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Article

Investigating the Efficacy of Oily Water Treatment at a De-Oiling Facility in the Northern Industrial Center of CINA, Hassi Messaoud: A Statistical Physics Assessment

Asma Nour El Houda Sid [1], Fedoua Mokrane [2], Mimoune Hadj [3], Nihad Chagour [4], Amira Atamnia [4], Meriem Boudoukhani [5], Hichem Tahraoui [6,7,*], Mohammed Kebir [8], Jie Zhang [9] and Abdeltif Amrane [10,*]

[1] Department of Chemical Engineering, Faculty of Engineering Processes, University of Salah Boubnider Constantine 3, Constantine 25000, Algeria; asma.sid@univ-constantine3.dz
[2] SONATRACH XP DP, Hassi R'mel 03000, Algeria; fedwa.mokrane@gmail.com
[3] Department of Refening, Faculty of Hydrocarbons and Chemistry, University Boumerdes, Boumerdes 35000, Algeria; mimounhadj@yahoo.fr
[4] Department of Engineering Processes, Faculty of Technology, University of 20 Aout 1955, Skikda 21000, Algeria; n.chagour@univ-skikda.dz (N.C.); a.atamnia@univ-skikda.dz (A.A.)
[5] LME—Material and Environmental Laboratory, University of Medea, Medea 26001, Algeria; boudoukhani.meriemlme@gmail.com
[6] Laboratoire de Génie des Procédés Chimiques, Department of Process Engineering, University of Ferhat Abbas, Setif 19000, Algeria
[7] Laboratory of Biomaterials and Transport Phenomena, University of Medea, Medea 26000, Algeria
[8] Research Unit on Analysis and Technological Development in Environment (URADTE-CRAPC), Bou-Ismail 42000, Algeria; medkebir@yahoo.fr
[9] School of Engineering, Merz Court, Newcastle University, Newcastle upon Tyne NE1 7RU, UK; jie.zhang@newcastle.ac.uk
[10] Univ Rennes, Ecole Nationale Supérieure de Chimie de Rennes, CNRS, ISCR—UMR6226, F-35000 Rennes, France
* Correspondence: hichemm.tahraouii@gmail.com (H.T.); abdeltif.amrane@univ-rennes.fr (A.A.)

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Abstract: Environmental protection is becoming a primary objective when choosing processes and technologies for treating oily waters resulting from hydrocarbon production. The focus of treating oily waters is to eliminate contaminants from effluents before discharging them into the receiving environment while adhering to discharge standards. Our work aims to analyze the treatment process for oily waters in the API unit of the North Industrial Center (CINA), which involves a physical–chemical treatment using activated silica and Kurifix. The study aims to improve the treatment process used for oily water treatment to ensure water conservation for reuse. To enhance the CINA-HMD oily water treatment process, we created coagulants with different doses (C1–C6) using sodium silicate, activated silicate (sodium silicate + sulfuric acid), distilled water, Kurifix, and an oxygen scavenger while measuring pH, HC (hydrocarbon), and SS (suspended solids) levels. Coagulation and flocculation processes were used to remove suspended solids and hydrocarbons from the water. The results show that the coagulant used reduces suspended matter and hydrocarbon content and increases pH. The best treatment is achieved with a coagulant prepared with distilled water, 5% sodium silicate, and 2% sulfuric acid. The optimal dose of coagulant is 16 ppm. Automatic dosing provides better efficiency than manual dosing. The study recommends continuous verification of chemical preparation and injection, periodic cleaning of settling tanks, and monitoring of oily water entering the station.

Keywords: oily waters; hydrocarbons; treatment; activated silica; suspended solids

1. Introduction

For a long time, water has been considered a natural resource, a "gift from the sky" that is easy to exploit, cheap, and almost valueless [1,2]. However, the spectacular evolution of urban and industrial environments has made the issue of water increasingly worrying in many countries [3–5]. Since the discovery of oil and natural gas, humans have sought to exploit their potential and have begun to develop and implement large industrial complexes to process oil and gas and transfer them to other materials that can be used in various fields [6–8]. During their production and refining operations, the oil and petrochemical industries generate significant amounts of oily water loaded with various types of pollutants such as organic, mineral, and physical matter [9–11]. The discharge of such effluents into the environment is the cause of numerous surface and groundwater contaminations, soil erosion, disturbance of the ecosystem, and risks to human health [12–14].

In fact, environmental protection has become a major issue in economic development [15]. Through global awareness, polluting emissions, industrial waste, water contamination, climate disruptions, and health impacts are now sensitive topics in which the oil industry is often accused [16,17]. Water treatment is the process of improving the quality of water to make it safe and suitable for its intended use. Water treatment involves a series of physical, chemical, and biological processes to remove contaminants, such as suspended solids, organic matter, bacteria, viruses, and minerals from water; the type and extent of the treatment required depend on the source of water, the intended use, and the regulatory standards for water quality [3,18–20]. Water treatment typically involves several stages, including coagulation and flocculation, sedimentation, filtration, disinfection, [21–23] flotation, biological treatment, membrane separation technology, combined technologies, advanced oxidation processes, and sometimes additional treatment steps, such as reverse osmosis, ion exchange, or activated carbon treatment [24]. Coagulation and flocculation involve adding chemicals, such as coagulants and flocculants, to the water to cause particles and impurities to clump together and form larger particles that can be more easily removed [25,26]. Sedimentation involves allowing the larger particles to settle to the bottom of a tank or basin so that the clearer water can then be drawn off from the top [27,28]. Filtration involves passing the water through layers of sand, gravel, or other media to remove the remaining particles and impurities [29]. Disinfection involves adding chemicals, such as chlorine or ozone, to kill bacteria, viruses, and other microorganisms [30]. Disinfection involves adding chemicals, such as chlorine or ozone, to remove bacteria or radionuclides [31]. Overall, SONATRACH's commitment to environmental protection and sustainable development is a reflection of its long-term vision and strategy to balance economic growth with social and environmental responsibility. By implementing a comprehensive environmental management system and working closely with stakeholders, the company aims to minimize its impact on the environment and contribute to a sustainable future for all.

The use of activated silica and Kurifix in the treatment process is founded on their remarkable capability to efficiently eliminate pollutants from oily water [32]. These substances have proven to be highly effective in remediation efforts due to their unique properties and mechanisms of action. Activated silica, also known as activated silica gel or activated silica adsorbent, is a porous material that possesses a large surface area and a high affinity for hydrophobic compounds; when added to oily water, activated silica acts as an adsorbent, attracting and binding to organic contaminants such as oil and grease [33]. This process helps to separate the pollutants from the water, resulting in cleaner and clearer effluent. Kurifix, on the other hand, is a specific type of coagulant commonly used in the treatment of oily water. It works by destabilizing and aggregating fine particles and emulsified oil droplets, allowing them to form larger flocs or clumps. These clumps can then be more easily separated from the water through processes such as sedimentation or filtration [34]. Kurifix's coagulation properties help to enhance the overall efficiency of the treatment process, facilitating the removal of contaminants and improving the quality of the treated water [35]. By incorporating activated silica and Kurifix into the treatment process, operators can effectively target and remove the contaminants present in oily water. This not only helps to meet regulatory standards for discharged water quality but also contributes to environmental conservation efforts by minimizing the release of harmful substances into natural ecosystems. The use of these substances underscores the importance of advanced treatment techniques and underscores the commitment to sustainable water management practices [36].

