LOGGING WHILE DRILLING (LWD) IN OIL AND GAS INDUSTRY

Dr.R.Giri Prasad[1], ,Mr. Goru Lakshmi Papa Rao[2], Mr. MVVS Anuprakash[3], Associate Professor, Assistant Professor, Assistant Professor, Dept. of Petroleum Technology, Aditya Engineering College, Andhra Pradesh, India.

ABSTRACT

Logging while drilling (LWD or Measurement while drilling (MWD), the terms are used interchangeably) is a general term to describe systems and techniques for gathering down-hole data while drilling without the requirement to remove drill pipe from the well. LWD offers similar functionality as wireline logging with differences in data quality, resolution, and/or coverage. LWD tools are basically large, instrumented drill collars. In general, the practice is to put the “most important” tools closest to the bit. LWD tools can go anywhere that the bit can go, so they tend to be significantly more effective in extended-reach-lateral horizontal wells. They send their data to the surface using either pulses into the mud or signals superimposed on the drill pipe. Because the environment on the rig floor is so noisy, two-way communication is not possible and communication from the tool to the surface is very slow (1–2 bits of information/second) .

INTRODUCTION

Logging while drilling (LWD) is a technique of conveying well logging tools into the well borehole downhole as part of the bottom hole assembly (BHA).

Although the terms Measurement while drilling (MWD) and LWD are related, within the context of this section, the term MWD refers to directional-drilling measurements, e.g., for decision support for the smooth operation of the drilling, while LWD refers to measurements concerning the geological formation made while drilling.[1]LWD tools work with its measurement while drilling (MWD) system to transmit partial or complete measurement results to the surface via typically a drilling mud pulser or other improved techniques, while LWD tools are still in the borehole, which is called "real-time data". Complete measurement results can be downloaded from LWD tools after they are pulled out of hole, which is called "memory data".

LWD, while sometimes risky and expensive, has the advantage of measuring properties of a formation before drilling fluids invade deeply. Further, many wellbores prove to be difficult or even impossible to measure with conventional wireline tools, especially highly deviated wells. In these situations, the LWD measurement ensures that some measurement of the subsurface is captured in the event that wireline operations are not possible. Timely LWD data can also be used to guide well placement so that the wellbore remains within the zone of interest or in the most productive portion of a reservoir, such as in highly variable shale reservoirs.[1]

LWD technology was developed originally as an enhancement to the earlier MWD technology to completely or partially replace wireline logging operation. With the improvement of the technology in the past decades, LWD is now widely used for drilling (including geosteering), and formation evaluation (especially for real time and high angle wells).

HISTORY OF LWD

Initial attempts to provide M/LWD date back to the 1920s, and attempts were made prior to WW2 with Mud Pulse, Wired Pipe, Acoustic and Electromagnetics. JJ Arps produced a working directional and resistivity system in the 1960s.[2] Competing work supported by Mobil, Standard Oil and others in the late 1960s and early 1970s lead to multiple viable systems by the early 1970s, with the MWD of Teleco Industries, systems from Schlumberger (Mobil) Halliburton and BakerHughes. However the main impetus to development was a decision by the Norwegian Petroleum Directorate to mandate the taking of a directional survey in wells offshore Norway every 100 meters. (Norsok D-010, 5.7.4.2 (b)). This decision created an environment where MWD technology had an economic advantage over conventional mechanical TOTCO devices, and lead to rapid developments, including LWD, to add Gamma and Resistivity, by the early 1980s.

LWD MEASUREMENTS:

LWD technology was originally developed to guarantee at least a basic data set in case high cost exploration wells could not be logged with wireline. Although the aspiration was to partially or completely replace wireline logging, that was not the driver for early deployments, such as in the limited drilling season offshore in the Arctic summer in the early 1980s. Over the years, more of the measurements have been made available in LWD. Certain new measurements are also development in LWD only. The following is an incomplete list of available measurement in LWD technology.

- Natural gamma ray (GR)
  - Total gamma ray
  - Spectral gamma ray
  - Azimuthal gamma ray
  - Gamma ray close to drill bit.
- Density and photoelectric index
- Neutron porosity
- Borehole caliper
  - Ultra sonic azimuthal caliper.
  - Density caliper

- Resistivity (ohm-m)

  Attenuation and phase-shift resistivities at different transmitter spacings and frequencies.

  Resistivity at the drill bit.

  Deep directional resistivities.

