Kosimova Khurshida Islomovna
applicant
Karshi State University,
Uzbekistan Karshi city
Lobar Sharipovna Bazarova
Lecturer
Karshi State Technical University
Uzbekistan Karshi city
Kurbanov Mingnikul Zhumagulovich
Assoc. departments,
Karshi State University,
Uzbekistan Karshi city

CHEMICAL COMPOSITION AND CORROSION ACTIVITY OF FORMATION WATERS OF THE FERUZA DEPOSITS

Abstrakt. This article examines the results of a six-component analysis and an elemental analysis of water from the Feruza field. It also discusses the most common types of corrosion in oilfield equipment. Particular attention is paid to the influence of highly mineralized formation waters on the corrosion activity of metal structures and technological pipelines. The study identifies the main aggressive components responsible for accelerating electrochemical corrosion processes under field operating conditions. Based on the obtained analytical data, the necessity of implementing effective corrosion protection methods and continuous monitoring of formation water composition is scientifically substantiated. The research results may be applied to improve the operational reliability, safety, and service life of oilfield equipment.

Key words: corrosion, well, corrosive components, formation water, brine, electrochemical corrosion, mineralization, oilfield equipment, chloride ions, corrosion inhibitor, metal degradation, pipeline protection, reservoir conditions, chemical composition.

Косимова Хуршида Исломовна
соискатель
Каршинский государственный университет,
Республика Узбекистан, г. Карши
Базарова Лобар Шариповна
преподаватель
Карашинский государственный технический университет
Республика Узбекистан, г. Карши
Курбанов Мингникул Жумагулович
доц. кафедры,
Каршинский государственный университет,
Республика Узбекистан, г. Карши

ХИМИЧЕСКИЙ СОСТАВ И КОРРОЗИОННО АКТИВНОСТЬ ПЛАСТОВЫХ ВОД МЕСТОРОЖДЕНИЙ ФЕРУЗА

Аннотация. В статье рассмотрены результаты шестикомпонентного анализа и анализа по определению элементного состава воды месторождение Феруза. А также рассмотрено наиболее распространенные виды коррозии в нефтепромысловые оборудования. Особое внимание уделено влиянию высокоминерализованных пластовых вод на коррозионную активность металлических конструкций и технологических трубопроводов. Определены основные агрессивные компоненты, способствующие ускорению электрохимических процессов коррозии в условиях эксплуатации нефтепромысловых объектов. На основе полученных аналитических данных научно обоснована необходимость применения эффективных методов противокоррозионной защиты и постоянного мониторинга состава пластовых вод. Результаты исследования

могут быть использованы для повышения надежности, безопасности и долговечности нефтепромыслового оборудования.

Ключевые слова: коррозия, скважина, коррозионно-активные компоненты, пластовая вода, рассол, электрохимическая коррозия, минерализация, нефтепромысловое оборудование, хлорид-ионы, ингибитор коррозии, разрушение металла, защита трубопроводов, пластовые условия, химический состав.

Introduction: The key areas of economic and social development in Uzbekistan through 2030 foresee high rates of growth in the oil and gas industry, which requires further efforts to conserve all types of resources, improve oil, gas, and gas condensate field development systems, and improve drilling and well operation processes.

The fixed assets of both the oil and gas industries consist of metal surface and underground structures, extensive utility lines, and various equipment, all of which are exposed to aggressive environments and high mechanical loads. Reduced reliability and durability of these fixed assets due to corrosion leads to lost production, enormous repair costs, and environmental pollution.

One of the significant factors affecting the performance of oilfield equipment is internal corrosion. This phenomenon is the spontaneous destruction of metal due to its interaction with an aggressive environment [1]. Equipment corrosion is associated with several factors, including high water cuts in well production, increased removal of salts and mechanical impurities, increased formation fluid flow rates, and increased currents and voltages in cable lines [2]. Other risk factors for pipeline corrosion include transportation mode, temperature, pipeline metal surface condition, etc. These factors can influence the corrosion rate—in some cases, they can decrease or increase it [2].

The overall damage caused by corrosion depends on direct losses, which include the cost of manufacturing and replacing failed equipment and the costs of corrosion protection measures. However, indirect costs can cause even greater damage. Indirect costs include economic losses due to equipment downtime and capacity loss, accident response costs, disruptions to the field development system, and reduced product quality due to corrosion. Indirect costs can be several times greater than direct costs [3]. The need for emergency response measures in pipelines is determined by the presence of an aqueous phase in the media transported through them. This process is the cause of frequent failures and accidents, resulting in significant losses and substantial economic investment. Expert assessments have shown that economic damage from corrosion amounts to at least 5% of GDP. This figure also ranges from 2–4% of GDP in other countries [4; 5]. With the average cost of pipe steel at 35,000 rubles per ton, oil and gas companies spend approximately 12 billion rubles per year on steel pipeline replacement alone [6].

