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Air Drilling Improves Efficiency in Wellbores in Disi Water Field Project

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Air Drilling Improves Efficiency in Wellbores in Disi Water Field Project

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I. INTRODUCTION

It has been shown conclusively that air or gas is a better drilling fluid than liquid. The use of air or gas as a circulating medium was introduced in the early 1950. Even though initial attempts were crude, significant increasing penetration rate and bit life were obtained. Since these initial attempts development of air and gas drilling techniques have expanded and are widely accepted⁽¹⁾ today as a method to reduce drilling times and cut cost of many wells. Along with the time and resultant money savings, other advantages such as immediate and continuous hydrocarbon detection, minimum damage to liquid sensitive pay zone, better control of lost circulation and cleaner cores are obtained.

Air-hammer drilling evaluation first presented by Howard, Vincent, and Wilder⁽²⁾ and Liljestrand. The five wells described herein are located in the Permian Basin of West Texas (3,4).

Air drilling techniques⁽¹¹⁾ are used to drill formations prone to lost circulation, stuck pipe, slow rates of penetration, and other associated problems. The method of using air as a circulating "fluid" has been used for a long time, mainly to drill hard and dry Formations. Larger diameter wells⁽¹²⁾, particularly those with severe fluid loss zones, can be drilled using foam as a drilling fluid.

Changes in the normal air-compressor services for air drilling have been required, other than 10 to 20 percent more volume to maintain a clean hole while drilling at higher penetration rates, because the basic design of the air hammer permits optimum performance between 200 and 300 psi air pressure^(5,9).

Drilling with "foam" combined with compressed air is used in different ways to help the drilling process. It involves using small-capacity pumps to inject a 'foam' mix at quite low flow rates into the compressed air supply line to make soap bubbles form in the borehole.

In shallow boreholes where there is little backpressure, the piston impacts the top of the bit shank at a rate of from 600 to 1700 blows, (depending on volumetric flow rate per minute of air). However, in deep boreholes where the annulus back pressure is usually high, impact rates can be as low as 100 to 300 blows per minute⁽⁶⁾

- Foam. A larger amount of foaming agent is added into the flow. Bubbles and slugs of bubbles in an atmosphere of mist bring cuttings back to the surface. (Sheffield, J.S:Exxon co.USA)⁽⁷⁾
- Stable foam. An even larger amount of foaming agent is added into the flow. This is the consistency of a shaving cream. The purpose of this study is to investigate the current technology used in air drilling and to determine the advantages and limitations of air drilling. Further, air drilling in various areas is to be compared to mud drilling to determine which method is the most economical. This paper addresses field experience in hard rock air and foam drilling technology to be used in the Disi Areas, and covers pertinent operational design topics. An important operational, an important ingredient to any air or foam drilling operation is knowing when and where to use it. Well construction optimization requires carefully matching of the technology to the application, including dry air, gas, mist, foam and gasified fluids⁽⁸⁾.

This type of technology provides unique performance characteristics in a wide range of applications. Including formations that are extremely hard or consolidated, produce water, have lost circulation problems or are sensitive to hydrostatic pressure and improve operating efficiency.

Drilling five wells involved compressed air, water mixed with foam, as illustrated in table (2).

II. EQUIPMENTS USED IN AIR DRILLING WITH FOAM

Conversion of a conventional rotary rig to an air drilling operation is a simple matter. Most of the liquid and solids handling equipment, normally used for mud

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drilling can be removed for an air drilling operation, the liquid handling equipment should consist of one mud pump, a centrifugal transfer pump and sufficient water storage (steel mud pits can be used for water storage).

For today's air drilling operations, air compressors are available which provide adequate air volumes along with portability.

The most commonly used oil field air compressor is a positive displacement, double acting, reciprocating, two or three-stage type compressor. This type compressor offers a wide range of sizes and

Pressure ratings necessary for an efficient drilling operation. Also, this type Compressor has been designed for continuous operation. Package units consisting of two or more compressors can be put together. The number of compressors in a package will depend on the air volume required to drill the hole efficiently. Generally, one air compressor, available on today's market, for oil field drilling will put out from 400 to 1200 cubic feet of air per minute at 300 to 320 psig maximum pressure. The positive displacement type air compressor is rated according to piston size and the output is dependent upon the altitude at which the compressor will operate. The compressor manufacturers can provide data on volume output at varying operating rates.

