AI 3010 WASTE AND BY PRODUCT UTILIZATION

UNIT II NOTES

Oil water separator

An **oil water separator** (**OWS**) is a piece of equipment used to separate oil and water mixtures into their separate components. There are many different types of oil-water separator. Each has different oil separation capability and are used in different industries. Oil water separators are designed and selected after consideration of oil separation performance parameters and life cycle cost considerations. "Oil" can be taken to mean mineral, vegetable and animal oils, and the many different hydrocarbons.

Oil water separators can be designed to treat a variety of contaminants in water including free floating oil, emulsified oil, dissolved oil and suspended solids. Not all oil separator types are capable of separating all contaminants. The most common performance parameters considered are:

- Oil droplet size (in the feed to the separator)
- Oil density
- Water viscosity (temperature)
- Discharge water quality desired
- Feed oil concentration and the range of oil concentrations likely
- Feed oil water flow (daily and peak hourly)
    - An API oil-water separator is a machine that segregates oil and colloidal matter from industrial effluents. These effluents produced by petrochemical industry, oil manufacturing plants, natural gas processing plants, and from other oil – based waterbodies. These treatment plants mainly work on the standard that is American petroleum institute so we called **API waste water treatment plant**.

API waste water treatment plant.

Principle of API Separator Plant

- The API separator is generally a gravity separation instrument that usually works on the principle of Strokes Law. According this the rise in the velocity of oil droplets is based on the density, weight and water properties.

- The specific gravity difference between oil and contaminated water is smaller than the specific gravity difference between suspended solids and water. The separator's concept is based on that difference. According to this concept oil will present on the top of the separator. In the middle region waste water is present while in the suspended sediments layer are present. Once the oil and suspended solids are removed the middle phase again sent in most refineries waste water treatment plants. The oil top, which may contain absorbed water and associated particles, is normally skimmed off continuously. This oily layer can also process to extract valuable components or may be discarded. A chain and flight scraper and sludge pump generally used to remove the thicker bottom sediment layer.

