

AN EMPIRICAL STUDY OF EMERGING TECHNOLOGIES USED IN THE CONSTRUCTION OF WELLS IN HIGH TEMPERATURE AND HIGH PRESSURE HYDROCARBON ZONES

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Recently ONGC and Cairn energy companies discovered huge amounts of oil reserves in Krishna delta area. These oil reserves are extended about 1697 square kilometers. They are able to find the reserves with the help of Schlumberger digital technology. High pressure and high temperature hydrocarbon zones exist in Krishna delta area, extending from Diviseema to Repalle in Guntur district. An estimation of oil reserves in those areas are approximately 550 million barrels.

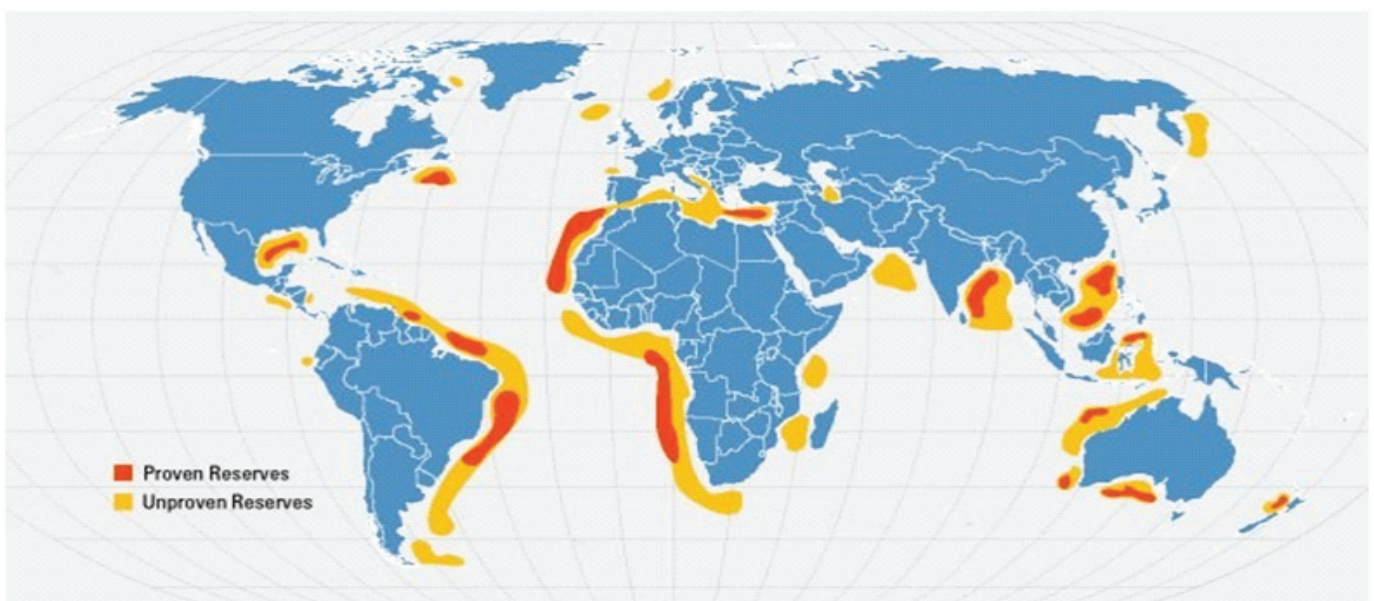
HPHT zones

Generally 123.5 degree centigrade temperatures and 69 MPa pressure is required to mature the organic matter into hydrocarbon. These kinds of conditions exist in normal oil wells, whereas in HPHT wells the temperature

and pressure conditions are 150-205 degree centigrade and 70 – 138 MPa. In ultra HPHT wells the temperature and pressure conditions are 260 degree centigrade and 241 MegaPascal, beyond this classification conditions come under horse category HPHT.

If either of the parameters, temperature or pressure, falls within one of the three HPHT regions, the well is classified accordingly.