Some points that to be remembered for optimum compressor operation is as follows:

- Compressors should be located in the direction of prevailing winds to maximize circulation and minimize dust intake from exhaust lines. They should be located about 200 ft from the rig floor to permit cooling of the air before it reaches the rig floor.
- The engine exhaust should be directed away from the compressor to provide maximum cooling. This also explains the purpose in locating compressors in a series or line arrangement. This prevents the discharge of hot exhaust gas from hitting another compressor.
- Battery and oil filters should be checked regularly because of evaporation from the batteries and collection of dust in the oil bath. An added precaution should be the use of automatic shutdown devices to prevent excessive temperatures.
- An adequate starting system is required, particularly during cold weather.
- Air pressure gauges should be located on the rig floor and be kept under constant surveillance by the driller. Any sudden change in pressure may indicate water encroachment, caving formations or changes in penetration figure (1 a, b), illustrated the equipments used in air drilling technology with foam.

Air requirements for operation may vary; however under most conditions a flow volume of 1200 cfm is required for an inlet pressure of 350 psi. Under normal operating conditions the hammer will strike about 1800 blows per minute under the inlet pressure of 350 psi ⁽¹¹⁾.





Figure (1 a, b)

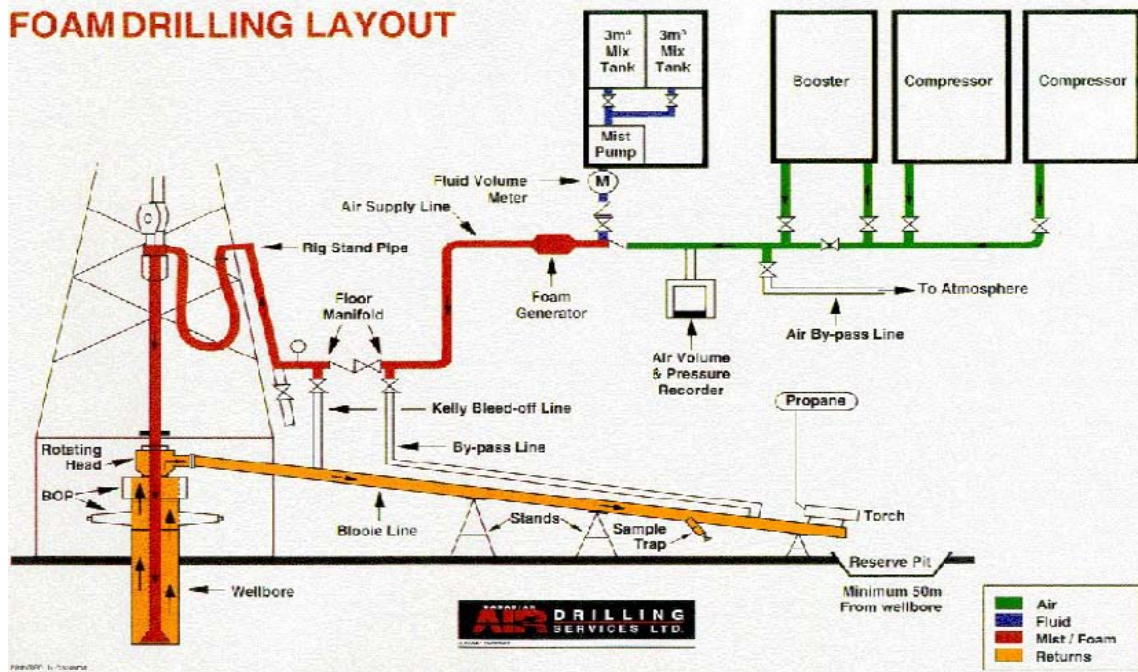


Figure 2 : Foam Drilling Layout

III. FIELD RESULTS

The results of using air and foam drilling in the field actually need no Explanation, since it is common knowledge that drilling rates with this medium may be 10 times those obtained using fluids. Frequently the question is asked "Why is the drilling rate increased when using air and foam". The increase in penetration rate is believed to be a result of reducing the hydrostatic pressure on the formation. This believed is justified by the many field and laboratory results that show a reduction in drilling rate as fluid weight is increased. The decrease in drilling rate as hydrostatic Pressure or mud weight is increased. These are typical results for porous and Impermeable shale sections.

