ENERGY FROM SALTWATER

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ABSTRACT

There is a growing need for energy throughout the world and this increase in demand for energy has now also put a strain on the current sources of energy. In the process of oil/gas production, there are large amounts of water released into the atmosphere as well as into the ground or soil. This water contains chemicals such as Sulphur and Nitrogen oxides, Bitumen, Calcium, Base oil, and Sodium. It is commonly referred to as "wastewater" and is disposed of. The goal of this project is to investigate the conductivity of electrical energy by this wastewater. This is can be done by using various types of soils and water. Various mixtures were created using soils mixed with different percentages of clay and water with varying salinity. A small source of electricity was then applied to the saltwater mud to provide a voltage to the experiment. The chemicals in the mud are then expected to amplify the input voltage and create enough energy to power electrical devices. To prove this, a voltmeter will be connected to the mud via an electrode. It was found that clay soil produced more energy than sandy soil. Also, an increase in water volume would dilute the mixture and this would slow down the transfer of energy in the mud. The results of this work can be useful for the environment and the decreasing energy sources.

INTRODUCTION

Excess water production has become a major problem of oilfield operations as reservoirs mature (Seright, 2003). Water production can be as much as 98% of the material brought to the surface for crude oil wells nearing the end of their productive lives (Veil, et al., 2004). Treatment of water associated with hydrocarbon production is a key goal of Oil Company because production of salt water has resulted in serious environment issues. Excess water production makes a well unproductive and economically inefficient, leading to both an abandonment of early wells and a reduction in hydrocarbon production. In addition, excess water increases costs related to scale, corrosion, water/oil separation, and, eventually, well shut-in. These costs climb as water production increases (Dalrymple, 1997).

Worldwide, an estimated 210 million barrels of water, accompanied with 75 million barrels of oil, are produced daily; on average, approximately three barrels of water are produced with each barrel of oil (Bailey et al., 2000). The situation is even worse in the United States, where more than seven barrels of water are produced for each barrel of oil (Bailey, 2000; EPA, 1999). The annual cost of both treating and removing this water is estimated to be 40 billion U.S. dollars (USD) worldwide (Bailey et al., 2000). Therefore, water shutoff and conformance control represent a significant financial and environmental challenge for the petroleum industry.

The oil and gas production industry have processes that involve drilling and heavy refinery. Both these processes operate mainly with the use of water. Because of such procedures, there is therefore a copious yield or large amounts of effluent, liquid waste produced. The effluent is in fact usually in the form of wastewater. The wastewater mostly consists of a substance called brine. Brine is defined as a mix of water and chemicals that comes to the surface with oil and gas when they are pumped from the Earth (Wattles, 2017, and Robert Hanson & William Casey, 2007). Translated simply, brine is water that is heavily saturated or impregnated with salt. The word 'Salt', in this case, refers to chemicals or chemical compounds such as sodium, chloride, sulfate, calcium and magnesium ions that are part of the discharge from the above-mentioned processes. It is believed that the high salinity of the wastewater can be put to use by conducting energy; motion energy, electrical energy or perhaps even thermal energy. This will be done by using an idea that is similar to that of a mud cake, which is better known as a 'filter cake' or filtration cake'. A filter cake is formed by the substances that are retained on a filter (Ershaghi et.al 1986). The filter cake grows in the course of filtration, becomes "thicker" as particulate matter is being retained.

With increasing layer thickness, the flow resistance of the filter cake increases. The residue deposited on a permeable medium when a slurry, such as a drilling fluid, is forced against the medium under a pressure. Filtrate is the liquid that passes through the medium, leaving the cake on the medium. While several ways of attaining energy from water have been explored, the idea of investigating saltwater as a potential source has been rather undermined.

Presently, there is a growing need for energy throughout the world. The gradual increase or surge in demand for energy has now also put a strain on the current sources of energy. This, in turn, has made energy of any form more expensive to attain.

Statement of Theory and Definitions:

Mud cake: is the layer of particulates from drill mud coating (caking) the inside of a borehole after the suspension medium has seeped through a porous geological formation.

