MARINE ENGINEERING

By

Prof. Abdus Samad

IIT Madras

Lecture77

Centrifuge

Gravity based system is very good. It is cheaper. There is no extra energy required. Just you have one mechanical design and fluid will be flowing and you are separating oil and water. But that is not so much efficient.

So there are some other technology one called centrifuge. Centrifuge is very heavily used in medical industry like drug discovery or maybe blood sample separation like blood cells and serum separating. In that case they use centrifuge. Milk and butter separation they also use centrifuge. So centrifugal liquid-liquid separator it consists of rotating cylindrical container with stationary one.

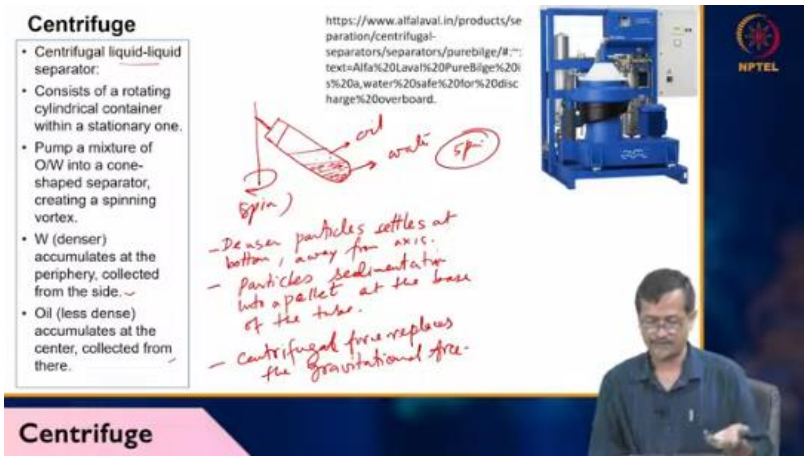
So it will be let us say I have taken certain sample oil water sample now if I rotate it high speed give high speed rotation spin then what will happen the oil and water will get separated. Okay. So this one, your low density oil, this high density water. Because water is high density, if you rotate at very high speed, what will happen? Water particle, high density particle will try to take larger diameter or it will try to go away from your spinoprotection.

So, high density particle will be collected at the bottom of your tube or separator system while oil will be collected at the top of this section. So, in this way, you separate and the separation efficiency is very high. You can reach to 5 ppm also. Okay. Consists of rotating cylindrical container.

Cylindrical container you can see here. Pump a mixture of oil and water into cone shaped separator. So, it will be cone shaped. creating spinning vortex so you are creating a very high speed so water denser accumulates at the periphery collected from the side oil less denser accumulate to the center collected from there okay now denser particles settles at

the bottom denser particles settles settles at bottom so we can say sets away from or away from axis spinning axis okay so particles sedimentation into pellet particles sedimentation

into a pellet at the base of the tube centrifugal force is used centrifugal force force is given and replacing the gravitational force which is responsible for sedimentation of two-phase particles. So, you can have three-phase or multi-phase also, for example, solid is there. solid will be further away from water solid then water and oil so different phases you can separate if you have centrifuge and because you are creating very high amount of force for separation so it will be giving higher efficiency than your normal gravity based separation gravity separation is having limitation because system is very slow but in this case you can things can be very fast but you need a mechanical or electrical energy or mechanical energy to give in the system So, this is actually similar to the centrifuge is similar to hydrocyclone.



So, there are lots of research paper they are suggesting to use hydrocyclone for oil water separation, but whether I do not know anyone has used for a bilge water separation. So, this is also very simple case and you need maybe mechanical energy. It can separate different density fluid. This is especially oil and water. So design is like this.

It will have one cylindrical section then cone section. Okay. Now you will have inlet pipe. Inlet oily water. And when at high velocity at high velocity.

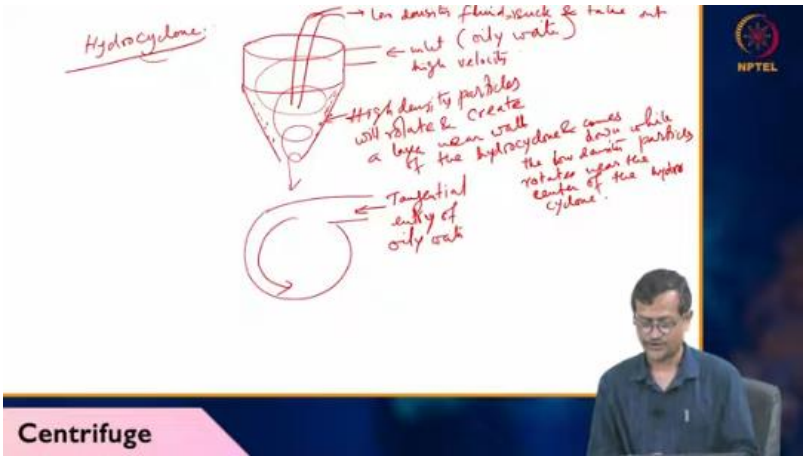
when inlet fluid at high velocity will be entering it will be creating one vortex like this and it will be coming down so inlet will be creating one tangential so if I take top view from there so inlet is like this so it will create tangential entry so tangential tangential entry of oily water okay so oil water will be tangentially entering and will be rotating and because of gravity slowly fluid will be falling down or it will be going down but when it is going down the high density particle will try to touch this surface area okay in a inner wall so