Well construction optimization requires carefully matching of the technology to the application .including dry air, gas, mist, foam and gasified fluids.

This type of technology provide unique performance characteristics in a wide range of applications, Including formations that are extremely hard or consolidated, produce water, have lost circulation problems or are sensitive to hydrostatic pressure.

IV. LINE A SAND RATE OF PENETRATION

Slow penetration rates and hole deviation, when drilling by conventional methods, line A, silty shale, sandstone medium to hard, siliceous cement in Dubadydib formation Area.

A conventional well plan in the hard dry rock. To drill four wells 24 inch surface hole to total depth between 300 to 310 m. (984.3FT ,1000.70 FT), as illustrated in table (1). The parameters of drilling Regime. We drill four vertical wells using conventional drilling with mud fluids and tricone bit. The first well was drilled low penetration rates, 3 .58 ft/hr, 270m (886.85ft) in 247.3 hours. In The second well 269.95 m (886.69 ft) in 246.8 hours 3.51 ft/h. The third well 287.4 m (942.95 ft) in 372.5 hours 2.53 ft/hr. In the fourth well 265.5m (871.10 ft) in 259 hours 3.36ft/hr. During the drilling these wells have deviation problems, it takes long time to straight the hole and waste time for reaming the hole. Figure (3) show the penetration rate according the parameters of drilling Regime.

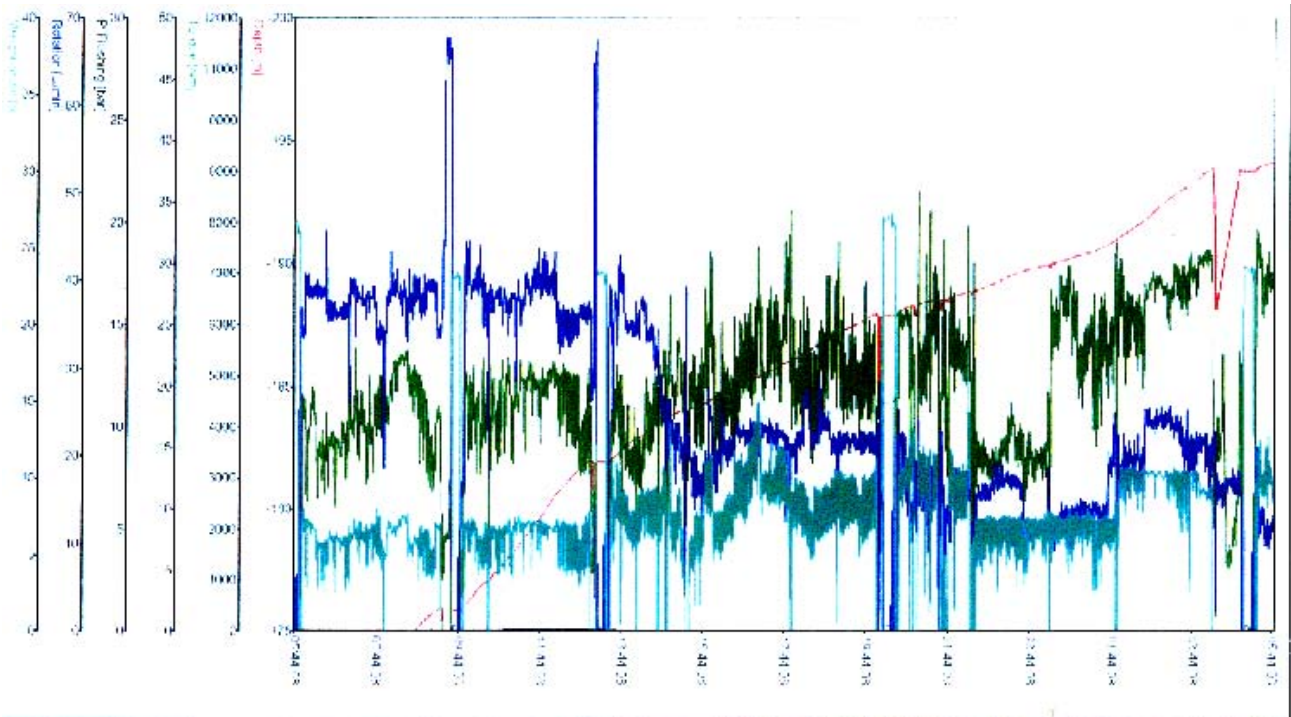


Figure 3 : The penetration rate according the parameters of drilling Regime

Slow penetration rates were (2.53 to 3.58) ft/hr, hammer with foam using down the hole hammer bits and hole deviation problems 2.5 degree, when used (DTH). conventional drilling, provide to shift to air drilling

