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Apply Cost Effective Multiple Cementing Technologies to Sidetrack in Air Drilling Environment in Chiya Khere Field

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Abstract

Chiya Khere field development plan is to drill a lateral hole from existing pilot holes. While in the drilling phase, severe losses were hindering the drilling plans due to lack of effective solutions to sidetrack in air drilling environment. Historically, losses circulation pills were never effective to cure the losses in highly fractured zones, the drilled wells in this field were abandoned using mechanical barriers (Bridge plugs) to facilitate the lateral plan, which was increasing the field development time and cost. Also, due to difficulties to obtain open-hole mechanical bridge plugs the well project duration was extended significantly, furthermore, isolating the loss zone using mechanical tools is the least preferred primarily due to availability and then setting failures in the big hole. In this paper, a newer approach will be presented to demonstrate the specialized technique to cure total losses which resulted in a significant reduction in the operational cost to drill these laterals in Chiya Khere field without changing the casing designs or postponing the project due to no viable solution and explains detailed techniques to overcome the challenges. Some techniques to combat severe losses are pumping loss circulation pills, drilling under balance, and pumping cement plugs. A new and unique loss control strategy was introduced in one of the recently drilled well in this field, in which two pills of solid free spacer separated by a fiber carrier fluid were pumped for instant bridging and viscosifying at the downhole were injected into the losses zone to create a temporary lock-up prior to pumping a rapid gelled cement plug for permanent isolation, once the losses been controlled a firm base cement plug was placed to spot a high compressive strength cement plug (kickoff cement plug), Applied proposed techniques led to having successful results in which rapid gelled cement headed by losses circulation material (LCM) solution combination cured the losses and successfully isolated the bottom of the hole which facilitated to placement a basement plug then kick off cement plug, and tag at the designed top of cement (TOC) to drill the lateral to the new planned trajectory.

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Introduction

Setting cement plugs for sidetrack operations is a critical, challenging, and time-consuming operation. In many cases, a successful sidetrack operation requires several cement plugs attempts or lengthy drilling operations, resulting in increased operating costs. In the past, when required to sidetrack a well, cement kickoff plugs were regularly tagged without having achieved the desired compressive strength, with the added risk of stuck pipe in soft cement and increased wait-on-cement (WOC) time. (Rusty Hanna, 2015), How if the hole was drilled with under balance drilling technique in total losses and requires sidetrack to deviate from main bore to drill lateral? Firstly, we need to understand the underbalance drilling technique which requires air drilling to lift the cuttings and it is designed to keep the pressure in the wellbore below the formation pressure. Secondly, a proper characterization of losses before proposing a solution of sidetrack technique in this environment is criticality important. In the air drilling technique, the use of lower hydrostatic pressure allows the rock at the bit surface to be easily crushed and the chips to explode off the bottom and be introduced into the air stream, thereby increasing the penetration rate. (D.S. Wolcott, 1986). There are significant advantages of using air drilling in extreme loss circulation conditions as we can drill the formation below the pore pressure, but it becomes similarly challenging to initiate a kickoff to drill a lateral, or sidetrack above the fish due to severe losses. losses are encountered during drilling, are caused by the differential pressure of the hydrostatic column, which is generally greater than the formation pressure and is especially through the openings in the rock in low pressure or depleted zones (K. M. Suyan, 2017), cavernous formations, and natural or induced fractures. Losses are categorized based on the losses rate, Seepage when the loss rate is up to 10 barrel per hour, Partial when the loss rate is between 10 – 50 barrel per hour and Severe when the loss rate is above 50 barrel per hour (Rabia, 2002). In some cases, loss circulation is difficult to control because some formations are inherently fractured or has large permeabilities, if the loss rate is acceptably low then these formations are to be drilled with the initial known loss rates, but in another case, the loss rate might increase to a higher rate and the combating solution will require to reduce the drilling time and cost. The type of treatment or selecting loss circulating material are dependent on the losses category and loss circulation material (LCM) classification. Conventional LCM's can be classified based on their appearance as fibrous, flaky, and granular or a blend of all three. LCM's have different physical and chemical properties and therefore a proper LCM selection is a key factor for a successful lost circulation treatment (Howard et al 1951) classified LCM's based on their physical properties into four groups: fibrous, granular, lamellated, and dehydratable. (Robert J White 1956) modified the previous classification by replacing the dehydratable category with a mixture of LCM categories. And then Mortadha Turki Alsaba updated the LCM classification in 2014 based on the different properties of LCM's and how these properties contribute to their various applications and based on both the physical and chemical properties and their application. The physical properties include the appearance and the size of these particles while the chemical properties include material solubility in acids, swellability, and reactivity with other chemicals to activate the blend. LCMs are re-classified by Mortadha Turki Alsaba into seven categories: granular, flaky, fibrous, LCM's mixture, acid-soluble, high fluid loss LCM's squeezes (HFLS), swellable/hydratable LCM's, and nanoparticles, (Mortadha Alsaba, 2014).