The coagulation and flocculation processes work through several mechanisms. Firstly, the coagulant neutralizes the negative charges on suspended particles, allowing them to come closer together and form flocs [37–39]. Secondly, the process of flocculation helps to increase the size and weight of the flocs, making them settle more rapidly during subsequent sedimentation or filtration steps [40–43].

Overall, the coagulation and flocculation processes are fundamental in the removal of suspended solids and hydrocarbons from water. They are integral components of many water treatment systems and are crucial for achieving the desired water quality standards, protecting the environment, and ensuring the safety of water resources for various applications [44–47].

Many studies in the literature have discussed the use of coagulants and flocculants in the de-oiling process. Pan et al. [48] found that the degreasing effectiveness of polyanionic cellulose (PAC) and polyacrylamide (PAM) in treating tightly emulsified oily wastewater is compromised due to the inadequate sedimentation of these flocs, resulting in a lower efficiency compared with treating regular emulsions. Bruno et al. [49] optimized the results of a jar test by evaluating a continuous bench-scale plant designed for treating challenging slop wastewater. Chaouch and Chaouki [50] cited that the application of a coagulant consisting of an activated silicate blended with sulfuric acid, along with the use of Kurifix as a flocculant, yields encouraging outcomes in the treatment process. Sellami et al. [51] found that the substantial 5 cm thick layer of dune sand, along with the presence of fine particles, effectively eliminates the majority of the remaining oil. The results of Al Battashi et al. [52] showed that using ceramic membrane (100 nm pore size) managed to completely remove oil from produced water for high and low oil-in-water concentrations. This study introduces innovation by improving the oily water treatment process in order to conserve and reuse water resources. It uses coagulation and flocculation with a proprietary coagulant blend, resulting in lower suspended particles, lower hydrocarbon content, and higher pH. The study emphasizes continuous monitoring, tank maintenance, and vigilant water quality assessment, distinguishing it as an innovative contribution to environmental protection and resource conservation.

The study aims to improve oily water treatment for water conservation. It uses coagulation and flocculation to reduce suspended solids and hydrocarbons while increasing the pH. The ideal coagulant is 5% sodium silicate and 2% sulfuric acid in distilled water with 16 ppm dosage. Automatic dosing is more efficient than manual. The study recommends continuous process monitoring, tank cleaning, and quality checks for incoming oily water.

2. Materials and Methods

2.1. Chemicals

In order to enhance the treatment process implemented at the CINA-HMD oily water treatment unit, several coagulants based on sodium silicate were prepared. These coagulants were formulated using a combination of activated silicate (sodium silicate + sulfuric acid), distilled water, Kurifix CP 606 (a commercial product) (Netsun Korea Company, Seoul, Republic of Korea), and an oxygen scavenger. The activated silica refers to a silica-based material that is used as a coagulant in the oily water treatment process. It is essential in the removal of suspended solids and hydrocarbons from water. Another component used in the treatment process is "Kurifix", which is used in conjunction with activated silica. These substances work together to improve the overall efficiency of the coagulation and flocculation processes that are required for treating and remediating oily water. The specific recommendations and proportions for each component are detailed in Table 1 provided.

Table 1. Preparation conditions for coagulants (activated silica).

Coagulant Designation	Water Preparation	Sodium Silicate (% Mass-Related)	Sulfuric Acid (% Mass-Related)
C1	Distilled water	4	1.5
C2			2
C3			2.5
C4		5	1.5
C5			2
C6			2.5

2.2. Methods

The water sample to be treated is taken from the outlet of the tri-phase tank of the oily water treatment unit CINA (Northern Industrial Center of the Production Division of SONATRACH-HMD (National Company for Research, Production, Transportation, Transformation, and Marketing of Hydrocarbons, Hassi Messaoud)). A control sample after final treatment by the CINA unit was taken and analyzed in the laboratory in order to compare it with our proposed treatment tests.

To prepare a solution, first weigh 0.1 g of Kurifix. Then, transfer the solid into a 100 mL volumetric flask, using a funnel if necessary. Rinse the funnel and watch glass with distilled water, allowing the rinse water to flow into the flask. Fill the flask with distilled water up to about 3/4 of its volume. Agitate the flask to accelerate the dissolution of the solid and homogenize the solution. Add more distilled water until the solution reaches the calibration mark and adjust precisely to the mark using a dropper with distilled water. Finally, place the flask on a magnetic stirrer to accelerate the dissolution of the solute and homogenize the solution.

The methodology uses a methodical process to establish the ideal concentration of activated silica. Initially, the jar test method was used to disperse equal amounts of the oily water sample into five 800 mL beakers. Then, each beaker received progressive additions of six previously prepared coagulant solutions (4 mL, 8 mL, 12 mL, 16 mL, and 20 mL). After 1 min of vigorous agitation at 100–150 rpm, 1 mL of Kurifix was added and the stirring speed was reduced to 25–30 rpm to encourage floc formation. Decantation, also known as stopping agitation, is the act of letting the flocs to spontaneously settle for 30 to 45 min. In order to effectively treat the oily water samples and achieve the necessary water quality characteristics, the ideal concentration of activated silica was then established based on the intended criteria, including hydrocarbon (HC) reduction, suspended solids (SS) removal, and pH correction.

3. Results and Discussions

3.1. pH Results

pH is a measure of the acidity or basicity of a solution. It is defined as the negative logarithm of the hydrogen ion concentration in the solution [53]. pH plays an important role in many chemical and biological processes, such as enzyme activity, cell metabolism, and the solubility of minerals and nutrients in soil [54].

According to the results (Table 2), it is noted that the variation in pH at the inlet and outlet of the API unit does not comply with the required standards (ISO 14001).

Table 2. Daily analysis of water pH at the inlet and outlet (API).

Date	pH		Norm
	pH Input	pH Output	
1st day	4.92	6.18	7.5
45 days	3.9	7.2	7.5
30 days	5.9	6.17	7.5
25 days	4.91	9.22	7.5
5 days	3.87	8.25	7.5
average	4.7	7.404	7.5

3.2. HC Results

Hydrocarbons are organic compounds composed of hydrogen and carbon atoms. They are the primary constituents of crude oil and other petroleum products and are commonly found in oily water. Hydrocarbons can be classified into two major types: aliphatic and aromatic. Aliphatic hydrocarbons are chains of carbon atoms with hydrogen atoms attached to them, whereas aromatic hydrocarbons are cyclic molecules with alternating double bonds between carbon atoms [31]. In oily water, hydrocarbons can have a range of negative impacts on the environment, including toxicity to aquatic organisms, bioaccumulation in the food chain, and contamination of drinking water sources [55]. Hydrocarbons are also highly flammable and can pose a risk of fire and explosion if not properly handled [56]. Therefore, the accurate identification and quantification of hydrocarbons in oily water is essential for effective pollution control and environmental management.

The table below (Table 3) provides some results (in terms of HC content) of the water analysis.

Table 3. Analysis of HC (hydrocarbon) at the inlet and outlet (API).