Filter cake: formed by the substances that are retained on a filter. The filter cake grows during filtration, becomes "thicker" as particulate matter is being retained. With increasing layer thickness the flow resistance of the filter cake increases.

EXPERIMENTAL WORK

In this work, various types of soils, and water were used. The percentage of clay was also varied. For the water sample, the experimenter collected some real water production samples from the oil wells in Texas or Oklahoma oilfields. In addition, different water with different brine concentration was used including sodium and calcium chloride. It was also important to have a container to reserve and carry out both the soil and water samples. In addition, the experiment required a source of electricity to provide a voltage to our experimental work. A current will be applied to one side of the filtration cake and the other side will be connected to a voltmeter to determine whether energy was conducted by using this method.

Equipment and Materials

- Clay soil
- Sandy soil
- Electrodes
- Glass container
- Voltmeter
- Voltage generator
- Salt
- Wastewater from oil field

PROCEDURE

- A mass of 286 g of clay soil was measured and weighed
- The same mass was weighed and recorded for salt
- The salt and sand was then mixed together in 200 ml of water to create the mud
- Mud was then transferred into glass container where electrodes where then attached to it
- A small voltage was then applied to one end of the mud using the voltage generator and then measured and recorded after 20 minutes at the other end using the voltmeter. A light bulb will also be used to test the presence of electrical energy
- This procedure was repeated whilst keeping all variables constant except only changing the mass of the salt
- After a plethora of readings has been obtained, repeat procedure again using sandy soil

RESULTS AND DISCUSSION

Data was collected and analyzed after conducting experiments on different kinds of soil when it is exposed to saltwater. Each type of mud is expected to produce different level of voltage. The salt concentration is also expected to affect how much electricity is conducted through the mud. This is because when salt or sodium chloride (NaCl) is dissolved in water, the salt molecules split into two pieces, a sodium ion and a chlorine ion. The sodium ion is missing an electron, which gives it a positive charge. The chlorine ion has an extra electron, giving it a negative charge. The ions form a bridge, the sodium ions absorbing electrons from the negative terminal, passing them to chlorine ions and then the positive terminal. This charge was measured with a Voltmeter at the other end of the mud. From these experiments, deductions were made about the conductivity.

From the table (1), it is observed that all variables are kept constant except for the salt mass. As the salt mass increases, this increases the salt concentration which means more ions are present in the mixture. Hence, a greater output voltage is measured at the other end of the mud using the voltmeter. It was also observed that the voltage output from the clay mud was higher than that of sandy soil and it could be because the molecules in the clay are more tightly packed which makes it easier for the flow of electrical energy hence causing the clay mud to produce more light from the light bulb than the sandy mud.

From the table (2), it can be seen that volume of water is increasing for both sandy mud and clay. This will in turn decrease the salt concentration which means the ions present in the mixture are more dispersed. Hence, a smaller output voltage is measured at the other end of the mud using the voltmeter. It was also observed that the voltage output from the clay mud was still higher than that of sandy soil and it could be because the molecules in the clay are more tightly packed which makes it easier for the flow of electrical energy hence causing the clay mud to produce more light from the light bulb than the sandy mud. However, the voltage produced by the clay mud with the lower salt concentration is much lower than when the salt was in higher concentration.

From the figure (3) it is clearly seen that as the salt concentration increases the voltage output also increases. The voltage output is greater in the clay mud compared to the sandy mud

From the figure (4) it is clearly seen that with a decrease in salt concentration also decreases the voltage output. The voltage output is greater in the clay mud compared to the sandy mud

Numerous experiments were done using reservoir water to determine what factors may affect voltage retention. From figure (5), we notice that reservoir water on its own is not good retainer of voltage, but when soil is added to it more voltage can be measured. Figure (6) tells that the higher the salt content of the reservoir water the greater the voltage retained will be.

However, in figure (7) we noticed that reservoir water mixed with oil will decrease voltage retention drastically. And this is due to the resistive properties of oil.