high density particle will create layer here rotating but near the wall High density rotate and create a layer. near wall wall of the hydrocyclone comes down while the low density particles particles creates a central layer creates or rotates near the center of the hydrocyclone.

So, what happens? High density particle will be rotating at a very high speed and it will be touching near the wall. Low density particle, this density low, so they will not get space at larger radius. So, the center area, they will be rotating. So, center area, you put one other pipe here.

Then you suck the low density particles. Low density fluid will suck and take out. So high density fluid will be rotating and it will be moving down while the low density particle will be rotating at the near the center. So there you put one pipe and suck from the top. So two fluid already separated inside the cylinder.

one particle already will be falling down because of its own density and gravity and while the low density particle rotating in the center from center you just suck it so you will be separating this one so any two fluid with different densities this is sand and liquid or oil and water or maybe dust particle in air so you can create such cyclone and you can separate actually okay so this is called hydro cyclone so Hydro means water, cyclone means spin you are creating. So using this one. So this is not, there is no mechanical rotation, actual mechanical rotation moving element. So this life is longer.



So this is very much commonly used for many industries to separate particles. Only you need the inlet high pressure fluid, high pressure or high velocity fluid. So, if you have available high pressure, high velocity fluid, then hydrostatic clone can be your very good

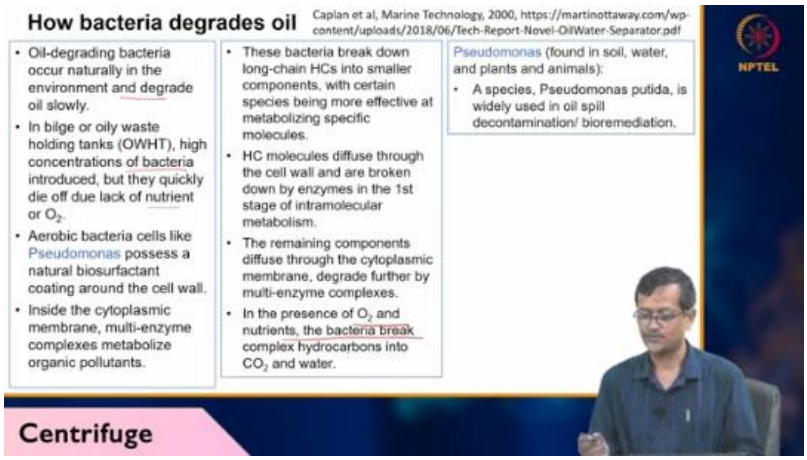
choice. So, petrol emitter or OWC or oily water separator. So, here I have taken from Ensolve company.

So, they have this product Ensolve biosystem petrol emitter. So, this is biochemical water and oil separator and they use actually some chemical to separate So, this is non-precise 3 stage vessel 5 to 20,000 gallon of oil water per week they can process. So, they have 2 stage heavy phase separation removes pure oil. Second stage oil degradation non-pathogenic microbes will be working and they will be separating.

So, how this microbe work I will explain. So, oil degrading bacteria occurs naturally in the environment and degrades oil slowly. In bilge or oily water holding tank High concentration of bacteria inducted, but they quickly die off due to lack of nutrient oxygen. Arabian bacterial cells like Pseudomonas possess natural biosurfactant coating around the cell wall.

Inside the cytoplasmic membrane, multi-enzyme complex metabolizes organic pollutants. These bacteria break down the oil with long-chain hydrocarbon to small-chain hydrocarbon. These are in specific being more effective at metabolizing specific molecules. Hormonal molecules diffuse through the cell wall and are broken down by enzyme in the first stage of intermolecular metabolism. The remaining component diffuse through the cytoplasmic membrane, degrade further by multi-enzymic complex.

In the presence of oxygen and nutrient, the bacteria break complex hydrocarbons into carbon dioxide and water. So, Pseudomonas, it is found in soil, water and plant, animal. This is species Pseudomonas. is widely used in oil spill application. Now you got oil and you have gravity settling chamber because that will be removing larger amount of oil particle and very small particle you are not removing or if you have any emulsifying agent then you cannot remove using gravity settling system.



