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UNCONVENTIONAL RESERVOIRS: FROM EXPLORATION TO PRODUCTION: THE NEW ENERGETIC CHALLENGE, AT WHICH PRICE?

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Abstract

Shale gas and tight reservoirs resources emerged as a viable energy potential for the near future. Shale gas particularly and tight reservoirs become vital in characterizing their properties: starting from TOC rating to maturation, gas in place brittleness and low permeability. Thus, it is very harsh to reach a wise economical recovery stage (seepage and flooding). Similar types of resources are classified as unconventional owing to their complexities from their low K to their high pressure mostly exposed to formation damage. Thus, recovery obstacles complicate the unconventional reservoirs exploitation and management. Production from unconventional reservoirs is related not only to their characterisation properties but it is own also to the state of the art technologies in use. Therefore integrated approach is essential to success and, improving methodologies are needed. The contribution of the incorporated breakthrough technologies, surely, will help to stimulate unconventional reservoirs up to commercial production. Beside, alternatives and effective tertiary methods are also present. They consist on the extraction of amount of crude oil-gas based on residual oil in place using the following techniques: thermal recovery, gas injection, and chemical injection. Hence, now days Oil – Gas Recovery revolution is taking place with enormous volume of oil and gas to fill the gap: Not to be feared of running out of fossil fuel but at which price. Different and various laboratory investigations have led to viable results based on core lab analysis. The use of SEM (microstructure pore determination, autopore use for the PSD and geometry determination, Triaxial tests (for mechanical brittleness index) and surfactants use constitutes the most challenging approaches.

Introduction

Countries dependence energy has led to sharply rising oil prices thus, economic stagnation and high inflation. Importance of oil and natural gas production are changing the energy strengths and vulnerabilities. Investigation on unconventional H-C becomes vital where more advanced technology has to be set. Atypical reservoirs exploitation at lower cost over time, allowing economically viable scale with a lesser environmental effect is targeted. The shale gas revolution has stimulated tremendous production especially in the United States and Canada (Fig 1).

Potential on Shale Gas-Oil over the world - Focus on the Algerian Basins budding

As said previously, the booming of oil and gas exploration and production is mainly related to the advanced set technology. The new combination of horizontal drilling and hydraulic fracturing remain among the most important means to easy the different maneuvers. In Algeria according to different sources principally geological and geophysical data, sedimentary basins cover almost more than 1.5 Km2 with an average thickness of 3000 m in most cases. In Algeria: The sedimentary basins characterising atypical or unconventional shale oil - gas reservoirs cover more than 1.5 million km2 with an average thickness exceeding 3000 m in most cases. The presence of thick source rocks rich in organic material, the right conditions for hydrocarbon generation, offer excellent oil and gas potential on the Sahara platform (Fig 2). With an average exploration drilling density of approximately 7 wells/10,000 km2, Algeria remains under-explored (World average is 95wells/10000 Km2). The majority of exploration wells in Algeria were drilled before the mid 1970s, using methods and technology which are now considered obsolete (WEC Evaluation, 2007, SLB)