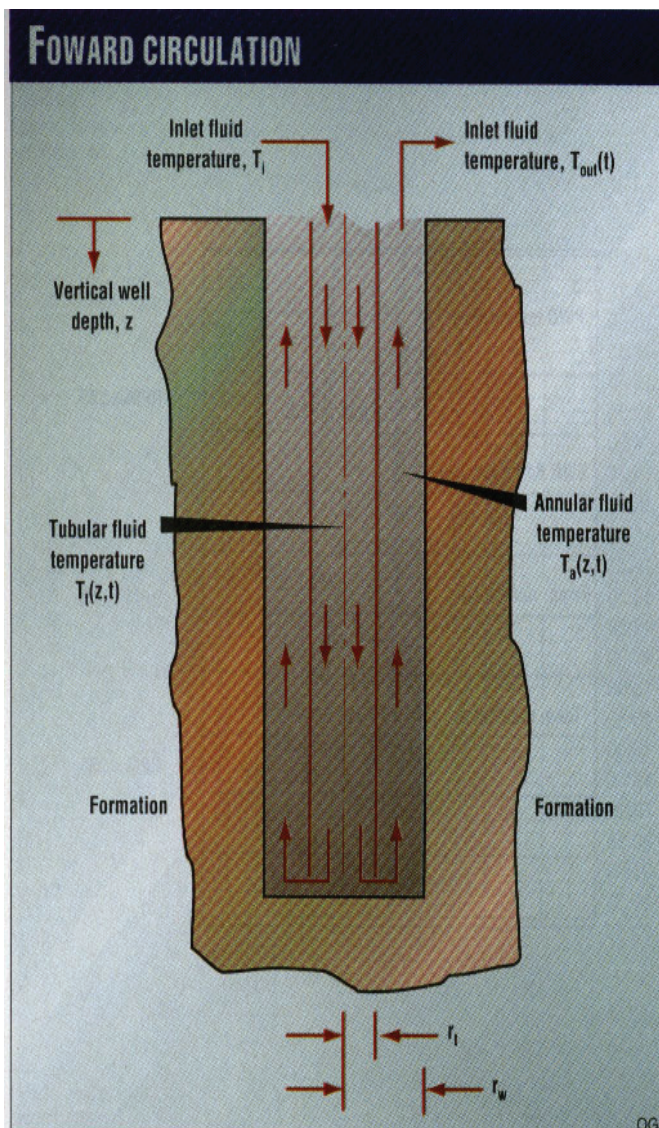
When we are using normal logging tools in HPHT environments they can't sustain the host line environments, why because temperature and pressure are too high to keep normal logging tools for long time. Logging tools, testing tools and drilling fluids are exposed for limited time but packers, sand screens, reservoir monitoring equipment and cementing system must survive for long time.



Testing HPHT technologies

Before applying in field applications, the HPHT technologies are tested in the lab to qualify to sustain those environmental conditions. Lab testing falls into three categories. 1) Fluids 2) Mechanical devices 3) Electronics devices.

Well construction and facing problems in HPHT environments



Well construction in high pressure and high temperature conditions is challenging.

Mud Properties do vary with the changing temperature at various levels of down hole which in turn effects the estimations of mud density and viscosity. In HPHT wells, encountering with over pressure formations is

a frequent phenomenon. These wells would be drilled with high enough mud weight to give safety margin over pore pressure. So mud engineer makes mud to minimize formation damage and maximize rate of penetration and reduce the risk of formation kicks. Mud CADE program(a software) will be useful to understand vertical temperature profiles under various conditions. We input the thermal conductivity of each component and MudCADE gives the output of temperature of mud inside the drill string and casing. In HPHT wells some minor but serious errors will be encountered due to temperature of drilling fluids, mud density and viscosity changes with temperature. So in this case down hole temperature profiles at all phases of the drilling operations will be useful to understand. In case of total pressure approaches fracture pressure, the first option is to reduce the dynamic pressure. It can be achieved by reducing mud viscosity, mud weight, mud solid content, pump rate and ROP.

