EPH - International Journal of Applied Science
ISSN (Online): 2208-2182
Volume 06 Issue 02-June, 2020

DOI: https://doi.org/10.53555/eijas.v6i2.98

STUDY OF AN ELECTROCOAGULATION (EC) TECHNIQUE FOR THE TREATMENT OF PRODUCED WATER OF ARABIAN GULF OIL COMPANY-NAFOURA FIELD, LIBYA

Sami. H. Almabrok[1*], Salema.A. Sultan[2], Eman. N. Zew[3], Ebtisam, A. Mosa[4], Mona. M. Alsok[5]
*[*1, 2, 3, 4, 5]Department of Chemistry, Faculty of Science, University of Benghazi, Benghazi. Libya*

Corresponding Author:-
E-mail:- *Samihus2009@googlemail.com*

Abstract:-

This work deals with the investigation of electrocoagulation (EC) treatment of produced water Arabian Gulf oil company-Nafoura field, Libya. Electrolysis time, pH, voltage and temperature were considered to assess the recovery of physical and chemical species such as total dissolved solid, total suspended solid, chloride, sodium, turbidity, oil content and chemical oxygen demand (COD). Samples were collected from different point using principle of random or probability (Stratified samples). Optimization of electrolysis time, pH, voltage and temperature for treatment of produced water using aluminum and platinum electrodes were shown, 10 minutes to 15 minutes were found the best suitable times to recovery most species from produced water, 15 millivolt was found the best suitable value for treatment of produced water. There was not a significant effect of pH on recovery of physical parameters. For chemical parameters, the pH was given a good recovery at pH =14 for total hardness; this is might be referred to form calcium and magnesium hydroxide. For recovery of sodium and chloride, the pH= 7 was the best value. Temperature between 20 ^{0}C to 25 ^{0}C were found the best suitable temperatures for treatment the produced water for all the analyzed samples.

Keywords:-*Produced water, Electrocoagulation, Electrodes, Turbidity*

INTRODUCTION

The growth the population and the industrial activities over the world leads to consumption and contaminated of raw water. For this reason, the required of a new treatment technologies becomes an important issue to reducing pollution of receiving water body [(1)]. Electrocoagulation technique was used first time in London in 1889 to EPH - International Journal of Applied Science | ISSN: 2208-2182 51 treatment sewage plant. Electrocoagulation (EC) has been suggested as an advanced alternative to chemical coagulation in the pollutants that removal from raw water and wastewater. Electrocoagulation has several advantages over the conventional techniques of coagulation, flotation,and electrochemistry in water and wastewater treatment. An electrocoagulation use of simple equipment, ease of operation, less treatment time and reduction or absence of chemicals addition [(2)]. Elecetrococolulation based on the principle that catians produced electrolytically from iron or aluminum anodes, which lead to form coagulation of contaminants from an aqueous solutions. When applying electrical current, dispersed particles due to the electrophoretic motion tend to concentrate the negativity charged particles close to the anode. On the other hand, the positively charged particles close to the cathode. The sacrificial anodes are used to produce divalent metals cations in the region of the anode. These cations neutralize the negativity charged particles and electrolysis gases such as hydrogen released at anode and oxygen released at cathode [(3)]. Electrocoagulation (EC) is a complicated process involving many chemical and physical phenomena that use consumable electrodes to supply ions into the wastewater stream. In an EC process the coagulating ions are produced and the steps that taken place can be classified as (i) formation of coagulants by electrolytic oxidation of the sacrificial electrode (ii) destabilization of the contaminants, particulate suspension, and breaking of emulsions and (iii) aggregation of the destabilized phases to form flocs [(4)].Electrocoagulation technique in this study is used to treatment produced water using different conditions. Produced water is water that naturally exists immediately in the rocks before drilling and this water usually is co-produced with hydrocarbons as natural part of petroleum production activity [(5)].These hydrocarbons include residual volatile compounds as well as non-volatile hydrocarbons not removed by separation regime utilized on the platform[(6)].The contents of the certain trace metals in some information waters that leeched from the reservoir rocks when compared with sea water , suggested that it would be of interested to test the concept of the recovering various trace metal from information water by passing natural gas through the water , thereby precipitating the trace metal as result of contact with acid gases (Hydrogen sulphide and carbon dioxide) in the natural gas [(7)].