Table 1 : The parameter of drilling regime

Well Number	RPM	W.O. B T	Q L/m	P bar	Total penet m (ft)	Total hours	ROP ft/hr	Formation
1	30-40	7.5-15	1500	2	270m (886.85ft)	247.3	3.58	Sand stone medium to hard
2	25-35	5-15	1800	1.5-2	269.95m (868.698ft)	246.8	3.51	Sand stone medium to hard Siliceous cemented
3	25-40	5-15	2100	2	287.4m (942.95ft)	372.5	2.53	Sand stone medium to hard Siliceous cemented
4	30-40	4-13	2200	2.5	265.5m (871.10ft)	259	3.36	Sand stone medium to hard Siliceous cemented

V. LINE B SAND RATE OF PENETRATION

The shift to air drilling was tracked in 5 Wells where it is use cut time from spud to total depth illustrated in table(2).

Air hammer drilling with foam in the line B, silty shale and sandstone medium hard to hard, eliminated 11.71 to 1.67 days of drilling time by minimizing and reducing well bore deviation in comparable with conventional drilling which was 2,5 degree. The significant reduction in deviation allowed to drill the hole section to be drilled with a single hammer for each well.

Total air drilling cost for the hole section U.S. \$17901per well was cut more than half, compared to conventional drilling methods, the cost drilling for the same hole section U.S. \$ 117212 per well .

Deviation problems reduced in the line B sand. Hammer drilling places a light weight on the bit—typically just enough to keep the face of the bit on contact with formation, with less weight, the bit drills a much straighter vertical hole.

Table 2 : Parameter air hammer drilling with foam at water project in Jordan

Well Number	RPM	W.O. B T	Q L/m	P bar	Total penet m (ft)	Total hours	ROP ft/hr	Formation
1	6-8	2- 4		14-18	266m (872.74ft)	42.20	20.68	Sand stone medium to hard
2	6-8	2- 3.5		12-20	276.16m (906.08ft)	39.45	22.96	Sand stone medium to hard Siliceous cemented
3	8	2.5- 5		10-14	296.14m (971.63ft)	40.05	24.26	Sand stone medium to hard Siliceous cemented
4	12	3- 4		14	290m (951.49ft)	39.40	24.14	Sand stone medium to hard Siliceous cemented
5	8	3- 4.5		12-15	233m (764.47ft)	53.75	14.22	Sand stone medium to hard Siliceous cemented

In table (2) illustrate the drilling parameters of air drilling hammer with foam.

Drilling the four wells involved compressed flow volume air injection rates ranging (500-600 cfm), pump pressure 200-204 psi and the liquid rates during mist –foam drilling were (13 gal /m to 15 gal/m) (49.20 l/min to 56.77 l/min) and strike of hammer was expected to be in range of (925-950) blows per minute.

The first well was drilled with one hammer bit type Bulroc and average 6.30m/hr(20.68 ft/hr) including connection time .Instantaneous ROP (Rate of Penetration) in the range of 6.30 m/hr (20.68 ft/hr) records with 266m (872.74 ft) drilled in 42.20 hours was observed the hammer bit ,Penetration rates while conventional drilling methods were significantly less than the offset records ,with 270 m (886.85 ft) drilled in 247.3 hours.

In the second well, 276.16 m (906.08 ft) were drilled in 39.45 hours using one hammer bit type Bulroc. The third well used one hammer bit to dill 269.14 m (971.63ft) in 40.05 hours.