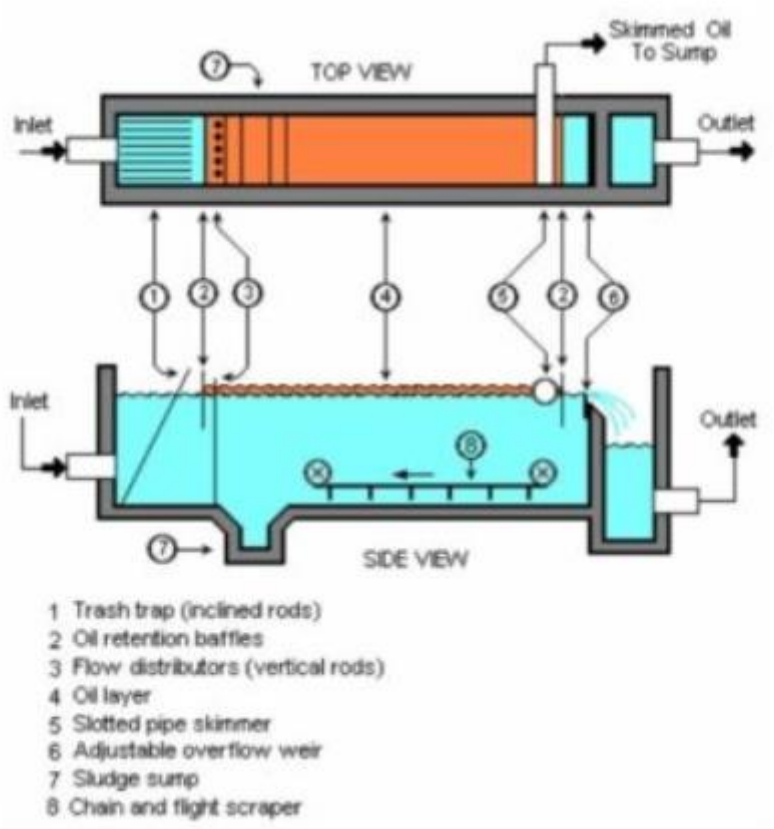
Performance Factors of API

- The water temperature, horizontal velocity, density, size of the oil droplets, and the amount and characteristics of the colloidal matter are all important factors that affect API separator efficiency.
  API separators are designed to separate oil droplets of size 0.015 cm in diameter (150 microns). The API separator are also used to maintain laminar flow. This device also used to remove both free oil and suspended particles of concentration between50 and 200 mg/L. Removal of large amounts of free oils, greases, and suspended particles from reduces overloading and other downstream mechanism

Design and Operation of API Separator Plant

- The API oil-water separator is a gravity-based separation instrument. It utilizes Stokes Law to determine the increase velocity of oil droplets depending on size and density. Since the specific gravity discrepancy among oil and wastewater is probably lower than that of the specific gravity discrepancy between suspended solids and water. The API oil-water separator is designed around that disparity. The majority of the suspended solids will settle to the bottom of separator as a layer of sediment. The oil will rise to the surface of the separator, as well as the wastewater will become the middle layer between both the oil on top as well as the solids on the bottom, according to that selection criterion.

- The oil layer is usually skimmed off and later thrown off or reprocessed. The bottom sediment layer is scraped away using a flight and chain scrapper and a sludge pump. Then the water layer is treated with a dissolved air flotation machine to remove any remaining oil. It is followed by a biological treatment unit to remove any unwanted absorbed chemical compounds.



Centrifugal oil separator

A **centrifugal water–oil separator**, **centrifugal oil–water separator** or **centrifugal liquid–liquid separator** is a device designed to separate oil and water by centrifugation. It generally contains a cylindrical container that rotates inside a larger stationary container. The denser liquid, usually water, accumulates at the periphery of the rotating container and is collected from the side of the device, whereas the less dense liquid, usually oil, accumulates at the rotation axis and is collected from the center. Centrifugal oil–water separators are used for waste water processing and for cleanup of oil spills on water bodies.Centrifugal oil–water separators are also used for filtering diesel and lubricating oils by removing waste particles and impurities.

Mechanism

A mix of oil and water is pumped constantly into a cone-shaped separating apparatus at an angle, which creates a spinning vortex. The filtration is a result of the force balance that occurs on fluids in a vortex. High-density liquids will move to the outside, along with any contaminant, displacing the lower-density liquids to the inside (center of rotation). Water, being the more dense liquid, sits on the outside and is removed through a discharge outlet. Any segregated oil can now safely be recovered through a suction orifice at the center. The process will continue to function in this fashion as long as sufficient oil is added to maintain coverage of the suction orifice.

Disadvantages

Centrifugal oil and water separators do have their disadvantages. One known disadvantage of these separators is that they tend to have low powered suction. For example, when the pump end is dry and the impeller is rotating at high speeds, it is simply not powerful enough to lift the oily water mixture into the separator. For this reason, these separators must always be primed before use

Coalescing to separate oil, grease from water

Coalescence means coming together. It refers to small droplets coming into contact with other droplets and combining to form larger drops. In an oil/water mixture, if two oil droplets are brought into contact with one another there will exist a separating film of water between the droplets. If they are held in contact for a sufficient length of time, this film will thin until it ruptures and the droplets will join (coalesce).

Factors may be present such as dirt or certain chemical agents that will interfere with this process and inhibit coalescence. In this case we have what is known as an emulsion. If sufficient inhibitors are present, a stable emulsion will result and will not separate in any reasonable time. Examples are soluble oil coolants and mayonnaise. The only practical way to separate chemical stabilized emulsions is to interfere with the action of the emulsifying agent. Mechanical coalescers/separators are only effective on mechanically induced emulsions.