DESCRIPTION OF STUDIED AREA

The study of aera was Arabian Gulf oil company- Nafoura field. NFR field was founded in 1965 and is located south of coast.The production of oil per day between 35,000 to 45,000 barrels and the discharged of produced water per day about 80,000 barrels. There are 359 wells in the field, including the wells of water injection, wells of observation and follow-up of each group wells are pumped to the complex (Figure 1)

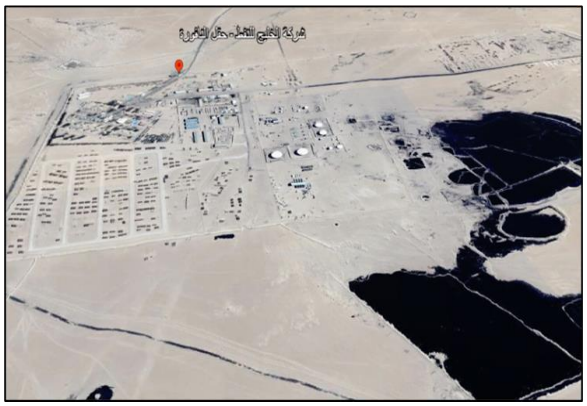

Figure1: Image from google earth illastrated NFR field

Sampling

In according to the shape of Nafoura Lake, it is not symmetrical as illustrated in Figure 2, the major trends is not cycles or patterns. However samples were taken in accordance with principle of random or probability (Stratified samples).The heterogeneous population were broken down into sub-lots and a simple random samples is selected from each stratum. To achieve that, ten samples were taken from the water surface than bulked into one composite sample.

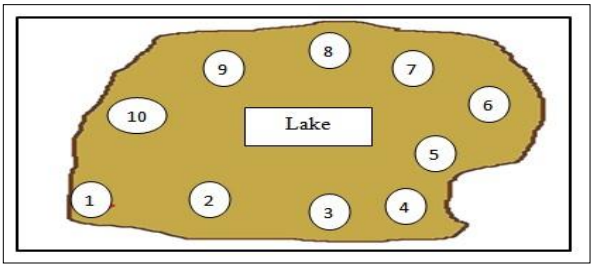

Figure 2: Illustration location of samples

EXPERIMENTAL WORK

Chemical and reagent

Deionized water, Chloroform ($CHCl_3$), 0.1N Silver nitrate ($AgNO_3$), 0.3 N Potassium Dichromate ($K_2Cr_2O_7$), Buffer solutions (4, 7and 9), 1000 ppm Potassium chloride (KCl) and 10 NTU turbidity standard.

Instrumental and devices

PH meter, Turbidity meter, conductivity meter, oxygen meter, chemical oxygen demand (COD) unit, heater, thermometer, magnetic stirrer and direct current (DC).

Sample preparation

After the samples were collected from the lake, (0.1 M) nitric acid was added to preserve the sample till measuring. All the samples were filtrated to remove the debris and large size of suspended particles. Samples were kept on dark bottles to avoid any surrounded atmosphere conditions that might effecting the components samples.

Set-up of EC technique

The components for EC technique are DC power supply, three liter beaker, platinum and aluminum electrodes, wire electric supply, magnetic stirrer, stop watch and magnetic heater (see Figure 3)

1. The DC device was connected to electrical source and then the electrodes platinum and aluminum of 10 cm × 5 cm × 0.15 dimension were connected properly to DC.
2. 1500 ml of prepared sample of produced water was putted in a beaker. The electrodes were hold using stand and then plunged on produced water.
3. After the electrodes with placed in produced water, suitable distance between the platinum and aluminum electrodes was 5.4 cm.
4. Magentic stirrer was adjusted to suitable speed to make the soultion homogeouns.

