MARINE ENGINEERING

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Lecture75

Bilge water flocculant

Good morning everybody. We are discussing bilge water separation, water and oil separation. We have started already few things on water separation. For example, emulsion, how emulsion is getting formed and how demulsifier is being added. So, here one example is given from one company, Harex Chemicals.

So, they produce bilge water flocculants. So, this is actually polychloride they are saying. So, this is I am giving just one example how This flocculant will be added in bilge water so that bilge water emulsion can be broken and will be separated. this is oil water separator thing.

Oil and water separator. separator oil reduces from bilge water if it is iron free and completely safe to environment. From the company document I am reading. this is exactly copied from company document. international environment regulations says it will be your oil content should be less than 15 ppm.

typical dosage rate 100 to 500 ppm in a multi-stage bilge water cleaning system. Bilge water flocculant is fed and diluted through a dosage pump. it is called dosing pump, chemical dosing, that term is used. flock tank is fed according to the flow of the bridge water pumped into it. The feed is adjusted in connection with the installation and normally needs no alteration.

If required, dosing point can also be controlled by measuring the level of the container. this is exactly from the RX Chemical company website or product brochure. whenever you are talking about oil and water, so water is here and oil particle is oil particle moving up. actually oil particle will be settling.

oil particles will be settling. Settling means it will be floating and it will be creating one layer here above water. Now what will be the velocity of the oil particle so that your retention time will be lower. So retention time lower means accordingly you can design your settling tank settling tank sizing for example in the input is here and output is here say in inlet outlet of water inlet may be oily water outlet also will be oily water because 100 oil you cannot remove from here so again it will be like i cannot write like pure water it will be oily water again but reduced oil content okay

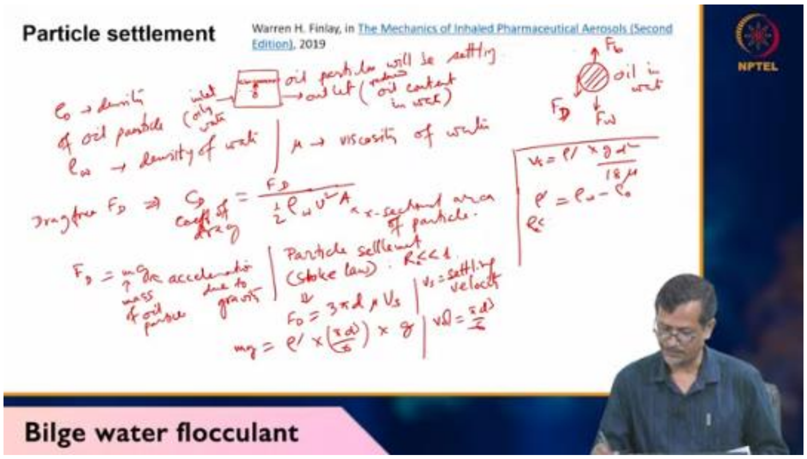
reduced oil content in water. Now if I know the settling time, settling time is very low then my separator sizing or settling tank sizing will be lower. but in some case if we have very large settlement time or the oil particle velocity very low in that case your tank size will be very high your large tank size required so for that we need to create one formula you may remember this is your particle and if particle is moving up let's say this is oil particle in water so oil particles moving up and water may be flowing down or may be fixed so in that case oil particle will have drag force f d drag and its own weight f weight and buoyancy force so buoyancy force is moving is pushing it up while drag force will be pushing it down and its own weight it will be downward so this way the particle be moving but it will get three forces.

Now, rho density rho p density of oil particle and rho f density of fluid of water I can write rho w that is better and rho p I can write And mu is viscosity of water. Because if water viscosity is very high, then particle will try to move, but it will get more drag force. Fd related to drag force related to viscosity. drag force Fd or drag force Fd.

from there Cd coefficient of drag or drag coefficient equals Fd half rho water u velocity a, a means area. It is completely sphere. it will be surface cross section area of particle. particle or oil particle okay what is continuous phase so water is not having particle now we are assuming and oil is having oil is the particle we assume the oil particle having spherical dia and spherical dia normally the drag coefficient in water will be like 0.5 or something okay now f drag fd equals mg m is the weight mass of oil particle g acceleration due to gravity.

