EOR and Reservoir preservation in Rag-e Sefied Oil and Gas Field: With Base of Reservoir Fluid Geochemistry

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Abstract

Mineral ions are present in aqueous solutions in most industrial and operational processes, including oil operation. Accurate analysis and sampling of the formation water and its dissolved minerals during the operation of the oil industry can be a valuable solution for the efficient management of oil production from the reservoir. Therefore, in this study, evaluation of inorganic ions and their concentration in formation water for 6 well samples in the Rag-e Sefid Oil and Gas Field was considered. According to the results of this study, calcium, sodium and magnesium cations as well as sulfate, bicarbonate and chloride anions are soluble inorganic ions in the Rag Sefid Oil Field Formation. Also, in this study formation of inorganic sediment CaSO_4 , $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$, CaCO_3 and MgCO_3 was studied. Based on the operating conditions of the Rag-e Sefid Oil and Gas field, the formation of calcium sulfate and calcium carbonate mineral deposits is significant. With base of geochemical analysis in reservoir rock samples and ions ratios these reservoir is good for preservation. The results thus provide more accurate predictions in terms of where to find gas reservoirs in the Zagros basin, and can lead to significantly better exploitation of these resources and also estimation of rate of sedimentation for EOR.

Introduction

Waters is recognized as an important fluid in the oil fields. They are in contact with the oil field formation materials. Therefore, by careful analysis, important geological and geochemical information can be obtained. All waters of the Formation contain minerals. Important cations include sodium, calcium, barium, strontium, potassium and iron, as well as common anions such as chloride, sulfate, sulfide, carbonate. According to available reports, the concentration of minerals in the formation water in the oil fields is higher than in seawater. In the other words, the total mineral solids in the Oil Formation is 300,000 ppm and in seawater is about 35,000 ppm (McCain,1999). One of the reasons for this topic is the effect of ion exchange from formation to water. Important factors can affect the concentration of minerals in the formation water. Factors such as dilution with groundwater, the presence of anaerobic bacteria and petroleum components, ion exchange of cations with clay, dissolution of mineral solutes (due to the movement of formation waters), exchange of magnesium and calcium during dolomite formation and the passage of mineral solutes through the cracks are cited. In the process of oil recovery operations (especially when seawater is used for injection operations), mineral deposits may be formed in surface and subsurface equipment(Hashemi et al., 2014,2017a,2017b ; McCain, 1999 ; Mirzayi et al., 2016). In the other words, with the mixing of the injection water and the formation water, the concentration of minerals in the solution increases. Hence changes in the solubility of minerals (based on changes in temperature and pressure of the reservoir and well) occur. Changes in the solubility of minerals can lead to the formation of mineral deposits in the reservoir and oil wells and reduce production efficiency. Figure 1 shows the process of mineral deposition formation during operation. The formation of mineral deposits in petroleum systems has been considered by many researchers such as Jones,)1964(, Mongan,)1965(, Oddo et al.,)1991(, Chong and Sheikh al-Islami,)2001(,Bagci et al.,)2001(, Voloshin et al.,)2003(, Ahmad and Abu Khamsin,)2005(and Hashemi et al.,)in press ,2019,2020(.

Jones,)1964(considered the effect of ions such as calcium and magnesium on reservoir porosity blockage. According to his results, the adsorption properties of clays with calcium and magnesium mineral ions are higher than that of sodium mineral. In the other words, clays that have absorbed significant amounts of calcium and magnesium lead to blockage of the oilfield subsurface reservoir.

Mongan, 1965 examined the effect of pH and ion concentration on the damage of cores in the oil industry. According to his results, the main factor for the reduction of permeability can be the blockage of the pores with mineral particles.

Oddo et al.)1991(studied 24 soluble wells sampled from floating pumps in Indonesian offshore wells to investigate calcium carbonate and calcium sulfate mineral deposits. One of the important factors in their study for the formation of these two sediments is the increase in temperature and pressure drop.

