Surface Facilities for Oil and Gas Handling

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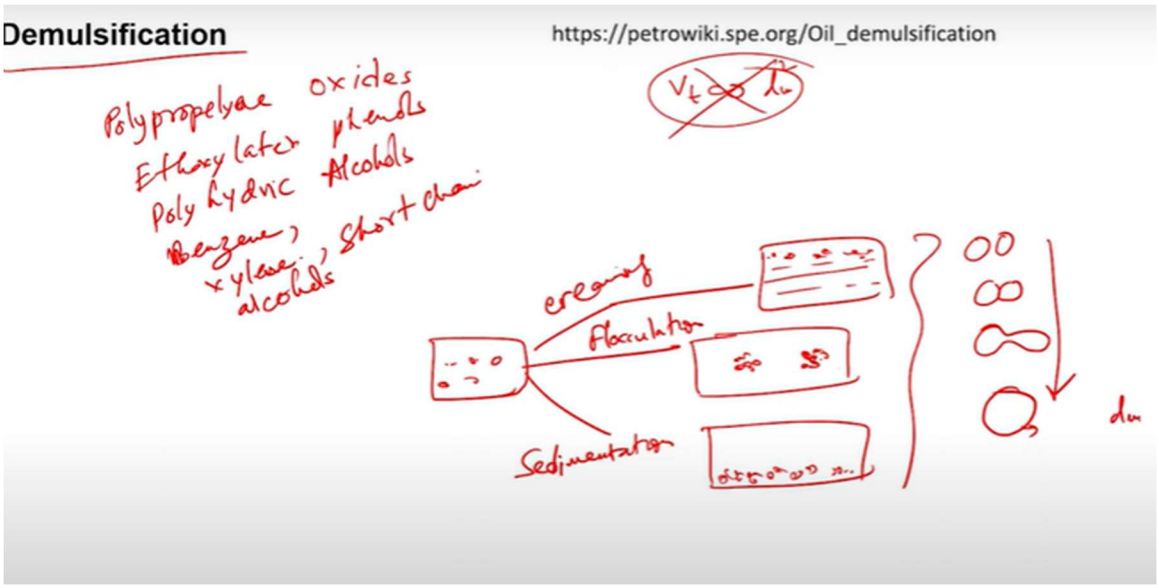
Principle Of Separation-02

Now, demulsifier, we have emulsifying agent. So, your particles are not getting bigger. So, your V t is becoming smaller because of the small d. Now, you want to remove this one and you want to make bigger d. So, the diameter should be bigger. So, particle settlement may be water particles, bigger water particles will fall quickly, and bigger oil particles will move up quickly if it is in water.

So, demulsifiers are also chemical, these chemicals for example, polypropylene oxide some example, polypropylene oxides, ethoxylated phenyl. One example you should remember polyhydric alcohol. Now, some simple names are like benzene, xylene, then short-chain alcohol, and co-holes. These are some examples of demulsifiers.

How it is happening? Let us say you have a water mixture, then one will be, creaming will be there, sedimentation and flocculation. So, how creaming is happening? If you have oil particles in water, oil particles will try to create, and float over water. Flocculation will be like this, particles will be joining somewhere like this. The sedimentation means it is just the opposite of creaming. So, particles will be like water in oil.



So, the particle will be trying to settle the bottom. So, altogether what they are doing? Initially when particles are agglomerating or coming together nearby, so they will try to touch each other. When they are touching like this, so slowly what will make like this, then it will make bigger particles. So, sequentially it will happen. So, lots of particles coming together, so it is there is a high chance that the particles will be colliding with each other.