Often projects are limited to vertical drilling, drilling multiple new wells from the first casing in the same field for production enhancement instead of drilling lateral or multilateral due to inability to sidetrack in severe to total losses.

In this paper a new and unique loss control strategy comprised of three steps methodology (temporarily plugging the pores/fractures-spotting of quick setting solid base and finally high strength cement plug) will be introduced to successfully sidetrack in air drilling environment with total losses.

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Pumping Sequence

Step#1

Two pills of a solid-free solution, consisting of a train of reactive fluids of calcium chloride brine and sodium silicate solution (The system can be pumped alone or ahead of the cement), separated by a fiber carrier fluid. As soon as the calcium chloride brine gets in contact with the sodium silicate solution, it forms a solid precipitating gel that plugs the loss zone. The brine is normally 10% BWOW of calcium chloride. While the sodium silicate solution is a 50% solution of sodium silicate with water. The placement is engineered to ensure the two fluids get mixed at the exact zone. Furthermore, when the cement gets in touch with the gel, it develops very high gel that stops losses in the larger fractures and fissures system. A typical treatment can be as:

- 10 bbl of calcium chloride brine 10% BWOW
- 5 bbl of viscosified spacer
- 20 bbl of sodium silicate solution 50% BV
- 5 bbl of viscosified spacer
- 20 bbl calcium chloride10% BWOW
- Fresh water or viscosified spacer
- Cement slurry

Calcium Chloride brine and sodium silicate solution are not compatible. The two fluids should be prepared in separate tanks. Every effort should be made to ensure that the two fluids will have the potential to mix only in the annulus. In addition, both fluids are incompatible with cement slurries, and they will cause a direct increase in viscosity and premature job termination. Hence, a spacer between the cement and the combination spacer is important. These train of solutions are used for instant bridging and viscosifying at downhole conditions were injecting into the thief zone to create a temporary lock-up prior to pumping a rapid gelled cement plug where it is desirable for a cement slurry to become immobile very quickly after placement, the use of a rapid gel slurry is advantageous. Such slurries have thixotropic property, that is they become fluid under conditions of shear such as pumping or stirring but develop a rapid gel structure when motion is stopped. Therefore, those slurries are thin and fluid during mixing and pumping but rapidly form a rigid gel when pumping stops. If pumping is resumed within a short period, the gel structure breaks, and the slurry returns to a fluid state. The gel structure will break and reform over several cycles.

Step#2

Verify step#1 and evaluate the losses rate, repeat step#1 if required, when the losses rate is low enough then pump lightweight balanced cement plug below the planned kickoff cement plug, the purpose of this plug is to avoid fracking the weak zone which leads to resuming the losses circulation and to have a good basement for the heavyweight high compressive strength cement plug.

Step#3

Spot heavyweight cement plug to provide a high compressive strength ground to sidetrack to the new planned trajectory.

