Aphron Drilling Fluids: A Silver Lining for Depleted Reservoirs

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Abstract - *Aprons are specially stabilized micro-bubbles created in place to help in drilling through high permeability formations. Water-based apron's designed for liquid drilling fluids, whereas oil-based aprons are designed for non-aqueous fluids. In each cases, the micro bubbles are composed of a core of gas or liquid stabilized by proprietary polymers and surfactants, which may combination to make a troublesome, elastic barrier to loss of drilling mud in permeable zones. A number of these zones are typified by water wet sands that are liable to fluid ooze and differential protruding. Others are characterized by laminated sand and sedimentary rock sequences that are costly to drill with typical drilling fluids or underbalanced drill rig instrumentality. The authors describe however use of water-based and oil-based apron's in drilling fluids will mitigate losses of drilling fluids down hole.*

Key Words: Aprons, micro-bubbles, permeability, underbalanced drill

1. INTRODUCTION

Depleted reservoirs in mature oil and gas fields area unit sometimes composed of water-wet sands. whereas the formations on top of and below these zones generally have abundant higher pore pressures and need higher fluid density to stabilize them, exposure of a depleted zone to the present high-density fluid may end up in vital loss of whole fluid and differential sticking out. each of those events area unit extraordinarily pricey to correct. Uncontrollable drilling mud losses area unit occasionally inevitable within the typically giant fractures characteristic of those formations. moreover, pressured shale's area unit typically found interceded with depleted sands, therefore requiring stabilization of multiple pressured sequences with one drilling mud. Drilling such zones safely and inexpensively is incredibly troublesome with standard rig instrumentation. as an alternative, one might strive drilling underbalanced, however that is also fraught with risks that ultimately increase the price of the operation considerably. a brand new drilling mud technology was developed

recently that doesn't entail drilling underbalanced, however is meant to handle simply those kinds of issues mentioned on top of which frequently result from drilling overbalanced. This novel technology is predicated on the utilization of unambiguously structured micro-bubbles of air. once incorporated in water-based muds, these micro-bubbles take the shape of "water-based aphrons," whereas in oil or synthetic-based muds (OBM/SBM), they take the shape of "oil-based aphrons." Water-based aphrons are used with success in numerous fluids to drill depleted reservoirs and alternative nonaggressive formations in a very sizable amount of wells in North and South America. This technology has tried to be a cheap different to drilling underbalanced. In what follows, we'll expand on laboratory studies conferred recently that were undertaken to grasp however water-based aphrons perform to cut back lost circulation in high-permeability formations. additionally, we'll introduce the OBM/SBM counterpart of this technology, oil-based aphrons

1.1 The Structure of Aphrons

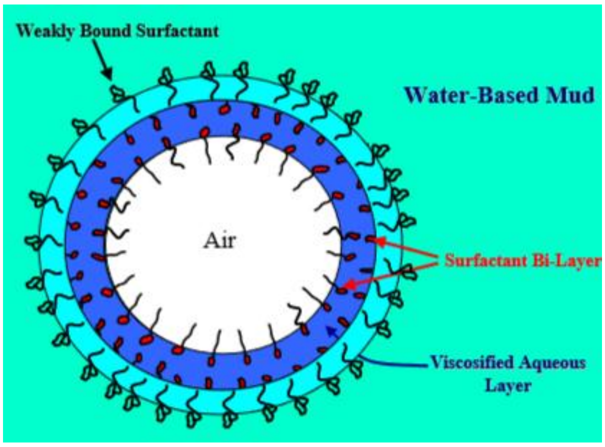

Fig -1: Structure of an aphron.