CONCLUSION

This lab was done to investigate the possibility of using wastewater mud from oilfields to conduct electrical energy. It was found that the wastewater mud can be used in that capacity due to its extremely high salt content. The ions and other dissolved metals found in the mud allows a small electrical energy to pass through rather easily and in some cases even amplify it. Proof of this was found in the lighting of a bulb connected to the mud and also voltage measured via a voltmeter connected to the mud. One of the highlights of this research was that it can be concluded that wastewater mud composed of clay soil produced more energy than those composed of sandy soil. This was because the molecules in the clay are more tightly packed which makes it easier for the flow of electrical energy whereas in sandy soil the molecules and grains are more spaced out. It was also found that, an increase in water volume would dilute the mixture and this would slow down the transfer of energy in the mud. Not only does it decrease the transfer of energy, but it also stores the electrical charge for a smaller time period. Now that it has been proven that the wastewater mud can be used to conduct electrical energy, future work can be done to determine how this energy can be amplified more and how long does the charge last in the mud.

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Table 1. Increasing salt concentration of saltwater mud

Soil Type	Mass (g)	Salt Weight(g)	Volume of Water (ml)	Voltage in (V)	Voltage out (mV)	Time (min)	Salt Concentration (%)
Sandy	286	286	200	12	4	20	59
	286	386	200	12	6	20	66
	286	486	200	12	9.5	20	71
clay	286	286	200	12	6	20	59
	286	386	200	12	7.7	20	66
	286	486	200	12	11	20	71

Table 2. Lower salt Concentration of saltwater mud

Soil Type	Mass (g)	Salt Weight (g)	Volume of Water (ml)	Voltage in (V)	Voltage out (mV)	Time (min)	Salt Concentration (%)
Sandy	286	100	200	12	2.5	20	33
	286	150	200	12	4	20	43
	286	200	200	12	7	20	50
clay	286	100	200	12	4	20	33
	286	150	200	12	6.4	20	43
	286	200	200	12	9	20	50

Table 3. Voltage retained in reservoir water only

Volume (ml)	100			200		
Voltage applied (V)	12	15	20	12	15	20
Charging Time (min)	20	20	20	20	20	20
Voltage retained (V)	0.7	0.8	0.95	0.4	0.56	0.6

Table 4. Voltage retained in reservoir water with soil

Volume (ml)	100			200		
Voltage applied(V)	12	15	20	12	15	20
Charging Time (min)	20	20	20	20	20	20
Voltage retained (V)	2	3.5	6	1.6	2	4.8

Table 5. Voltage retained in reservoir water with added salt

Volume (ml)	100			200		
mass of salt added (g)	100					
Voltage applied (V)	12	15	20	12	15	20
Charging Time (min)	20	20	20	20	20	20
Voltage retained (V)	2	2.5	3	1	1.9	2.1

Table 6. Voltage retained in reservoir water with oil

Volume (ml)	100			200		
Voltage applied (V)	12	15	20	12	15	20
Charging Time (min)	20	20	20	20	20	20
Voltage retained (V)	0.2	0.4	0.5	0.15	0.19	0.21

