Unit-4

19) Give an account on the determination of groundwater flow by logs.

Unit-4

→ Flow meters measure the vertical flow speed of water in the well. Frequently an impeller flowmeter is used in water exploration. The rotations of an impeller per second are a measure of velocity of fluid (water) relative to tool. In case of a continuous measurement (tool is moving with constant speed) the measured flowmeter rate (rot/sec) gives sum of two velocities (water flow & tool speed). Therefore registration of tool speed for correction is a part of flowmeter measurement.

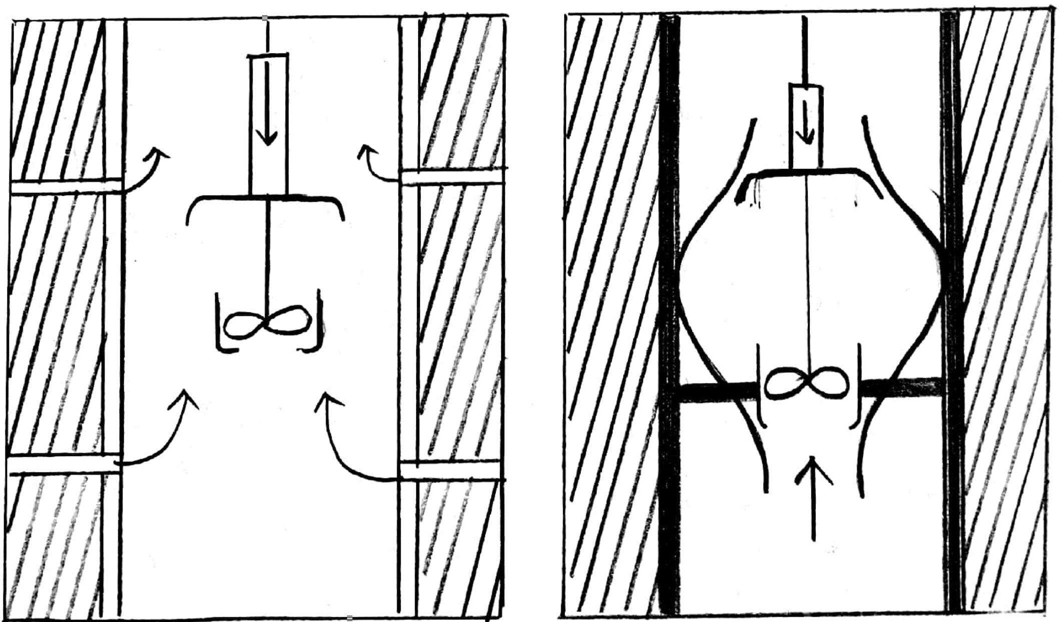

Fig: Two modes of a flowmeter for Water Wells.

Flow profile:

The tool with a packer disc moves downward. There is a highrate as result of an inflow from aquifer

A and aquifer B and from the speed of tool in upper section Below aquifer A measured signal results only from aquifer B & from speed of tool. And below aquifer B, there is no inflow - measured signal represents the tool speed effect. This curve allows a quantitative descripti of inflow. If aquifers are not artesan a pump above uppermost aquifer can activate the inflow.

Hydraulic function of screens:

This mode controls the hydraulic function of the completion. The well is completed. The downgoing flow meter gives the highest flowrate within the tubes because all displaced water must pass the sensitive impeller section If tool passes a permeable screened section, a part of displaced water flows behind screen crossing permeable gravel pack. Thus step to low flowrate indicates a screened section with good permeability. If gravel pack is not permeable then the step is less steep & indicates the well completion is of low hydraulic quality. All screens are at correct depth position & have a full hydraulic function indicated by high permeability.

20) Give an account on the identification & delineation of subsurface structures from well log data.

Delineation of fractures:

→ Natural fractures are usually created by tectonic stresses. Induced fractures associated with natural fractures might also be expected to have a preferred orientation, although this would not necessary be parallel and even be perpendicular to natural fractures. In addition to natural & induced fractures, there are pre-existing fractures which are extended or opened in borehole by drilling. These are called 'Enhanced fractures'. The logs generally used for identifying the fractures are Sonic, Dipmeter, Laterolog, induction, Litho-density log, NGS & SP.

Sonics:

When an acoustic wave encounters a fluid-filled borehole fracture, part of wave is reflected back but part is converted to a wave in fluid in what is termed a mode conversion. When the fluid wave reaches opposite fracture walls, it undergoes a second mode conversion into a compressional, shear or stonley wave. Measuring the energy loss caused by these mode-conversions can indicate the presence of fractures.

