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Infusion of Standards in Water Drilling Rig Fabrication in Nigeria

Abdulmalik I. O.[1], Amonye M. C.[2], Ambali A. O.[3], Akonyi N. S.[4], Mahdi M.[5]
[1] *National Agency for Science and Engineering Infrastructure (NASENI), Federal Ministry of Science and Technology, Nigeria.*
[2,5] *National Board for Technology Incubation (NBTI), Federal Ministry of Science and Technology, Nigeria.*
[3,4] *Hydraulic Equipment Development Institute (HEDI), National Agency for Science and Engineering Infrastructure (NASENI), Federal Ministry of Science and Technology, Nigeria.*

Abstract: *One of the major challenges and constraints to equitable access to safe, adequate, improved and affordable water supply and sanitation to its population is lack of appropriate water supply and sanitation facilities infrastructure in Nigeria. One very important water supply facility is water drilling rig. The water situation in Nigeria is precarious. As water resource stresses become acute in future, water deficit intensification in some areas (especially in the North) increases, coupled with escalating human demand, the conflict between human and environmental demands on water resources shall also intensify. The Governments and the External Supporting Agencies (ESAs) have supported the development of groundwater especially in the rural areas over the years, through the provision of Drilling Rigs, Geophysical equipment, chemical laboratory kits, hand pumps and spare parts to ensure sustainability of the programme. Some of these ESAs have provided direct funds for private sector drilling of borehole projects. Despite this huge investment there is still severe scarcity of water supply for domestic, agricultural and industrial purposes in Nigeria. This study investigates drilling rig technologies in Nigeria; understand their production and acquisition methods, their operation and the possible reasons for their poor impact on water provision.*

Key Words: *Water, Drilling, Technology, Rig, Operation.*

I. Introduction

The Federal, State and Local Governments have supported the development of groundwater especially in the rural areas over the past twenty years. In addition the External Supporting Agencies (ESAs) like UNICEF, UNDP, JICA, Water Aid etc. have committed huge sum of money through the provision of Drilling Rigs, Geophysical equipment, chemical laboratory kits, hand pumps and spare parts to ensure sustainability of the programme. In recent times some of these ESAs have provided direct funds for private sector drilling of borehole projects. Despite this huge investment there is still severe scarcity of water supply for domestic, agricultural and industrial purposes in Nigeria (Eduvie 2006). Nigeria is blessed with abundant water resources but largely untapped. In spite of the abundant water resources, governments at all levels (federal, state and local) have not been able to successfully harness these resources (Nigeria Vision 20: 2020, Volume III [2010]). Water drilling is the art of making a hole in the earth's crust in order to explore water. Drilling is achieved manually or by machines. There are about five common drilling methods, which include:

(a) Percussion or Cable Tool Drilling,
(b) Auger Drilling,
(c) Jetting,
(d) Rotary Percussion Drilling, and
(e) Rotary Drilling with mud flushing.

But the most common methods of water drilling in Nigeria are:

(a) Rotary drilling with mud flushing and
(b) Rotary Percussion or Down the Hole Hammer.

The geology of Nigeria can be divided into two broad units - the basement complex and the sedimentary basins (Maduabuch 2002). The basement complex covers about 50% of the country (Ayoade 1975). The rotary drilling with mud flushing method does well in the other 50% of the country covered by sedimentary formation, while Rotary Percussion or Down the Hole Hammer thrives in weathered basement. The burden for provision of portable water, in as much it depends on the skill of the driller, is majorly determined by the efficiency of the drilling rig used. Also the cost of drilling equipment is deterministic since low cost would enable the establishment of many more wells leading to better availability of water. Standardization in equipment selection and procurement method is

an effective way of controlling a variety of short and long term cost. Similarly, selecting the right size of drilling rig plays a very important role particularly in rural water supply where operational challenges are high, funds limited and terrain difficult.

II. Aim and Objective

It is the aim of this work to study water drilling fabrication in Nigeria to ascertain the practice and how it affects portable water provision in the country. The objectives include:

a. Understanding drilling methods and equipment provision.
b. Meet with stake holders in the industry and ascertain their fabrication difficulties and operational problems.
c. Asses and recommend the panacea for improvement in the water drilling rig fabrication industry.