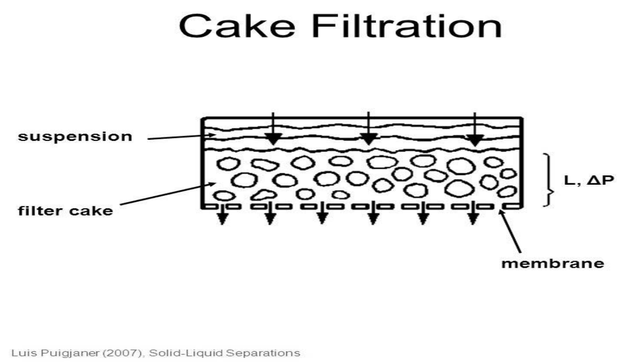

Figure (1) Demonstrating Cake Filtration

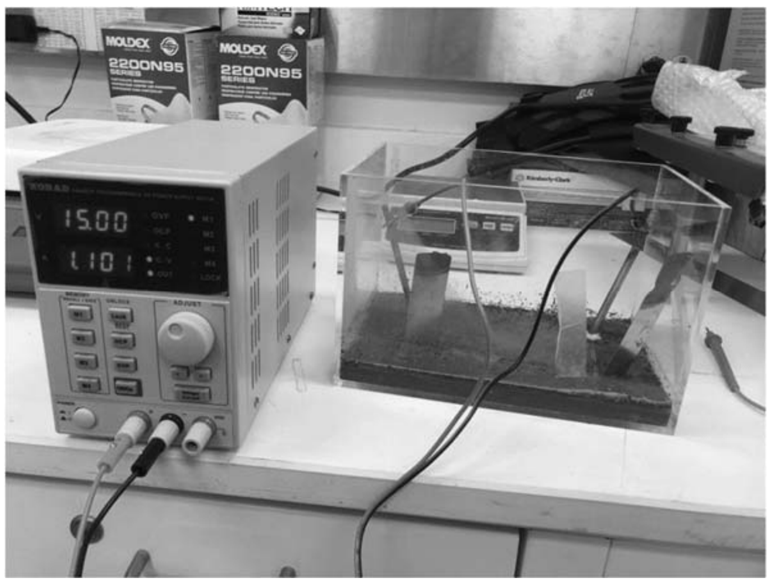

Figure (2) Applying a voltage across saltwater mud

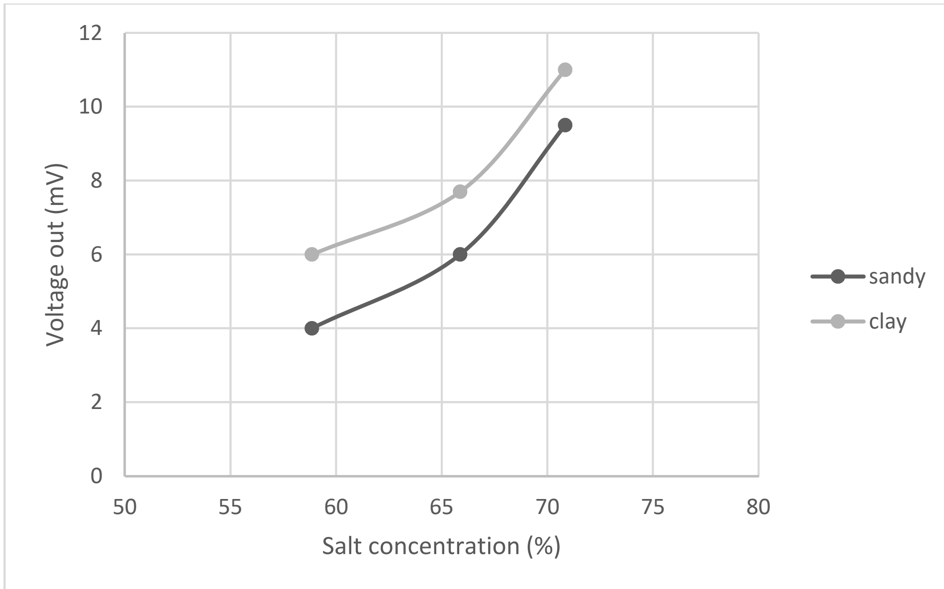

Figure (3) Graph of increasing salt concentration vs voltage output in sandy and clay mud