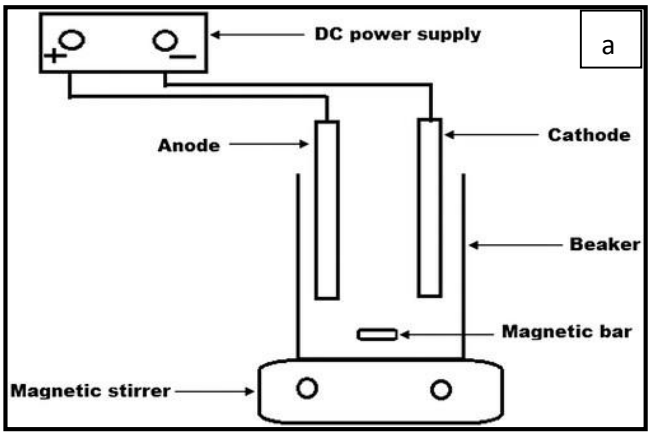

Figure 2: Schematic diagram of designed EC technique

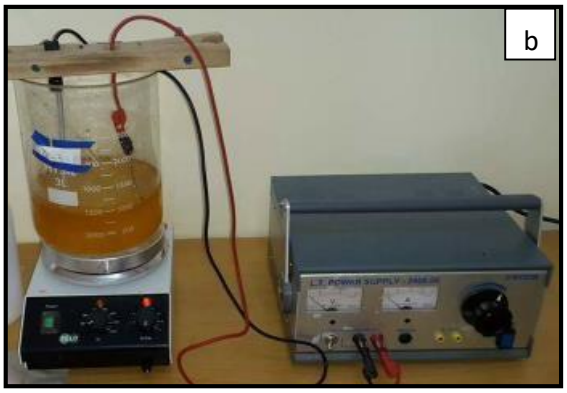

Figure 3:Set-up of EC technique

EC during the treatment of produced water

The DC device was adjusted to the working conditions such as time, temperature, pH and voltage as shown in Figure 4. At the beginning of the reaction, a gradual change in the color of the produced sample was noticed and then bubbles around the electrodes at meddle of reaction was noticed. This is due to electrolysis gases such as hydrogen released at anode and oxygen released at cathode (see Figure 5). At the end of reaction, the electrodes were taken off and the sample was filtered to remove any suspended matter (see Figure 6

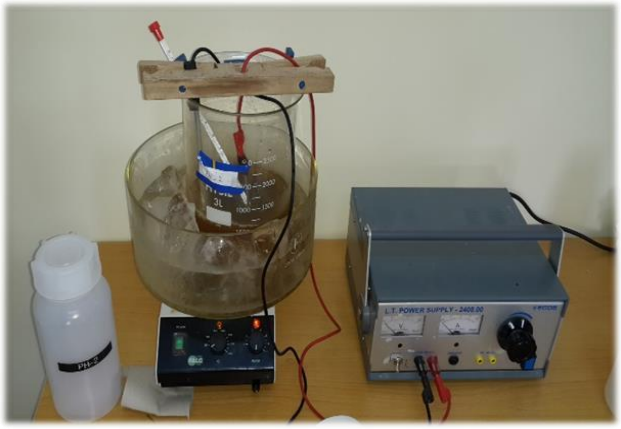

Figure 4: Photo shown change in the color at beginning of reaction

Figure 5: Shown bubbles formed around the electrodes

Figure 6: Shown filtration the samples after treatment.

RESULT AND DISCUSSION

Characterization of produced water samples before treatment

Table is shown physical and chemical parameters before treatment of produced water

Table1: Physical and chemical parameters before treatment

Parameters	Value
pH	6.3
Conductivity ($\mu s/cm$)	875054
Total suspended solid (mg/L)	360000
Total dissolved solid (mg/L)	525032
Turbidity (NTU)	60
Chloride (ppm)	317370
Sodium (ppm)	8970
Sulphate (ppm)	250
Oil content (ppm)	4600

Optimization of electrocoulgaution EC

Effect of time on treatment of produced water using EC

Time was varied from 5 minutes to 30 minutes. As it is clear from Figure 7 (a & d), 10 minutes to 15 minutes were found the best suitable times to recovery most species from produced water.

