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Assessment study of the produced water from Adar-Yale oilfield in Melut basin, for injection

[1]Laila Elhassan Obeadalla and [2]Saif Elnasr Abdelmagd

[1]Ministry of Oil, Centeral Petroleum Laboratories, Sudan
[2]Dept. of Chemistry, College of Sciences, University of Elneelain, Sudan

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ABSTRACT

Produced water management should be done to avoid problems with the environment. The produced water is either injected into a disposal well or injected into a producing formation for enhanced oil recovery .This study carried out in Adar-Yale oilfields. One water sample collected from field processing facilities in d Adar-Yale and One water sample collected from formation water in the same field .The water sample for every field (formation and produced water blend together). Nineteen blends of these waters tests for anions using UV Spectroscopy and cations using Inductive Coupled Plasma –optical Emission Plasma (ICP-OES).Scale deposition calculated for every blend and select the best blend to use for injection.

Key words: Produced water, formation water, injection, enhances oil recovery

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INTRODUCTION

Produced water is the largest volume waste stream in the exploration and production process. Produced water streams are usually separated from the oil and gas at or near the wellhead; because of the composition of these streams they must be disposed in manner that is protective of human health, animals, birds and the environment. Over the economic life of a producing field, the volume of produced water can exceed by ten times the volume of hydrocarbons produced. During the latest stages of production, it is not uncommon to find that produced water can account for as much as 98% of the extracted fluids. During 1990, Gulf of Mexico oilfield operation produced 866,514,000barrels of water (Reilly, 1991).With volume of this magnitude; the disposal of produced water becomes an important issue to both the operator and the environment. Currently 4,320,000barrels of produced water are generated each year with the production of oil and gas in Petro-Dar Operating Company (PDOC).Management of produced water to protect the environment is a big issue after production.

The main constituents of the produced water stream are:
- Suspended oil
- Dissolved oil
- Suspended solids (scale, corrosion products, sand, etc.)
- Dissolved solids
- Dissolved Gases (CO_2, H_2S, O_2)
- Bacteriological matter
- Added materials

Produced water injection for enhance oil recovery
The injection water into oilfield reservoirs to maintain reservoir pressure and improve secondary recovery is a well established mature operation.

Scale formation in surface and subsurface oil and gas production equipment has been recognized to be a major operational problem. It has been also recognized as a major cause of formation damage either in injection or producing wells. Scale contributes to equipment wear and corrosion and flow restriction, thus resulting in a decrease in oil and gas production.

Experience in the oil industry has indicated that many oil wells have suffered flow restriction because of scale deposition within the oil producing formation matrix and the downhole equipment, generally in primary, secondary and tertiary oil recovery operation as well as scale deposits in the surface production equipment.There are other reasons why scale forms, and the amount and location of which are influenced by several factors, supersaturating is the most important reason behind mineral precipitation.A super saturated condition is the primary cause of scale formation and occurs when a solution contains dissolved materials which are at higher concentrations than their equilibrium concentration. The degree of super saturation also known as the scaling index is the driving force for the precipitation reaction and a high super saturation condition implies higher possibilities for salt precipitation. Scale can occur at downstream of any point in the production system, at which super saturation is generated. Super saturation can be generated in single water by changing the pressure and temperature conditions or by mixing two incompatible waters. Changes in temperature, pressure, pH, and CO_2/H_2S partial pressure could also contribute to scale formation (Mackay *J.E.*, 2003)

Common oil field scales
The most common oilfield scales are listed in Table (1) along with the primary variables affects their solubility (Moghadasi *et al.*, 2003). These scales are sulfates such as calcium sulfate (anhydrite, gypsum), barium sulfate (barite), strontium sulfate (celestite) and calcium carbonate. Common scales have also been reported such as iron oxides, iron sulfides and iron carbonate. Lead and zinc sulfide scale has recently become a concern in a number of North Sea oil and gas fields (Collins and Jordan, 2001). Many case histories of oil well scaling by calcium carbonate, calcium sulfate, strontium sulfate, and barium sulfate have been reported (Mitchell *et al.* 1980; Lindlof and Stoffer, 1983; Vetter *et al.*, 1987; Shuler *et ah*, 1991