Chong and Sheikholeslami,)2001(investigated the effect of accumulation and deposition of calcium sulfate and calcium carbonate sediments in a mineral solution (under 60, 70 and 80 ° C). According to their extracted results, with the presence of calcium sulfate in the concentration range of 0.01 - 0.002 molar, increase in solubility of calcium carbonate is noticeable.

Bagci et al. (2001) investigated the effect of ionic concentrations such as alkaline fluids and injection rates on permeability in monolithic and non-monolithic calcareous cores. According to their results, the permeability was reduced in monolithic and non-monolithic calcareous specimens for experiments where the salt concentration was less than a critical value.

Voloshin et al., (2003) , in a research work, investigated the formation of mineral deposits during oil recovery operations using water injections in the western Siberian oilfield. Based on the results of their work, the mineral composition of injectable water is an effective factor in the process of mineral deposition in the reservoir and well.

In a research work, Abu Khamsin and Ahmad, (2005) investigated the process of calcium sulfate deposition in the presence of sandstone using a mixture of calcium-containing saline with sulfate-rich impure water. According to the results of their research, the rate of accumulation and sedimentation of inorganic calcium sulfate is markedly increased despite the high injection rate and high temperature.

Due to the challenge of mineral deposition of barium sulfate and strontium sulfate in oilfields, Hashemi et al., (2019) studied the conditions of water injection operations in the Siri and Nusrat oilfields using a thermodynamic model. Based on the results of their study, the deposition of barium sulfate and strontium sulfate in the Nusrat oil field depends on the composition of the formation water and Water injection operation (Persian Gulf water) and operating conditions. However, the formation of barium sulfate and strontium sulfate is not significant for the Siri oil field based on water analysis and operating conditions information. In their study, temperatures were 50, 100, and 110 ° C, as well as pressures of 135, 270 and 2465 psi.

Mineral deposition of calcium sulfate is one of the most common sediments in petroleum systems. Therefore, the conditions of calcium carbonate deposition in several oilfields based on the concentration of mineral water ions in the formation and temperature and pressure conditions were investigated by Hashmi et al.,(In press). In their study, the solubility of calcium sulfate precipitate in the presence of magnesium chloride and calcium chloride was studied. Based on their results, the solubility of calcium sulfate precipitate in the presence of magnesium chloride and calcium chloride decreases with increasing temperature. In their study, the pressure range was between 25 and 250 bar and temperatures between 1 and 300 ° C.

The water of the Nosrat Oilfield Formation contains high concentrations of inorganic ions. For this reason, Hashemi SH and Hashemi SA, (2020) studied the prediction of carbonate and sulfate mineral deposits in the Nusrat Oil field in light of operating conditions. According to the results of their study, the formation of mineral deposits of calcium carbonate, magnesium carbonate and barium sulfate in the Nusrat oil field could cause problems during operation.

In this study, the analysis of mineral ions in the formation water in Rag-e Sefid Oil and Gas field is based on 5 wells studied. Also, considering the importance and challenges of mineral deposition phenomena in petroleum industry, evaluation of mineral deposition of Calcium Carbonate, Magnesium Carbonate, Calcium Sulfate and Gypsum has been performed under StimCade2 software in operating conditions of well in Rag-e Sefid Oil and Gas Field.

Rag-e Sefid Oil and GasField

Rag-e Sefid oil field is one of the south western Iranian oil fields, located on the border between Khuzestan and Kohgiluyeh and Boyerahmad provinces (fig 2). In the hydrocarbon layer in the section of the Asmari and Bangistan reservoirs, oil production is carried out in the Rag-e Sefied Oil and Gas field. The Asmari reservoir of the Rag Sefid oil field was discovered by surface geological operations in year 1951, and finally the existence of oil and gas reserves in the Rag Sefied oil field was proved by drilling a well in year 1964. This oil field is geologically located at the bottom of the Zagros Sedimentary Zone. The Rag Sefid oil field in the southeast is associated with the Bibi Hikmieh oil field, in the northeast with Paznan, in the northwest with Ramshir, and in the southwest with Zagheh, Hindijan-Behrganasar and Tango (Rezaie and Nogole-Sadat, 2004).