III. Methodology

The methodology entailed visits to some states in the country by a team of nine personnel made up of two engineers who are rig fabricators, two geologists who are drillers and three stake holders from the private sector. The visits were targeted at meeting identified water drilling rig fabricators in their workshops, asses their facilities and capacities for rig fabrication. It also comprised visits to drillers in operation for field tracking of some of the rigs produced by the fabricators so as to assess their operational efficiency and determine frequently changed parts.
Two sets of field assessment questionnaires (FORMS A and B) were administered during the visits. The FORM A is a three page document designed to collect information from the rig fabricators pertaining to their workshop facilities, sources of rig components, types of rig being fabricated, and rating characteristics of the components used for fabricating the rigs. The FORM B is designed for field tracking of the fabricated rigs to ascertain their operational efficiencies. The states visited include Kano, Kaduna, Edo, Delta, Oyo, Ondo, Anambra, Ebonyi, and Lagos.

IV. Results

The commonest water drilling method in Nigeria as found in operation during the visits is the rotary drilling which employs a sharp rotating bit to bite its way through the earth's crust and also removes debris using a solution of bentonite in water. This solution is locally called mud. Both rotational force and a downward force are applied to the bit for effective action. The bit is fastened to and rotated by a drill string, composed of high quality drill pipes and drill collars, with new sections or joints being added as drilling progresses. Drilling fluid (solution of bentonite in water) is continuously circulated down the inside of the drill string through water routes or nozzles in the bit. As it flows out through the annular space between the borehole and the drill pipe, it lifts the sand and rock cuttings to the surface. At the surface, the returning fluid is moved through screens, shale shakers, de-sanders and series of tanks and pits to ensure the separation of the cuttings from the fluid. In the last of these pits, the debris-free fluid is picked by the pump suction and re-circulated. The fluid, usually a solution of bentonite in water, serves several purposes:

a. Removes cuttings from the drill hole as explained above:
b. Prevents the collapse of the drill hole and reduce water loss to the formation by forming a filter cake on the borehole wall.
c. Suspends cuttings when drilling is stopped.
d. Cools and cleans the drill stem and bit, and
e. Lubricates bit bearings

In rotary drilling, penetration is achieved by applying thrust and torque to the drill bit. Thrust ensures a pressing action downwards enhancing grip on the soil or rock surface while torque produces the rotary action required by the bit to cut the rock. To render the required torque, a diesel or petrol engine operates a rotary table in the case of mechanical rigs or hydraulic motor through a hydraulic pump in the case of hydraulic rigs. The exertion of thrust or pulling of the drill string is achieved via a mechanical winch, a hydraulic winch or a hydraulic cylinder as the case may be. Conventional rotary drilling rigs in Nigeria are of five major variations differentiated by the operational components in the two key areas of bit rotation and the type of winch system employed for its draw-works. They are:

1. Mechanical Rigs with mechanical winch draw-works,
2. Mechanical Rigs with hydraulic winch draw-works,
3. Mechanical Rigs with hydraulic cylinder draw-works,
4. Hydraulic Rigs with hydraulic cylinder draw-works, and
5. Hydraulic Rigs with hydraulic winch draw-works.

The flow-line and schematic diagrams showing key components of the different variations as they are locally constructed in Nigeria are shown in Figures 4.1 – 4.5.

4.1: Mechanical Rigs with Mechanical Draw-Works:

The drilling point is at **A**, which rotates the drill string at the end of which is attached the drill bit. Drilling is done at a predetermined speed and the rotary table must operate at the requisite speed for efficient drilling. The speed could be varied depending on the formation and size of hole. **B** is a multiple gearbox for speed selection. Motions to this gearbox and other components of the system are supplied by the engine. The engine has its gearbox which is set at a speed suitable for supplies to gearboxes B and F. The clutch coupling gearbox 1 to the engine is also utilized for operating gearboxes B and F. Motion to gearbox F is through chain or belt drive from **C.** In small drilling rigs, an engine with compound gearbox (gearbox and auxiliary) may be employed wherefore the main gear drives the rotary table, while the auxiliary drives the winch. This application removes gearboxes B and F. The job of the winch G is to pull and release the drill string at a determined speed. Gearbox 3 enables the selection and supply of the proper speed to the winch. When the motion and power requirements for drilling together with the pull and release of the weight on bit, are articulated and synchronized, drilling is efficiently discharged.