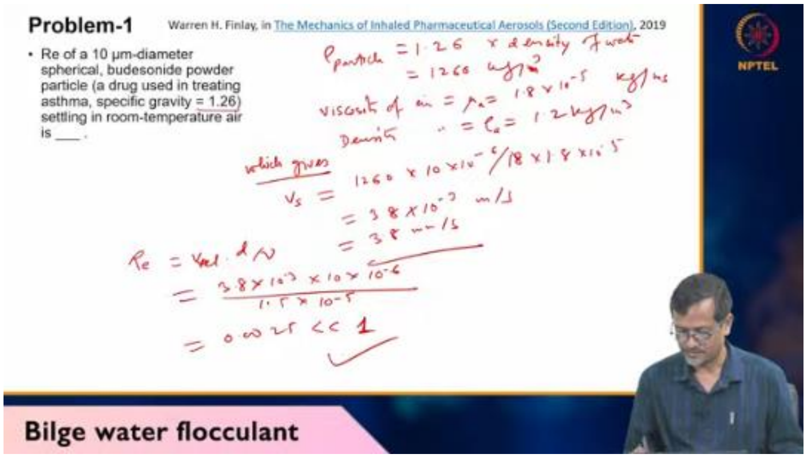
So, we have one Stokes law this is called particle settlement. Stokes law and condition is that Reynolds number must be very very lower than 1. Stokes law says Fd equals 3 pi d mu Vs or V settling. settling velocity. Now, mg equals rho particle means rho oil into volume, volume is pi dq by 6 into g.

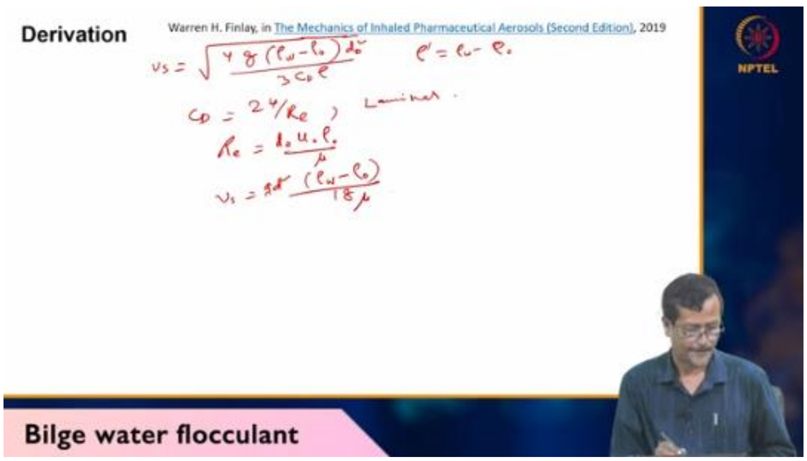
volume volume equals pi d cube by 6 now settling velocity vs your settling velocity is equals rho oil into g d square 18 mu so here mg equals should be rho dash rho dash. rho dash should be rho water minus rho oil. this is your formula. criteria is that R Reynolds number should be less than very very less than 1 and D should be more than mean free path.