The Rag-e Sefid Field is located in Khuzestan province, southwest Iran and has approximately 6 Km in nearest distance from the Persian Gulf. These field has an accurate asymmetrical anticline structure. This structure has 45 Km length and 5-9 Km width. This structure has three-horizon reservoirs, which in ascending stratigraphical order are Khami Group (Gas bearing), Bangestan group and Asmari Formation (Oil/Gas bearing).

The first exploration well in 1963 was drilled in the Rag-e-Sefid structure and reached to the Asmari Formation. After it well drilled on this structure for evaluation of the Bangestan and Khami groups in 1964. The estimated hydrocarbon of this reservoir is 2.4 Billion Barrel oil and 20 Trillion Cubic Feet gas

(Motiei, 1995). The Asmari oil reservoir is characterized by 30° API and low sulfur, whereas the Bangestan Oil reservoir is marked by 25° API and 3.5% sulfur. Based on data from oil production, it has been indicated that the amount of sulfur increases in crude oil of Asmari Formation by production. This phenomenon suggests that the oil of Asmari and Bangestan Reservoirs are connected by fractures and faults. It should be mentioned that, more than 118 wells have drilled in this structure up to now. 95 out of 118 wells drilled in the Asmari reservoir, 11 in the Bangestan reservoir and the rest for the Khami reservoir (Rezaie and Nogol Sadat, 2004).

Method Of Analysis

In this study, measurement methods for bicarbonate based on Betz Handbook, (1962), calcium and magnesium ions based on ASTM-D511 standard, chloride ion based on ASTM-D512 standard, iron ion based on HACH 8008, sodium ion using Flamephotometer, sulfate ion based on HACH 8051, is done. Also, the ASTM D-4007 standard was used to determine the percentage of sediment in the formation water.

The StimCad 2 software was used to prediction of sulfate and carbonate mineral deposition. This software is intended to simulate the acidification of wells and to predict mineral deposition in oilfields.

The StimCad 2 software has a temperature range of -50 to 600 degrees Fahrenheit and a compression range of 15.99 to 24999.988 psia. Predictable inorganic sulfate and carbonate mineral deposition of this application include iron carbonate, calcium carbonate, magnesium carbonate, calcium carbonate, calcium sulfate (anhydrite and gypsum), strontium sulfate, barium sulfate and iron sulfate. The software reports saturation percentage, sedimentation rate and pH. In Figure 3, this application software is shown. 5 samples from rock reservoir in the studied field were analyzed with XRF with PW1410 Philips instrument for comparison with water analysis.

Results And Discussion

Table 1 presents the analysis of inorganic ions in 5 samples of Rag-e Sefid Oil and Gas field wells. Based on the results in Table 1, calcium, magnesium, sodium cations as well as anion sulfate, chloride and bicarbonate are significant in the oil field water. Based on the analysis, the amount of iron ions in the 5 samples studied was zero. The pH level in the 5 samples studied is between 5.98 and 6.42.

According to the results of Table 1, the sulfate ion is more concentrated than bicarbonate. One of the reasons for significant amounts of sulfate (SO_4^{2-}) ion can be the dissolution of gypsum.

Also, due to results, Chloride (Cl^-) ions are significantly present in the Rag-e Sefid formation. The origin of high Chloride ions can be the dissolution of minerals containing Chloride ions in the formation water. Based on the results of Table 1, the solubility of the aqueous solution mineral water changes in exchange for the change in the concentration of mg/L of sodium, calcium, magnesium, chloride, sulfate and bicarbonate ions. In the other words, the electrolyte solutions due to the electrostatic forces between the

ions and the short-range forces between the ions and the water, can form a saturated solution in the water of the formation. By changing the solubility of the mineral ions in case of appropriate temperature and pressure conditions of the reservoir, it is possible to form mineral deposits at the well entrance to the reservoir and along the well. Therefore, utilization of thermodynamic reflectors can be considered as a suitable solution for controlling solubility of mineral ions.