Table (1) : Most common oilfield scales

Name	Chemical Formula	Primary Variables
Calcium Carbonate	$CaCO_3$	Partial pressure of CO_2, temperature, total dissolved salts, pH
Calcium Sulfate: Gypsum Hemi hydrate Anhydrite	$CaSO_4.2H_2O$ $CaSO_4$.1/2H2O $CaSO_4$	Temperature, total dissolved salts, pressure
Barium Sulfate	$BaSO_4$	Temperature, pressure
Strontium Sulfate	$SrSO_4$	Temperature, pressure, total dissolved salts
Iron Compounds: Ferrous Carbonate Ferrous Sulfide Ferrous Hydroxide	$FeCO_3$ FeS $Fe(OH)_2Fe(OH)_3$	Corrosion, dissolved gases, pH

(Moghadasi et al., 2003).

MATERIALS AND METHODS

Data collected for this study from different methods:
a) Data from literature review.
b) Data from Ministry of Petroleum(MOP)
c) Data from Petro-Dar Operating Company (PDOC)
d) Data from Site survey for produced water samples.
e) Data from Central Petroleum Laboratories (CPL).
f) Data from Laboratory analysis.

Laboratory analysis:-
Laboratory analysis was done in Central Petroleum Laboratory (CPL) to measure the main parameter for formation, produced and injected waters. Four samples were collected from different locations includes formation water and produced water tank in Palogue and Adar-Yale fields. The water samples were examined in accordance with the "Standard Methods for Examination of Water and Waste Water" 20 Edition.

pH test was done in central petroleum laboratory using JENWAY 3510 pH meter . A test for cations done by using Inductively Coupled Plasma-Optical Emission Spectrometry (ICP- OES) .Alkalinity is the acid neutralizing capacity of water. Usually expressed as "M" alkalinity (the methyl orange titration end point at a pH of 4.3) and "P" alkalinity (the phenolphthalein titration end point at (pH 8.3).Several ions contribute to alkalinity. It is generally assumed to be due to bicarbonate, ($HCO_3^{-)}$), carbonate ($CO_3^{=}$), and hydroxyl (OH^{-}) ions. The test carried out by using Automatic Titrate (Titrino plus) using (2320 APHA Method).Chloride test (4500-Cl-APHA Method) using UV-4000 spectrophotometer. Sulphate test (HACH -Sulpha -Ver 4 Method) using UV- 4000 Spectrophotometer

Water analysis:

Table (2) Produced and formation water analysis from Adar-Yale oilfield

Sample	CL mg/L	SO_4 mg/L	OH- mg/L	CO3 mg/L	HCO3 mg/L	pH	cond. ms/cm	TDS g/l	Salinity gl	Ba ppm	Ca ppm	Mg ppm	Na ppm
Produce water	195.00	28.50	0.00	800.00	4495.00	7.90	8.20	4.64	3.30	3.18	30.75	8.56	2325.03
Formation water	191.25	85.00	0.00	1500.00	4645.00	8.25	8.70	4.10	2.90	0.33	18.68	9.59	2822.84

The formation water and produced water blended in ratio for injection started from 5% produced water and 95% formation water then 10% produced water and 90 % formation water till blend 19 (95% produced water and 5% formation water). Table (3)

Table (3) Adar-Yale blends of produced and formation water (1-19)