Dipmeter:

The 4-arm dipmeter tool measures fracture 2 ways. Crudely, the two orthogonal calipers measure the elongation of borehole (this is done with more sensitivity by Ultrasonic borehole imager tool), and indicates breakout directions & consequently the direction of minimum horizontal stress.

Laterologs & Inductions:

Micro-SFL often fluctuates dramatically in front of fractures, but care has to be taken to rule out bad borehole which can cause similar effects. In fractured rocks, large seperations are observed between shallow & deep laterolog curves. An estimate of fracture porosity, ϕ_{frac}, from difference in conductivity between shallow & deep laterologs is derived from following equation:

$$\Delta C = C_{LLS} - C_{LLd} = \phi_{frac}^{m_{frac}} C_m.$$

C_{LLS} & C_{LLd} = Conductivity measured by Shallow & Deep laterologs respectively.

$C_m = 1/R_m \Rightarrow$ Conductivity of mud.

m_{frac} = Archie formation factor exponent of fractured network.

Litho-density log:

Density compensation component of Lithodensity curve is used to corect raw density for effect of mudcake. It can be used to find fractures, assuming that in dense formations, more mudcake accumulates at fractures than elsewhere.

Natural Gamma ray Spectrometry:

Radioactive anamolies can result from watersoluble Uranium salts being deposited by Connate water. In some areas fractures can be identified by high Uranium & low Thorium & Pottassium concentrations.

Spontaneous Potential:

Spontaneous potential can indicate fractures when mud-filterate invasion causes a streaming potential

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21) Give an account on the measure of well logging methods for metallic & non-metallic minerals?

Evaporite deposits are easily identifiable through logging techniques. Bedded evaporite minerals are essentially are non-porous & electrically non-Conductive. Calyper & Resistivity log locate the Evaporite content. Sonic-neutron crossplots position non-radioactive minerals.

Metallic Non-radioactive Evaporites:

Trona, a commercially important evaporate mineral, is hydrous Sodium carbonate & bicarbonate & is non-radioactive & water soluble. The mineral is clearly identified by logs. Gamma-ray curve indicates low radioactivity, and caliper curve shows pronounced hole enlargement in trona beds.

Metallic Radioactive Evaporites:

Potash minerals are among radioactive evaporites. The Radioactivity stems from all isotope (K_{40}) which comprises a constant fraction of total amount of natural Pottassium. Gamma ray response defines apparent K_2O content, unit customarily used in Potash industry.

Non-Metallic Components:

1) Sulphur:

If the formation contains sulphur & limestones, the values are recorded by either a sonic or density log are simple function of relative quantities of each can be expressed as

$$\rho_b = V\rho_{sulphur} + (1-V)\rho_{limestone}$$

V is fraction of bulk Volume occupied by sulphur,

Sulphur is indicated by a divergence of curves, with density curve indicating the higher apparent porosity. This sulphur bearing zones are denoted by diagonal hatch lines in depth column. Sulphur content is based on assumption that the formation is comprised only of limestone, sulphur & water.

2) Coal:

High resistivity of coal beds cause distinctive anomalies of resistivity curves. Infact early logs through coal seam anomalies help to define resistivity curves for thin, high resistive beds. On Electric survey, as in fig. thin coal beds cause high lateral curve readings opposite beds & Very low readings are 'blind zones'. below coal. Long Normal curve gives sharp 'reversal' reading opposite coal beds thinner than electrode spacing.

Modern porosity logs readily identify coal beds because sonic, neutron & density all indicate unusually high Values of apparent porosity in such zones.

22) Explain how well logs used in fresh & salt water Exploration?

Borehole measurements for water exploration apply a small no. of logs & tools & depth of wells is smaller compared to hydrocarbon exploration. Main aim is as follows.

a) Investigation of lithological profile.

b) Detection of aquifers with exact depth of bed boundary.

c) Control of Completion & production

This method is comparitively cheaper than hydrocarbon log exploration.

→ In many cases, the profile consists of unconsolidated rocks (rock, shale), but also hard rocks with fractures are target especially in thermal & mineral water exploration.

→ Pore or fracture filling fluid is water with mostly low salinity (except mineral water). Aquifers have relatively high resistivity compared to shale beds.

→ This high water resistivity results in a high sensitivity of rock resistivity with respect to shale Content - in freshwater saturated reservoir a small amount of shale decreases rock resistivity much more than in a deep reservoir with saline formation water.