HC (ppm)			
Days	HC Input	HC Output	Norm (ppm)
1 day	522.82	80	≤10
30 days	187.09	18.7	≤10
15 days	727.76	90.1	≤10
13 days	90.63	32.8	≤10
3 days	133.51	49.2	≤10
15 days	124	55	≤10
15 days	420	77.3	≤10
2 days	132.52	40.5	≤10
5 days	322	65.4	≤10
5 days	233	54.2	≤10
5 days	132.162	35.7	≤10

3.3. Suspended Solids Results

Suspended solids are a common problem in the treatment of oily waters. Suspended solids can include organic and inorganic particles as well as non-dissolved oils. If these materials are not effectively removed from the water flow, they can cause problems such as pipe blockages, equipment wear, and a decrease in the overall effectiveness of water treatment. Common methods for removing suspended solids in oily waters include filtration, gravity separation, flotation, and the use of chemicals to coagulate or flocculate the suspended solids. Each treatment method can be adapted to meet the specific needs of each application, depending on the quantity and nature of the suspended solids present in the water. In general, the choice of treatment method will depend on the complexity of the suspended solids, the concentration of oil and other contaminants, as well as the quantity of water to be treated. Table 4 presents the analysis of TSS (total suspended solids) of water at the inlet and outlet (API). The samples before the injection of the coagulant are presented in Figure 1.

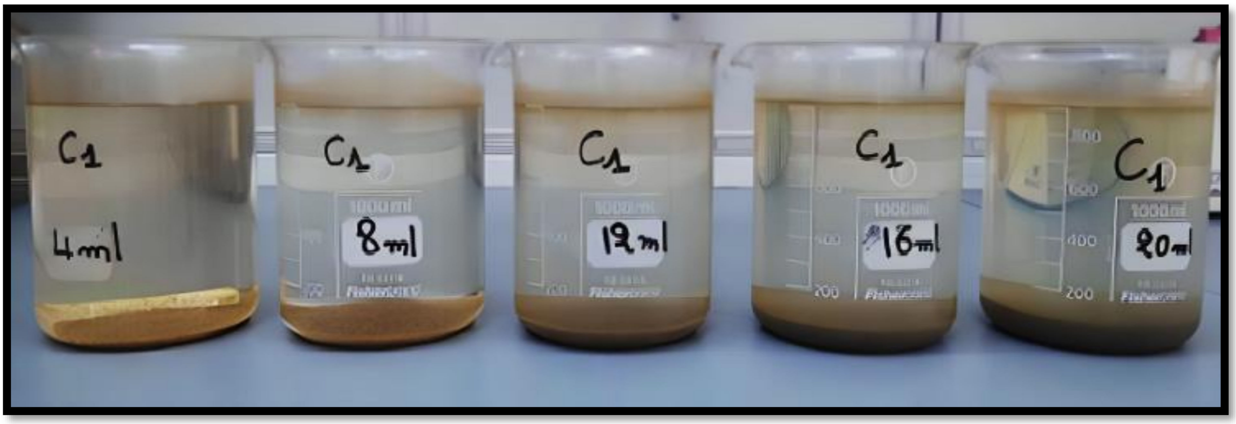
Table 4. Analysis of TSS (total suspended solids) of water at the inlet and outlet (API).

Days	SS Input	SS Output	Norm (ppm)
1 day	232	60	≤30
30 days	159	57	≤30
15 days	132	45.5	≤30
13 days	124	73	≤30
4 days	141	56	≤30
15 days	157.6	31	≤30
15 days	155	27	≤30
15 days	148.5	97	≤30
5 days	165	38	≤30
5 days	113	81	≤30
5 days	271	48	≤30

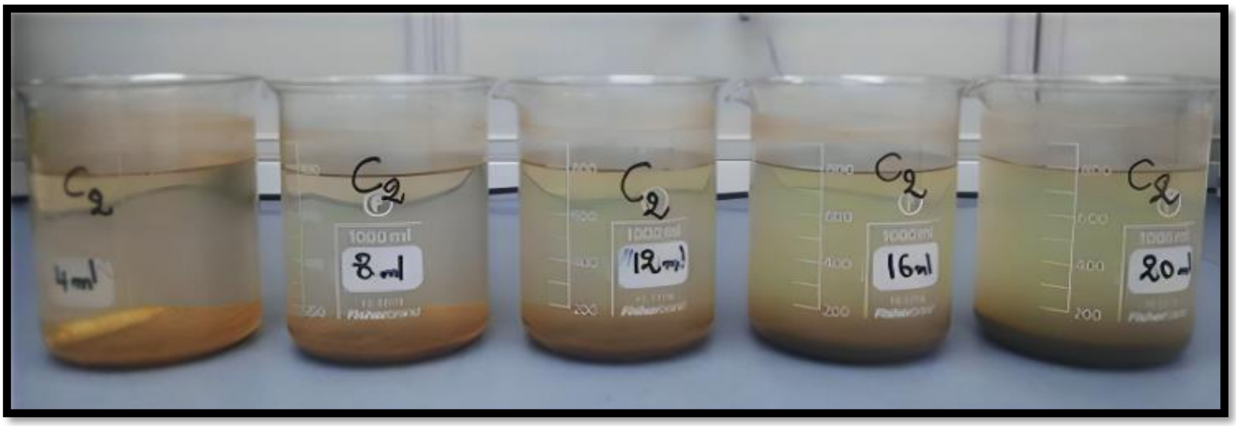
Figure 1. The samples before the injection of the coagulant.

The concentration of activated silica can have a significant impact on the treatment of oily waters. Activated silica, also known as fumed silica, is a finely divided form of silicon dioxide that is commonly used as a coagulant aid in water treatment processes. When added to oily water, activated silica can help to destabilize and coagulate suspended solids, allowing them to be more easily removed from the water.

The effectiveness of activated silica as a coagulant aid is highly dependent on its concentration. If the concentration of activated silica is too low, it may not be able to effectively coagulate the suspended solids in the water. On the other hand, if the concentration of activated silica is too high, it can lead to excessive coagulation and the formation of large flocs that can be difficult to separate from the water (see Figure 2).



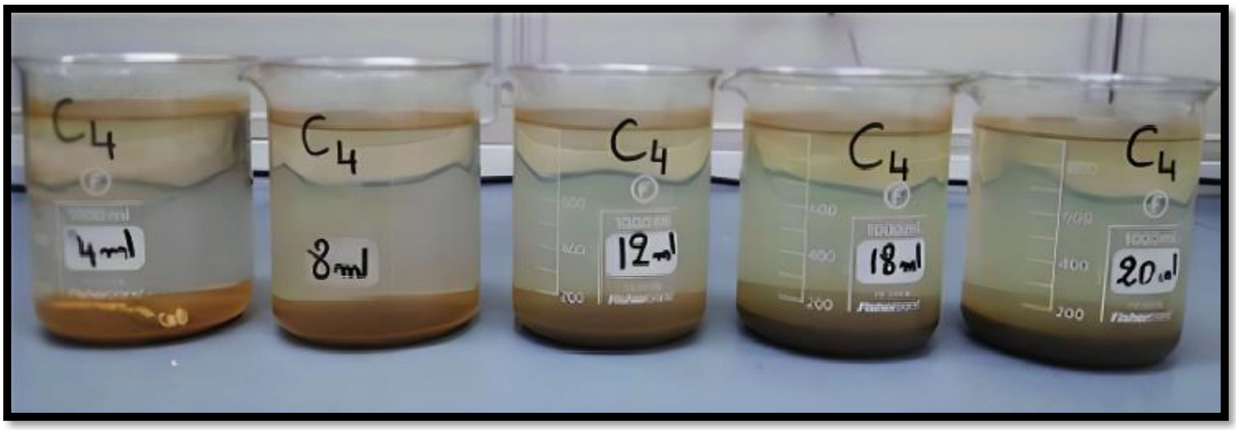
(**a**)