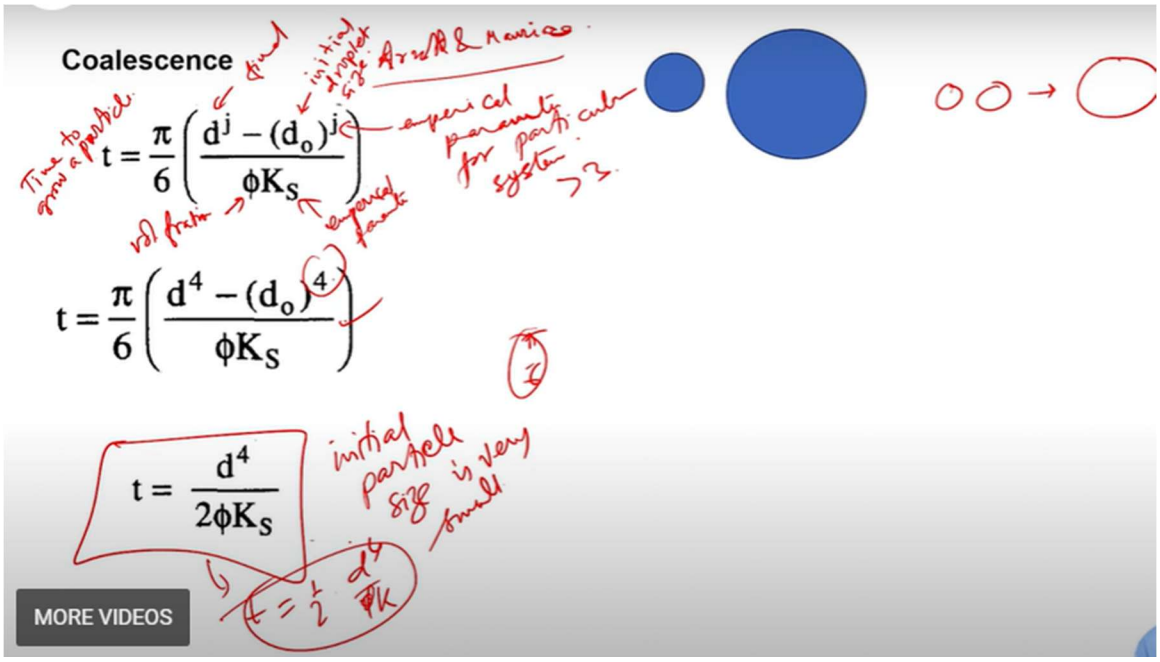
When they are colliding, they will try to make bigger particles. So, then you got a bigger particle, your DM increased, and you are happy. So, three things they say creaming, flocculation, and sedimentation. Whenever you are talking about coalescence two particles mixing making bigger particles and they are making bigger particles. So, coalescing, joining, agglomerating.

They have some formula like T equals pi by 6 d power j d naught power j phi k s. So, this formula is taken from your book Arnold and Morris, Arnold and Morris, surface production operation, this book. d o is the initial droplet size, droplet size, d j is the final, j is the empirical parameter, empirical parameter, the empirical parameter for a particular system, for a particular system. k k s also empirical parameter, empirical parameter. j value normally will be more than 3 and phi is the volume fraction, phi is the volume fraction and T is the time to grow, time to grow a particle, or time to grow droplet size.

So, this formula, if you have a higher volume fraction, so quickly it will be settling. So, the volume fraction is like a large number of particles there. That means there is a high chance that they will collide with each other very quickly. Now, this says that if you have j value 4, so in that case formula is getting changed like this. So, j power will be this and if d o initial particle size is very small, so they are approximating this one.

Initial particle size is very small and approximating pi they are taking around 3, so pi by 6 becomes almost half. So, that is why this formula is like this, T equals half d power 4 because d 0 is d 0 ignored and phi k s. So, that way they derive the formula. Now, if you can make collinearism is making two particles bigger, that bigger particle means you can use any technique to make a bigger particle. So, if you are increasing temperature you are changing viscosity also.

With temperature how viscosity changes? Mu, mu is viscosity. So, heavy, heavy crude, and other crude like light crude. So, in all cases you can see viscosity changing, viscosity reducing when if viscosity means resistance to flow, something is trying to move viscosity means pulling back. So, viscosity going down means that pulling back force is lower. So, increased temperature pulling of force is lower, so the settlement rate will be quicker.