	CL mg/L	SO_4 mg/L	OH- mg/L	CO3 mg/L	HCO3 mg/L	Ba ppm	Ca ppm	Mg ppm	Na ppm	K ppm	Sr ppm	PH
B 1 (5/95%)	227.50	219.00	A	800.00	4200.00	0.41	5.57	8.21	2331.00	162.24	1.69	8.07
B 2 (10/90%)	189.00	200.00	0.00	600.00	4450.00	0.39	9.86	7.94	2265.70	108.12	1.66	8.07
B 3 (15/85%)	199.25	206.00	0.00	600.00	4250.00	0.38	4.82	8.55	2182.30	145.56	1.56	8.07
B 4 (20/80%)	206.50	175.00	0.00	600.00	4400.00	0.45	5.51	7.74	2232.90	139.64	1.42	8.07
B 5 (25/72%)	209.25	173.00	0.00	700.00	4200.00	0.44	5.54	8.68	2224.00	155.25	1.40	8.07
B 6 (30/70%)	197.25	170.00	0.00	600.00	4350.00	0.85	7.91	8.92	2206.90	128.65	1.84	8.07
B 7 (35/65%)	177.25	151.00	0.00	700.00	4150.00	0.59	4.01	7.57	2186.90	139.71	1.17	8.07
B 8 (40/60%)	198.25	131.00	0.00	500.00	4350.00	0.70	5.22	7.80	2117.40	129.28	1.55	8.07
B 9 (45/55%)	166.75	162.00	0.00	400.00	4550.00	0.55	6.37	7.89	2090.60	160.59	1.40	8.07
B10 (50/50%)	189.50	153.00	0.00	300.00	4600.00	0.89	9.52	7.53	2024.30	156.99	1.84	8.07
B 11(55/45%)	182.80	133.00	0.00	800.00	3750.00	1.07	4.14	7.03	2095.14	162.34	0.63	8.07
B12 (60/40%)	178.80	130.00	0.00	1300.00	2900.00	1.22	9.48	7.19	2151.80	154.84	0.69	8.07
B13 (65/35%)	171.80	130.00	0.00	600.00	3850.00	1.40	8.11	7.67	1965.90	160.95	0.79	8.07
B14 (70/30%)	171.90	90.00	0.00	600.00	3850.00	1.65	10.18	7.38	1961.00	150.76	0.83	8.07
B15 (75/25%)	170.20	88.00	0.00	500.00	3950.00	1.83	11.46	7.25	19206.40	154.44	0.91	8.07
B16 (80/20%)	171.10	84.00	0.00	600.00	3800.00	1.45	8.68	7.38	1925.70	158.90	0.79	8.07
B17 (85/15%)	165.30	42.00	0.00	1000.00	3250.00	1.56	9.15	7.06	2003.40	154.73	0.84	8.07
B18 (90/10%)	164.00	36.00	0.00	600.00	3650.00	1.47	9.16	6.54	1847.80	149.89	0.78	8.07
B19 (95/5%)	165.10	28.00	0.00	600.00	3500.00	2.14	6.55	6.50	1595.80	480.85	1.07	8.07

RESULTS AND DISCUSSION

Scale Index calculations:
- If scale index calculation positive means scale likely and deposition starts to appear.
- If the saturation index is zero means the saturation point.
- If the saturation index negative means scale unlikely but corrosion start to take place.
- A positive value for the saturation index indicates that the water is oversaturated and will precipitate calcium carbonate; a negative value indicates that the water is corrosive, i.e., will dissolve calcium carbonate scale.

Adar-Yale oilfield:

Table (4) $CaCO_3$ Scale Index (Is) at 68^{O}F

Blend	$CaCO_3$Scale Index (Is)
B 1 (5/95%)	0.359
B 2 (10/90%)	0.649
B 3 (15/85%)	0.325
B 4 (20/80%)	0.395
B 5 (25/72%)	0.373
B 6 (30/70%)	0.549
B 7 (35/65%)	0.233
B 8 (40/60%)	0.384
B 9 (45/55%)	0.494
B10 (50/50%)	0.683
B 11(55/45%)	0.207
B12 (60/40%)	0.43
B13 (65/35%)	0.532
B14 (70/30%)	0.633
B15 (75/25%)	0.704
B16 (80/20%)	0.561
B17 (85/15%)	0.493
B18 (90/10%)	0.578
B19 (95/5%)	0.421