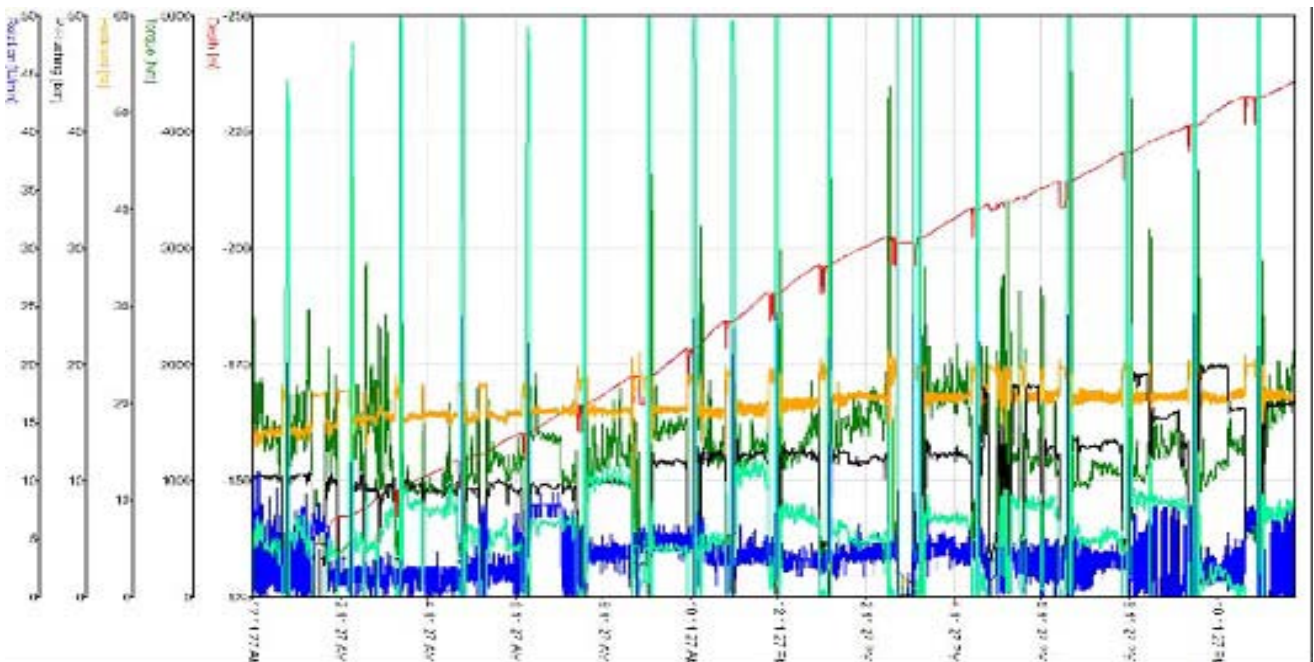
In the fourth well 290m (951.49 ft) were drilled in 39.40 hours using two hammer bits type Bulroc.

The fifth well 233 m(764.47ft)were drilled in 53.75hours using one hammer bit type Numa.

Hammer drilling with foam places a light weight on the bit and just enough to keep the face of the bit in contact with the formation, with less weight the bit drills a much straighter vertical hole.

Drilling a high –quality vertical borehole with an air hammer with foam, enhances drilling, it means the rate of penetration ranging from (14.22 ft to 24.14 ft /hr) were enhanced with down hole the hammer (DTH).

Figure 4 : Shown the penetration rate by air hammer with foam



The drilling with hammer bits also have a much longer life than conventional bits, resulting in fewer trips and lower bit expenses. Air drilling with foam removes cuttings from the face of the bit by using high air velocities to get best hole cleaning and able to deal with large water influx recyclable, and fewest compressors, minimized lost circulation compared to conventional fluid systems.

VI. CONCLUSIONS

Planned and applied correctly, air drilling hammer technology can address problems of lost circulation, deviated hole and poor penetration rates. Based on the analysis of the real cases studied during operation in the water field, the following conclusion could be cited:

1. The air drilling hammer is a very useful technique especially when you phase problems, it prevents formation deviated hole, increase rate of penetration (ROP) and reduces the total cost of the well.
2. The air drilling hammer with stable foam, can be conducted safely and successfully drilling with foam has some appeal because foam has some attractive qualities and properties with respect to very low hydrostatic densities, which can be generated with foam systems. Foam has good rheology and excellent cutting carrying capacity and maintain hole wall stability.
3. A proposed air drilling hammer with foam program to be implemented in Jordan water field Disi–Mudawarra to Amman Water Conveyance System Project to be completed partially enhanced the project.

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