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Case Study

Chiya Khere field is a Jurassic fractured carbonate oilfield, located near Dohuk approximately 85km northwest of Erbil, Kurdistan region of Iraq (Figure-1), Chiya Khere field is one of the biggest new oil developments in the Kurdistan region of Iraq. The Chiya Khere field lies within the hydrocarbonrich Zagros sedimentary basin that spans approximately 200,000km² on the north-eastern margin of the Arabian platform. The main source rocks in the basin comprise the Jurassic Naokelekan and the Cretaceous Chia Gara formations. (https://www.nsenergybusiness.com/projects/atrush-oil-field-kurdistan). The first well drilled in this field and was successfully spudded in 2010.

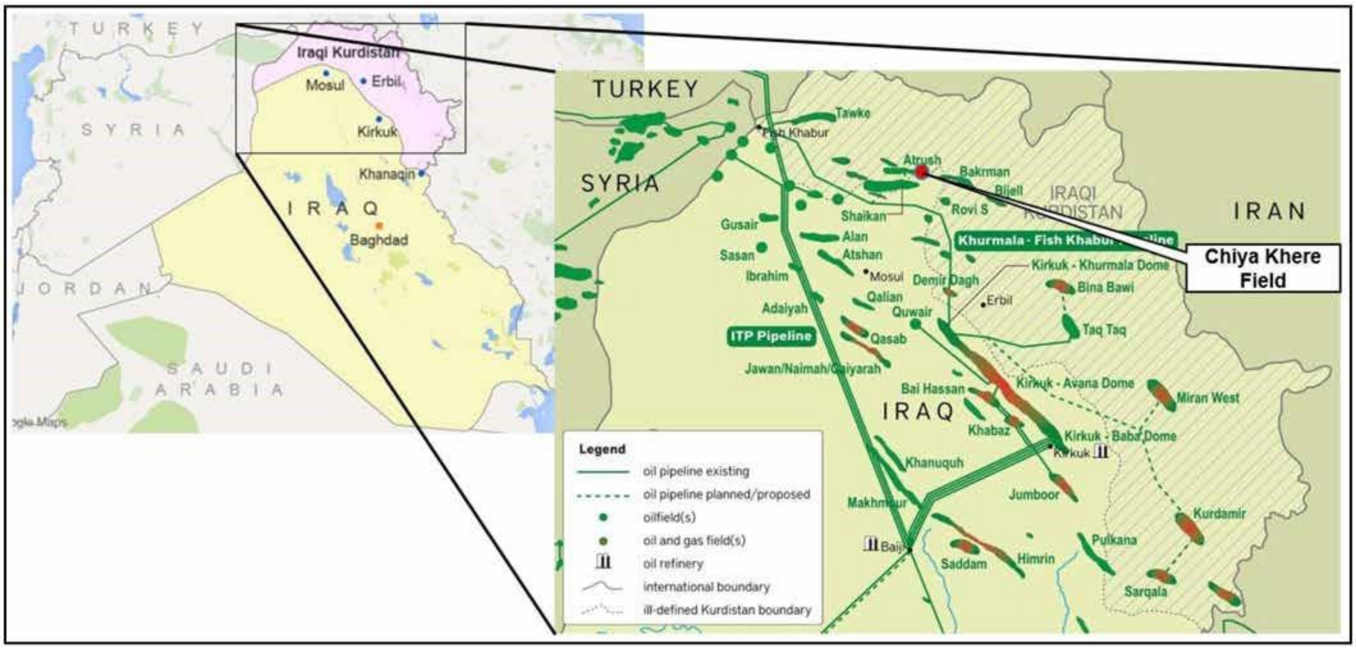

Figure 1—Chiya Khere field location in the map

Chiya Khere field is a developed field with single bore deviated wells but recently wells are drilled with a lateral sidetracked from the mother bore to enhance the reservoir's recovery. Due to total losses in the pilot hole, drilling a lateral is operationally very challenging with applied drilling practices, such as hole cleaning, stuck pipe, wellbore stability, differential sticking, formation damage remarkably influenced by the pore pressure decline, increasing the risk of losing part or even all the horizontal intervals (Rida Mohamed Elgaddafi, 2021). Case study is presented to demonstrate the specialized technique to cure total losses and placement of sidetrack plug which resulted in a significant reduction in the operational cost to drill these laterals in Chiya Khere field.