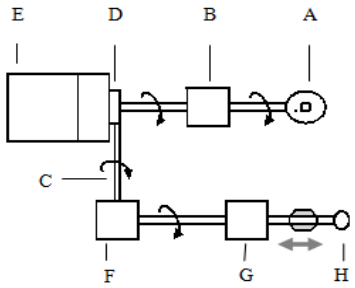

Figure 4.1: Mechanical Rig with Mechanical Draw-Works

A - Rotary Table; B - Gear Box 2
C - Chains or belts; D - Gear Box 1
E - Engine or Prime Mover; F - Gear Box 3
G - Winch; H - Weight on Bit (WOB)

4.2: Mechanical Rigs with Hydraulic Winch Draw-Works:

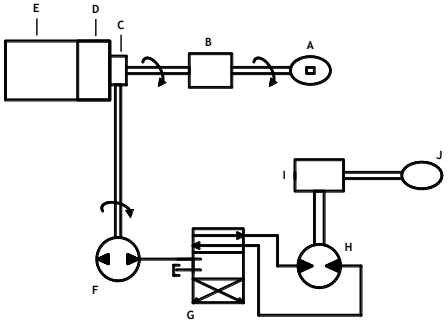

Figure 4.2: Mechanical Rig with Hydraulic Winch Draw-Works

A - Rotary Table; B - Gear Box 2
C - Multiple Pulleys; D - Gear Box 1
E - Engine or Prime Mover; F - Hydraulic Pump
G - Hydraulic Valve; H - Hydraulic Motor
I - Winch; J - Weight on Bit (WOB)

Here the motion and power transmission to the drill bit is replicated, but instead of transmitting motion from **C** to a gearbox for draw works, the motion is transmitted to a hydraulic pump. Through the operation of the hydraulic valve, the hydraulic winch **H** regulates the release and pulling up of the weight on bit, (WOB).

4.3: Mechanical Rigs with Hydraulic Cylinder Draw-Works:

This rig is the same as the preceding rig except that the hydraulic motor and winch is replaced with a hydraulic cylinder.

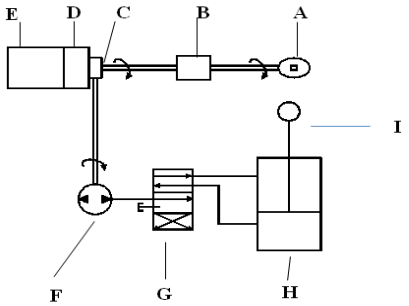

Figure 4.3: Mechanical Rig with Hydraulic Cylinder Draw Works.

A - Rotary Table; B - Gear Box 2
C - Multiple Pulleys; D - Gear Box 1
E - Engine or Prime Mover; F - Hydraulic Pump
G - Hydraulic Valve; H - Hydraulic Cylinder
I - Weight on Bit (WOB)

4.4: Hydraulic Rigs with Hydraulic Cylinder Draw-Works.

The rotation of the drill bit is executed through a hydraulic motor locally called power head. The engine **D** turns the pump **C** which in turn supplies hydraulic power to both the hydraulic motor at **A** and the cylinder **E**.

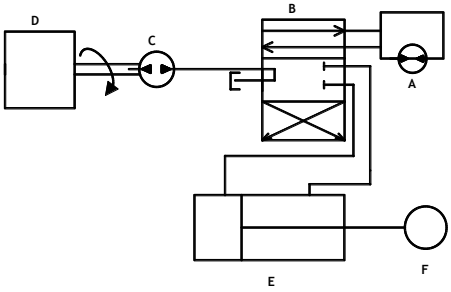

Figure 4.4: Hydraulic Rig with Hydraulic Cylinder Draw-Works

A - Hydraulic motor or Power Head; B - Hydraulic Valve
C - Hydraulic Pump; D - Engine or Prime Mover
E - Hydraulic Cylinder; F - Weight on Bit (WOB)

4.5: Hydraulic Rig with Hydraulic Winch Draw-Works:

Here the hydraulic cylinder of the preceding rig is replaced with a hydraulic winch. Similarly, the pump transmits power to both the motor **A** and the winch **F** through the hydraulic valve **B.** Another hydraulic motor **E** drives the winch