The use of composite pipes is justified by the design and development of metal-structural materials with increased corrosion resistance. This is achieved by displacing impurities from the alloy or metal that accelerate the corrosion process, or by introducing components that enhance corrosion resistance [7].

Chemical corrosion protection involves the introduction of inhibitors into the environment, the protective effect of which is based on their ability to adsorb and form a protective film on the metal surface. Inhibitor protection is one of the most convenient and cost-effective means of combating corrosion in these conditions [8].

Currently, oilfield pipelines are made of steel due to their availability and rapid installation. However, the failure rate of these pipelines is twice as high as that of corrosion-resistant structures [9].

The use of composite pipes is economically feasible over long-term field operation, but the average field life in Russia does not exceed thirty years [10].

The authors indicate that inhibitors such as MAD-20, at concentrations of 50 mg/L, 100 mg/L, 250 mg/L, and 500 mg/L in mineralized formation waters of the Shakarbulak oil and

Severo-Guzarskoye gas fields, provide corrosion protection efficiency of 87.8% to 99.5% for steel samples. Also, MAD-type inhibitors at concentrations of 100 mg/L, 250 mg/L, and 500 mg/L in a 15% sulfuric acid solution at 20°C for 96 hours yield 98.64% [11; 12].

Discussion of Results.

The corrosive effects of well products on oilfield equipment depend on their physicochemical properties and the content of corrosive components, including depolarizing agents such as oxygen, carbon dioxide, and hydrogen sulfide.

Table 1 presents the results of a six-component analysis of water from the Feruza field.

Table 1

Results of a six-component analysis of water in the Feruza field

Indicators	Feruza microdistrict, sq. No. 1		Feruza microdistrict, sq.№2		Feruza microdistrict, sq. No. 12	
Ions	мг/л	ммоль/л	мг/л	ммоль/л	мг/л	ммоль/л
Chlorides (Cl)	87455,0	2457,3	88357,50	2492,45	88357,5	2492,45
Sulfates (SO4-2)	458,82	9,55	1989,60	41,42	682,58	14,21
Hydrocarbonates (HCO3-)	433,10	7,10	411,75	6,75	564,25	9,25
Calcium (Ca+2)	8316,60	415,00	7915,80	395,00	8216,40	410,00
Magnesium (Mg+2)	911,25	75,00	1215,00	100,00	1032,75	85,00
Sodium+potassium (Na+ +K+)	47654,9	1993,93	48890,52	2045,63	48299,8	2020,92
Total hardness, mmol/L	490,00		495,00		49500	
Total mineralization, mg/L	145239,72		148780,2		147153,36	
Hydrogen index, pH	6,3		6,74		6,27	
Suspended solids, mg/L	2413,00		8007,00		1869,00	
Density, g/cm3	1,0835		1,0815		1,0835	
Sulin classification	Calcium chloride type		Calcium chloride type		Calcium chloride type	
Sample appearance	Turbid, brown in color, containing suspended particles, fine suspended matter and sediment, with an oil film		Turbid, dark brown in color, containing suspended particles, fine suspended matter and sediment, with a layer of oil		Turbid, brown in color, containing suspended particles, fine suspended matter and sediment, with an oil film	

As can be seen from Table 1, the formation water of the Feruza fields is characterized by corrosive activity due to the fact that it contains a large amount of hydrocarbonate ions from 411.75 mg / l to 564.25 mg / l and sulfur ions from 28.842 mg / l to 38.384 mg / l. According to the analysis result, the selected water sample of the Feruza field is a highly mineralized brine, on average reaching 147.057 g / l with a prevailing concentration of chlorine ions on average 88.056 g / l and ions of alkali metals 48.281 g / l. The waters of the specified fields are distinguished by an increased content of sulfates (1.989 g / l) and prevail over hydrocarbonates (0.564 g / l), and calcium (8.316 g / l), which causes salt deposits on the equipment. Oil deposits are developed under active pressure from bottom waters.

The water is turbid and brown in color, containing suspended particles, fine suspended matter, and sediment, with an oil film. Chemically, the water is very hard (495.0 mmol/L), and its litmus test reaction is slightly acidic (pH 6.74).

Table 2 presents the results of elemental analysis of the Feruza field water.