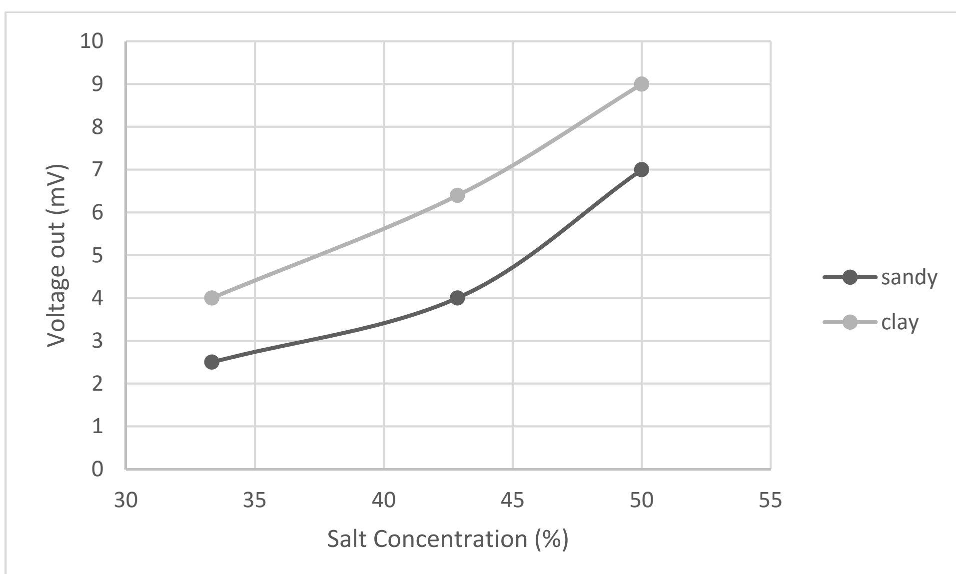

Figure (4) Graph of lower salt concentration vs voltage output in sandy and clay mud

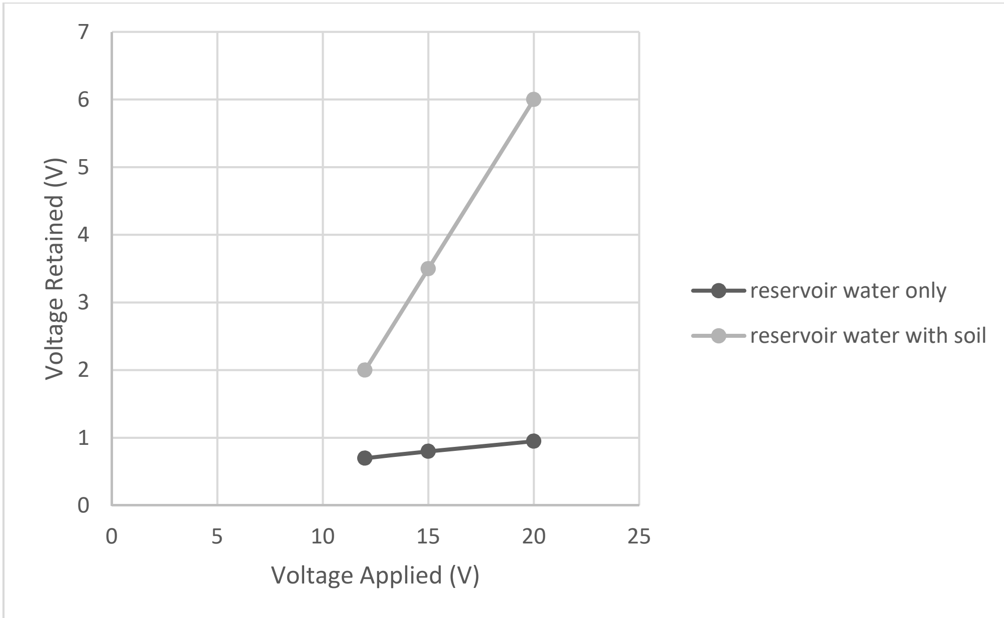

Figure (5) Graph of voltage retained in 100 ml of reservoir water only vs reservoir water with soil