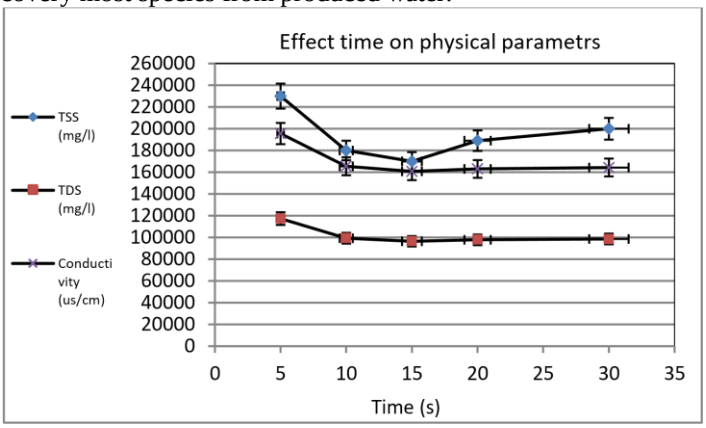

Figure 7(a): Effect time on recavery of physical in produced water

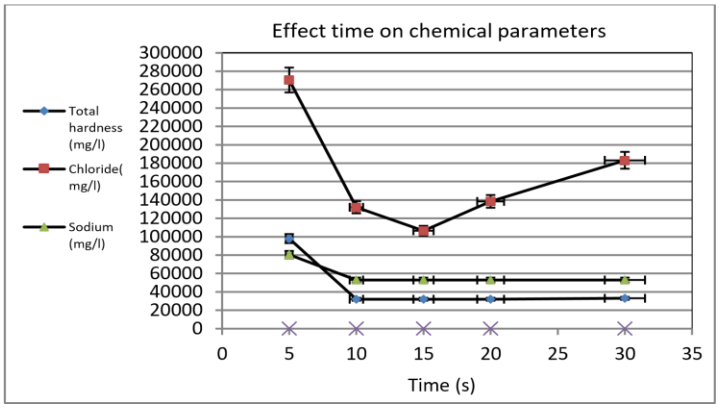

Figure 7 (b): Effect time on recovery of chemical parameters in produced water

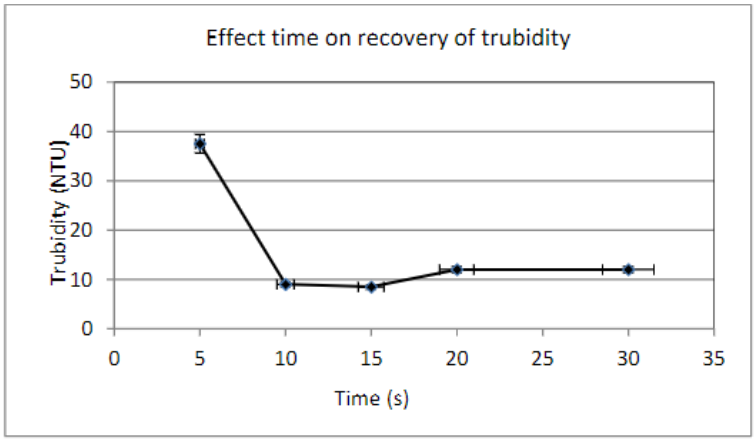

Figure 7(c): Effect time on recovery of trubidity in produced water

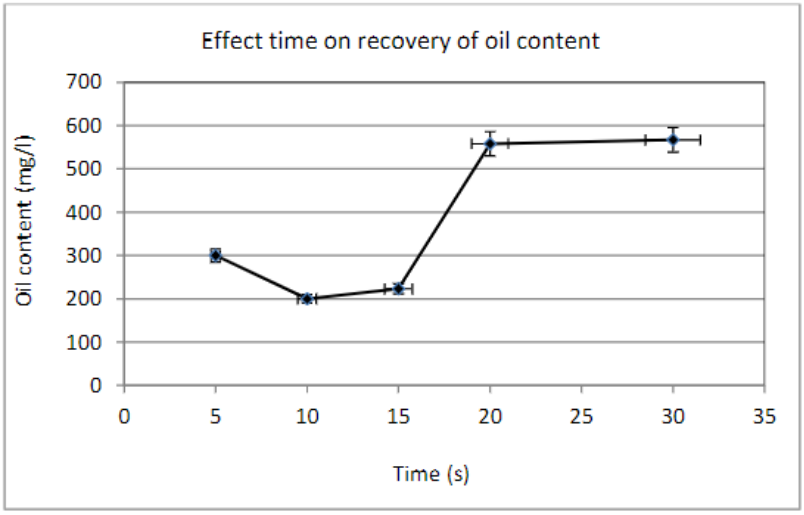

Figure 7(d): Effect time on recavery of sulfate in produced water

Effect voltage on treatment of produced water

Voltage was varied from 5 mV to 25 m. As it is clear from Figure 8 (a& d), there is no a significant effect of changing volt on treatment of physical and chemical parameters, but for recovery of turbidity and oil content,15 millivolt was found the best suitable value can be used for treatment produced water.