- Sonic

  Compressional slowness (Δtc)

  Shear slowness (Δts)

- Borehole images

  Density borehole image

  Resistivity borehole image

- Formation tester and sampler

  Formation pressure

  Formation fluid sample

- Nuclear magnetic resonance (NMR)
- Seismic while drilling (SWD)

  Drillbit-SWD

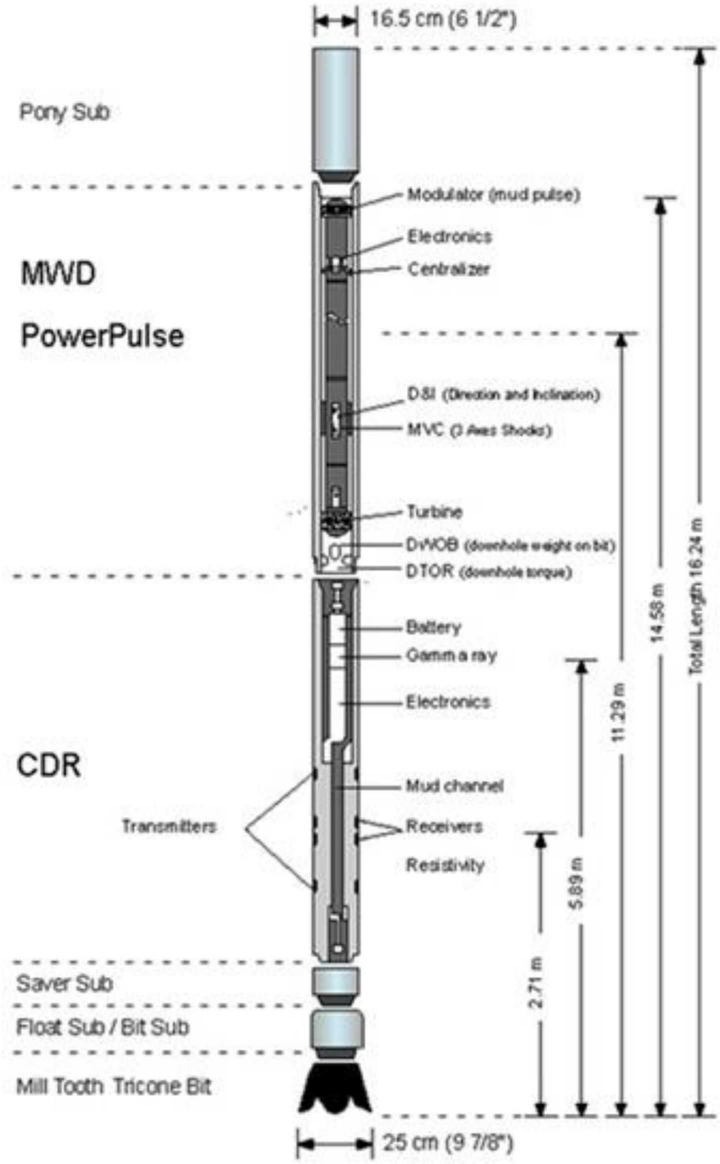

Figure: 1 Loggin While Drilling LWDSource: Leg Summaries & Maps

LWD TYPES

- Electromagnetic logging
- Logging while drilling induction tools
- Acoustic logging
- Nuclear magnetic resonance (NMR) logging
- Nuclear logging

Overcoming well logging challenges presented by directional drilling, LWD has revolutionized the well logging concept. By locating well logging tools near the drill bit on the end of the drilling apparatus, LWD enables drillers to log wells that exceed 60 degrees, which makes pushing the tool through the well impossible.

Additionally, by providing real-time information, LWD helps drillers and engineers to make immediate decisions about the future of a well and the direction of drilling.

Providing information on porosity, resistivity, acoustic waveform, hole direction, and weight on bit, LWD transmits logging measurements at regular intervals while drilling is taking place. Data is transmitted to the surface through pulses through the mud column (also known as mud pulse of mud telemetry) in real time.

A type of LWD, Measurement-While-Drilling (MWD) specifically refers to information used to help in steering the drill, such as direction, orientation and drill bit information.

Drillers and engineers are able to use LWD information immediately to define well placement and predict drilling hazards. Known as "intelligent drilling," use of real-time logging information provided by LWD is enabling stronger, more successful wells both onshore and off.