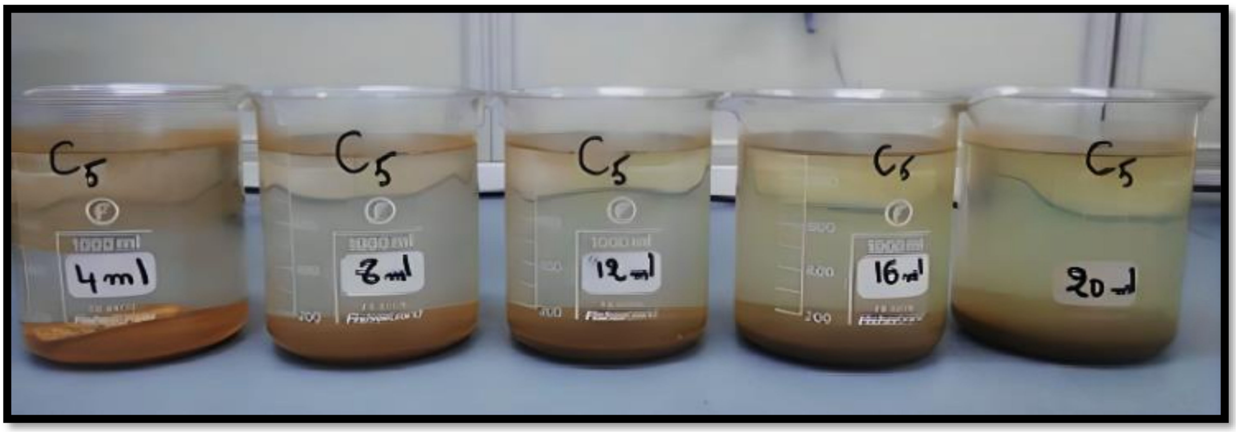
(**b**)

(**c**)

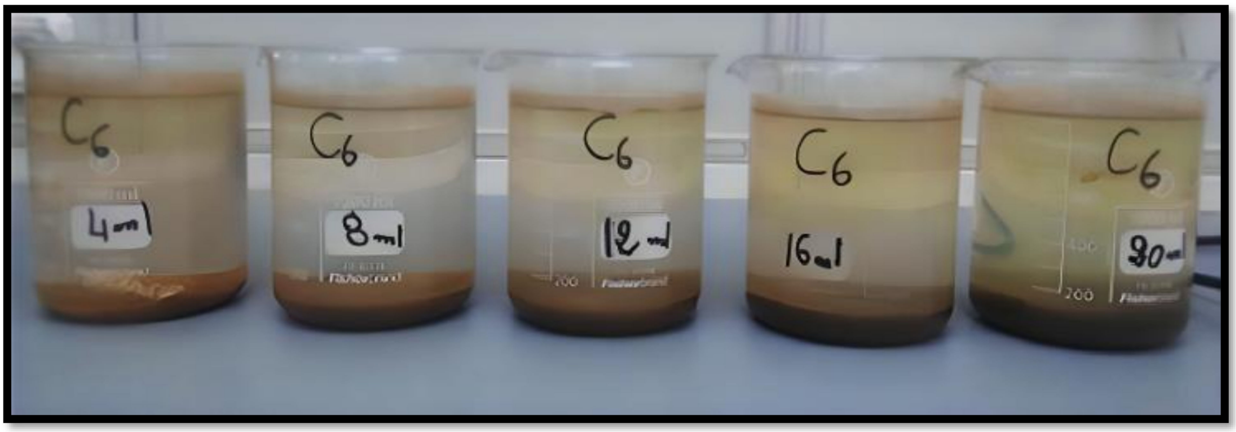
Figure 2. *Cont*.



(**d**)



(**e**)



(**f**)

Figure 2. Influence of the concentration of activated silica on oily waters. (**a**) Coagulant 1, (**b**) Coagulant 2, (**c**) Coagulant 3, (**d**) Coagulant 4, (**e**) Coagulant 5, (**f**) Coagulant 6.

3.4. Water Treatment by Coagulation

3.4.1. Coagulant 1

The results of the study on the influence of the dose of coagulant C1 on the treatment process are presented in Figure 3.

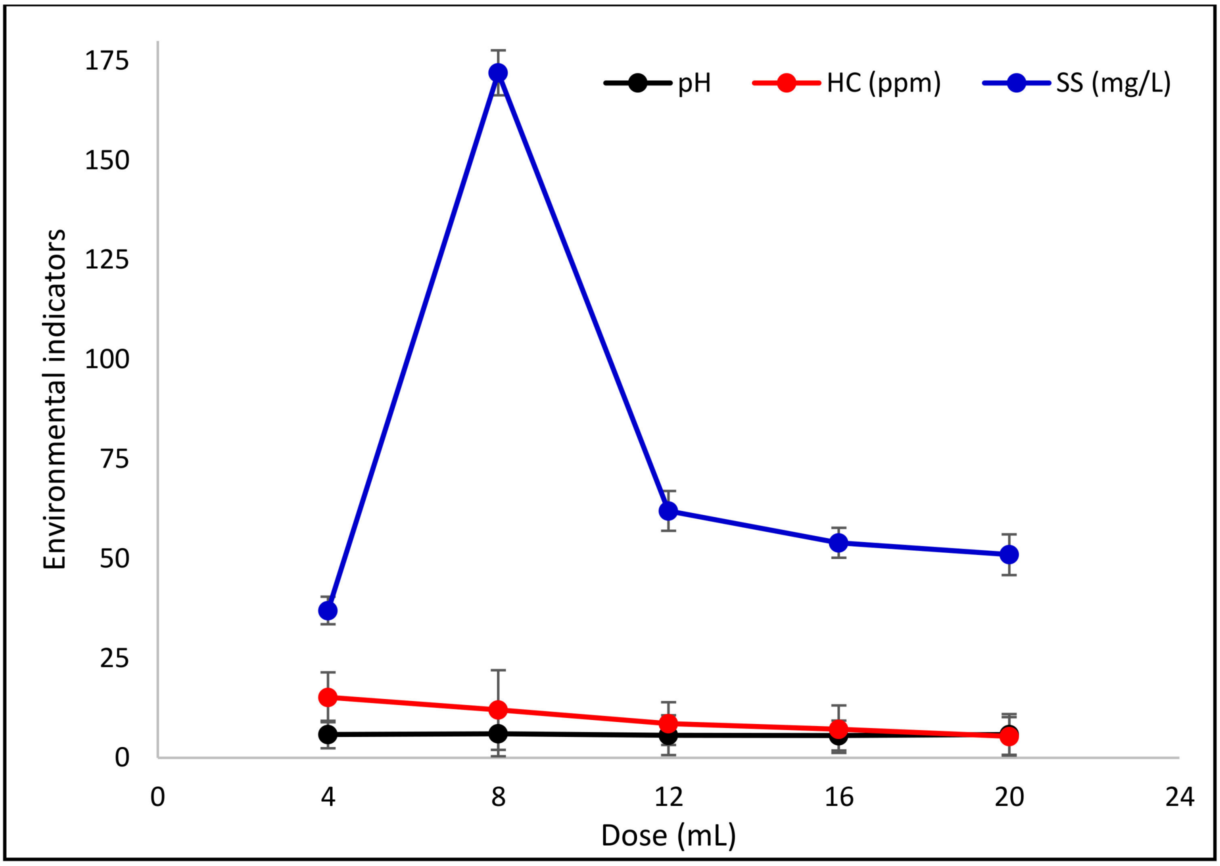


Figure 3. Evolution of environmental indicators based on the dosage of coagulant C1.