Coalescence can be enhanced as well as inhibited. Increasing the force holding the droplets in contact (centrifuge, fiber mat) will enhance coalescence, as will bringing the droplets into contact with a surface that will wet with oil but not water. This latter is the coalescing action of a superior coalescer/ separator. As the oil droplets make contact with the surface of the media, they sheet out on the material and flow upwards towards the top edges. When enough oil gathers at an edge to

overcome the surface tension, a droplet will be released toward the surface. This droplet will be sufficient size to separate rapidly from the water (recalling the discussion on the effect of droplet size on separation rate).

In the best coalescer/separator machines, the oil/water mixture is introduced to the tank through either a bag filter or a primary coalescer/diffuser. The bag filter is an option when solids are present and results in a non-turbulent flow into the tank volume. This is important to the process of separation. instead of the bag filter, an oil flow diffuser may be used. This serves two purposes. First, it acts as a coalescer to enhance separation rate. Second, it functions as a flow diffuser to minimize tank turbulence.

From this point, the oil/water mix begins gravity separation. Once in the coalescing media two effects are observed. First, the media surface coalescing action described above. Second, the material matrix serves to break up the tank into units with smaller height; therefore, an oil droplet has a shorter distance to rise before it encounters a surface. This greatly enhances separation for a given tank size.

At the tank discharge end an oil retaining weir is located to prevent separated oil from flowing out of the tank with the clean water. This barrier extends almost to the bottom of the tank. The separated water must flow under this weir and then over the water discharge weir to exit the tank. The purpose of this water discharge weir is to maintain a constant depth of fluid in the separator tank.

Separated oil accumulates on the tank surface until it reaches sufficient depth to overflow the adjustable oil discharge weir or be removed by a motorized wheel skimmer. Why use a wheel skimmer on a coalescer? It maintains the tank surface in an oil free condition, preventing the buildup of anaerobic bacteria. This results in a much cleaner coalescer tank than is the case if the entire surface remains covered with a film of oil. If a proper wheel skimmer is installed, the oil is removed to a secondary separation reservoir, where any water picked up by the wheel is allowed to drop back into the separation tank before the oil is discharged through an adjustable weir.

The secondary separation volume used with well designed wheel skimmer installation offers several advantages. First, when used with machine tool coolants, wheel skimmers tend to pick up some coolant once most surface oil has been removed. This secondary separation volume

has an open bottom to allow the coolant to fall back out rather than be discharged with the oil. Second, this volume acts as a second coalescer stage for the oil and by restricting the surface area we are able to run a much thicker film of oil, resulting in almost no water in the oil discharge while at the same time maintaining the main volume surface almost free of oil. This improves efficiency and greatly improves system cleanliness.

Corrugated plate Interceptor

The Corrugated Plate Interceptor is a gravity separator. The CPI is designed to separate oily waste water in the lighter oily fraction and the heavier water fraction. The heavy particles will be separated as well and sink to the bottom of the CPI. The CPI is designed to separate oily water on a small footprint, using plate pack technology and an advanced distribution system to optimize the separation circumstances. The plate packs create an effective separation surface up to 50 times the footprint of the CPI.

- Simple in use.
- Compact construction.
- Capacity for treatment: 10 to 660 m^3/h according to the models.
- Low cost of maintenance.
- Also supplied as internals only, very high capacities possible.