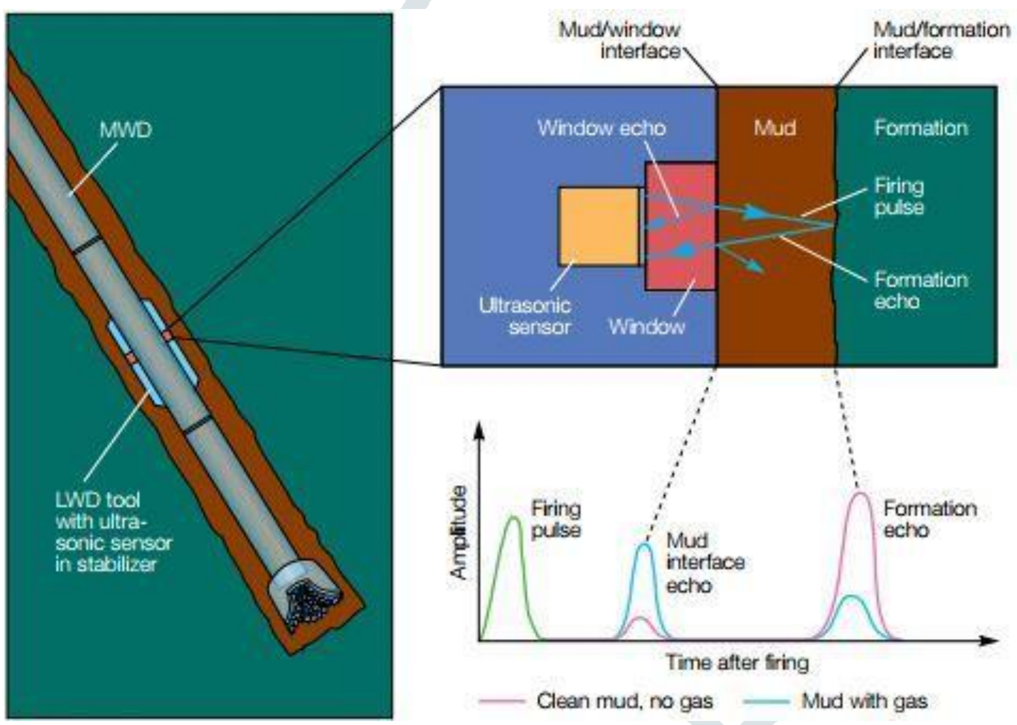

Figure:2 Basic configuration of an LWD tool. Schlumberger

DEPTH MEASUREMENT

Good consistent knowledge of the absolute depth of critical bed boundaries is important for geological models. Knowledge of the relative depth from the top of a reservoir to the oil/water contact is vital for reserves estimates. Nevertheless, of all the measurements made by wireline and LWD, depth is the one most taken for granted (despite being one of the most critical). Depth discrepancies between LWD and wireline have plagued the industry.

LWD depth measurements have evolved from mud-logging methods. Depth readings are tied, on a daily basis, to the driller's depth. Driller's depths are based on measurements of the length of drillpipe going in the hole, and are referenced to a device for measuring the height of the kelly or top drive with respect to a fixed point. These instantaneous measurements of depth are stored with respect to time for later merging with LWD downhole-memory data. The final log is constructed from this depth merge. On fixed installations, such as land rigs or jackup rigs, a number of well-documented sources exist that describe environmental error being introduced in the driller's depth method. One study suggested that the following environmental errors would be introduced in a 3000-m well[1][2] :

- Drillpipe stretch: 5- to 6-m increase.
- Thermal expansion: 3- to 4-m increase.
- Pressure effects: 1- to 2-m increase.

Floating rigs can introduce additional errors with depth measurements for wireline and LWD from heave and tide. In LWD, these effects are sufficiently overcome by the placement of compensation transducers in locations fixed with respect to the seabed.

Wireline measurements are also significantly affected by depth errors, as shown by the amount of depth shifting required between logging runs, which are often performed only hours apart, since wireline depth is stretch corrected, but readily computable stretch and thermal expansion effects are not applied to drillipipe measurement. Given the errors inherent to depth measurement, if wireline and LWD ever tagged a marker bed at the same depth, it would be sheer coincidence.

Environmentally corrected depth would be a relatively simple measure to implement in LWD. Although this measure would certainly reduce gross depth errors, it probably would not eliminate them, due to the complexity of stretch models under dynamic conditions in a high angle well.Gross thermal effects would be simpler to correct for. The "cost" of corrected depth is an additional depth measurement that must be monitored. Driven by the increasing availability of wireline-quality measurements while drilling, the industry is beginning to realize the need to adopt a new process for measuring depth accurately. Running a cased-hole gamma ray during completion operations is a practice adopted by many operators as a check against LWD depth errors and lost-data zones

CONCLUSION

International crude oil prices are continuously fluctuating, thus affecting the Exploration and Production activities around the world. Operators consistently trying to minimize the production cost by inventing in the advancement of technology. Several techniques used to tactically handle the complications while drilling. Logging while drilling (LWD) is one of the significant services used oilfield service companies to obtain real time formation evaluation. The physical properties of the well such as porosity, density, resistivity, conductivity, and saturation among others decide the production capability of the borewell. LWD is very important in investigating the actual physical properties of the borewell which allows the operator to make changes and reassessment during the process. It also helps to calculate the rate of penetration which is crucial determining the speed at which the borewell is being drilled. Several methods are used to get real time formation information and these include electromagnetic logging, acoustic logging, and nuclear magnetic resonance logging among others. These techniques help to optimize the exploration activities and improve the rate of penetration. Many operators seek precise and reliable information for evaluation, that further helps them to take crucial decisions about borewell future production. In addition ever increasing demand for oil and gas owing to the tremendous growth of industries, rising capital expenditure and growing urbanization are stimulating the E & P activities around the world.

REFERENCES

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