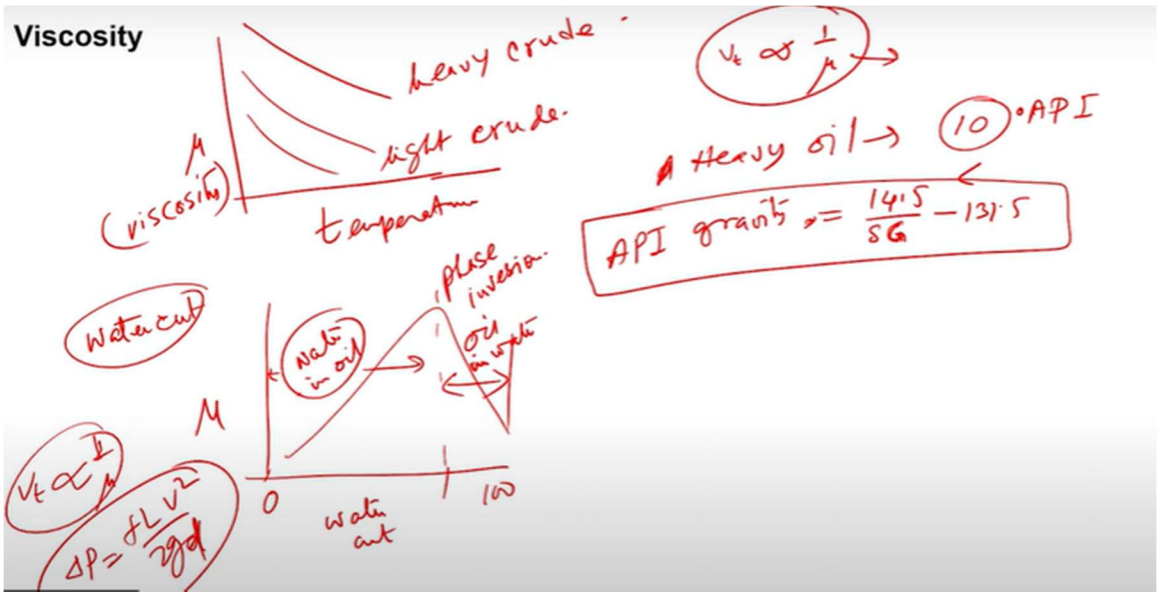
Whatever particle size is there if your bigger particle size is good, if you have a smaller particle size also viscosity change means your resistance force is changed resistance change

means quicker. So, V T, you can remember, is inversely proportional. So, terminal velocity or particle movement velocity will be quicker, viscosity changed viscosity why change because it change temperature. How you are changing temperature? You will have some heating mechanism using that one you are changing temperature and then viscosity. Normally this heavy oil, heavy oil API gravity will be around 10, if some API gravity, if API gravity is 10 it is the same as water.

If less than 10 then the oil will sink in the water, if more than 10 then the oil will float. So, this relationship is just the opposite, and API what is API? API API gravity, API gravity equals 141.5 divided by S g minus 131.5. You should remember the formula because every time you say API gravity, if you have if you are given S g specific gravity then you can convert it to API gravity.

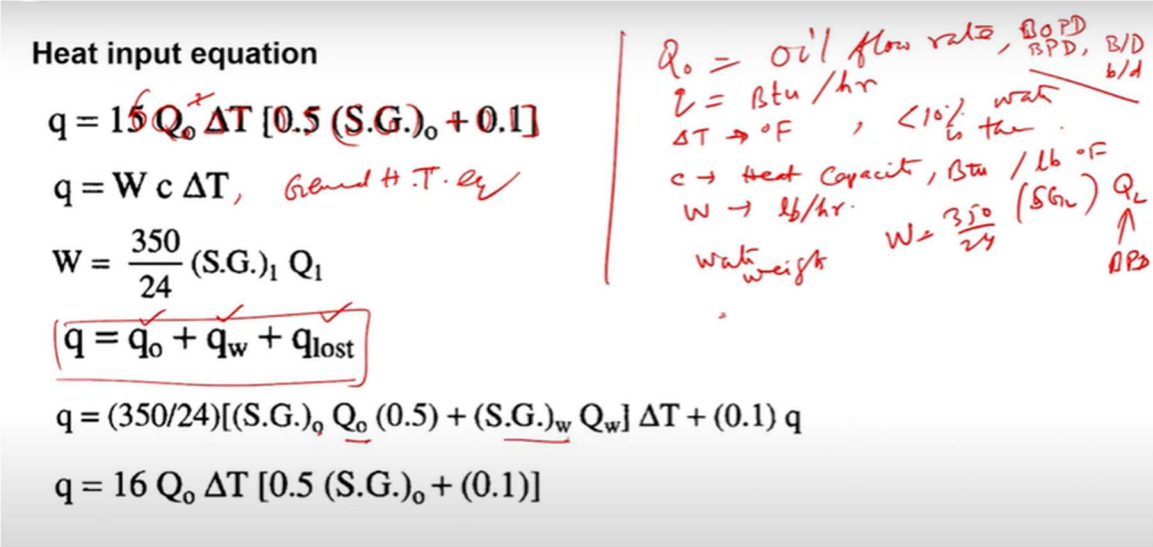
Now, here you can see if I put S g equals 1 it becomes 10 if right. So, if some oil has 10 specific gravity that means, it is equal to the same gravity as water it will not flow nor float not it will sink. So, phase inversion one term will be coming water cut. The term water cut means how much percentage of water there is in oil. This is 0 percent water cut means there is no water, and 100 percent water cut means there is no oil.