Gravity settling system will work better if you have larger bigger particle oil and you don't have any contaminant. Then after that you are passing to gravity OWS then maybe you are passing to centrifuge then you are polishing. Sometime you are using bio surfactant and many other things you are using. Unit operation ready to clean. Polish bridge water.

Polishing steps like onboard oil water separation is more economical than holding on soil. Most post cavity odolish separators are absorption, adsorption system, biological treatment. Already you have seen biological treatment. Coagulation, flocculation, flotation, membrane technologies. So gravity OWS or centrifuge treatment first step of bulk removal of non aqueous component.

Ultra filtration, so the polishing stage, ultra filtration also you can do, effective to remove turbidity and suspended solid, organic carbon, metal like aluminium, iron and zinc. So absorption and adsorption. Absorption involves the integration of substance from one physical state into another, such as liquid absorbed by solid. Absorption refers to the physical adherence of bonding of molecules into the surface of another phase. In both phases, both processes, binge water pulses flow through sorption media in the reaction vessel or contactor, oxygen removed, oil is removed from the media.

Once the sorption media capacity is depleted, it must be replaced. Sorption media like granular substance, absorbent, cartridge filter, so many other there. Absorption process is often used granular activated carbon or GSE. Absorption process is suitable for smaller vessels less than 400 gt plus ton due to their compactness, relatively low capacity, operational cost and ease of maintenance especially when using modular cartridge. However, frequent media replacement may be required.

Coagulation of flocculation. Coagulation of flocculation is often called emulsion breaking flocculation. step aggregate small particle making settling them easier okay so small particle will be nearby together they'll be joining and they'll make a bigger particle after free oil separation in ows gravity gravity based okay gravity ows emulsifying water is directed to a circular tank where flocculant chemical and air are added for flotation so first you've got ows gravity based system then after that they're adding chemical and air and other things. So, step by step they will be doing.

So, aggregation involves two steps, particle transport to inter-particle contact and destabilizing attachment upon contact. The resulting flock and the oil are skimmed off and the remaining water undergo filtration. Drawback, sensitive to Changes in influent quality and required vessel specific optimization for chemical type and quantity. Air and gas flotation improve gravity separation by exploiting the difference density between the air, gas, bubbles and water.

The difference cause oil droplet, small solid particle to access to the bubble and rise to the surface, whereas they are removed by skimming. So, let us say I have one pot oily water mixture and I have oil particle here, here. Now inject air or gas. So air will be attaching to these particles. So when air is getting attached so those buoyancy will be higher.

Attaching air increases buoyancy. Increases moissimus, it will be moving faster rate to the surface. So, bubbles collides, attract to oil, increases rate. So, injecting bubble, bubble in a mixture. So, what will happen?

It will be, bubble will be attached. Bubbles attach to oil particle. Okay, then infusorize it. Infusorize it, gas bubbles to attach oil droplet and create higher aggregates that rises to the surface of water. So here I will draw one picture.

Okay, so one is here, one is here, one is here, one, one, one, one, one, okay. So I have inductor here, inductor here, inductor here. how the gas will be injected so you create lots of bubbles here bubbles here bubbles here okay and from where the bubbles will be coming gas inlet here okay uh not this one like gas inlet okay so gas is coming here gas is coming here gas then gas balancing happening here and Gas is here.

Then it is going to eductor. Again gas is going to eductor. Gas is going to eductor. Okay. This is eductor.

And recycled water. This is recycled water and water from it is coming here is going here i have pump and pump is transferring water to there okay and some water will be disposed

here clean water out and oily water inlet is here oily water inlet so oily water is coming here it is going through this it will pass through like this it will go like this it will go like this you are creating we are here scheme out okay so is your hair

skim out so this is skimmer so you are taking oil out here actually oil or skim out so this is oil this layer is oil layer this is water this is water This is where. Okay. And pump clear water out. Recycle.

So gas flotation unit. This is gas flotation unit. This is adjustable valve. This is adjustable valve. Adjusting valve.

adjustable valve this is gas bubbles this is flow control valve flow control valve is like this control valve okay so whenever you are drawing any valve flow control then you should draw like this cross then like this adjustable valve only just this one okay flow control means one valve knob will be there so using that one even control so that symbol we should use proper symbols every time and here one adapter i have written okay adapter So, inductor actually it will create vacuum. Inductor or ejector or jet pump. So what happens?

I already explained I think jet pump will have like a small nozzle and it will be sucking some other fluid. So this way the inductor or ejector or jet pump will be working. So when sucking some fluid that means you are creating a low pressure. For this one actually you just you see your desalination lecture. So there I have explained how jet pump will be creating vacuum for your multi filter system MSF system.

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