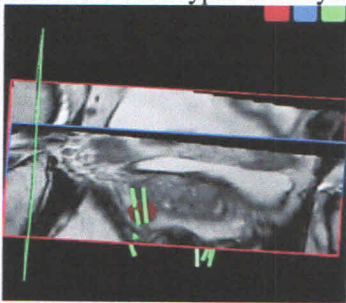
This operation is done as a starting point for the estimation of the quantity of the adsorbed gas and also having an idea about the matricial porosity and permeability

3. Special core preparation:

The remaining cores after being transported in a suitable way by avoiding the exposure and the jolts will be the object of laboratories analysis necessary for the evaluation of the reservoir parameters and also the evaluation of the characteristics of completion.

The core is scratched by scratch test and the fracable intervals are selected for analysis

These same samples are the subject of a second test of selection through the CT Scanning in order to ensure the integrity of the sample. In these same intervals another sampling will have to take seat for the other types of analyses.



4. Petroleum potential analysis:

The samples taken are immediately transferred for geochemical evaluation, then mineralogical and finally Pétrophysique.

a. Geochemical analysis:

Three types of analyses must be made at the beginning:

- The evaluation of total organic Carbon (TOC) existing in the rock.
- The evaluation of the hydrogen potential and the maturation degree of the organic matter.
- The evaluation of the thermal history and possibly geochemical modelling.



These parameters will indicate the richness of the formation, which in case of shales gas require values more than 4 % of TOC. Also the obtained results show the maturation level of the source rock which has to be within the gas window to dry gas.

b. Mineralogical analysis:

Considering that the reservoir is with high

argillaceous composition, it is very important to evaluate its mineralogical composition and the type of clay forming this composition, In order to take in account this aspect very accurately. We try to use several types of converging analyses such as:

- The qualitative and semi quantitative analysis of clay content and clay minerals using the X ray diffractometry (XRD).
- The quantitative and molecular evaluation of the clay component by X ray fluorescence (or XRF)
- The evaluation of the non crystalline and amorphous components by the Infrared spectrometry or FTIR.
- The estimation of the petrographical composition and the clay diagenetic evolution using the optical microscopy.
- The evaluation of the porous media and the filling material of the pores using the electronic microscopy (SEM).



This composition defined can identify the facies type and give clearly information about its fracability and sensitivity of the formation. Even the interstratified clay minerals, when they exist make completion job very difficult.

c. Petrophysical analysis

At the end of the depression evaluation and results obtained from this operation done on the canister conserved samples, an analysis of the adsorbed gas rate by clays is made according to the of the Langmuir isotherms laboratory procedure, which consists in saturating by using the pressure depletion reverse curve till reaching the maximum stage. This analysis and test is used on a gas adsorption – desorption equipment (generally using nitrogen and CO₂, and also methane). This evaluation allows to recover equivalent saturation parameter in conventional reservoirs type.

The porosity estimation uses the fundamental principles of Archimedes and Boyle Marriott. It is used on scratched rocks and non complete for more reliability; even porosity values are very low.

However, the permeability and due to the weak porous network it is estimated in two ways:

- The pulse decay which is generally used in transient regime
- The pressure decay which is applied to non turbulent and laminar regime.

d. retrospective :

All these parameters once identified gives accurate information about the oil potential and reservoir characteristic of the shale gas formation. However, and due to heterogeneity of these levels, it would be judicious to subdivide this formation into micro sequences where each one represents specific criteria. This allows better to converge very well the reservoir characterization.

