Ministry of Higher Education and Scientific Research Al-Mustaqbal University College

Department of Chemical Engineering and petroleum Industrials

Pollution

2nd Stage

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Treatment of Waste Water from Petroleum Industries

The composition of effluent in refinery wastewater depends on the crude quality. It varies with the operating conditions. **Petroleum refineries produce large volumes of wastewater including oil well produced water brought to the surface during oil drilling** which often rich in organic pollutants therefore cannot be treated easily and difficult to be treated biologically. *Removal of pollutants produced by industrial plants is required for reuse of water and obtains to environmental standards.* Petroleum wastewater are a major source of aquatic environmental pollution and are wastewater originating from industries primarily engaged in refining crude oil, manufacturing fuels and lubricants and petrochemical intermediates. It was reported that the volume of petroleum wastewater generated during processing is 0.4–1.6 times the amount of the crude oil processed.

If the petroleum wastewater, which contained high organic matter, discharged into the aquatic environment, which required 2 mg L-1 from dissolved oxygen for

normal life, results in decreased dissolved oxygen by the bacteria. In anaerobic systems, the products of chemical and biochemical reactions produce displeasing colors and odors in water.

Characteristics of oily wastewater

Petroleum industry generates large amount of oily waste either solid or liquid due to upstream and downstream operations Upstream process includes extracting, transporting, and storing crude oil, and downstream process includes refining of crude oil. Depending on a ratio of water and solids waste is categorized into simple wastewater crude oil or sludge. The pH value of oily sludge is usually ranging from 6.5 to 7.5, but it varies depending on sources of crude oil, processing method, reagents used, etc. Wastewater from petroleum industry contains oil **impurities**, high level of **biochemical oxygen demand (BOD)** and **chemical oxygen demand (COD**), **high total solids**, **hydrocarbons**, and **other waste**. This waste includes oily sludge, waste catalyst, heavy metals, volatile organic compounds, oil and grease content, high total dissolved salts, ammonia, nitrates

sulfides, etc. Table 1 summarizes the characteristics of oily wastewater/effluents and standards for their discharge in environment. These pollutants typically disperse, emulsify, or dissolve within the oily wastewater.

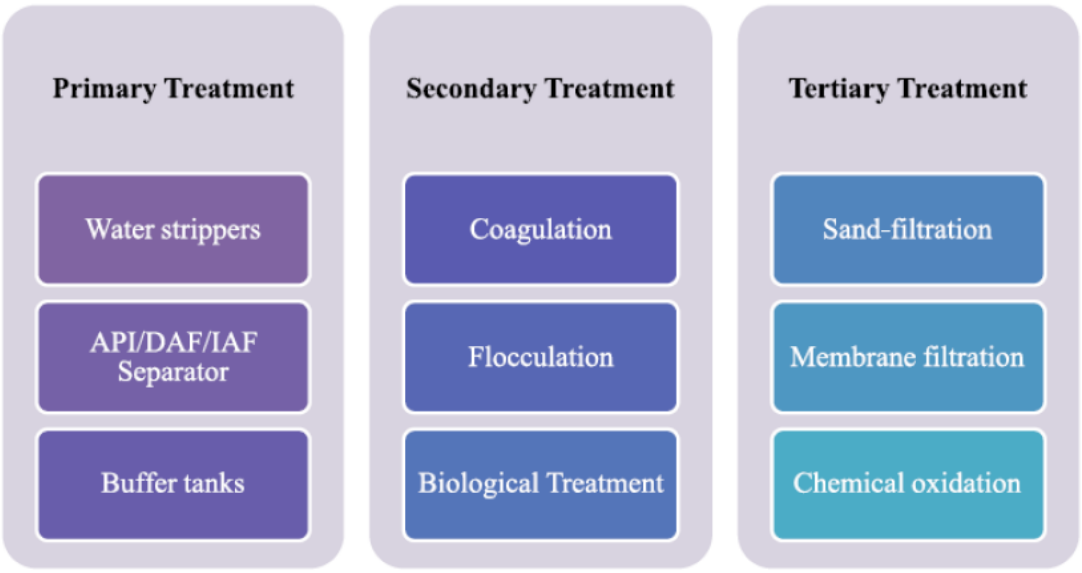
Table 2. Minimum standard discharge limits for refinery effluents

pH	Composition (mg/L)								Ref.
	COD	BOD	TDS	SS	TOC	Ammonia	Phenols	Sulphides	
6-9	100	10-15	-	70		15	-	-	Ma *et al.*, (2009)
6-9	150	30	-	30		-	-	1.0	Environmental Health Safety Guidelines (2009)
6-9	150-200		1500-2000		50-75				Aljuboury *et al.*, (2015a)