So, water cut means the percentage of water there in oil, and if I draw water cut 0, 100 water cut. So, viscosity apparent viscosity apparent viscosity will be like this. Around 70 percent the viscosity will be very high. This is called the phase inversion area when viscosity is suddenly changing that portion is called phase inversion.



So, in that case, what is happening initially low amount of water is there in oil. So, that is water in oil this is water in the oil area. But the oil percentage increased. So, in that case, this area is oil in water. So, now, you have more water and less oil.

So, it becomes oil is there in the water. So, oil in water emulsion. So, emulsion changes water in oil to oil in water. So, the change in the point is called the phase inversion point. So, knowing this one is important because whenever you are trying to calculate fluid flow through any pipe or any settlement or anything.

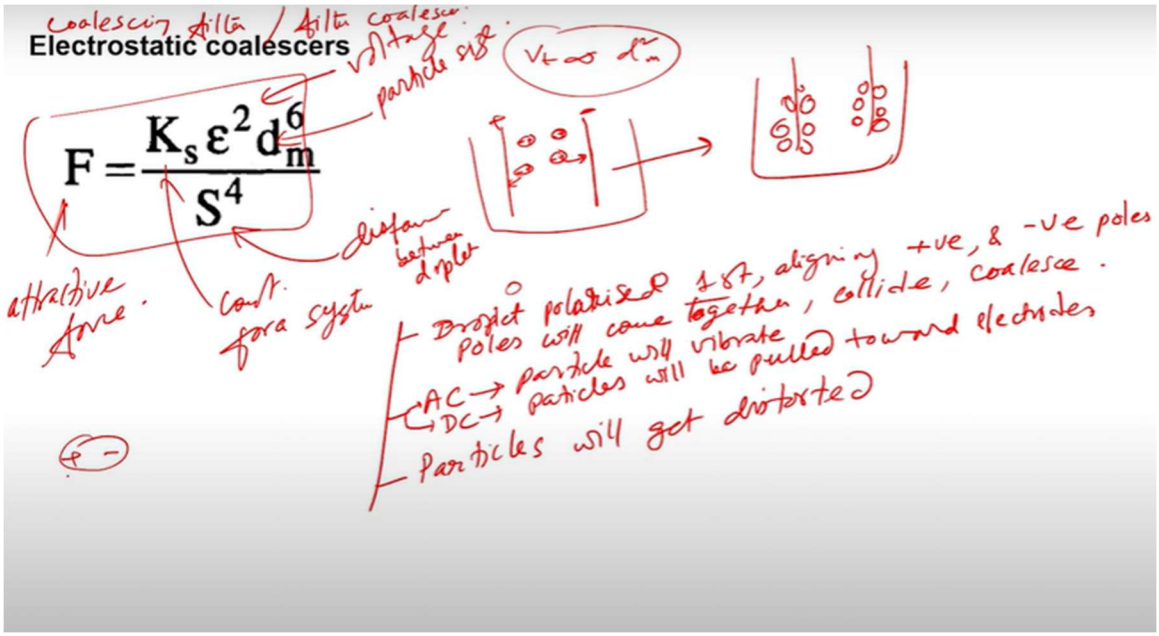


So, there you have to know the viscosity and water cut also. If water is cut your viscosity will change. When viscosity changes viscosity relevant to your fluid friction. You can remember fluid friction or you can see the formula also directly V T viscosity can change if you have emulsion. And if you have a pressure drop formula you can remember F L V square by 2 G D flowing through pipe friction factor length of pipe velocity of fluid G D.

So, F will be coming with viscosity F means friction factor friction factor is linked with viscosity. How is linked friction factor linked to the Reynolds number Reynolds number linked to viscosity? So, viscosity will give the Reynolds number Reynolds number will give the friction factor then your calconic pressure drop. So, your phase inversion or water cut percentage is playing a role there. So, water cut changing viscosity changing Reynolds number changing Reynolds number changing friction factor friction factor changing your pressure drop.