One of the well in Chiya Khere field was proposed as an upper Jurassic development well drilled in April 2021, the development strategy for this well is to provide a long-deviated reservoir section in the upper Jurassic which can be recompleted downhole in response to gas ingress associated with a development gas cap. The final TD for the well was to be in anhydrites of the Upper Alan Formation at -214m TVDss. The planned reservoir section of the well allows for a production interval of around 1000m MD over a 300m elevation (73-degree inclination) spanning the Barsarin to Upper Sargelu formations.

Drilling 17.5in open hole section under total losses is the most challenging section in Chiya Khere field, in the above mentioned well this section was drilled with under balance drilling (UBD) from 520m MD (20" CSG shoe) to 1850m MD, 1212m TVD, deviated at 69 deg inclination, few cutting samples were collected during drilling the entire section due to the total losses, the decision was made to plug back the

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hole and drill new lateral hole, Unsuccess past experience for curing losses by pumping cement or losses circulation pills in this sections, the decision was immediately toward using mechanical barriers and avoid pumping cement, Historically, cement plugs or pumping loss circulation pills in air drilling environment are never being effective to cure losses across the thick naturally fractured limestone in Chiya Khere field. Eventually, the thief zone is isolated with a bridge plug to sidetrack through a 17 ½" pilot hole. isolating loss zone using bridge plugs are least preferred primarily due to availability and then setting failures in the big hole.

Open-ended cement stinger ran to 850m MD the above-mentioned system (specialized spacer ahead of rapid gel short thickening time cement) (Figure-2) has been pumped and injected to the loss zone, the volumes described in the below:

– 20 bbl of viscosified spacer + 1 pound/barrel polypropylene fiber
– 20 bbl of calcium chloride brine solution
– 5 bbl of viscosified spacer + 1 pound/barrel polypropylene fiber
– 20 bbl sodium silicate solution
– 5 bbl of viscosified spacer + 1 pound/barrel polypropylene fiber
– 20 bbl of calcium chloride brine solution
– 20 bbl viscosified spacer + 1 pound/barrel polypropylene fiber
– 160 bbl of 13.5ppg rapid gel cement + 1 pound/barrel polypropylene fiber
– Displace and inject the cement into the thief zone