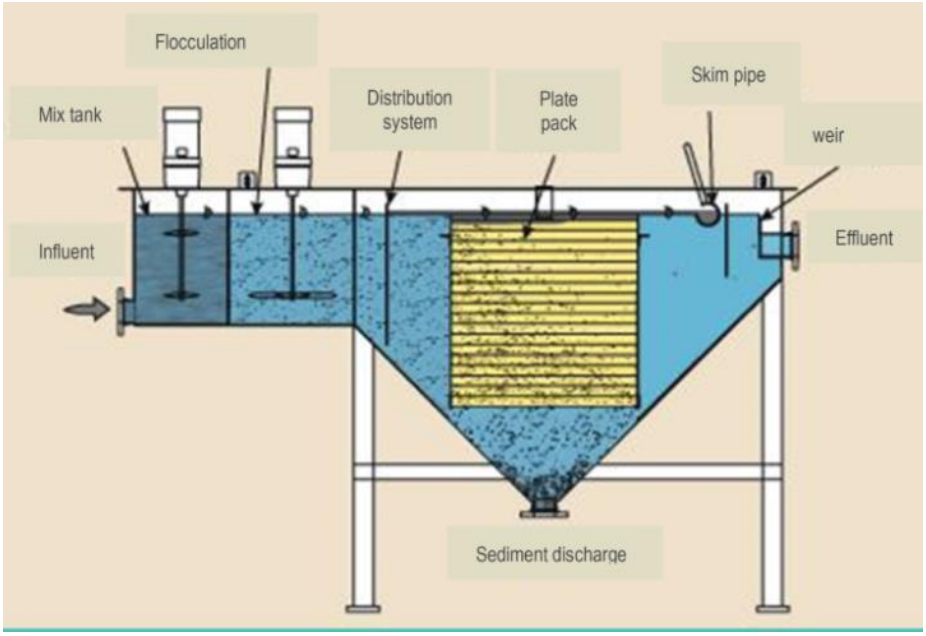


Figure:CPI Interceptor

Tank farm treatment

Crude oil, intermediates and finished products are stored in the tank farm. It is the first facility in a refinery where free water can be removed by settling from the oil. Pumped crude oil from the well contains water in emulsified and free states. A crude oil emulsion consists of small globules of water surrounded by oil. Water is the internal phase and oil is the external phase, which can easily be detected by microscope. With the help of gravity, small water droplets coalesce to form bigger droplets. An adequate residence time is essential for separation into two phases. The bigger droplets finally settle down to be removed by drainage.

Most of the time, emulsified water cannot be separated effectively by gravity settling only, as the emulsion can separate into three phases:

- Oil on the top
- Water at the bottom
- Persistent emulsion in the â€¨middle or below the water layer.

To break such a persistent emulsion, chemicals have to be applied. A number of demulsifiers are commercially available with varying degrees of performance and selectivity. Generally, demulsifiers are diluted with an organic solvent and injected into crude oils. The nature of the emulsion changes from crude to crude, which can influence the performance of the emulsion breaker programme. This necessitates the evaluation of cost effectiveness and performance in breaking the emulsion.

Crude oil desalting

Crude oil fed from the tank farm to the crude distillation unit still contains water, salts, sludge and various kinds of impurities. This can cause corrosion, fouling, plugging and catalyst degradation in the downstream refining units. The main purpose of electrostatic desalting is therefore to remove impurities, such as inorganic microparticles, suspended solids and water-soluble contaminants, together with the water.

The major variables and effects on the desalter operation are:

- Wash water mixing
- Wash water quality and rate

Desalting temperature

- Electric field
- Retention time
- Use of demulsifiers.

Wash water is added in front of the mixing valve to the crude oil to prepare a temporary emulsion. A key point of desalting is an appropriate mixing of crude oil with the wash water to obtain a sufficient desalting rate. Heating lowers the viscosity of crude oil. This promotes demulsification and the formation of large water droplets from the emulsion. An electric field is induced by AC or DC current in the oil/water mixture to improve water coalescence. The electrical field imposes an electrical charge on the small water droplets entrained in the temporary emulsion. The water droplets coalesce into bigger droplets, which can settle by gravity. Therefore, sufficient retention time in a desalter is required for efficient water and oil separation. A suitable demulsifier is commonly used to promote the separation of water and oil. The desalted crude oil is continuously fed from the desalter vessel to the atmospheric crude distillation column. The desalter effluent water is discharged from the desalter vessel to the wastewater treatment facility.

Separation of oil-in-water emulsions

In aqueous systems, the hydrocarbons generally carry a negative charge at their surface. Often, they are steady dispersed into small droplets because of their repellent forces. A cationic charged long-chain polymer neutralises the negatively charged oil droplets. The repellent forces are weakened and oil droplets are brought together. This resolves the emulsion of water and oil. The emulsion-breaking process involves three steps:

- Agglomeration
- Creaming
- Coalescence.