In carbonate gas reservoirs, basically several chemical reactions occur during geological periods (shariatpanahi et al., 2011). High concentrations of Ca^{2+} in the water of the Rag-e Sefid Formation can indicate a carbonate sedimentary environment.

The concentration of SO_4^{2+} ion in the water of the Rag-e Sefid Oil and Gas Field formation can also be due to the high concentration of H_2S in most of its gas reservoirs.

Concentration of Mg^{2+} also indicates a strong reaction between the reservoir rock of Rag-e Sefid Oil and Gas Field with the water of formation (formation of dolomite and dissolution of anhydrite ; Ellis and Mahon, 1967; Giggenbach, 1986; Gunter et al., 2000)

The high concentration of chloride ion compared to sulfate and bicarbonate mineral ions in the water of Formation of Rag-e Sefid Oil and Gas Field can be related to the concentration of sodium chloride in ancient seawater and low solubility of CaSO_4 and CaCO_3 (Ellis and Mahon, 1964; Ellis and Mahon, 1967).

Table 2 presents the analysis of the percentage of water-soluble materials for 5 wells in the Rag Sefid oil field. According to the results of Table 2, the percentage of dissolved solutes in the water of the Rag-e Sefid Formation for samples 1 to 5 were 90%, 46%, 95%, 24% and 95% respectively. This amount of sediment can cause problems in the operation system.

Table 1- Formation water analysis based on 5 samples of Rag-e Sefid Oil and Gas field

Componets (mg/lit)	Sample1	Sample 2	Sample 3	Sample 4	Sample 5
Na ⁺	80224	59087	77458	66409	58056
Ca ²⁺	8000	7600	8000	7600	7200
Mg ²⁺	2187	972	1701	1458	1701
Cl ⁻	142000	106500	136675	118925	106500
SO ₄ ²⁻	2400	1200	2100	1600	925
HCO ⁻	1098	244	854	244	293
Total Dissolved Solid	235909	175603	226788	196236	174675
Ph	5.98	6.42	6.0507	6.42	6.38

Table 2 -Rate of sediment content in formation water based on 5 well Rag-e Sefid Oil and Gasfield

Deposition	Formation Water
90%	Sample 1
46%	Sample 2
95%	Sample 3
24%	Sample 4
95%	Sample 5

Table 3 presents the prediction of mineral deposition of calcium carbonate, magnesium carbonate, calcium sulfate and gypsum for 5 wells in the Rag-e Sefid Oil and Gas field. According to Table 3, calcium carbonate sediment formation is significant for samples 1 to 5. Also the formation of calcium sulfate mineral precipitates for samples 1, 2, 3 and 4 is significant. However, it is not possible to form gypsum and magnesium carbonate mineral deposits based on the concentration of water-soluble ions and the temperature and pressure conditions of the well. According to the results of Table 3, with increasing temperature and pressure, the saturation rate of gypsum and magnesium carbonate mineral deposits decreases and increases respectively. This can be related to the solubility of magnesium carbonate and gypsum as well as the activity coefficient of calcium, magnesium, bicarbonate and sulfate ions.

Mineral ions such as calcium, sodium, magnesium, iron, sulfate, chloride and bicarbonate affect each other's behavior in the solid-liquid equilibrium system due to their electrical charges. It can cause supersaturation conditions in the water formation and sediment formation in surface and subsurface facilities of oil and gas fields. Also, the presence of intermolecular forces of mineral anions and cations in

water and the formation of ion pairs can be other factors affecting the behavior of mineral ions in order to form mineral sediments in oil and gas field facilities.

For the formation of calcium carbonate, magnesium carbonate, calcium sulfate and gypsum sediments wells, temperatures and pressures are significant and in these wells were studied as 3093 Psia & 177.96 F, 3156 Psia & 181.6 F, 3220 Psia & 184.79 F and 3358 Psia & 186.63 F. With base of geochemical analysis in the rock samples reservoir Ca and Mg ions are major components in this samples (fig 6). In the water analysis SO₄ and Cl are major component (fig 4, 5), therefore this comparison show source of ions (except for calcium and magnesium ions) in the water reservoir are not rock reservoir and these related to marine original water.