Current treatment process in petroleum industry

Different technologies adsorption, coagulation, anaerobic treatment, reverse osmosis, ultrafiltration, chemical destabilization, flocculation, dissolved air flotation (DAF), membrane process, etc. have been used to treat wastewater from petroleum industry. Depending upon **concentration** and **source of contamination**, different type of treatment technique is required to reduce the toxic level of pollutants Mainly

the treatment process has been differentiated into three categories: (a) primary, (b) secondary, and (c) tertiary treatment (Fig. 1).



Primary treatment

Primary treatment is usually used for physical operation in petroleum refinery wastewater treatment plant. It is important step as it allows waste for the further secondary treatment unit. Mostly gravity separation applies to classify the floating and settle down material from wastewater. The primary treatment step includes an oil/water separator which can separate oil, water, and solids. Gravity separation followed by skimming is carried out for removal of oil from wastewater. Oil–

water separator such as API oil–water separator is widely used because of its low cost and high effectiveness or primary treatment step. API separators work on phenomena of difference in specific gravity to allow heavy material to settle below lighter liquids. Hydrocarbons that float on the surface and the sludge settle down to the bottom.

American Petroleum Institute (API) Oil-Water Separator

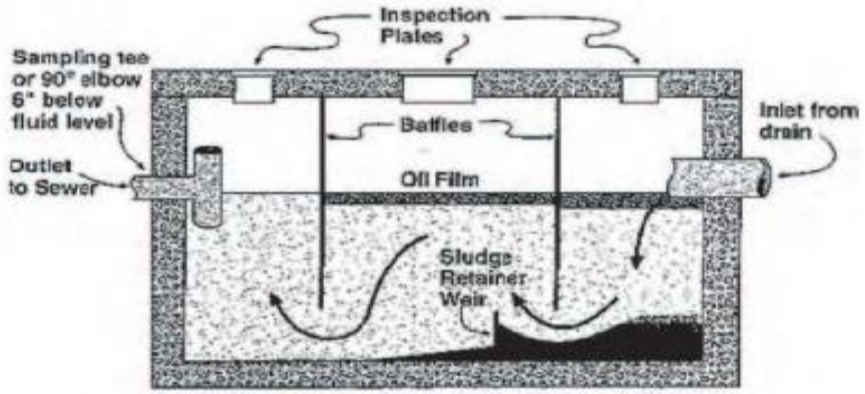
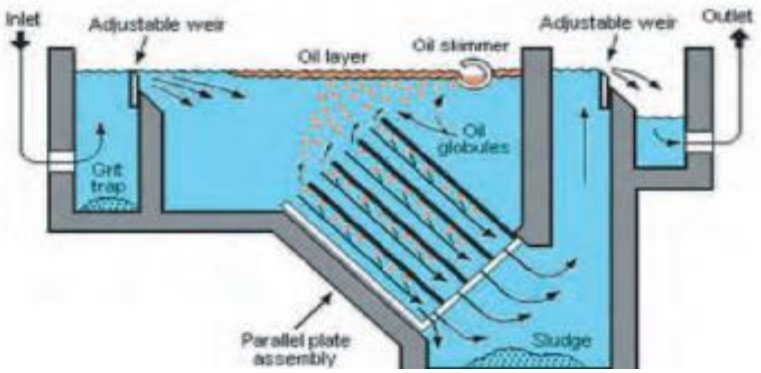


Photo source: WERF (2005)