Figure 3 represents the evolution of the suspended solids (SS) rate, hydrocarbon content, and pH as a function of the dose of coagulant C1.

The given statements describe the impact of coagulant C1 on the pH, hydrocarbon content, and SS rate.

The first statement indicates that the addition of 8 mL of coagulant C1 caused an increase in pH from 5.27 to 6.04. This suggests that coagulant C1 may act as a pH regulator and can be used to adjust the pH of the system to the desired level.

The second statement highlights the effect of coagulant C1 on the elimination of hydrocarbons. The hydrocarbon content decreased by 15.2 ppm at a dose of 4 mL of coagulant C1 and continued to decrease with increasing doses, reaching 5.4 ppm at 20 mL of coagulant C1. This indicates that coagulant C1 can be effective in reducing hydrocarbon contamination in the system.

The third statement reveals that a dose of 4 mL of coagulant C1 caused a significant reduction in the SS rate from 417 to 37 ppm. This indicates that coagulant C1 can effectively reduce the concentration of suspended solids and organic matter in the system, leading to improved water quality.

Overall, these observations suggest that coagulant C1 can be a useful tool for managing water quality by regulating pH, reducing hydrocarbon contamination, and lowering the SS rate.

3.4.2. Coagulant 2

Figure 4 represents the evolution of the suspended solids (SS) rate, hydrocarbon content, and pH as a function of the dose of coagulant C2.

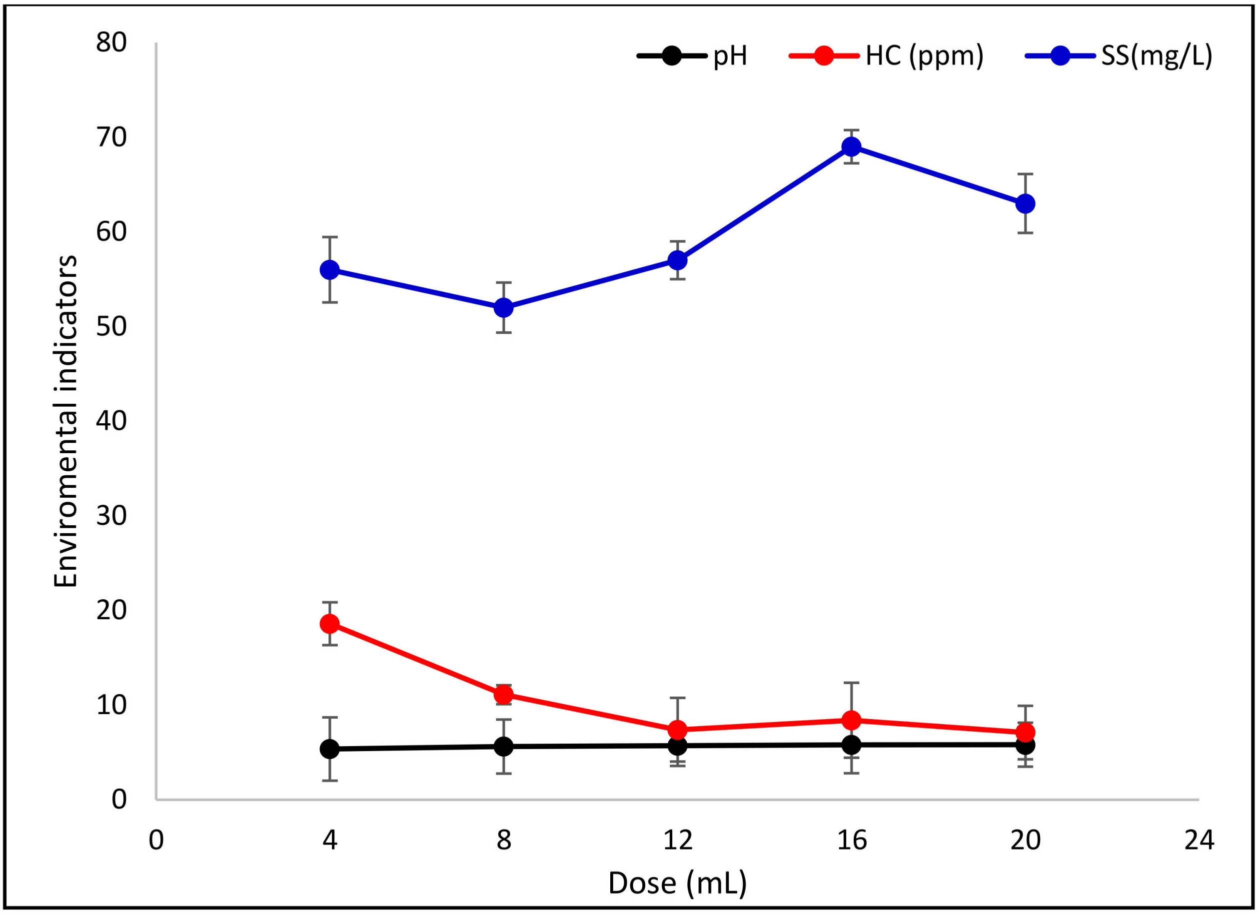


Figure 4. Evolution of environmental indicators based on the dosage of coagulant C2.

The given statements describe the impact of coagulant C2 on the pH, hydrocarbon content, and SS rate.

The first statement indicates that different doses of coagulant C2 can increase the pH of the system from 5.36 to 5.82. This suggests that coagulant C2 may be used as a pH regulator to adjust the pH level to an optimal range.

The second statement highlights the effectiveness of coagulant C2 in reducing the hydrocarbon content in the system. At a dose of 4 mL of coagulant C2, the hydrocarbon content decreased by 18.6 ppm; this reduction continued as the dose was increased, reaching 7.1 ppm at 20 mL of coagulant C2. This indicates that coagulant C2 can be effective in removing hydrocarbon contamination from the system.

The third statement reveals that a dose of 8 mL of coagulant C2 led to a significant reduction in the SS rate, from 417 to 52 ppm. This suggests that coagulant C2 can effectively reduce the concentration of suspended solids and organic matter in the system, leading to improved water quality.

In summary, coagulant C2 can be a useful tool for managing water quality by adjusting the pH level, reducing hydrocarbon contamination, and lowering the SS rate. The findings from these observations can be used to determine the optimal dose of coagulant C2 needed to achieve the desired water quality goals.

3.4.3. Coagulant 3

Figure 5 represents the evolution of the suspended solids (SS) rate, hydrocarbon content, and pH as a function of the dose of coagulant C3.