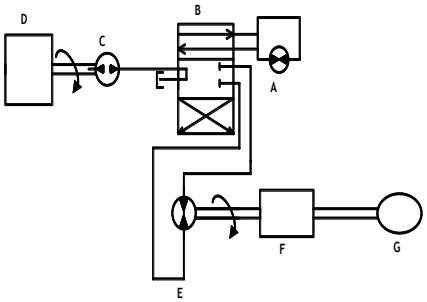

Figure 4.5: Hydraulic Rig with Hydraulic Winch Draw-Works

A - Power Head; B - Hydraulic Valve
C - Hydraulic Pump; D - Engine or Prime Mover
E - Winch Hydraulic Drive; F - Winch
G - Weight on Bit (WOB)

4.6: Rotary Percussion or Down The Hole Hammer Method

The next popular drilling rig prevalent in Nigeria as witnessed by this study is the rotary percussion rig for drilling weathered basement. It conquers rocks more smoothly than the conventional rotary method. The method typically involves a pneumatically operated special bottom-hole drill bit often known as a down the hole hammer (DTH). Compressed air is used to drive this tool. The air also flushes the cuttings and dust from the borehole. Slow rotation of the tool gives the borehole a straight and circular cross-section. The pneumatic drill is attached to the bottom end of the drill string where the rotary bit is usually attached in the conventional rotary method. High pressure air is admitted through the internal annulus of the drill pipe and after actuating the hammer, lifts the cuttings as it moves out to the surface through the gap between the bore hole and the drill pipes. Rotary percussion drilling equipment is made up of the conventional rotary rig with a high pressure compressor either incorporated and installed on the same frame or assembled on its own. Fast penetration results from the blows transmitted directly to the bit by the air-piston. It is generally the fastest method of penetration in hard rock. The bit is turned very slowly (5 – 15 rpm) by the same method by which the drill bit is turned in the conventional rotary drilling. Due to vibration effects on formations, down-hole hammer is not recommended for unconsolidated formations.

V. Observations

It was observed that most of the rig components are sourced from the local market. Local capacities exist for the fabrication of some of the components. However none of the fabricators has a standard means of determining the ratings of these components due to the absence of standard workshop and testing equipment. Manually operated rotary rigs are extensively used in the South West geo-political zone. It is also gaining grounds in other states. The rotary percussion is the main successful drilling equipment employed for drilling in Ebonyi State. It is used for special wells in most states except in Anambra State where Mechanical rigs of the first and second variations are predominant. But the commonest variations in the entire states put together are variations four and five which are hydraulic rigs. There were no two rigs seen during the visits whose components were from the same sources. For instance the engines are varied and include: Mercedes Benz, Perkins, Ford, etc. Even those that have the same make of engine do not share the same model. This was the observation with all the components. Drilling companies using the locally fabricated rigs attested to the fact that indigenous fabricated rigs are quite satisfactory in performance when compared to the cost of imported ones. However, components like hoses, hydraulic pumps and valves are consistently problematic.

It was observed that hydraulic rigs are fabricated in Nigeria by employing hydraulic components of diverse earth moving machines. Because of the high cost of these components, indigenous fabricators of rigs make use of fairly used and discarded hydraulic components of Lorries and Earth Moving Equipment. These components do not stand the test of time. Plenty man hour is spent on sites repairing and servicing these components while in operation. Thus usage of locally fabricated rigs also becomes problematic and the rigs are soon abandoned for reasons of lack of spare parts and maintenance difficulties. One can only begin to imagine the difficult challenges of keeping an inventory of essential spare parts for all these different rigs at different locations in the country and different training requirements for crews on maintenance and repairs. Since there are no standardized components for the local construction of water drilling rigs in Nigeria, no spare parts consortium can serve the industry. There is simply no economic justification for this situation. Something needs to be done to save the industry from continuously trekking the same vicious circle without appreciable results.

VI. Conclusion

It is seen that the drilling rig fabrication industry is unorganized. Government attention is requested to bring all stake holders in the sector to a round table to determine and enforce a cause of action that would ensure sanity and standards in the industry. They would select one or two variations of the rigs as the country's choice. The components shall be listed with requisite capacities and ratings. Proper engineering design shall be done to ensure that components are properly matched. All fabricators shall need to come under one umbrella in order to be effectively coordinated. There is much work to be done and the sooner it is started the better for us all to save the already precarious water situation in Nigeria.

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