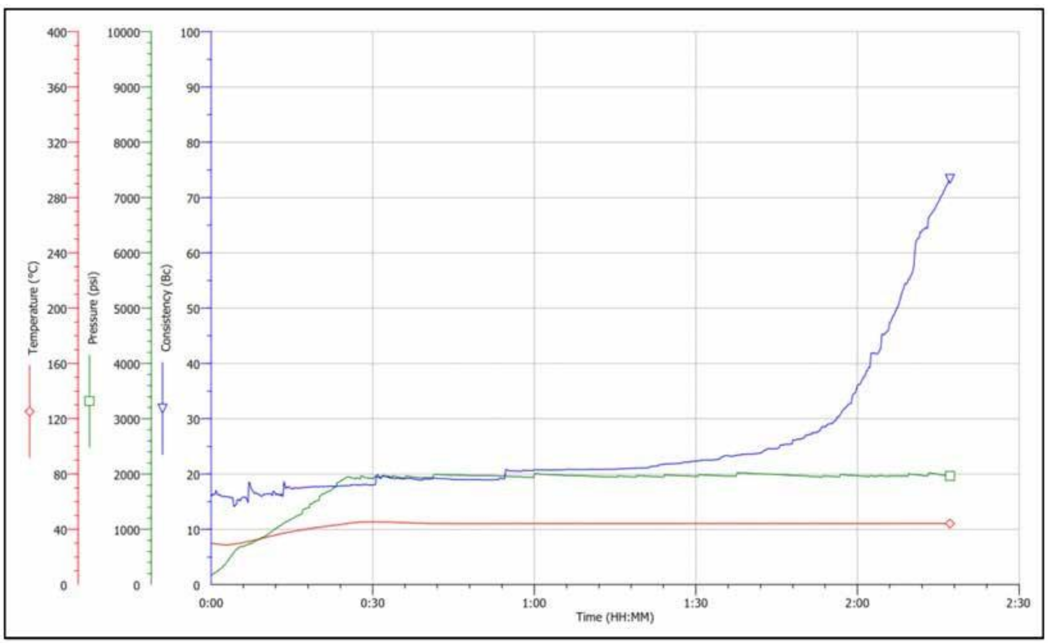

Figure 2—Cement slurry thickening time chart

After placing the first plug, the losses rate reduced from total to partial, then the well was prepared to pump a balanced cement plug (150m length) of lightweight cement (13.5ppg) from 842m to 692m MD, the purpose of this plug was to control the losses and having a strong base for 17.5ppg kickoff cement plug, after waiting on cement, top of cement tagged at the targeted depth and heavyweight high compressive strength cement (17.5ppg cement) spudded from 690m to 540m with having ~7000psi compressive strength within 24 hrs (Figure-4), the kick off plug tagged at 542m and new hole drilled from the new trajectory (Figure-3)

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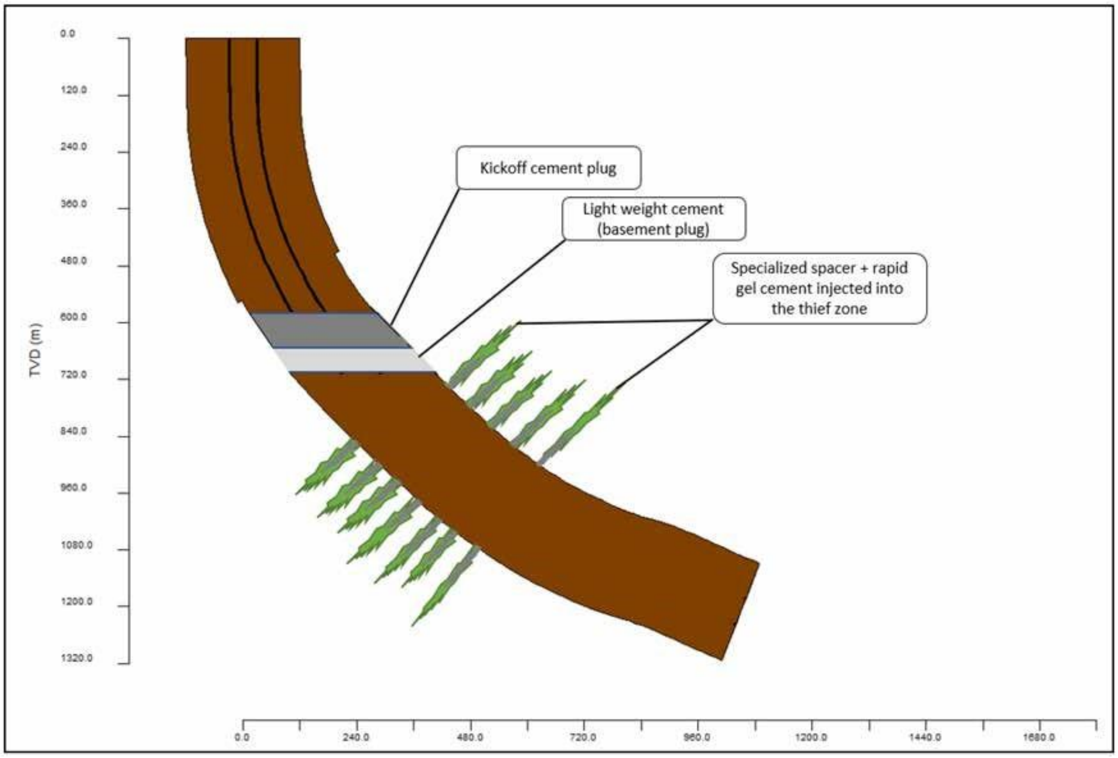

