Aphron Drilling Fluids a Solution for Depleted Reservoirs – Review

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***Abstract*— Drilling depleted reservoirs for the extraction of oil and gas has become a challenge. On drilling depleted reservoirs where there lost on circulation is very high. Drilling with conventional fluid system and also using non-invasive fluid additive will not prevent mud loss in fractured reservoirs. Aphron based drilling fluids helps in preventing fluid invasion and provides underbalanced drilling condition. The place where the conventional mud fails, Aphron mud has proven to be successful and economic.**

Keywords-micro bubble, invasion, LSRV, Lost Circulation, Coalescence.

I. INTRODUCTION

Extracting oil and gas from earth's crust is a need for future energy demand. Drilling fluid is one of the single most important element for entire earth excavation process. Depleted reservoirs are nothing but reservoirs having formation fractures. When drilling fluid passed through the drill bit, due the fractures mud enters into the formations. As a result there is drastic decrease in the volume of the drilling fluid. This condition of mud loss on return is termed as 'Lost Circulation'.

Aphrons "high energetic micro bubbles" are fluid for the future drilling process. Aphron due to its high Low Shear Rate Viscosity (LSRV) and its efficacy to seal the depleted formations, it's proven to be a better alternative for conventional drilling fluids. On the other hand its cost effectiveness and underbalanced drilling conditions makes it an attractive area for future research.

1.1. How it works?

Aphron drilling fluids contains micro bubbles encapsulated in a viscous polymer shell. When bubbles are subjected to high pressure bubble gets shrink. These micro bubbles have flow tendency from high pressure zones to low pressure zones. Aphron mud on returning when it comes across fractured formation, due to its flow property it enters into the fractures. As soon as it enters into the low pressured fracture zones, compressed micro bubbles starts to expand. These micro bubbles do not coalesce with each other. As a result when bubbles get accumulated, fractures get filled up and further there is no lost circulation is observed; as shown in fig.1. Due to its capability of stabilizing the formation it also assist in casing by reducing the number of casing which are generally being used to seal the well after drilling. It also reduces the cost of hole cleaning and as a result it's a viable option for drilling. The LSRV plays an important role in the invasion of aphron drilling fluids. As the fluid slows due to radial flow and bridging action of the aphrons, the shear rate decreases and the viscosity rises. This process continues until at some point the fluid essentially stops.

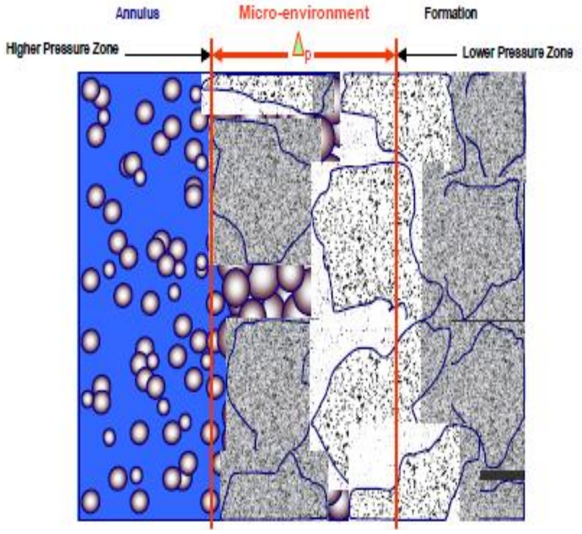

Fig.1.Work function of Aphron when it flows from high pressure zone to low pressure zone and invasion control by for bridge of micro bubbles.

1.2. Structure of Aphron

Aphrons are bubbles of size 20-200 µm. Aphron contains

- It contains a core which can be liquid or gaseous.
- Aqueous Protective layer

Protective layer contains stabilizers and surfactants. Shell protects the aphron from coalescence. The inward pointing surface of the surfactant is hydrophilic and outward layer is hydrophobic as shown in fig.2. Surfactant layer attracts the adjacent micro bubble and helps in agglomeration.