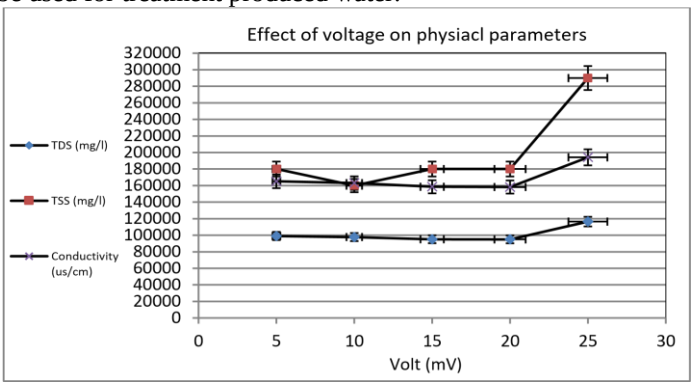

Figure 8(a): Effect voltageon recovery of physical parameters in produced water

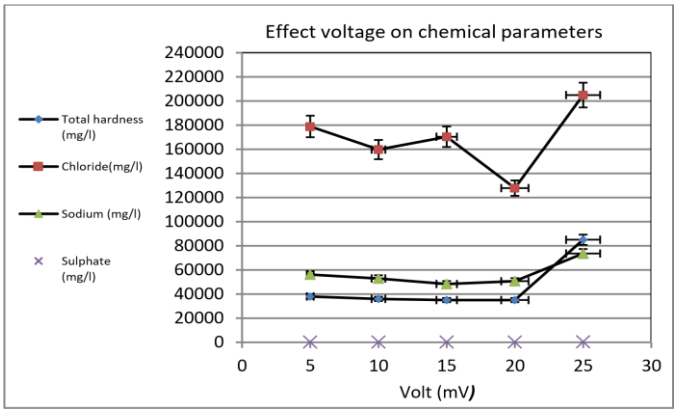

Figure 8(b): Effect voltageon recovery of chemical parameters in produced water

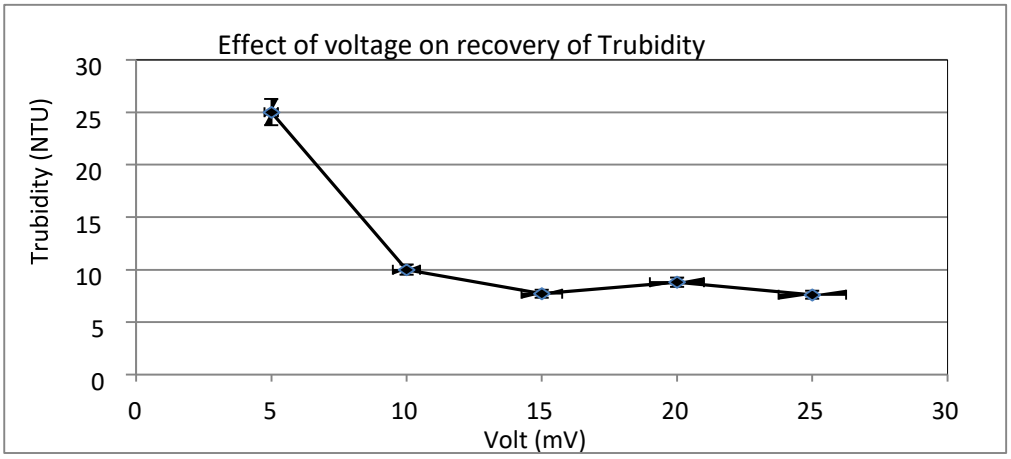

Figure 8(c): Effect voltage on recovery of turbidity in produced water

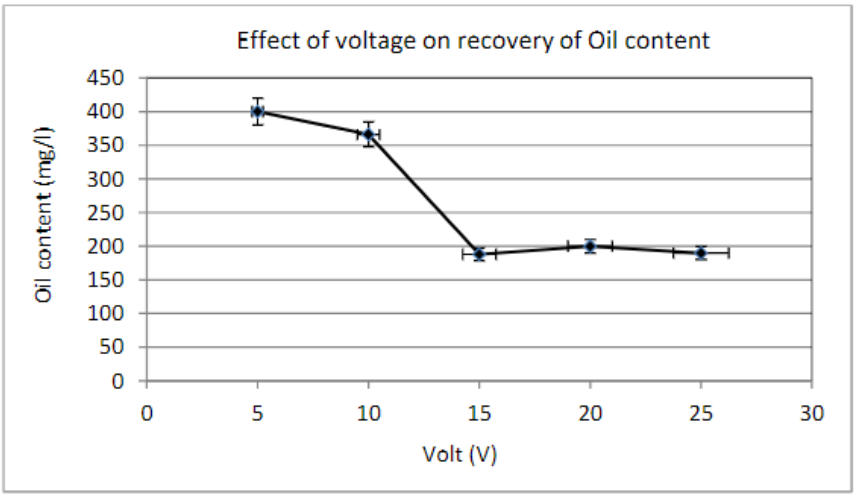

Figure 8(d): Effect voltage on recovery of oil content in produced water

Effect of temperature on treatment of produced water using EC