Table 2

Results of the analysis to determine the elemental composition of water at the Feruza deposit

No.	Name of the element	Element designation	Unit of measurement	Feruza field, well No. 1	Feruza field, well No. 1	Feruza field, well No. 1
1	Lithium	^{7}Li	mg/l	1,294	0,941	0,824
2	Beryllium	^{9}Be	mg/l	0,000	0,000	0,000
3	Bor	^{11}B	mg/l	22,528	13,398	13,781
4	Sodium	^{23}Na	mg/l	3363250,670	5382848,390	3553042,839
5	Magnesium	^{24}Mg	mg/l	93,677	62,110	94,369
6	Aluminum	^{27}Al	mg/l	0,000	0,000	0,000
7	Silicon	^{29}Si	mg/l	0,000	0,000	0,000
8	Phosphorus	^{31}P	mg/l	0,000	0,000	0,000
9	Sulfur	^{32}S	mg/l	28,842	38,384	33,080
10	Potassium	^{39}K	mg/l	25,019	46,797	25,220
11	Calcium	^{44}Ca	mg/l	11111,233	9444,513	9777,856
12	Vanadium	^{51}V	mg/l	0,014	0,000	0,000
13	Chromium	^{52}Cr	mg/l	0,000	0,000	0,000
14	Manganese	^{55}Mn	mg/l	0,000	0,000	0,000
15	Iron	^{57}Fe	mg/l	0,000	0,000	0,000
16	Cobalt	^{59}Co	mg/l	0,000	0,000	0,000
17	Nickel	^{60}Ni	mg/l	0,000	0,000	0,000
18	Honey	^{63}Cu	mg/l	0,000	0,000	0,000
19	Zinc	^{66}Zn	mg/l	0,000	0,000	0,000
20	Gallium	^{71}Ga	mg/l	0,000	0,000	0,000
21	Arsenic	^{75}As	mg/l	0,000	0,000	0,000
22	Selenium	^{77}Se	mg/l	0,000	0,000	0,000
23	Rubidium	^{85}Rb	mg/l	0,000	0,000	0,000
24	Strontium	^{88}Sr	mg/l	0,000	0,000	0,000
25	Molybdenum	^{95}Mo	mg/l	0,000	0,000	0,000
26	Silver	^{107}Ag	mg/l	0,000	0,000	0,000
27	Cadmium	^{111}Cd	mg/l	0,000	0,000	0,000
28	Indium	^{115}In	mg/l	0,000	0,000	0,000
29	Antimony	^{121}Sb	mg/l	0,000	0,000	0,000
30	Tellurium	^{125}Ti	mg/l	0,000	0,000	0,000
31	Cesium	^{133}Cs	mg/l	0,000	0,000	0,000
32	Barium	^{137}Ba	mg/l	0,000	0,000	0,000
33	Thallium	^{205}Ti	mg/l	0,000	0,000	0,000
34	Lead	^{208}Pb	mg/l	0,000	0,000	0,000
35	Bismuth	^{209}Bi	mg/l	0,000	0,000	0,000
36	Uranus	^{238}U	mg/l	0,000	0,000	0,000

The presence of a large number of aggressive components and high water cuts in well products accelerate corrosion rates. Products produced at the Feruza field contain large amounts of hydrocarbonate ions, which are considered strong corrosive agents. The mechanism by which well products corrode oilfield equipment is affected can be described as follows (Figure 1).

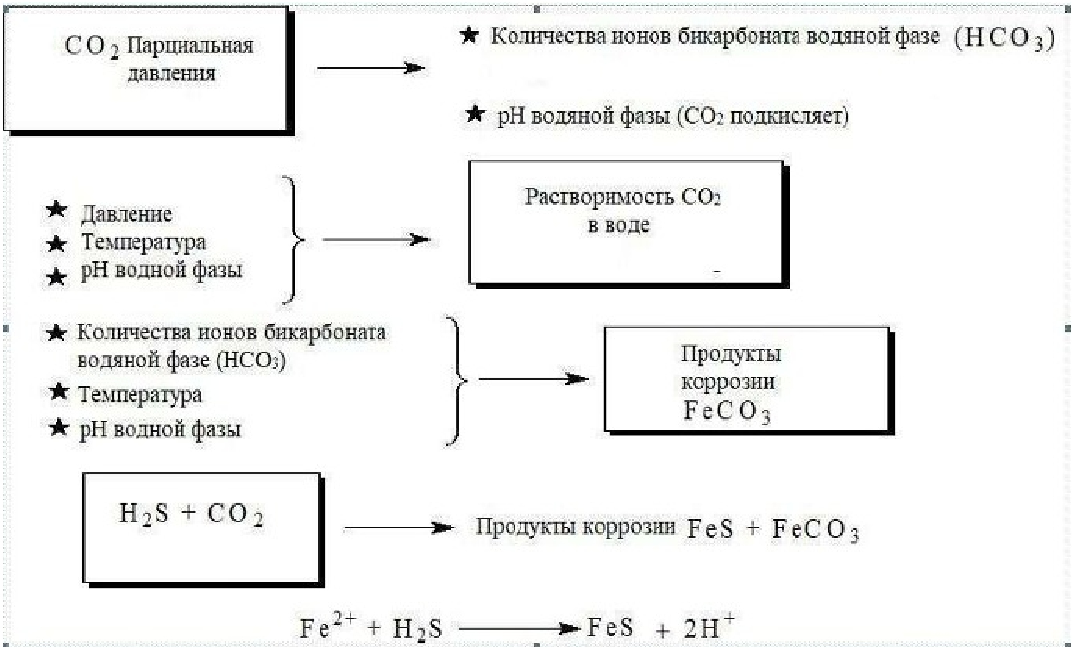

Figure 1. Mechanism of development of the corrosion process in the presence of carbon dioxide and hydrogen sulfide gases.