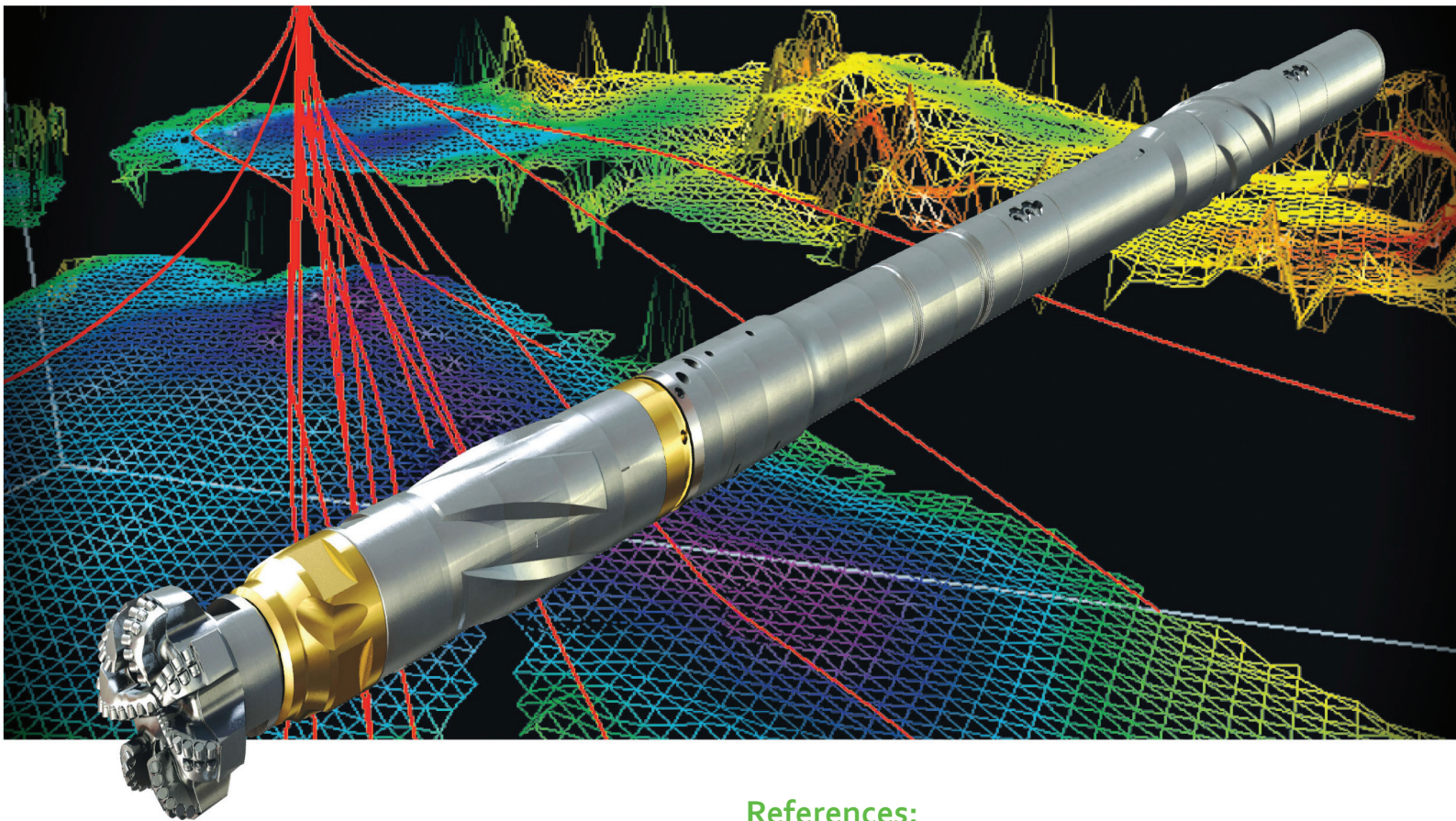
During drilling some kind errors or problems will be encountered like sagging. It will be caused by the gravity and pressure control factor. Total pressure reduction can be achieved by manipulating static pressure, at the expense of the safety margin above formation pore pressure.

HPHT Tools

During drilling of HPHT wells hydrostatic pressure properties of fluids must be understood. We are using Formate salts base fluids in HPHT wells because halide fluids have high corrosion to steel at elevated temperature.

Normal logging tools will operate up to pressure 207 MPa only; excess of this pressure the cartridge inside the sonde will be destroyed. Pressure protection is maintained by titanium alloy housings.

In HPHT wells, temperature also plays a dominant role. Normal logging tools can bear the temperature up to 177 degrees centigrade only, where as in HPHT logging tools a Dewar flask – vacuum sleeve is placed inside the tool, which delays the heat transmission. It can operate up to 260 degree centigrade.



While drilling downward the depth of bore decrease, in this case slimXstream logging tools will be useful which contain the 3 inch diameter. It will work even in 3 1/2 inch drill pipe or 3 7/8 inch open hole, this tool can operate at pressure up to 207 MPa.

HPHT Production techniques: In HPHT wells production is carried out using two techniques.

- **Matrix acidizing** consists of pumping of low PH fluid through naturally existing channels. In normal wells HCL is commonly used but in HPHT wells, matrix acidizing fluid is Hydroxyethylamino carboxylic acid (HACA) is used.
- **Hydraulic fracturing** consists of pumping the fluids to create fracture. Fluid engineers are using metal solutions of guar base polymers to have sufficient fluid viscosity. Boron and Zirconium are the commonly used metal cross linkers.

References:

- 1) Mac Andrew R, parry N, prier J-M, Wiggelman JH, Diggins E, Guichency P, Cameron D and Stewart A;
"Drilling and testing Hot, High-pressure wells," oil field review 5, no.2/3.
- 2) Gibson MT, Bergerot j-L and Humphreys A;
"Developing a Greater understanding of the well hydraulics in HPHT wells;An updated study of the wells in the Elgin/franklin fields", presented at Drilling. The 4th annual industry forum,aberdeen, UK, march
- 3) Houwen OH and Geehan T"rheology of oil-base muds", paper SPE 15416, presented at the 61 st SPE annual technical conference and exhibition, neworleans,USA.
- 4) The institute of petroleum; "well control during the Drilling and testing of high pressure offshore wells," london.
- 5) SEDCO 704 HPHT manual, mallard deveopment,November 1997.