5. Completion parameters analysis :

Although the intrinsic properties geomechanics are an advanced characterization, in the context of the shales gas these properties are regarded as reservoir parameters. They join the criteria of fracability checked before by the rate of the existing amount of silt and confirmed by XRD and petrography when the mineralogical evaluation is done.

a. Mecanic properties:

It consists on the estimation of Young modulus and Poisson's coefficient and also the break point of the samples. This analysis even it take in account the highly anisotropy, it was done following many directions. In the Algerian shales gas case, the young modulus, vary from one to four times following one direction to other.

b. Proppant imbedment properties :

Even the formation is shaley, embedment test are made in all the reservoir target interval, this allows to have an idea about the proppant capability to maintain the initiated fracture open, thus conserving the created petrophysical properties after fracturing. More the formation have more clay content, more it is difficult to maintain the fracture continuity. Where, it is necessary to make a simulation of these phenomena before concretizing this in the well.

c. Compatibility test :

The water type used in the fracturation job is a key factor for a success or not of the stimulation. It is so necessary to use a compatible formulation with the clay content. The presence of interstratified clay represents a harmful factor for this type of reservoirs. It is indicated to find specific formulation followed very closely when fracturing. The quantity of water injected for fracturation and the quality and type of existing proppant in this operation represent a determinant factor for the length and conserving continuity of induced fractures.

Remark: in order to recover clearly the problematic, it is advised to establish a geomechanic model of the region where the well is drilled in order to determine the resultant of the really existing constraints, taking in account the lithostatic one, the max and min constraint and the tectonic one. The resultant has to take also in account the anisotropy of this kind of reservoir which changes highly and fastly from direction to other.

Constatations :

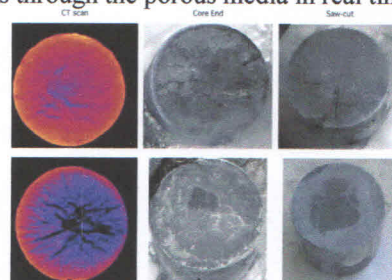
Even this standard analytical protocol is very long, the obligation to have all necessary information's is extremely recommended in order to prepare the development well program very carefully. All lack of information will traduce a simple mathematics and hypothetic extrapolation of any parameter and might induce mistakes in the real completion program. The anisotropy of this kind of reservoirs conduct interpreter to be very careful.

6. Upgrade of Technologies and development Division for the assumption of responsibility of the shales gas protocol:

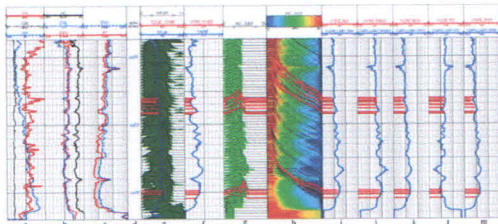
The Technologies and Development Division in its upgrade plan envisage to cover all the shale gas analytical protocol, this in the next few years with creation of shale gas dedicated laboratories in its Laboratory and Central Core Wharehouse Direction situated in Hassi Messaoud.

In addition to this protocol, the Division try to extend its capabilities to other new and advanced investigation technologies necessary for exploration and development of the non conventional reservoirs, we can quote the following:

- The use of the computized tomography scanning in the virtual reconstruction 3D of cores and the porous media
- The use of the computized tomography scanning and the nuclear magnetic resonance for the 4D laboratory simulation which consist on the study of the displacement of fluids with radioactive tracers through the porous media in real time.



- The evaluation of petrophysical parameters and the flow such as capillary pressure, porosity, permeability, volumetric factor by the nuclear magnetic resonance (NMR)



- The use of the gas adsorption-desorption for the determination of the porometry, capillary pressure in replacement of the mercury injection method.

7. Conclusion :

Even if technologically, the evaluation of the reservoir and completion parameters of the nonconventional tanks is relatively advanced, the technology and Development Division try to be in time before the start up of SONATRACH in the Exploration

and development of this kind of reservoirs. This is clearly seen by its total implication in the evaluation projects which are already engaged starting from the program preparation to the supervision of the obtained analysis results.

Taking in account the important factors assigned for this type of Project: time and reliability of the results, the Division try to make all necessary investments for getting quick and reliable analysis. This to take its engagements and give to operational structures the technological means and material for taking the true decision in true time.

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