Name: Precious Utomobong Okon
Dept.: Petroleum Engineering
MATRIC NO: 17/ENG07/016
COURSE CODE: PTE 312
COURSE TITLE: Reservoir Engineering

SUMMARIZATION FROM PAGE 110 - 129

Electrical Conductivity of Fluid-Saturated Rocks

Resistivity Relations

Porous rocks are comprised of an aggregate of minerals, rocks fragments, and void space.

Fundamental Properties of Fluid-Permeated Rocks

The electrical properties of a rock depend on the geometry of the voids and the fluids with which most voids are filled.

Resistivity: the resistivity of a material is the reciprocal of Conductivity and is commonly used to define the ability of a material to conduct current.

Resistivity is equationally defined as $\rho = rA/L$

where ρ = resistivity A = Cross-sectional area of the conductor

r = resistance L = length of the conductor

In the study of resistivity of soils and rocks, it has been found that the resistivity can be expressed more convenien[tly] in ohm-meters.

The most fundamental concept in considering electrical properties of rocks is that of formation factor. formation factor is

As define Archie, the formation factor is

$$F = \frac{R_o}{R_w}$$

Resistivity index: If the cube of porous rock contains both water and hydrocarbons, the water is still the only conductor.

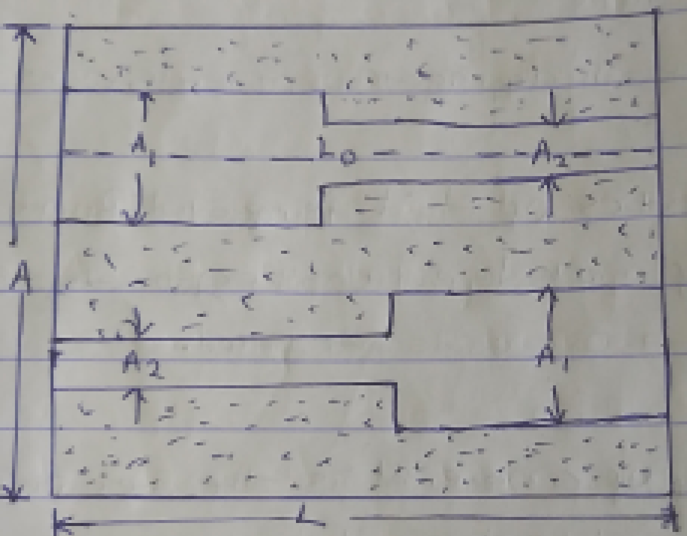

Fig 2-58

Straight Capillary-tube model of porous media

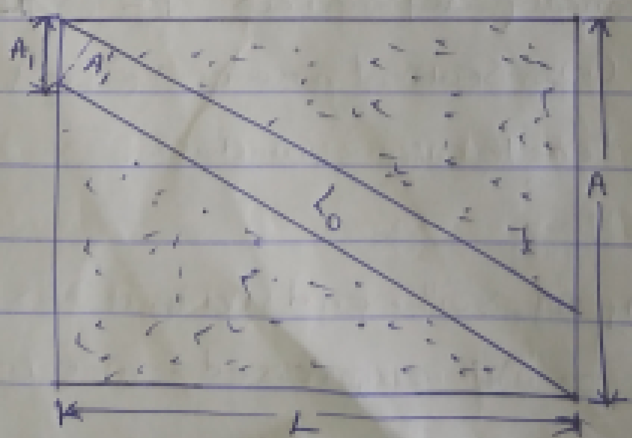

FIG 2-59

Inclined Capillary-tube model of porous media

Cornell and Katz presented a slightly different model as illustrated in Fig. 2-57.

The pores can be considered uniform in cross sections but oriented so that they have an effective length L_a which is greater than L.

Wylie et al presented the first of these model as shown in fig. 2-58

~~The pores~~ It is considered that the various pore openings are continuous.

The straight capillary tube model is equationally written as

$$A_a = A_1 + A_2 = \phi A$$

$$F = \frac{L_a/L}{\phi A/A} = \frac{L_a}{L}\frac{1}{\phi}$$

From the analysis of the electrical properties of the foregoing models, general relationship b/w electrical properties and other physical properties of the rock can be deduced. The formation factor has been shown to be some function of the porosity and the internal geometry of the rock system.

Measuresument of Electrical Resistivity of Rock

The measuring instrument are;

1) Core sample resistivity cell
2) Combined interstitial water and resistivity cell

Effect of Conductive Solids

The formation factor for a clay-free sand is constant. However, the formation factor for a clayey sand increases with decreasing water resistivity and approaches a constant value at a water resistivity of about 0.1Ω·m.

Wyllie proposed that the observed effect of clay minerals was similar to having two electrical circuits in parallel: the conducting clay minerals and the water-filled pores.

Thus:

$$F_a = \frac{R_{oa}}{R_w} \quad \text{and} \quad \frac{1}{R_{oa}} = \frac{1}{R_c} + \frac{1}{FR_w}$$

Resistivity of Partially Water-Saturated Rocks

A rock containing both water and hydrocarbon has a higher resistivity than the rock when fully saturated with water.

It has been shown to be a function of the water saturation S_w

Three methods of changing the saturation in the test specimens were:

1) Dynamic air brine in which the desired water saturation was obtained by flowing air and water simultaneously through the sample.
2) Dynamic air in which only air was introduced at the inlet, displacing both air and water from the outlet
3) Static air in which air displaced water from the sample through a capillary barrier which prevented the flow of air

from the Sample.

In Conclusion

Electrical transport properties of saturated porous media, such as soils, rocks and fractured networks, typically composed of a non-conductive solid matrix and a conductive brine in the pore spaces have numerous applications in reservoir engineering and petrophysics.

One of the widely used electrical conductivity models is the empirical Archie's law that has a practical application in well log interpretation of reservoir rocks. The Archie equation does not take into account the contributions of clay minerals, isolated porosity, heterogeneity in grains and pores and their distributions, as well as anisotropy. In the literature, either some modifications were presented to apply Archie's law to tight and clay-rich reservoirs or more modern models were developed to describe electrical conductivity in such reservoirs. In the former, a number of empirically derived parameters were proposed, which typically vary from one reservoir to another.

In the latter, theoretical improvements by including detailed characteristics of pore space morphology led to developing more complex electrical conductivity models. Such models enabled us to address the electrical properties in a wider range of potential reservoir rocks through theoretical parameters related to key reservoir-defining petrophysical properties.