Water-based and oil-based aphrons ar composed of an equivalent 2 basic elements: a core that's sometimes fluid (gas or liquid) and that, as applied here, generally is air; and a protecting shell. This shell is significantly totally different from a traditional bubble, that is stable during a liquid medium solely by a skinny surface-active agent film. Aphrons are somewhat additional complicated. In Sebba's conception, water-based aphrons have 2 extra layers outside of that inner surface-active agent layer. As indicated within the rendition, a sheath of viscosities water overlays the inner surface-active agent film, and out of doors of that's a bilayer of surfactants that ultimately renders the aphron hydrophilic and, therefore, compatible with the continual binary compound section. However, the structure of the bilayer is incredibly fluid, i.e. the outer surface-active agent layer within the bilayer isn't powerfully related to the remainder of the aphron. Consequently, water-based apron's possess some hydrophobic/lipophilic character that's provided by the next to-last surface-active agent layer. Indeed, the outer surface-active agent layer tends to be shed once aphrons are available in contact with one another. The structure of oil-based aphrons is believed to be similar. As viscosities binary compound or polar layer surrounds the inner surface-active agent film, Associate in Nursing this is often unbroken in situ by an outer monolayer of surfactants. The distinctive structure of oil based aphrons offers them a particular look underneath the magnifier.It ought to be noted that the thickness of the viscosities layer could also be quite variable. One version of oil-based aphron technology incorporates no binary compound layer the least bit, so the inner and outer surface-active agent films move to make a bilayer. within the field, aphrons are usually incorporated into the lubricator at the start at the surface victimisation standard mud intermixture instrumentation, although it's thought that at comparatively shallow depths some can also be created at the bit. The ensuing concentration and size distribution of the micro bubbles will play a crucial role in however well the system will seal a pervious formation. Generally, the system is designed to include eight to fifteen v/v air at the surface, although this might be adjusted as necessary. Air concentration is set from the density of the fluid, whereas Associate in Nursing Acoustic Bubble prism spectroscope, a method still underneath development, permits quantitative measure of the bubble-size distribution in opaque fluids typical bubble-size distribution measured during a extremely diluted water-based lubricator .The hydrophobic nature of the water-based aphron shell permits aphrons to clump along, nonetheless resist coalescence, as illustrated in. once water-based aphrons are forced along to make giant aggregates, like during a pore throat or at a fracture tip, the aphron network is engulfed by a gristle, like would possibly kind during a true foam (> seventieth v/v air). This gristle imparts to the mixture (or cluster) an equivalent lipotropic character possessed by the individual aphrons. This development is believed to occur with oil-based, likewise as water-based, aphrons in pervious formations, since oil based aphrons are per se lipotropic and most formations tend to be water-wet.

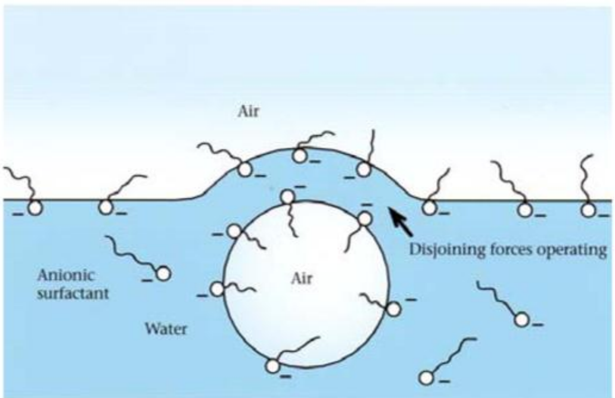

Fig -2: Aphron in aqueous base fluid

2. STABILITY OF THE APHRON

The shell structure of aphrons is predicted to stay stable as long because it meets sure criteria for film thickness and consistency. First, the shell should have a precise minimum thickness. If it becomes to a fault skinny, as could happen on growth once exposed to a awfully massive pressure drop, the film can break. Second, the shell should have a minimum consistency. In water-based aphrons, water tends to diffuse out of the shell and into the majority liquid, as a results of a development referred to as the "Marangoni result. This thins and destabilizes the shell. However, the speed of transfer of water is reciprocally proportional to consistency. Consequently, in properly designed systems, a viscosifier like a biopolymer is AN integral a part of the mud system. Of course, the viscosifier conjointly serves to slow the flow of bulk fluid into loss zones. There square measure alternative properties that the film should possess to possess a property aphron structure. One in all these is low diffusivity. once AN liquid fluid containing V-day v/v air beneath close conditions is subjected to a pressure of one hundred fifty psia, compression alone can scale back the air volume to regarding one.5% v/v. However, the solubility of air in water at that pressure is regarding fifteen cm3/g water (approx. 15% v/v), i.e. all of the air might dissolve in water at one hundred fifty psia. this is often not determined for water-based aphrons., compression and decompression (PVT) tests conducted with water-based aphrons during a changed Huxley-Bertram measuring system at numerous temperatures demonstrate that the density of the fluid (inversely proportional to the quantity of