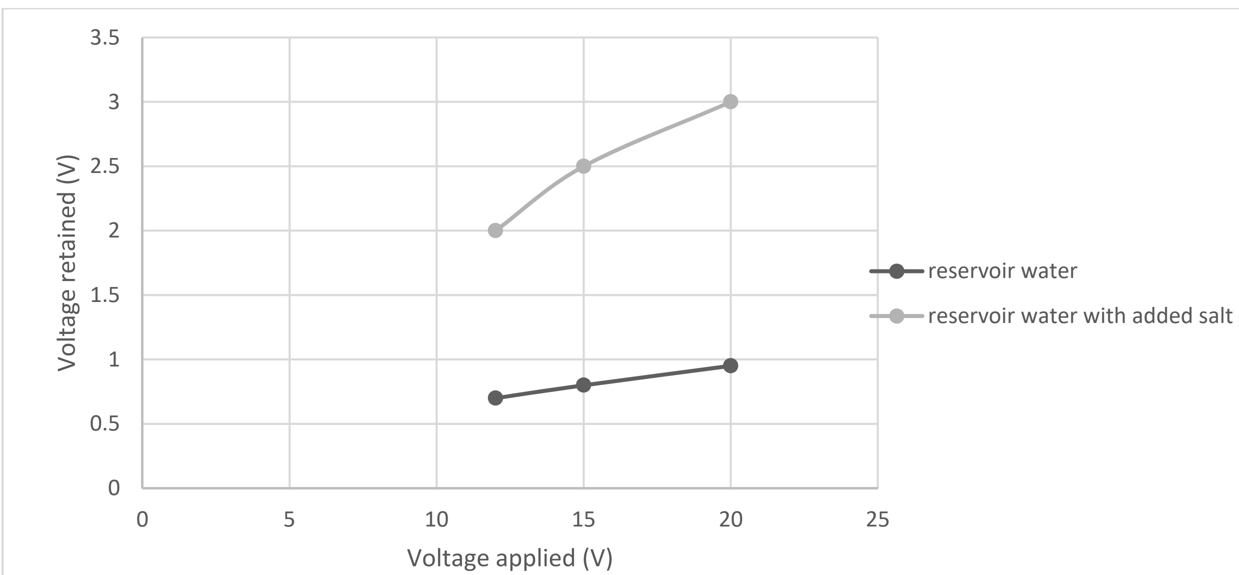

Figure (6) Graph of voltage retained in 100 ml of reservoir water only vs reservoir water with added salt

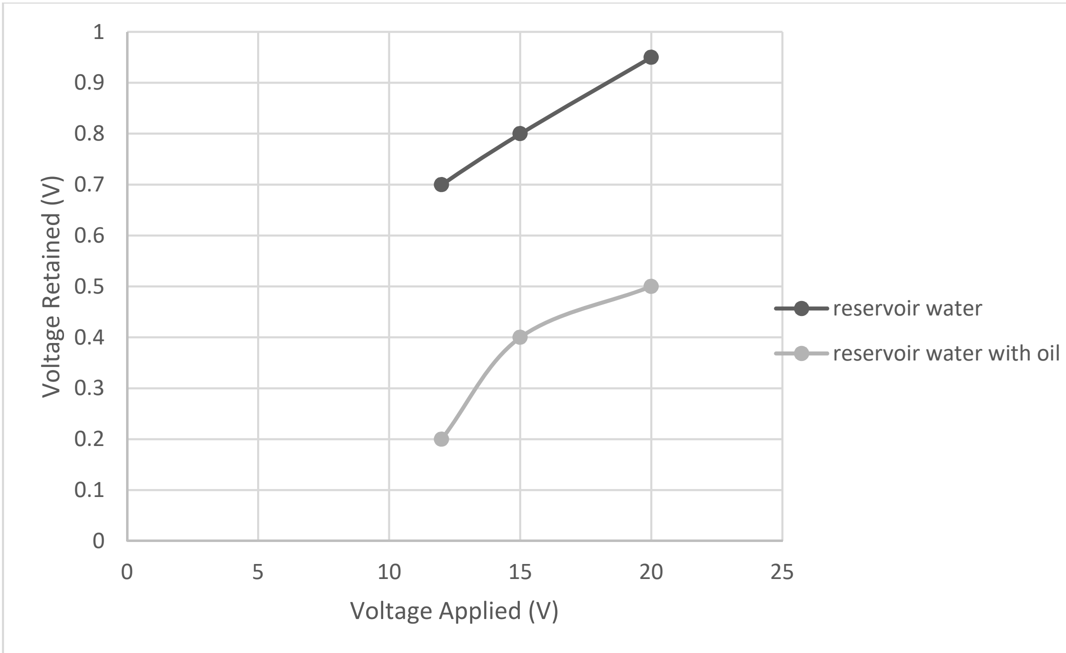

Figure (7) Graph of voltage retained in 100 ml of reservoir water only vs reservoir water with oil