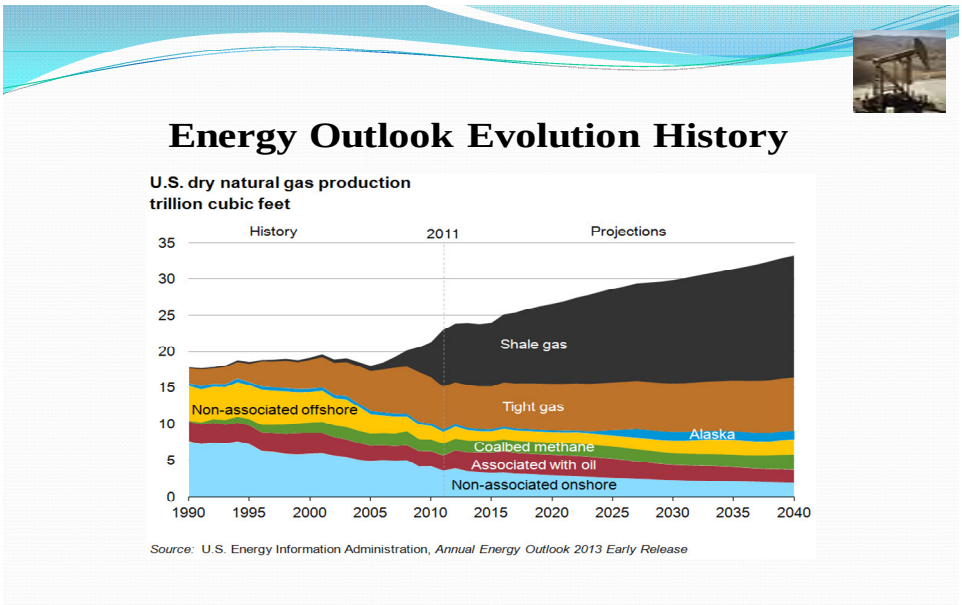

Fig 1 showing the history development of unconventional and tight oil-gas recovery and projection-progress

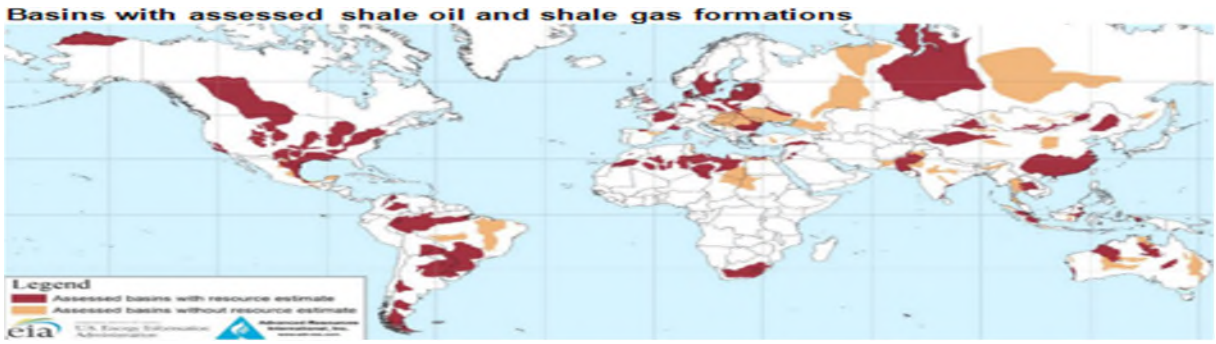

Fig 2 showing Basins with Shale oil- gas distribution including the Algerian basins (US Energy Administration source, USEIA)

Scheduled Time prior to any exploitation: Case of Algeria:

As known from different advanced oil companies dealing with unconventional reservoirs, in Algeria resources are mainly located in different basins, Ahnet, Mouydir etc. According to previous international experienced oil exploration companies, time allocated to preliminary investigation can last around 1 to 2 years duration. This due time is associated to basins quality extension geometry. In addition quantity and availability of gas - oil possibly exploitable can also last around 1 to 2 years. Focus on economical efficiency and apercu might be around 1 to 2 years duration.

Focus on Shale Gas Definition

As defined by most of the petroleum searchers and users, shale gas is known as a fine-grained reservoir in which gas is self sourced. Some of the gas is stored in the sorbed state predominantly stored in the organic fraction. This sorption or ability of adsorption in addition to storage can be related to the pore space distribution (PSD) in addition to the grain and type of specific surfaces.