entrained air) doesn't approach that of air-free fluid (given by the solid lines) till the pressure exceeds two,4000 psia. Not solely do water-based aphrons survive on top of two hundred psia, they conjointly don't bring home the bacon the little size expected from compression. it's thought that the aphron film is sufficiently sturdy and tight that it resists compression and suppresses transport of air to the liquid atmosphere. These same problems square measure expected to use to oil-based aphrons; so, they will have a lot of problem living at high pressures, since their shell structure is as such diluent and solubility of air in oil/synthetic fluid is even larger than in water. Transport of air through the aphron shell – diffusion – is mostly thought of a speedy method for typical bubbles. Even for polymer- or surfactant-stabilized bubbles, diffusion is predicted to occur on the order of seconds. whereas stabilization of bubbles with surfactants will scale back water-air mass transfer coefficients by factors of two to three, reduction of bubble size by the surfactants results in an enormous increase in surface space and a web overall increase in water-air transfer. Aphron films seem to be a lot of less semipermeable. Experiments conducted with water-based aphrons during a mental image cell indicate that they'll survive up to a minimum of1500 psi for extended periods of your time, in unison with the PVT take a look at results

3. INSIDE THE MICRO-BUBBLES

An aphron is far over a “gas bubble.” The shell structure of associate aphron creates associate “energized surroundings.” once these special micro-bubbles square measure initial generated, new surfaces square measure created, that increase in space in proportion to the expansion of the bubble. This enlargement should be balanced by a rise within the pressure among every bubble, therefore generating associate “energized environment” or “pre-compressed structure.” The encapsulated air among associate aphron is compressed once circulated down hole. The micro-bubble volume decreases and internal pressure will increase with increasing external pressure and temperature. Once the drill bit exposes a depleted formation, aphrons square measure forced through the openings of low-pressure zones. There, some of the energy hold on among every micro-bubble is discharged, inflicting it to expand. The enlargement continues till the interior and external pressures on the wall of the bubble square measure in balance.. because the energized micro-bubbles square measure jam-packed into formation openings, external stargazer forces increase dramatically, inflicting aggregation of the micro-bubbles and a rise in Low-Shear-Rate body (LSRV). The microenvironment created by this development forms a solids-free bridge.

4. COMPOSITION OF THIS DRILLING FLUID

The parts of typical water-based and oil based aphron systems. The high-LSRV base fluid consists of AN acceptable viscosifier, chemical agent and fluid loss management additives that make and stabilize the micro-bubbles inside the system. The chemical agent is intended to come up with the specified concentration of air. Once these systems square measure circulated, the physics properties square measure simply maintained to produce optimum hole improvement, cuttings suspension and a high degree of management over the invasion of whole lubricating substance. The polymers and pH scale management materials the system are chosen to fulfil Gulf of North American nation, Canadian and sea environmental regulative needs.

5. EFFECT OF MICROBUBBLES ON MUD PROPERTIES

(Leak-Off) square measure 2 of the foremost vital bulk properties monitored and controlled throughout a drilling operation. though one would possibly instinctively assume that aphrons would typically increase viciousness of the fluid, natural philosophy measurements prove otherwise. As shown in Fig. 8, the presence of the aphrons doesn't considerably have an effect on viciousness. At low pressures, wherever the gas volume is also on the order of 15 August 1945, the bubble size is comparatively giant (>>10 µm); downhole, wherever pressures square measure high, bubble size is reduced to merely some µm, however gas volume is additionally terribly low.

