# Application Of Coagulants In Oil Refinery Wastewater Treatment

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**Abstract:** *Wastewater from oil refineries has a great potential for contamination with mutagenic and toxic compounds. In the petroleum refining industry uses enormous amounts of water and large amounts of wastewater formed because of technological processes and washing. Deteriorating water quality poses a serious threat and at the same time gives researchers the opportunity to finally solve the problem with innovative coagulation strategies. The coagulation-flocculation process is considered one of the most important and widely used industrial wastewater treatment processes due to its simplicity and efficiency. This article provides an overview of recent studies in coagulation-flocculation treatment process of wastewater from oil refineries. This review includes an overview of the effect of technological parameters on cleaning efficiency and this review concludes with recommendations for improving the process.*

**Keywords:** *oil refinery wastewater; coagulant; coagulation-flocculation; flocculant.*

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## 1. Introduction

Increasing industrialization and the widespread use of petrochemicals (petroleum-related fuels) make crude oil refining a serious source of pollution due to the generation of large volumes of wastewater that pose a threat to human health and ecosystems [1]. In a refinery, some hydrocarbons are separated into various components, which are then mixed into useful products (gasoline, diesel fuel) [2]. Due to the complexity of the crude oil and the high concentration of oil (> 1000 mg / L) in the waste streams and the high content of persistent pollutants, the treatment of oily wastewater is difficult [3].

Typically, the refining sector produces the most important products that have helped improve the standard of living in every modern society [4]. However, it is estimated that due to increased global energy demand by 2030, global oil demand will rise to 107 million barrels per day, accounting for 32%

of global energy supply [3]. Wastewater from refineries is composed of several persistent pollutants such as waste oil, grease, phenols, a group of aromatics (benzene, toluene, xylene) and hydrocarbons [4]. Oily wastewater with a high organic content and complex chemical reactions with an unpleasant odor and color, if not properly treated, can cause cancer in humans, and reduce dissolved oxygen in aquatic organisms when discharged into water bodies [5].

Processes used in most wastewater treatment plants (classified as primary (physical and chemical) and secondary (membrane, disinfection, extended oxidation process) cleaning processes [6]. Coagulation as a chemical-physical process stands out as the first step in wastewater treatment plants, where coagulants play a vital role in the agglomeration of smaller particles into larger aggregates [1].

Coagulation and gravitational separation of oil droplets from refinery wastewater is one of the most important stages of the primary treatment process. The selection of coagulants depends on the hydrodynamic interaction and chemical composition of the surface with oil droplets, which depends on the source, composition, and density of refinery wastewater, which can significantly affect the subsequent cleaning process [5]. Coagulants based on iron and aluminium have been the most widely used coagulants for wastewater treatment [7].

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## 2. Selection of Coagulant

The opt of coagulants is one of the most important decisions in wastewater treatment, as different factors affect the water quality parameters. Several studies have been conducted to study coagulation-flocculation for wastewater treatment in refineries to optimize performance, that is, select the most suitable coagulant, determine the experimental conditions and, in general, assess the effect of pH [8].

*Coagulation with aluminium salt:* The coagulation process using alum as the sole coagulant can significantly remove organic matter. The pH of the wastewater during coagulation has a strong influence on the efficiency of coagulation to remove organic matter. Organic removal is much better in slightly acidic solutions. The optimum pH for coagulating alum depends on the concentration of organic matter in the water. For water with a higher organic content, the optimum pH value is shifted towards more acidic values. Thus, traditional coagulation methods can provide excellent organic matter removal if the coagulant dose and pH conditions are set within the optimum range. The removal of organic matter increases with increasing dosage of alum, and dosages of alum are higher than those commonly used for turbidity removal, which is necessary to achieve the best removal of organic matter. The currently widely used aluminum-based coagulants are Polyaluminium chlorides (PACl), Polyaluminium sulfates (PAS) and Polyaluminium chloro-sulfates (PACS) [9].

*Coagulations with iron salt:* Iron compounds have a coagulation pH range and floc characteristics like aluminium sulfate. The cost of iron compounds can often be less than the cost of alum. However, iron compounds are generally corrosive and often difficult to dissolve, and their use can lead to high iron concentrations in process effluents. Iron salts most used as coagulants include ferric sulfate, ferric chloride, and ferrous sulfate. These compounds often coagulate well under too acidic conditions for best results with alum. Sometimes particles are best removed under acidic conditions and iron compounds give the best results [10].

## 3. Influence of process parameters on coagulation-flocculation efficiency

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The efficiency of coagulation-flocculation largely depends on the technological parameters of the process. Optimization of important parameters such as pH, dosage of coagulant or flocculant, settling time, stirring parameters and temperature are necessary to provide more efficient coagulation-flocculation characteristics. Other process parameters include the initial concentration of contaminants. In this study, only the effects of pH and temperature are examined in more detail.

*Influence of alkalinity/pH:* Alkalinity refers to the ability of water to neutralize acid and is a general measure of the buffering capacity of water. Alkalinity and pH are related; higher acidity water has a higher pH. Metallic coagulants are acidic and the addition of a coagulant decrease alkalinity. For water with low alkalinity, the addition of a coagulant can absorbs all available alkalinity, lowering the pH to values too low for effective treatment. Water with high alkalinity (highly buffered) may require an increase in the amount of coagulant to lower the pH to values favourable for coagulation. Alum and ferric chloride are more acidic than PACls and therefore result in higher alkalinity consumption after addition. For PACls, alkalinity consumption is related to basicity [11].

For aluminum-based coagulants, the best coagulability is usually observed at pH values that are as close as possible to the pH of the minimum solubility of the coagulant. pH can be adjusted at one or more processing points, including rapid mixing, pre-filtering, and post-filtering.

*Influence of temperature:* Temperature influence the solubility of the metal hydroxide precipitate and the rate of formation of metal hydrolysis products. Low temperature affects the processes of coagulation and flocculation, changing the solubility of the coagulant, increasing the viscosity of water, and slowing down the kinetics of the reactions of hydrolysis and flocculation of particles. Cold water temperatures often reduce the efficiency of precipitation and make the correct choice of coagulant more important. PACls less sensitive to low temperatures than alum. Cold water reduces the solubility of alum and coagulant PACls, increases the viscosity of water and slows down the kinetics of hydrolysis and particle flocculation reactions. Thus, at low temperatures, higher dosages of coagulant and additional flocculation time are required. Low water temperatures reduce the rate of coagulant dissolution, sedimentation, meshing and floc formation, especially when using alum. Warm water seldom causes a rise in the level of algae and other organic matter in raw water. Warm water often causes an increase in the level of algae and other organic matter in raw water [12].

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## 4. Conclusion

Even though with the development of new and improved treatment processes, coagulation-flocculation is still a mandatory process for industrial wastewater treatment due to its simplicity of design and operation, low energy consumption and high versatility. The effectiveness of this treatment is greatly influenced by operating parameters such as coagulant/flocculant dosage, pH, stirring speed, stirring time, settling time and in some cases temperature. The efficiency of the coagulation-flocculation process can be increased by introducing a coagulant or flocculant aids. Improvement in floc characteristics such as the formation of denser and stronger flocs, as well as an increase in floc settling rate.

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