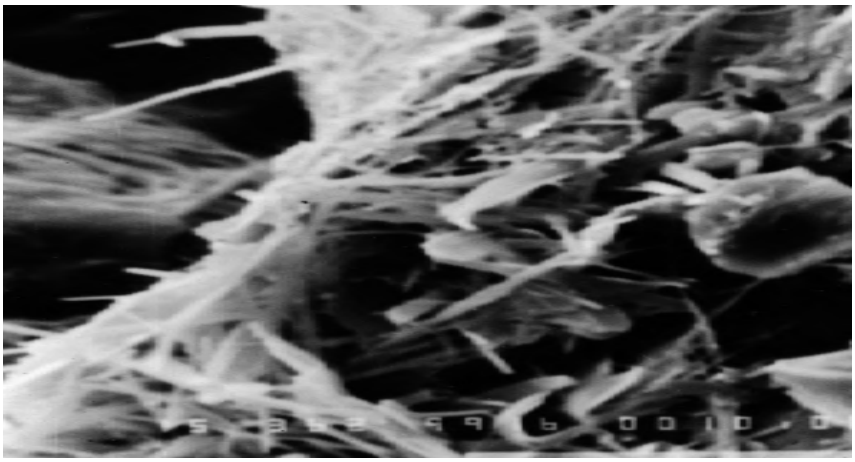

Fig 3 Clay ramifications showing exposed specific surface suitable for adsorption – sorption processes. The presence of inter ramification spaces are in favour of the

absorption route. Clay bridges and ramifications are retaining a potential of gas and fluid (Benzagouta, 1991)

Properties of reservoir material:

From characteristics point of view, shale gas and tight reservoirs are characterised by permeability less than 0.1 md. Owing to this status, artificial frac should be activated for better development of reservoir characteristics and fluid-gas circulation. Increase of this latter parameter is ascribed to fractures evolution.

Prior to any frac system, natural fracture intensity should be investigated. Their assessment provides amount of routes for the natural gas-oil mobility. Their presence and by intersecting with artificial fracking - process will combine towards an increase of K effectively. This fracking - system becomes one of the major parameters taken in consideration for reservoir porous medium improvement.

Ability of the fracking - process is associated to_rock mechanical properties of the reservoir material e.g. more artificial fractures are associated to brittle Shale/ductile. Thus, importance of defining the material chemical and mineralogical composition becomes of significant importance for the degree of brittleness determination. In addition, investigation on stress strain will deliver very useful information for the fracking process. Improvement of reservoir characteristics, allowing fluid or gas circulation within porous medium for better recoverable reserves, is also associated to the structural setting. Since, subsurface extensional or compressional (stretched or pushed) open fractures are of significant effect (Benzagouta, Amro, 2007)

Techniques of extraction-Cost

Gas reservoirs are extensive in horizontal dimensions/vertical way. The drilling operation remains one of the most important efficient _Innovative-Stimulation Techniques to schedule, while the process is associated with reservoir maximum contact (RMC). Thus, it has to be wise in the drlling decision type. However, the dilemma is the hight cost of the horizontal drilling which can only be restricted to some particular situations e.g. anisotropy in K distribution or efficient RMC . As known, horizontal well can cost up to 300 percent more/vertical well to the same horizon.

Fracking process:

Economical stimulations with regard to artificial frac is useful and present technology is an important issue to create pathways ramification around the wellbore allowing fluid circulation. State of the art techniques for Fracturing require care associated to a experted frac team. Injection of water based fluids at high pressure overcoming lithostatique pressure and opening up to millimeter sized gaps

In general, a fracking fluid can be defined as follows: three main components: Fracking Fluid = Based Fluid + Additives + Proppant;

Based Hydraulic FracturingFluid Types are water Fracturing (slick water fracturing) (fig 4) - Multi-stage Fracturing - Simultaneous Fracturing (Simo-Fracs) - Nitrogen Foam Fracturing (see 3 phases diagram)- CO2 Sequestration (3 phases diagram) - Hydrojet Fracturing - Refracturing Gel Fracturing