According to hydrogeochemical and geological studies of the region, the most important reasons for the salinity of the water of Rag-e Sefid Oil and Gas Field formation can be evaporated sea water and salt dissolution. Due to the evaporation of seawater, the concentration of all mineral ions such as sodium, calcium, chloride, sulfate and bicarbonate in the water of Rag-e Sefid Formation has been enriched to the point of saturation in brine. However, the ancient evaporated seawater (from burial time to the present tense) has changed from the original composition due to contact with the Rag-e Sefid Formation rock.

The amount of minerals dissolved in the water of Rag-e Sefid Formation, based on the 5 samples studied, is from 174675 to 235909 mg / l.

Table3.prediction of sulfate and carbonate mineral scale formation index at different pressure and different temperatures

Wall	Deposition (% Saturation*)	Survey Data			
3093 Psia & 177.96 F	3156 Psia & 181.6 F	3220 Psia & 184.79 F	3358 Psia & 186.63 F		
Sample 1	CaSO ₄	100	100	100	100
CaSO ₄ .2H ₂ O	23.38	21.88	20.81	20.13	
CaCO ₃	100	100	100	100	
MgCO ₃	17.93	19.38	20.53	21.33	
Sample 2	CaSO ₄	100	100	100	100
CaSO ₄ .2H ₂ O	25.16	23.55	22.4	21.66	
CaCO ₃	100	100	100	100	
MgCO ₃	7.5	8.11	8.59	8.92	
Sample 3	CaSO ₄	100	100	100	100
CaSO ₄ .2H ₂ O	23.64	22.12	21.04	20.35	
CaCO ₃	100	100	100	100	
MgCO ₃	13.56	14.66	15.53	16.13	
Sample 4	CaSO ₄	100	100	100	100
CaSO ₄ .2H ₂ O	24.56	22.99	21.86	21.14	
CaCO ₃	100	100	100	100	
MgCO ₃	11.57	12.5	13.24	13.76	
Sample 5	CaSO ₄	91.4	94.81	97.43	99.2
CaSO ₄ .2H ₂ O	23.05	22.37	21.86	21.53	
CaCO ₃	100	100	100	100	
MgCO ₃	13.72	14.8	15.65	16.24	

* % Saturation (% SR)= 100 : Scale Formation . Saturation ratio is usually expressed as the ratio obtained by multiplying the activity of the ions to the chemical equilibrium constant

Table 4 shows the amount of mineral sediment in Rag-e Sefid Oil and Gas field according to StimCad 2 software based on the percentage of saturation rate.

According to the results of Table 4, the formation of calcium sulfate and calcium carbonate deposits in the Rag-e Sefid Oil and Gas field is significant. This is while the rate of calcium sulfate deposition is higher than calcium carbonate. Also, the amount of mineral sediment formation in sample 1 was the highest and sample 5 was the lowest. According to the results of Table 4, $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ and magnesium carbonate mineral deposits cannot be formed due to the concentration of water ions in the formation. According to the results obtained in Table 4 for sample 1, at a pressure of 3093 psi and a temperature of 178 °F, the amount of mineral sediment formation for calcium sulfate and calcium carbonate is 1772.138 and 715.4 mg/lit, respectively. However, based on the concentration of mineral ions in the water formation (sample 1), at a pressure of 3358 psi and a temperature of 187 °F, the amount of mineral sediment formation for calcium sulfate and calcium carbonate is 1894.7 and 725.25, respectively.