B means Blend

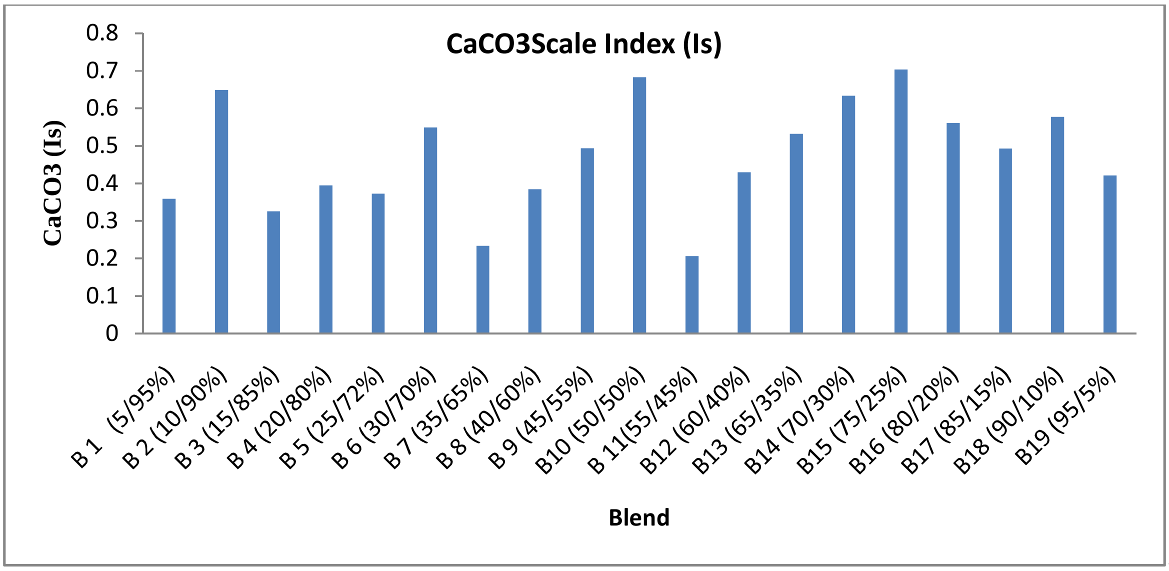

Figure (1) Adar-Yale water injection$CaCO_3$ Scale Index (Is) at 68^{O}F

From the above table (6):

1)All blends Ca CO_3 scale index (Is) is above zero means scale deposition of Ca CO_3.

2)The best blend for injection (mixing Formation water with Produce water is blend eleven (11) with lower scale index 0.207 which contains a mixture of 55% produce water and 45% formation water.

3)This mixing ratio means Produce water more than Formation water and this also decrease the produce water reach the environment.

Adar-Yale oilfield:

Table (5) Ca SO_4, BaSO4 and Sr SO_4 mg/l 68^{O}F

Blend / mg/l	Ca SO_4 mg/l	**$BaSO_4$** mg/l	$SrSO_4$ mg/l
B 1 (5/95%)	-1132	0.390	-1132
B 2 (10/90%)	-1129	0.481	-1129
B 3 (15/85%)	-1091	0.419	-1091
B 4 (20/80%)	-1045	0.447	-1045
B 5 (25/72%)	-1069	0.416	-1069
B 6 (30/70%)	-1027	0.513	-1027
B 7 (35/65%)	-979	0.538	-979
B 8 (40/60%)	-979	0.431	-979
B 9 (45/55%)	-955	0.534	-955
B10 (50/50%)	-941	0.380	-941
B 11(55/45%)	-976	0.800	-976
B12 (60/40%)	-929	0.521	-929
B13 (65/35%)	-881	0.642	-881
B14 (70/30%)	-876	0.777	-876
B15 (75/25%)	-826	0.589	-826
B16 (80/20%)	-855	0.557	-855
B17 (85/15%)	-827	0.687	-827
B18 (90/10%)	-794	0.520	-794
B19 (95/5%)	-1085	2.863	-307