Coalescing Plate Separator (CPS) Oil-Water Separator

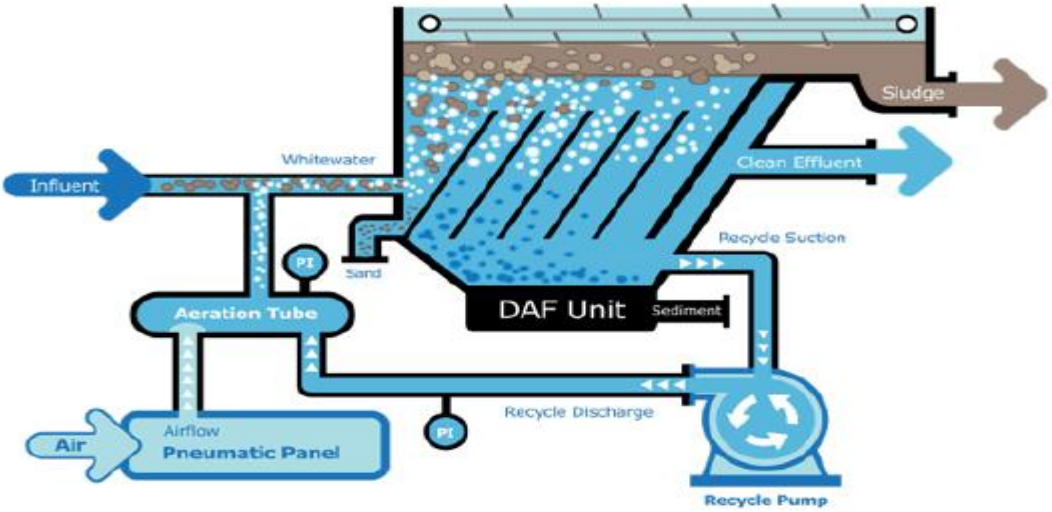


API separator is not very much applicable for removal of smaller oil droplets and emulsions.

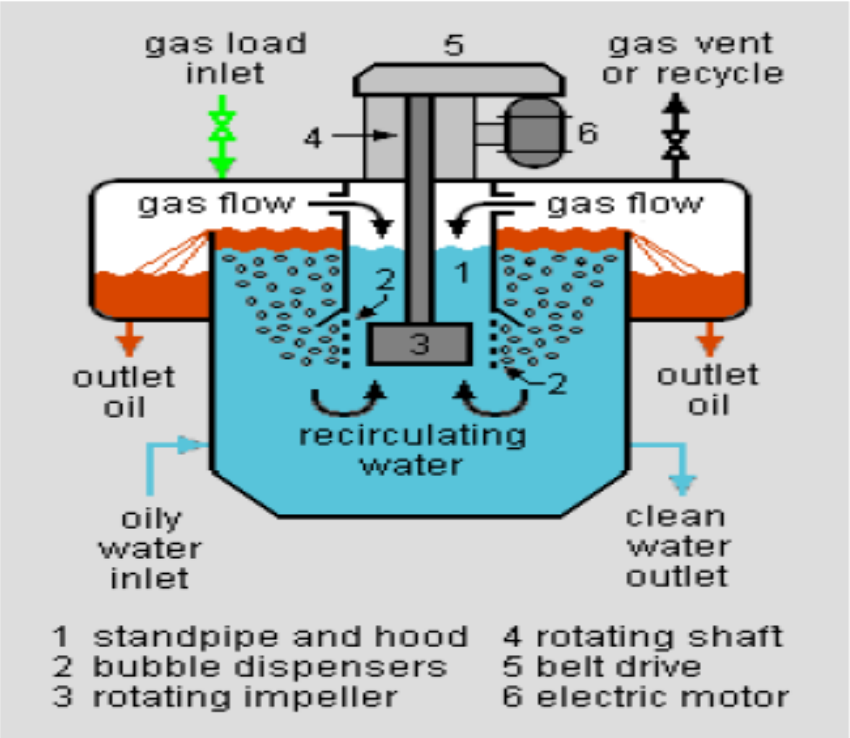
Dissolved air flotation (DAF) is a water treatment process that uses air to increase the capacity of smaller oil droplets and enhance the separation process (***Injection of the air while the liquid is under pressure, followed by the release of the pressure***). DAF In this stage, the heterogeneous components of the effluent such as suspended solid colloids or dispersion and immiscible liquids are reduced significantly. Colloids and dispersion also delay and damage equipment during proceeding stage. DAF unit typically consists of chemicals to

promote coagulation and increase floc size to make easy separation.

In induced air flotation (IAF) system, **air is induced by rotor disperse mechanism. the spinning rotor work as a pump and forces to the fluid. IAF can introduce more air by operating at a higher pressure of say 100 psig.** Some manufacturers state that they have mechanisms using impeller mechanisms pump veins or diffusers or other methods **to make microbubbles** as small or smaller than DAF systems. The advantages of the IAF process are compact size, low cost, and effective removal of free oil and suspended material.



DAF System



IAF System