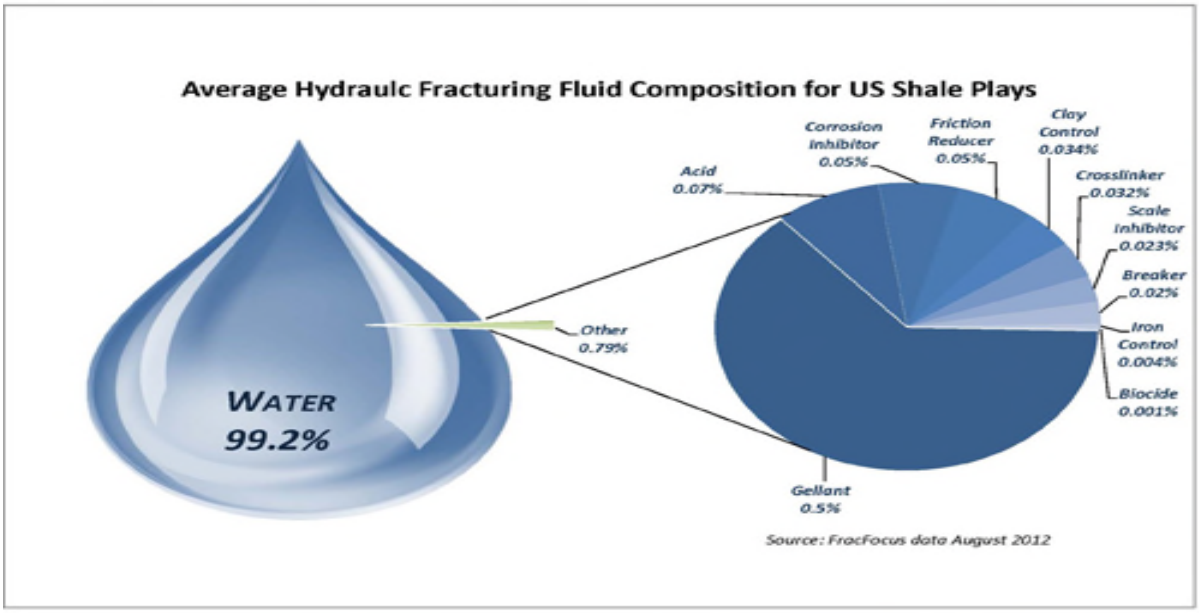

Fig 4 Hydraulic Fracking fluid composition as used for general drilling process (Fracfocus, data, August, 2012)

Environmental Potential Risks – Impacts

Fluids mixture from injected chemicals (additive chemical) will meet the formation water attaining the surface and subsurface formations. These fluids with their undesirable reduced chemicals can be potential contaminants (fig 3). Fluid Subsurface contamination becomes credible supported by faulting systems present: ramifications or paths for communications and fluid circulation able to handle the option of important drainage for reaching later on the upward permeable zones.

Precautions for undesired chemicals

Drilled Shale gas reservoirs are largely deeper than the aquifers (see depth around 2000 up to 3000 meters). Contamination occurrence can be from the casing and cementation leakages (source of strong menace). Thus, fluid leakages can be sustained by casing and cimentation system reaching 3 times round.

Conclusion and Recommendation

Team work-discipline package related to different field is vital: from petrophysical properties, Drilling Techniques, Geomechanics, Geology Production processes and environmental cares. Since unconventional gas shales and tight reservoirs become at present a marvelous ressources for a worth economical income for the near future but at which prices: Challenge and opportunity become a duty since life requires energy to survive but environmental impact remains a principal concern. Thus, technology and good management policies constitute the main target to economical issue and to mitigate the whole risks. At that time and, certainty, we will not be feared of running out from oil and gas for the next decades. Therefore, let us be enthusiastic and optimistic but at which price.... here is the dilemma. Others matching issues are on their way for bright and efficient recovery techniques: EOR (Enhanced Oil Recovery). They consist on the extraction of amount of crude oil-gas based on residual oil in place based on the

following techniques: thermal recovery, gas injection, and chemical injection. Hence, now days Oil – Gas Recovery revolution is taking place with enormous volume of oil and gas to fill the gap.

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