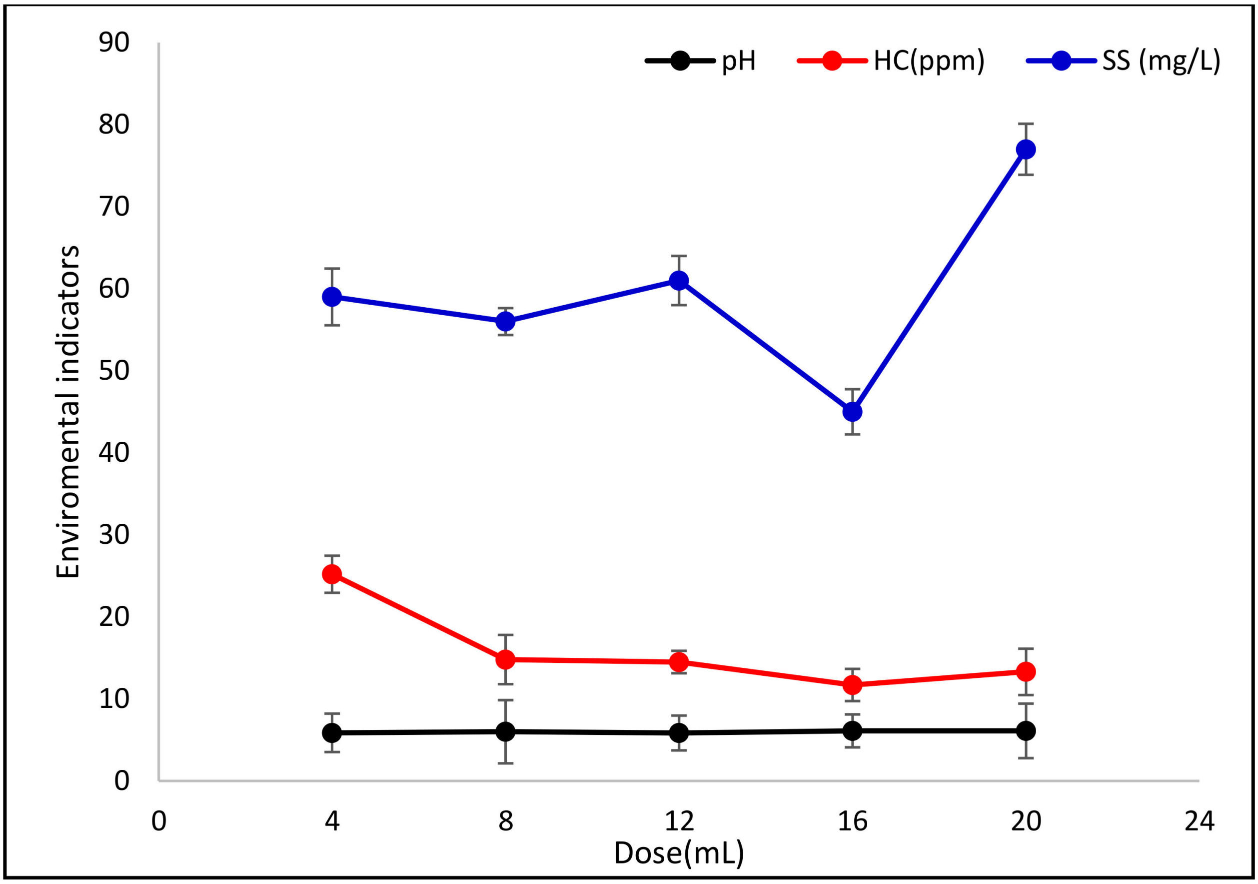


Figure 5. Evolution of environmental indicators based on the dosage of coagulant C3.

The given statements describe the impact of coagulant C3 on the pH, hydrocarbon content, and SS rate.

The first statement indicates that the addition of 8 mL of coagulant C3 resulted in a significant increase in the pH level from 5.27 to 6.11. This suggests that coagulant C3 can be an effective pH regulator to adjust the pH level of the system to an optimal range.

The second statement highlights the effectiveness of coagulant C3 in reducing the hydrocarbon content in the system. At a dose of 4 mL of coagulant C3, the hydrocarbon content decreased by 25.2 ppm; this reduction continued as the dose was increased, reaching 11.7 ppm at 16 mL of coagulant C3. This indicates that coagulant C3 can be effective in removing hydrocarbon contamination from the system.

The third statement reveals that a dose of 16 mL of coagulant C3 led to a significant reduction in the SS rate from 417 to 45 ppm. This suggests that coagulant C3 can effectively reduce the concentration of suspended solids and organic matter in the system, leading to improved water quality.

In summary, coagulant C3 can be a useful tool for managing water quality by adjusting the pH level, reducing hydrocarbon contamination, and lowering the SS rate. The findings from these observations can be used to determine the optimal dose of coagulant C3 needed to achieve the desired water quality goals.

3.4.4. Coagulant 4

Figure 6 represents the evolution of suspended solids (SS) rate, hydrocarbon content, and pH as a function of the dose of coagulant C4.

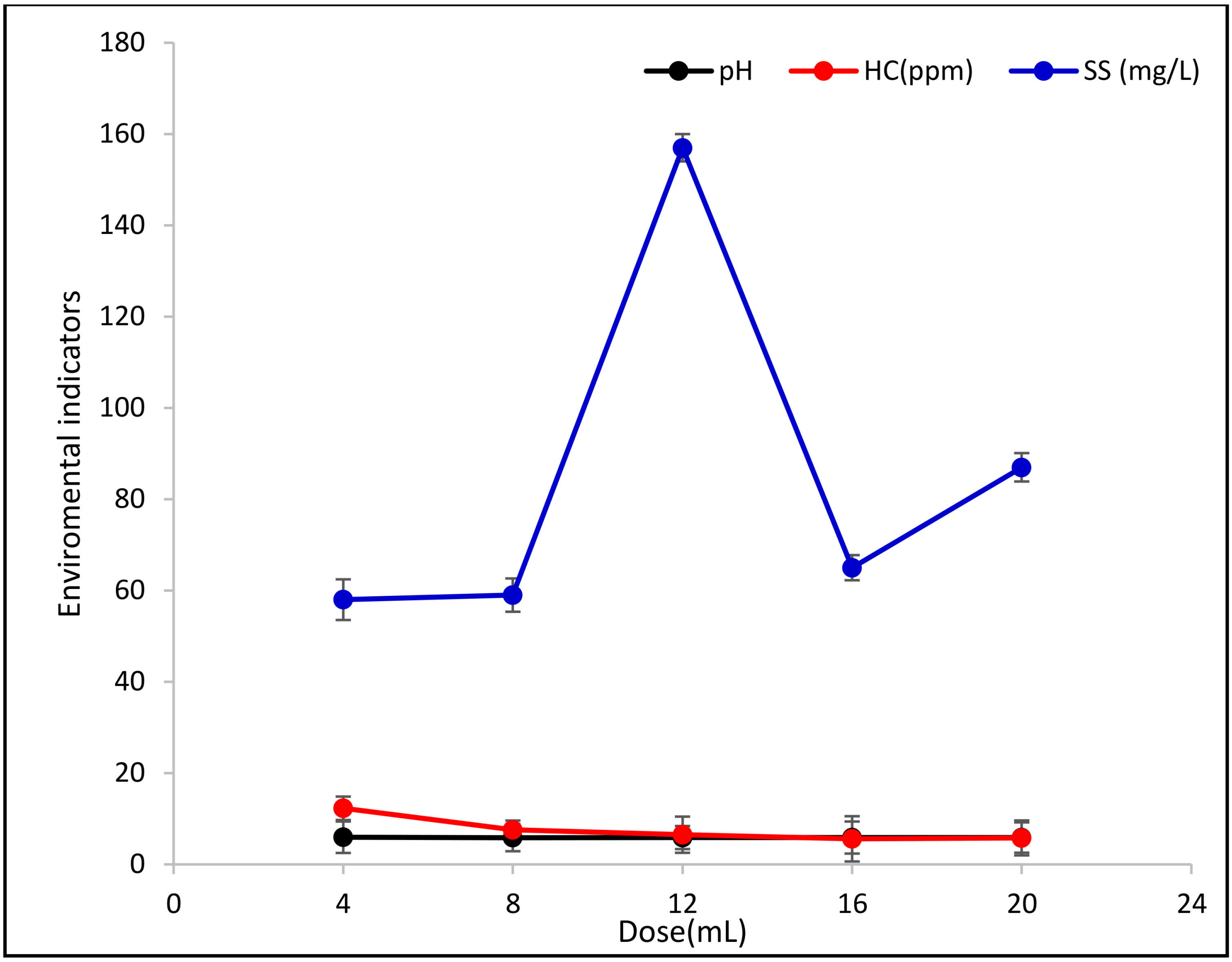


Figure 6. Evolution of environmental indicators based on the dosage of coagulant C4.