Table 4 . The amount of mineral sediment in Rag-e Sefid oil field according to StimCad 2 software based on the percentage of saturation rate

Wall	Deposition mg/lit))	Survey Data			
3093 Psia	3156 Psia	3220 Psia	3358 Psia		
178 F	182 F	185 F	187 F		
Sample 1	CaSO4	1772.138	1822.854	1868.5	1894.7
CaCO3	715.4	719.43	723.11	725.25	
Sample 2	CaSO4	326.57	373.64	407.67	429.75
CaCO3	129.51	131.01	132.12	132.85	
Sample 3	CaSO4	1396.87	1451.48	1490.99	1516.66
CaCO3	544.73	548.44	551.17	552.97	
Sample 4	CaSO4	788.78	839.61	876.37	900.24
CaCO3	127.42	128.95	130.1	130.85	
Sample 5	CaCO3	160.52	162.314	163.63	164.5

Preservation of Hydrocarbon

Table 5 presents the hydrochemical properties of the mineral ions in the water of the Rag-e Sefid Oil Field Formation.

With base of ion concentration can obtain relation between these and hydrocarbon preservation (Table 5) with following:

Sodium / Chloride ($\text{Na}^+ / \text{Cl}^-$) ratio

According to the table, the ratio of sodium to chlorine in the water samples of the Rag-e Sefid Oil and Gas field Oil Field Formation is in the range of 0.565 to 0.567. The numerical ratio of sodium to chlorine in the 5 samples studied (due to the fact that it is less than one) can emphasize that the water in the Rag-e Sefid Oil and Gas field formation is the ancient residual seawater that is sealed in the reservoir (Without being associated with shallow water or active aquifers) therefore useful for storing hydrocarbons (De Choudens-Sanchez and Gonzalez, 2009; Osborn et al., 2011; Rice et al., 2008).

Table 5. Ion ratio for estimation of preservation of hydrocarbon in the studied field

Water Foramtion	$\text{Na}^+ / \text{Cl}^-$ (mg / l)	$\text{Cl}^- - \text{Na}^+ / \text{Mg}^{2+}$ (mg / l)	$\text{HCO}_3^- / \text{Cl}^-$ (mg / l)	$\text{HCO}_3^- / \text{Ca}^{2+}$ (mg / l)	$\text{Mg}^{2+} / \text{Ca}^{2+}$ (mg / l)
Sample 1	0.565	28.24	0.0077	0.137	0.273
Sample 2	0.555	48.77	0.00229	0.032	0.127
Sample 3	0.567	34.81	0.00624	0.106	0.213
Sample 4	0.558	36.02	0.00205	0.032	0.192
Sample 5	0.545	28.48	0.00275	0.041	0.236

Metamorphic coefficient ($\text{Cl}^- - \text{Na}^+ / \text{Mg}^{2+}$) ratio

The metamorphic coefficient ratio (eg $\text{Cl}^- - \text{Na}^+ / \text{Mg}^{2+}$) is considered to evaluate the degree of water-rock interaction and ion replacement (Ranasinghe et al., 2005; Zheng, 2012). The ratio $\text{Cl}^- - \text{Na}^+ / \text{Mg}^{2+}$ in 5 water samples of the formation in the Rag-e Sefid Oil and Gas field, 28.24 to 48.77. This high metamorphic coefficient, in the studied samples, indicates strong interactions between water and rock (Yu et al., 2020), so Na^+ and Mg^{2+} are mainly displaced by Ca^{2+} and therefore have high metamorphic coefficients.

Magnesium / Calcium ($\text{Mg}^{2+} / \text{Ca}^{2+}$) ratio

The ratio of magnesium to calcium in the water of the study formation is less than one (higher concentration of calcium ions than magnesium ions). Dolomite formation leads to high concentration of Ca^{2+} versus low concentration of Mg^{2+} in the water of the formation. Therefore, dolomitization an essential role in controlling Ca^{2+} and Mg^{2+} concentrations. Dolomite formation occurs in sealed reservoirs (Nader and Sunen, 2004), so $\text{Mg}^{2+} / \text{Ca}^{2+}$ ratios have low ratios and can indicate sealing conditions (De Choudens-Sanchez and Gonzalez, 2009; Folk and Land, 1975; Koleini et al., 2018; Lear et al., 2002;

Nielsen et al., 2016; Shariatpanahi et al., 2011; Wilkinson and Algeo, 1989). Higher magnesium to calcium ratios can reduce hydrocarbon storage (Yu et al., 2020).