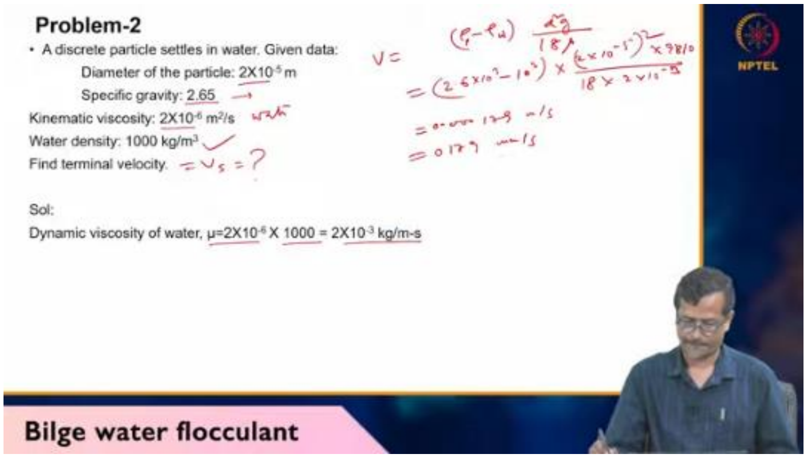
or in simplified form we can derive like this Vs equals root over 4 g rho w minus rho oil because rho dash we have written rho w minus rho oil d d oil square 3 c d rho. CD equals 24 by RE. This is laminar flow. RE becoming D oil U oil rho by mu. UVS equals G D square rho water minus rho oil by 18 mu.

let us take a simple problem Reynolds number of 10 micrometer diameter spherical powder particle in a drug okay specific gravity also given is settling in room temperature air so in that case instead of water they have taken some particle and it is air so to solve this one row particle row particle is given 1.26 into density of water equals 1260 kg per meter cube so viscosity of air equals 1.8 into 10 power minus 5 kg density of air density of air equals air air 1.2 kg per meter cube which gives which gives V settling 1260 into 10 into 10 power minus 6 divided by 18 into 1.8 into 10 power minus 5 kilometer second so this is giving 3.8 into 10 power minus 3 meter per second so equals 3.8 millimeter per second so reno's number v relative d nu equals 3.8 into 10 to the power minus 3 into 10 into 10 to the power minus 6 divided by 1.5 into 1 minus 5 this is giving 0.0025 so this is very very less lower than 1 so this is very assumption is correct because stock loss is it must be very very less than





one so you see another problem discrete particle settling in water given data diameter of particle and specific gravity it will be almost sand i think sand will be 2.6 so kind of viscosity is given for water water density also given so terminal velocity v s settling velocity of velocity have to calculate so dynamic viscosity water is given 2 into 1 by 6 into 1000 so 2 into 10 to the power minus 3 kg meter second and V equals 2.65, better we will write the formula, rho minus rho, rho particle minus rho water G D square 18 mu. so rho particle is given 2.6 into 10 to the power 3 minus 1000 or 10 to the power 3 into d particle size is given 2 into 10 to the minus 5 2 into 10 power minus 5 this should be squared and g value 9810 uh 9.81 okay and this one 18 into viscosity given 2 into 10 power minus 3. so this value is giving 0.000179 meter per second so it is giving 0.179 millimeter per second okay so coalescence uh onto particle are meeting each other they will make bigger particle so they have coalescence so collisions formula is like this t equals pi by six d power j uh so i'll write again t equals pi by six d power j minus d o j phi k s okay and it is simplified form t equals pi by six d power four minus d o power four by phi k s



if we make further simplification it will be like d bar 4 pi 2 phi k s okay so here do initial droplet size and after meeting they'll be growing so d is a final droplet size phi is a volume fraction of the dispersed phase how much this first phase is there this first is this one oil then k is empirical parameter of the particle system j is the empirical parameter more than three and depending on the probability that droplets will bounce apart from each other t is time to grow in size so when energy of oscillation particle will be oscillating inside the fluid so energy of oscillation is low j we can take 4 so in that case the formula will be simplified as t equals pi by 6 d power 4 minus do power 4 by phi ks so this will be a formula now do if do is very small then we can ignore And formula becomes T equals pi by d power 4 to phi ks after approximating it. this is called time to grow droplet.

in coalescence due to two coalescence. minimum time required this is t equals minimum time required to obtain a particle size Thank you.