Leak-Off (spurt loss + filtration through the filter cake) is usually thought to be affected solely by condensed section material (solids and liquids). Indeed, introduction of typical bubbles into a fluid sometimes will increase Leak-Off. Naturally, Leak-Off depends on the character of the leaky medium and pore fluid, similarly because the lubricating substance. In brine-saturated high-permeability cores like Ketton sedimentary rock, the most impact of aphrons seems to be a discount in spurt loss. In low-permeability cores, filtration rate seems to be affected a lot of. In kerosene-saturated cores, no impact of the aphrons on Leak-Off has been noted. This distinction in Leak-Off behavior between brine- and kerosene-wetted cores is thanks to the hydrophobic character of the aphron shell. Capillary pressure and also the Jamin impact square measure expected to be weaker in oil-wet formations than in water-wet formations; at constant time, oleophilic materials like hydrocarbon could disrupt the aphron hydro psychoneurotic shell. extra Leak-Off tests were conducted with water-wet artificial cores to work out whether or not aphrons may facilitate seal porous media with terribly high permeability’s .Total Leak-Off was monitored ceaselessly, in conjunction with pump flow and pressure. Again, aphrons were found to scale back Leak-Off, even within the highest porousness cores examined so far. Finally, it absolutely was of interest to match the waterproofing performance of water-based aphron fluid which of a typical xanthan gum-based drill-in fluid (reservoir drilling fluid) containing a big amount of $CaCO_3$ bridging material. For this purpose, a water-based aphron fluid was treated with constant quantity and particle size distribution of $CaCO_3$ because the drill-in fluid. The results show that the water-based aphron mud made lower Leak-Off than the drill-in fluid.

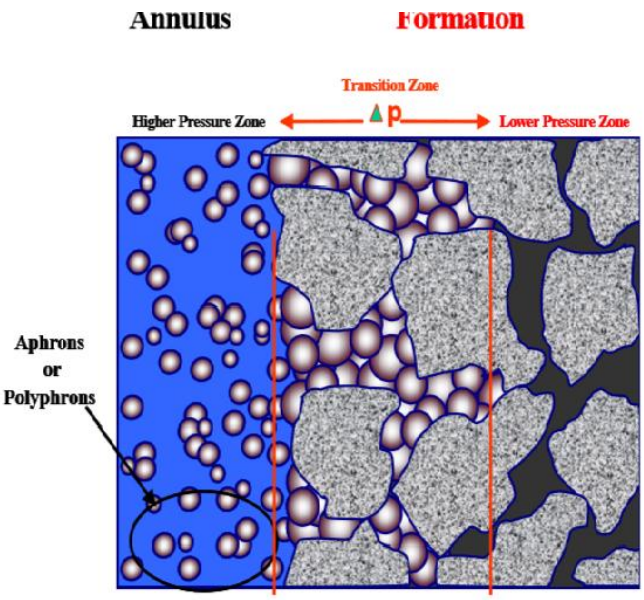

Fig -3: Mechanism of an aphron drilling fluid

6. SOLID CONTROLS

Any drill-in fluid should be unbroken clean. Solids harm to sensitive manufacturing zones is renowned. The HYSST/aphron system is well unbroken clean. owing to the chemical compound encapsulation, trained solids are preserved and without delay removed at the surface. Flocculants ar compatible and might be wont to enhance the removal of fines that would not be separated by mechanical suggests that. The aphrons exist as tiny, low-density particles, that suffer prong screens and don't seem to be removed by centrifugation. No mm promise within the solids removal system is needed so as to accommodate bridging and protection materials, as is that the case in another drill-in fluids.

The most efiective trained solids removal program victimization this technique may be a high-speed fine screen shaker or flow line cleaner, and a centrifuge combined with a chemical natural action program. victimization this technique, solids will be unbroken at a really low level, with a skinny, tough, effective wall cake.

7. CONCLUSION

The physics model appropriate for describing flow behaviour of lubricant before and when Aphron generation is Herschel Bulkely model. supported the fitting results of Herschel Bulkley model, either before or when Aphron generation, temperature rise would enhance the physics performance of the lubricant. when generation of the Aphron, the wellbore cleansing capability of the fluid improves. once the temperature reaches ninety three ?C (200 ?F), the properties of the lubricant don't decline a lot of. when generation, the bubble size grows slowly before a hundred and fifty minutes, when a hundred and fifty minutes the scale grows quicker. In terms of longevity, the Aphron lubricant has robust stability. within the static evacuation check, the evacuation rate of liquid is low, additionally proving smart stability of the lubricant. Its LSRV when the generation of Aphron is above its LSRV before the generation of Aphron, which suggests the Aphron lubricant will block pores additional effectively at low shear rate.

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BIOGRAPHIES

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