Figure 3—Chiya khere-7 schematic and plugs placement

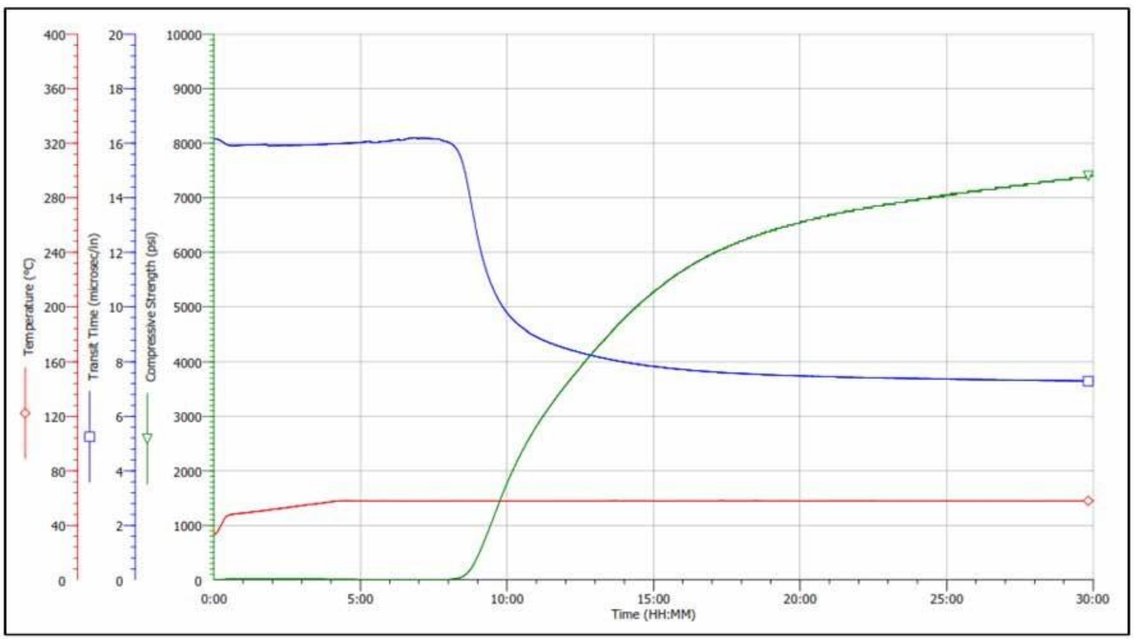

Figure 4—17.5ppg cement slurry Ultrasonic cement analyzer chart – UCA

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Conclusion

Applied the proposed placement technique with a specialized spacer ahead of rapid gelled cement plug led to a successful result in curing the losses and isolating the bottom of the hole which facilitated to place kick-off cement plug to drill the lateral without waiting for days to source bridge plug, hence this technique played a tremendous role to save time and cost for successful drilling operations of similar wells in Chiya Khere field

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List Of Abbreviations

Abbreviation	Meaning
TOC	Top of cement
BP	Bridge plug
UBD	Under balance drilling
BWOW	By weight of water
BV	By volume
LCM	Losses circulating material
TVD	True vertical depth
TVDss	True vertical depth below sea level
MD	Measured depth
TD	Total depth
WOC	Wait on cement
PSI	Pounds per square inch
PPG	Pounds per gallon
BBL	Barrel
BC	Bearden units of consistency
UCA	Ultrasonic cement analyser

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