Temperature was varied from 5 ^{0}C to 80 ^{0}C. As it is clear from Figure 9 (a & d). Range between 20 ^{0}C to 25 ^{0}C were found the best suitable temperatures to use for treatment the produced water for all the analyzed samples.

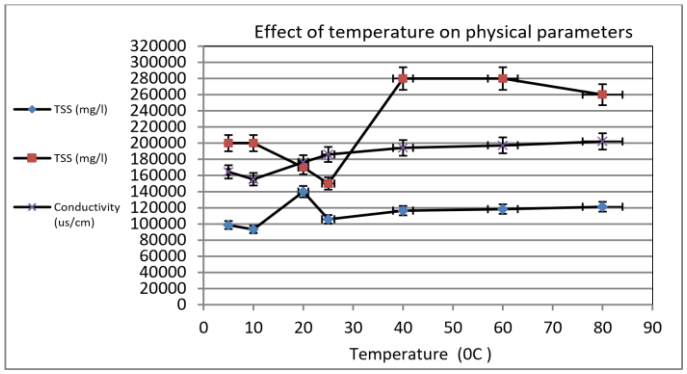

Figure9 (a): Effect temperature on physical parameters in produced water

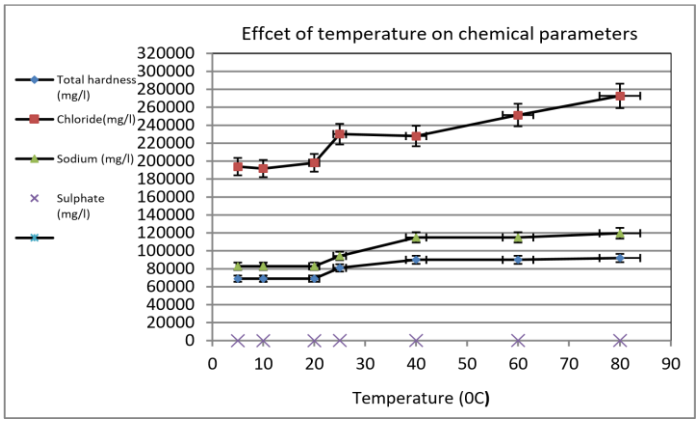

Figure 9 (b): Effect temperature on recovery of chemical parameters in produced water