(HCO₃⁻ - CO₃²⁻) / Ca²⁺) ratio

The ratio (HCO₃⁻ - CO₃²⁻) / Ca²⁺) is considered to test the decarbonization property (Van Voast, 2003). The ratios of (HCO₃⁻ - CO₃²⁻) / Ca²⁺) in the water of the formation are mostly less than 0.5. Bicarbonate is the product of the dissolution of carbonate by oxygenated water. Previous studies have shown that low ratios (HCO₃⁻ - CO₃²⁻) / Ca²⁺) are typically associated with high acid content, which is closely related to petroleum water organic matter (Deines et al., 1974; Yuan et al., 2007; Zeebe, 1999). It is therefore suitable for storing hydrocarbons (Chen et al., 2005; Kurita et al., 2008; Palandri and Reed, 2001).

(HCO₃⁻) / Cl⁻ ratio The ratio

(HCO₃⁻) / Cl⁻ in the studied samples in the water of the Rag-e Sefid Oil and Gas field Formation is in the range of 0.00205 to 0.0077. Considering that the ratio of $0.006 \geq (\text{HCO}_3^-) / \text{Cl}^-$ and also the ratio of $(\text{Cl}^- - \text{Na}^+) / \text{Mg}^{2+} > 17.855$ (Yu et al., 2020), therefore, the formation of the Rag-e Sefid Oil and Gas field has suitable conditions for gas production.

Conclusion

The importance of mineral ions in aqueous solutions is of great interest due to the saturation of mineral ions and the formation of mineral deposits in chemical systems such as the oil field. Lack of proper analysis and sampling can lead to many problems. One of the most important problems in the presence of mineral ions in the oil fields is the formation of mineral deposits in surface installations as well as reservoirs and wells. For this reason, in this study, for 5 well of Rag-e Sefid Oil and Gas field, mineral ions analysis in formation water was studied. The main conclusions of the study of the water formation of the Rag-e Sefid Oil and Gas field are as follows:

- (1) Based on the results, the concentration of inorganic ions such as calcium, sodium, magnesium, sulfate, chloride and bicarbonate in the formation water of this field can affect the conditions of oil exploitation process.
- (2) In this study, the prediction of inorganic sediment formation of calcium sulfate, gypsum, magnesium carbonate and calcium carbonate under well and pressure conditions in Rag-e Sefid Oil and Gas field was investigated. Based on the results of the formation of calcium carbonate and calcium sulfate deposits, the Rag-e Sefid Oil and Gas field is significant.
- (3) According to the results obtained from the geochemical properties of water of Rag Sefid Oil and Gas Field Formation, the formation of the Rag-e Sefid Oil and Gas field has suitable conditions for gas production

(4) Based on comparison of water formation and Rag-e Sefid formation rock, source of ions (except for calcium and magnesium ions) in the water reservoir are not rock reservoir and these related to marine original water.

(5) The amount of minerals dissolved in the water of Rag-e Sefid Formation, based on the 5 samples studied, is from 174675 to 235909 mg / l.

(6) Due to the relation between geochemical properties and water distribution of the Rag-e Sefid Formation, this formation has favorable conditions for hydrocarbon production.

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Figures

**Formation of mineral deposits based on mixing of two waters:
Injection water and formation water**

- water
- Cations (Ca , Ba , Na ,...)
- Anions (Cl , SO₄ , HCO₃ ,...)

Figure 1

Schematic of mineral sediment formation during oil well operation

Figure 2

Location map of Rag-e Sefid studied field (Sepehr and Cosgrove, 2004).

Figure 3

Stimcade2 Software

Stiff Diagram

Figure 4

Stiff diagram for water ion distribution in the water reservoir in the studied field

Piper Diagram

Figure 5

Stiff diagram for distribution of ion in water reservoir in studied wells

Figure 6

Distribution of elements in the rock reservoir in the studied field