The given statements describe the impact of coagulant C4 on the pH level, hydrocarbon content, and SS rate in a water treatment system.

The first statement indicates that adding 4 mL of coagulant C4 caused an increase in pH from 5.27 to 5.95. This suggests that coagulant C4 has the potential to act as a pH regulator, raising the pH level of the system to an optimal range.

The second statement highlights the effectiveness of coagulant C4 in reducing the hydrocarbon content in the system. At a dose of 4 mL, the hydrocarbon content decreased by 12.3 ppm; this reduction continued as the dose was increased, reaching 5.6 ppm at 16 mL of coagulant C4. This indicates that coagulant C4 can be effective in removing hydrocarbon contamination from the water treatment system.

The third statement reveals that adding 4 mL of coagulant C4 resulted in a significant reduction in the SS rate from 417 to 58 ppm. This suggests that coagulant C4 can effectively reduce the concentration of suspended solids and organic matter in the system, leading to improved water quality.

In summary, coagulant C4 can be an effective treatment agent for managing water quality by adjusting the pH level, reducing hydrocarbon contamination, and lowering the SS rate. These findings can be used to determine the optimal dose of coagulant C4 needed to achieve the desired water quality goals in the water treatment system.

3.4.5. Coagulant 5

Figure 7 represents the evolution of the SS rate, hydrocarbon content, and pH as a function of the dose of coagulant C5.

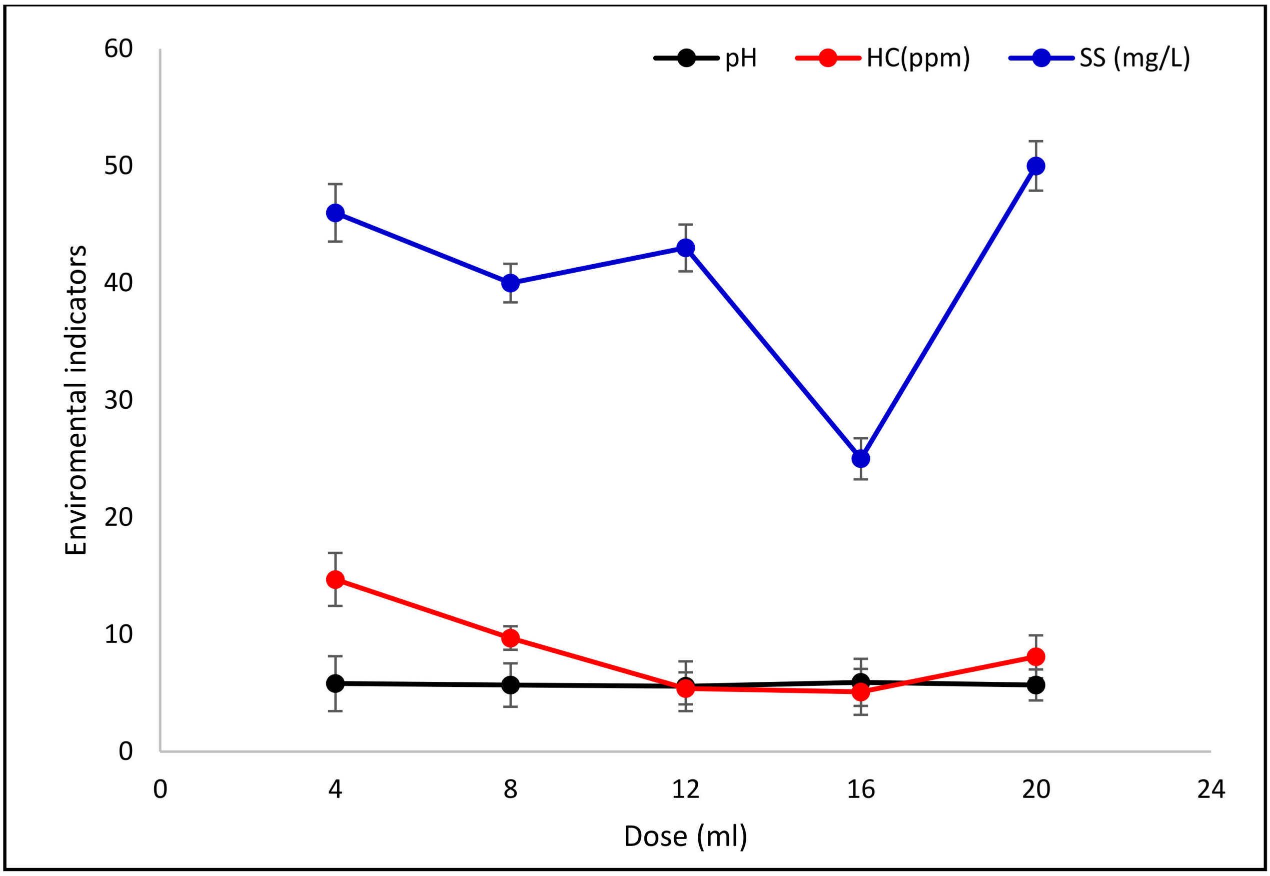


Figure 7. Evolution of environmental indicators based on the dosage of coagulant C5.

The given statements describe the impact of coagulant C5 on the pH level, hydrocarbon content, and SS rate in a water treatment system.

The first statement indicates that adding 16 mL of coagulant C5 caused an increase in pH from 5.27 to 5.91. This suggests that coagulant C5 can act as a pH regulator and can raise the pH level of the system.

The second statement highlights the effectiveness of coagulant C5 in reducing the hydrocarbon content in the system. At a dose of 4 mL, the hydrocarbon content decreased by 14.7 ppm; this reduction continued as the dose was increased, reaching 5.1 ppm at 16 mL of coagulant C5. This indicates that coagulant C5 can be effective in removing hydrocarbon contamination from the water treatment system.

The third statement reveals that adding 16 mL of coagulant C5 resulted in a significant reduction in the SS rate from 417 to 25 ppm. This suggests that coagulant C5 can effectively reduce the concentration of suspended solids and organic matter in the system, leading to improved water quality.

In summary, coagulant C5 can be an effective treatment agent for managing water quality by adjusting the pH level, reducing hydrocarbon contamination, and lowering the SS rate. These findings can be used to determine the optimal dose of coagulant C5 needed to achieve desired water quality goals in the water treatment system.

3.4.6. Coagulant 6

Figure 8 represents the evolution of the suspended solids (SS) rate, hydrocarbon content, and pH according to the dose of coagulant C6.