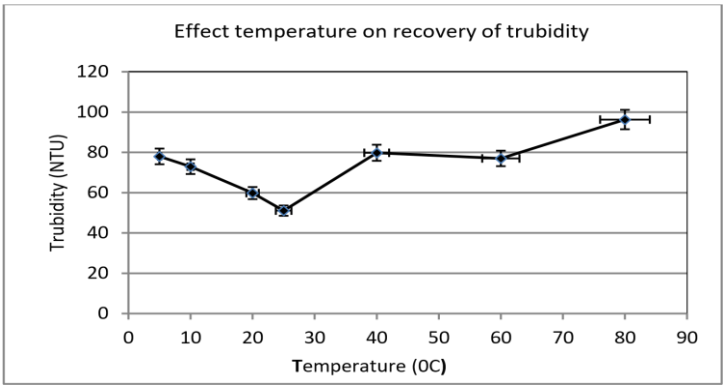

Figure 9 (c): Effect temperature on recovery of turbidity in produced water

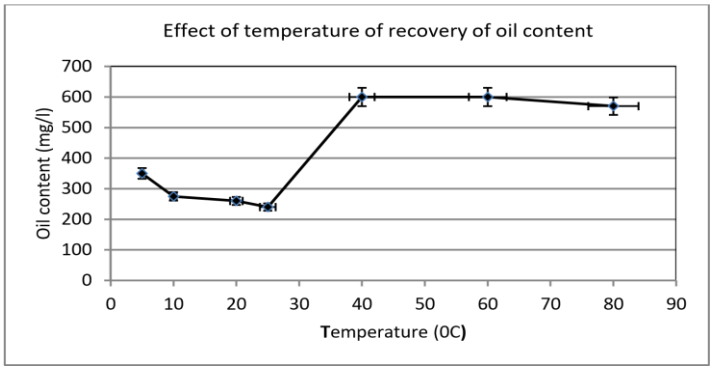

Figure 9(d): Effect temperature on recovery of oil content in produced water

Effect of pH on treatment of produced water using EC

PH was varied from 2 to 12 using buffer solution. There is no a significant effect of pH on recovery of physical parameters. For chemical parameters, the pH was given a good recovery at pH =14 for total hardness; this is might be referred to form calcium and magnesium hydroxide. For recovery of sodium and chloride, the pH= 7 was the best value (see Figure 10 (a & d)