Based on the analysis, it was determined that the water analyzed at the Feruza deposits is highly mineralized. Based on hydrochemical parameters, the water sample belongs to the calcium chloride type according to V.A. Sulin's classification.

Conclusion: The conducted six-component and elemental analyses of formation waters from the Feruza deposits demonstrated that the waters are characterized by a complex mineralized composition with elevated concentrations of chloride ions, bicarbonates, calcium, magnesium, and other dissolved salts. The obtained analytical results indicate that the chemical composition of the formation waters directly affects the intensity of electrochemical and chemical corrosion processes occurring in oilfield equipment and pipeline systems.

The obtained results can serve as a scientific and practical basis for developing optimized corrosion protection methods, improving water treatment technologies, and enhancing the efficiency and safety of hydrocarbon production at the Feruza deposits.

References

1. Козлов В.А. Основы коррозии и защиты металлов: учебное пособие / В.А. Козлов, М.О. Мисник– Иваново, 2011. – 177 с.
2. Ивановский В.Н. Коррозия скважинного оборудования и способы защиты от неё / В.Н. Ивановский // Коррозия «Территория НЕФТЕГАЗ». – 2011. - №1. – С. 18-25.
3. Азаренов Н.А. Коррозия и защита металлов. Часть I. Химическая коррозия металлов: учебное пособие / Н.А. Азаренов, С.В. Литовченко, И.М. Неклюдов, П.И. Стоев – Харьков: ХНУ, 2007. – 187 с.
4. Фархутдинова А.Р. Составы ингибиторов коррозии для различных сред / А.Р. Фархутдинова, Н.И. Мукатдисов, А.А. Елпидинский, А.А. Гречухина // Вестник Казанского технологического университета. – 2013. - №4. – С. 272.
5. Вайншток С.М. Трубопроводный транспорт нефти / С.М. Вайншток – М.: ООО «Недра–Бизнесцентр», 2006. – 621 с.
6. Федин Д.В. Сравнительный анализ экономической эффективности методов повышения эксплуатационной надежности промысловых трубопроводов / Д.В. Федин, А.Ф. Бархатов, А.А. Вазим // Известия Томского политехнического университета. – 2012. - № 6. – С. 32 35.
7. Мустафин Ф.М. Обзор методов защиты трубопроводов от коррозии изоляционными покрытиями / Ф.М. Мустафин // Нефтегазовое дело [Электронный ресурс]. – Режим доступа: http://www.ogbus.ru/authors/Mustafin/ Mustafin_3.pdf, свободный.

8. Кузнецов Ю.Н. Возможности защиты ингибиторами коррозии оборудования и трубопроводов в нефтегазовой промышленности / Ю.Н. Кузнецов, Р.К. Вагапов, Р.В. Игошин // Коррозия «Территория НЕФТЕГАЗ». – 2010. - № 1. – С. 38-41.

9. Тимонин В.А. Технико-экономические аспекты проблемы коррозии / В.А Тимонин // Антикор Гальваносервис: Труды Междунар. Научно-практ. конф. – М., 2007. – С. 54–57.

10. Гребенькова Г.Л. Анализ работоспособности коррозионностойких трубопроводов / Г.Л. Гребенькова, Е.Н. Сафонов, Р.Р. Терегулов, В.И. Агапчев //Нефтегазовое дело [Электронный ресурс]. http://www.ogbus.ru/authors/Grebenkova/Grebenkova_1.pdf, свободный.

11. Атакулова Д.Д., Қурбанов М.Ж., Кодиров А.А.Изучение ингирующих свойств 2,7-диметил-2,7-дицианид-3,6-диазаоктана // “Universum технические науки” –Москва: 2021 - С.16-19. (02.00.00; № 1).

12. Ataqulova D.D., Bobomuradov U.Z, Oripova L.N., Ismatov Sh., Kurbanov M.G., Kodirov A.A. A New Highly Effective Inhibitor Based On 2,7-Dimethyl- 2,7-Diciano-3,6-Diazaoctan. // Skopus. Journal of Pharmaceutical Negative Results.2023.Vol. 14, Regular Issue 02.– Pp. 883-889.