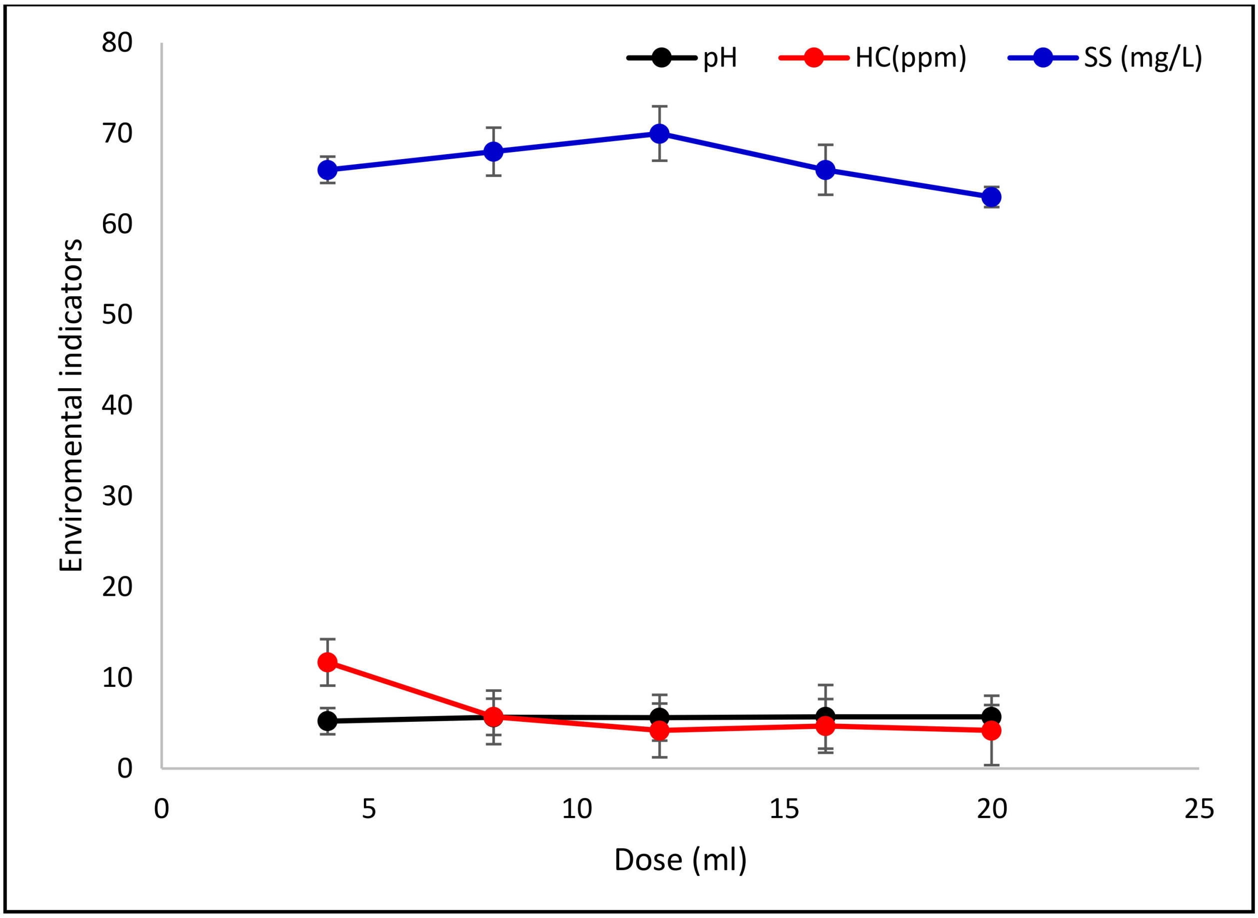


Figure 8. Evolution of environmental indicators based on the dosage of coagulant C6.

The given statements describe the impact of coagulant C6 on the pH level, hydrocarbon content, and SS rate in a water treatment system.

The first statement indicates that adding 16 mL of coagulant C6 resulted in a moderate increase in pH from 5.27 to 5.70. This suggests that coagulant C6 can act as a pH regulator and slightly raise the pH level of the system.

The second statement highlights the effectiveness of coagulant C6 in reducing the hydrocarbon content in the system. At a dose of 4 mL, the hydrocarbon content decreased by 11.7 ppm; this reduction continued as the dose was increased, reaching 4.2 ppm at 12 mL and 20 mL of coagulant C6. This indicates that coagulant C6 can be effective in removing hydrocarbon contamination from the water treatment system.

The third statement reveals that adding 20 mL of coagulant C6 resulted in a significant reduction in the SS rate from 417 to 63 ppm. This suggests that coagulant C6 can effectively reduce the concentration of suspended solids in the system, leading to improved water quality.

In summary, coagulant C6 can be an effective treatment agent for managing water quality by slightly adjusting the pH level, reducing hydrocarbon contamination, and lowering the SS rate. These findings can be used to determine the optimal dose of coagulant C6 needed to achieve desired water quality goals in the water treatment system.

Through this analysis of each coagulant, we understand that:

- For each preparation, the treatment efficiency depends on the dose of the coagulant, as shown in the table below (Table 5).

Table 5. Summary of optimal treatment conditions.

		pH	HC	SS
Optimal dose (mL)	C1	8	20	4
	C2	20	20	8
	C3	16	16	16
	C4	4	16	4
	C5	16	16	16
	C6	16	12	20

It is important to carefully optimize the concentration of activated silica in oily water treatment processes to ensure maximum effectiveness and efficiency. This can be achieved through laboratory testing and experimentation, as well as through careful monitoring of the treatment process parameters, such as pH, temperature, and mixing intensity. By properly controlling the concentration of activated silica, it is possible to achieve effective and efficient removal of suspended solids from oily waters while minimizing the use of chemical coagulants and reducing the overall treatment costs.

4. Conclusions

Given the significant discharge of polluted water from various crude oil treatment processes, the operation of purifying effluents is a primary objective to ensure substantial water conservation for reuse. The policy of preserving the environment established by the minimum concentration standards of components (pollutants and contaminants, etc.) always remains the limit not to exceed.

The treatment of oily water for reinjection aims to reduce the maximum suspended solids and hydrocarbons that they carry to make them compliant with the required specifications. To remove these particles, coagulation and flocculation processes are used, followed by a settling stage.

The oily waters treated at the API CINA unit are characterized by a slightly acidic pH, a high level of suspended solids (SS), and significant hydrocarbon content. Treatment tests by coagulation–flocculation and settling showed that the coagulant used removes suspended matter from the crude effluent, reduces its hydrocarbon content, and increases its pH.

The best treatment result is achieved with a coagulant prepared with distilled water, a concentration of 5% (4 mL) of sodium silicate, and a concentration of 2% (0.45 mL) of sulfuric acid.

The optimal dose of coagulant for ensuring the maximum treatment corresponds to 16 ppm. The automatic dosing mode provides better efficiency in the treatment scheme compared with the old manual dosing method. Finally, we propose some recommendations and suggestions that we consider useful:

- The continuous verification of the preparation and injection of activated silica.
- The continuous verification of the preparation and injection of Kurifix.
- The periodic cleaning of the API settling tank.
- The instantaneous monitoring of oily water entering the station.
- The verification and cleaning of pumps and chemical injection circuits.
- The draining of the DGF (dissolved gas filter) or IGF (induced gas filter) tanks.

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