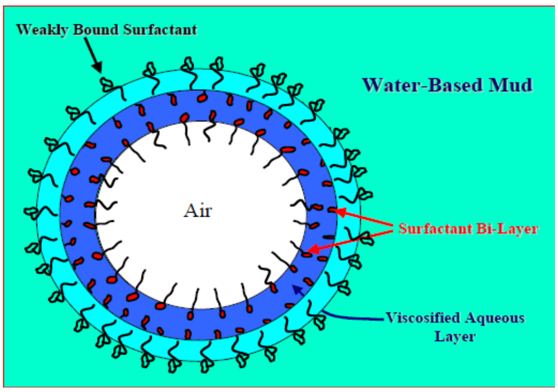

Fig.2 Structure of colloidal gas aphron[1]

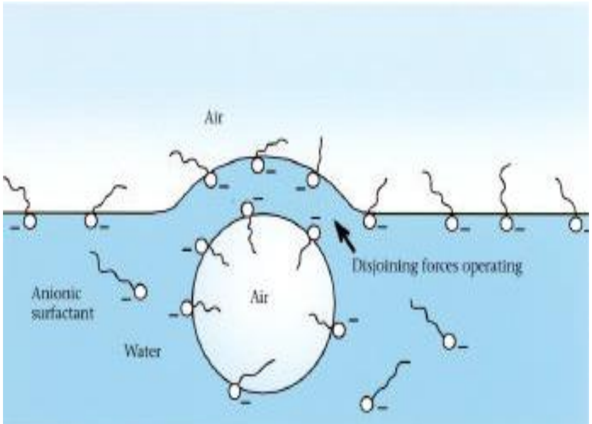

Fig. 3. Standard foam structure[1]

Aphron structure is stable as long as the aqueous viscosifier layer is presented and maximum threshold pressure capacity of the bubbles is retained. These are energetic micro bubbles because here micro bubbles being encapsulated in a viscous and surfactant layer and also some of the additives which are present in the thin layer provide pressure and thermal stability.

1.3. Formulation of Aphron system:

Generally aphron contains following additives and concentration of the additives can be decided as per well site requirements.

Component	**Functions**
Base fluid (freshwater or brine)	Provides continuous phase for system
Soda ash	Hardness buffer
Biopolymer blend	Viscosifier
Polymer blend	Fluid-loss control and thermal stabilization
pH buffer	pH control
Surfactant	Aphronizer
Biocide	Biocide

Table.1. Additives for Water Based Aphron Mud

Component	**Functions**
Oil or synthetic fluid	Continuous phase
Clay or Polymer Blend	Viscosifier
Surfactant	Aphronizer
Water	Polar Activator
Polymer	Filtration Control Agent
Polymer/Surfactant Blend	Aphron Stabilizer

Table.2. Additives for Non-aqueous based Aphron Mud

1.4 Characterization:

1.4.1) Measurement of Bubble size:

Growcock7 used Acoustic Bubble Spectroscopy to measure the bubble size.

1.4.2) Density Measurement:

Density can be determined by using pressurized mud balance and non-pressurized mud balance.

1.4.3) Rheology:

LSRV can be determined by using Brookfield viscometer. Measurement is done using LV Spindle No-3 at different RPM ranging 0.3 RPM to 10 RPM. LSRV should be more than 60,000cP.

1.4.4) API Fluid loss:

API Fluid loss is carried out at 100psi for 30 minutes at 24 ± 1^0C.

II. CONCLUSIONS

The Aphron fluid system product line has been used globally in hundreds of wells. It has found that

- Consistent Success in controlled invasion and leakoff
- Improved well site operations
- Accelerated fluid recoveries
- Improved production profiles
- Improved well design efficiency

The technology can be deployed in various phases of drilling and production. It optimizes the operations, reservoir potential and production.

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