B means Blend

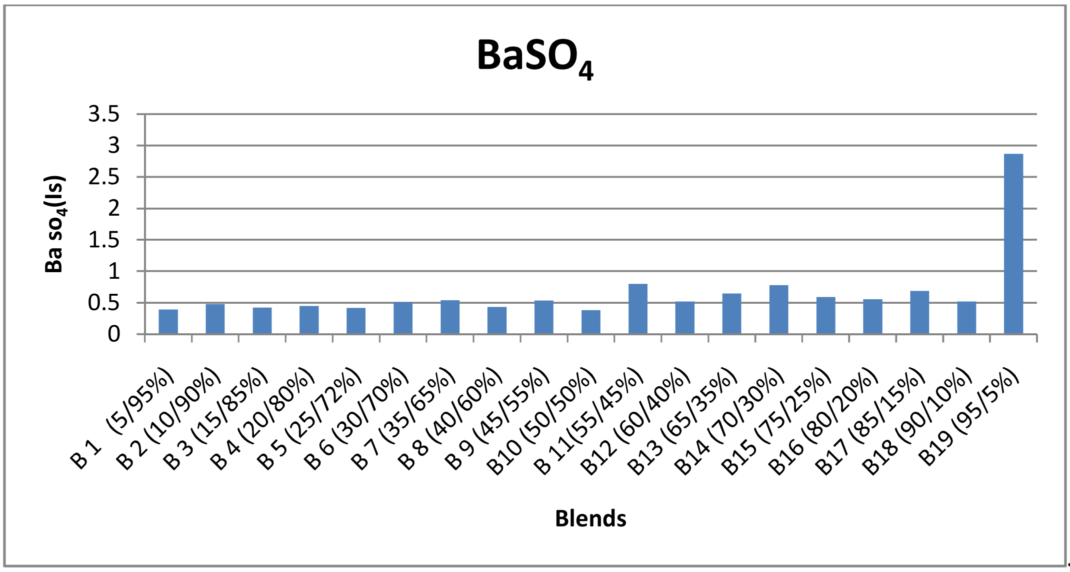

Figure (2) Adar-Yale oilfield water injection BaSO4 mg/l 68^{O}F

From table (5) :

1) No Ca SO_4 deposition in all blends, concentration is below zero.
2)$BaSO_4$ deposition in all blends but the deposition is less than $CaCO_3$
3)No Sr SO_4 deposition in all blends.

CONCLUSION

As a result of the study the conclusion listed on the following points:

The formation water and produced water mixing in Adar-Yale field, for water injection caused scale deposition.

The best blending ratio for Adar-Yale oilfield blend eleven (55% produced water and 45% formation water.

The above mentioned ratio less of scale deposited and high consumes of produced water that protecting the environment. The most common scale deposit is calcium carbonate.

The calcium sulphate deposit is not occurred (unlikely).Barium sulphate is likely but in small amount.
Strontium sulphate deposit is not occurred (unlikely)

The study area basement complex (Meta – Sediment) rich with Ca CO_3 rock found as crystalline marble at the surface (Rabak cement Query) and found also at subsurface as encountered at some drilled wells in block (7) and (3) (Central Petroleum Laboratories (CPL)) .This source supposes to introduce calcium carbonate in formation water beside the intruded volcanic sills inside sediment of Melut basin which related to the activity of African Rift zone. The accompanied solution with the volcanic rocks also adds sodium carbonate and chloride which is reported in many localize along the Rift zone like Magadi Lake at Kenya. (Baker, B.H. 1958. Geology of the Magahi area)

REFERENCES

[1] Baker, B.H. **1958**. Geology of the Magadi area, report of the Geological survey of Kenya, pp 42-81)
[2] Lindlof, C. J. and Stoffer, G. K. (**1983**). *Journal of Petroleum Technology*, July 1983 1256 - 1262.
[3] Mackay, J. E., Collins, R. I. and Jordan, M. M. (**2003**). PWRI: scale Formation Risk Assessment and Management. The SPE 5th International Symposium on Oilfield Scale. January 29 - 30. Aberdeen, UK: SPE 80385, 1 - 18.
[4] Moghadasi, J., Jamialahmadi, M., Muller-Steinhagen, H., Sharif, A., Ghalambor, A., Izadpanah, R. M. and Motaie, E. (**2003**). Scale Formation in Iranian Oil Reservoir and Production Equipment during Water Injection. The 5th International Oilfield Scale Symposium and Exhibition. January 29 - 30. Aberdeen, UK: SPE 80406, 1 - 14.
[5] Reilly **1991**.Technologyical / Environmental issue & solutions, page 1-2.
[6] Standard Methods for Examination of Water and Waste Water" 20 Edition.