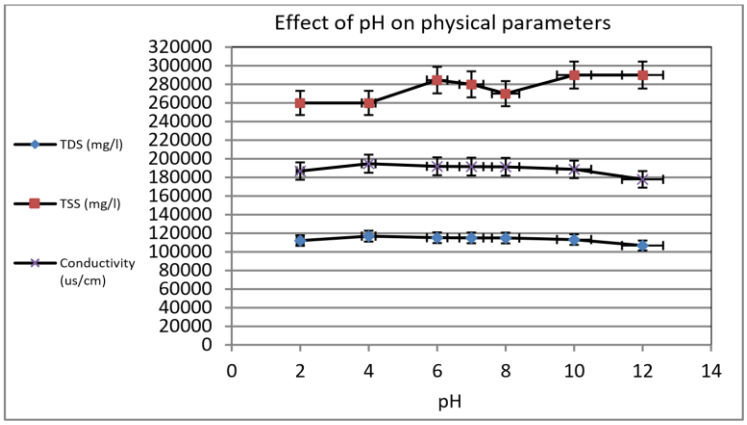

Figure 10(a): Effect pH on recovery physiacl parameters in produced water

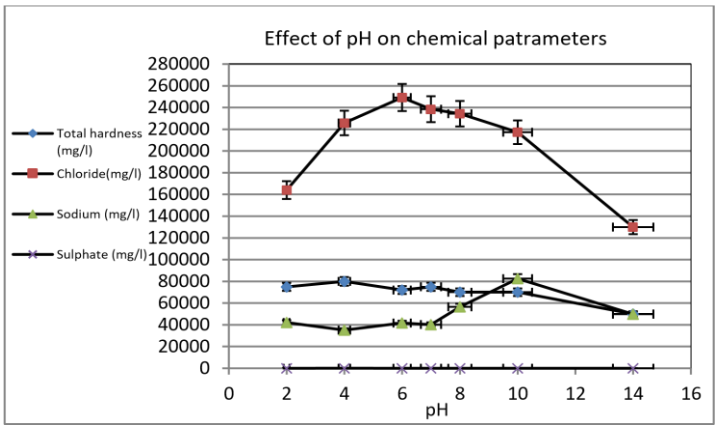

Figure10 (b): Effect pH on recovery of chemical parameters in produced water

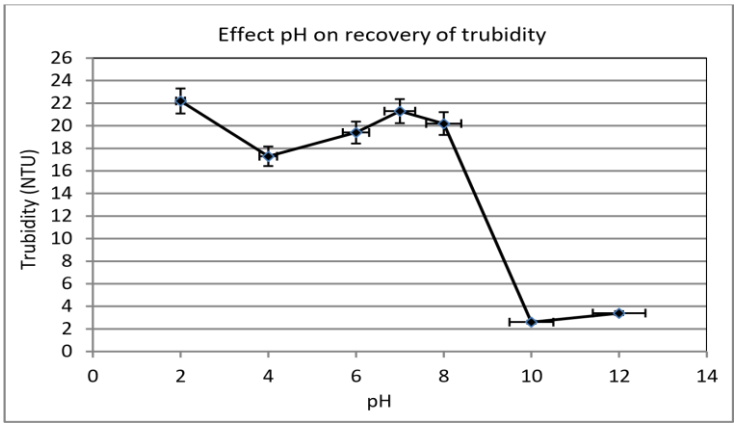

Figure 10(c): Effect pH on recovery of turbidity in produced water

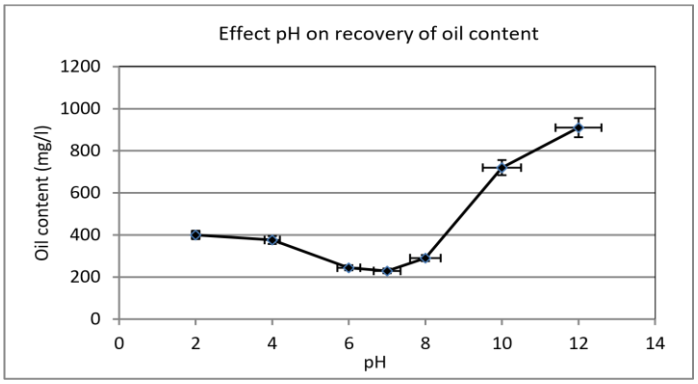

Figure 10(d): Effect pH on recovery of oil content in produced wate

CONCLUSION

This work has given a review of the successfully electrocoagulation application for the treatment of produced water in Arabian Gulf oil company-Nafoura field. Optimization of electrocoagation technique has also taken place by varied time,

voltage, temperature and pH.EC method has shown that can be used with a more efficient treatment processes and quicker than traditional coagulation and inexpensive than other methods of treatment such as ultraviolet (UV) and ozone. This technique unlike biological treatment which requires specific conditions, therefore limiting the ability to treat many wastewaters with high toxicity, eletrocoagulation can be used to treat multifaceted wastewaters, including industrial, agricultural, and domestic. Further research need to be achieved using gas chromatography mass spectrophotometer technique; this is to fund out and investigate how EC method as efficiency method to treatment produced water to recovery some volatile organic compounds. Also, different electrodes need to be used to using the same optimization conditions to compare the efficiency when each pair of electrodes are used.

REFERENCES

[1].Zongo. I., Belkacem, Kalifa.P., Joseph.W., Hama.M.,Jean-Pierre.L., François,Advances in Applied Science Research, **3** (1), 572-582 (2012).

[2].Dohare, D.D and, Tina,.S., International Journal of Engineering Sciences & Research Technology , **3** (11):November (2014).

[3].Satish, I. C, International Journal of Modern Engineering Research, **3** (1) :Feb, 93-100 (2013).

[4].Mohammad Y.A. Mollaha, Paul Morkovskyb, Jewel A.G. Gomesc, Mehmet Kesmezc, Jose Pargad, David L. Cockec, Institute Technology of Saltillo, Department of Metallurgy and Materials Sciencet (2004)

[5].Veil, J. A., Puder, M. G., Elcock, D., & Redweik Jr, R. J. (2004). A white paper describing produced water from production of crude oil, natural gas, and coal bed methane (No. ANL/EA/RP-112631). Argonne National Lab., IL (US).

[6].Reynolds Rodney, R. (2003). Produced water and associated issues: A manual for independent operator. South-Midcontinent Region, PTTC

[7].Douglas.A.H, Marin pollution bulletin, **44**(3), 185-203 (2002).