So, you create a certain pumping mechanism and you have a longer pipe and if you do not check the viscosity then although you have pumped everything around finally, you will find low pressure your target pressure is not getting reached because you did not consider the water cut percentage. So, that portion also you have to consider temperature. So, temperature changes viscosity already told and loss of volume this loss of volatile compare to going because of that volume will be lost from the liquid. So, loss of volume L O S S loss of volume will be there because low hydro low boiling point hydrocarbon will go off loss of income as gas will contain liquid.

So, you increase the temperature. So, some liquid gun to gas line. So, your income will be lower in oil when you are selling some oil already gun. So, you have to check that one also whenever you are heating for your viscosity changing. So, the temperature and loss of volume curve will be like this. So, if you increase more temperature your volume loss will be more and temperature will change your density also this is not time this is temperature.



So, density will reduce because of temperature the volume will expand. Why expanding because molecular resonance will increase if gas is there gas particle the burning motion will be increasing and if it is liquid in liquid case the particle resonance will increase. So, because of resonance it will take a little larger volume and it is a larger volume density reduced. The smaller volume is density high larger volume will be density low. So, increase

temperature resonance increase that is why volume changed volume change and density change you want to go.

Then a small portion is there I will complete I do not have many more slides I need 2 or 3 slides are there 3 or 4 slides are there maybe 10 to 20 minutes I will leave then I will complete this one. Increasing temperature will change your viscosity. So, when you are increasing the temperature of the oil and gas mixture or oil only. So, in that case, how much heat you have to put just try to get this formula. So, this formula is like Q 15 Q oil del T 0.

5 Sg of oil specific gravity of oil plus 0.1 this is the formula. So, this should be 16 this is flow rate Q Q o is oil flow rate Q o is oil flow rate this unit is BOPD BOPD here you can see I am writing BOPD I can write BPD or B by D. Someone will write in the small letter also. So, many types of forms are there, but many are the same barrel of oil per day. Some someone will write B by D or small all small BPD or BOPD.

Q small q is BTU heat required British thermal unit divided by per hour and del T is degree Fahrenheit units. So, whenever you are calculating you should know the unit. So, that is why I am giving all the units and we are assuming less than 10 percent water is there less than 10 percent water is there very small amount of water is there. And general heat transfer equation is the general heat transfer equation. So, C is heat capacity heat capacity C is heat capacity and the unit is BTU divided by pound degree Fahrenheit and mass LB per hour and del T degree Fahrenheit.

So, if we convert the unit we will be getting 350 by 24 because water weight W equals 350 by 24 SGL QL liquid. So, QL is BPD. So, Q is coming oil heat for oil heat for water and some amount of heat will be lost. So, all together is becoming like 350 by 24 SGL plus oil flow rate SGL water plus water flow rate delta temperature. In coalescing media, coalescing is you making smaller particles into bigger particles two or more particles combined and you are making bigger particles.

So, one way is the electric method you are using you are using a chemical method or using the mechanical method, or any other method you can use and you can make bigger particles. You can give longer time also. So, you can make bigger particles and particles settle because of the formula VT proportional dm square. Now how to do the mechanical

separation mechanism mechanical separation is like this let us say I have one layer here and fluid is entering here exiting here and lots of oil particles here. When fluid is moving up slowly very laminar flow you create laminar flow laminar flow.

So, what will happen because of laminar flow of oil particles slowly creates one layer here on the top? So, when oil particles create a layer two particles will create bigger particles because they are very much closer now when they are creating bigger particles. So, oil particles slowly can move up and water particles can go out and we can create a section. So, that way we can create some sections like this wavy section and you can give lots of surface area and the particles will be colliding with each other and we can create a laminar flow. So, that flow will create bigger particles and will be getting settled.

So, media is also very important where you are settling. So, if you are taking very big particles, particles are distant far away or whatever method you use your detection time will be longer. So, in the oil industry what they would do they will create a very thin section, and through a thin section, they will try to pass a fluid. So, when fluid passes through the thin section there is a greater chance that small particles will be colliding with each other when colliding with each other they will try to make bigger particles. So, bigger particle means quicker settlement maybe water or oil does not matter.

Common so, so a mechanical means it will be promoting coalescence, promoting coalescence providing large surface area, large surface area, and maybe common wood, common wood related coalescing media you can create, common wood or hay section you can create and you create resistance to flow or you create a very laminar very small thin section for laminar flow. So, that particle will be colliding and it should be creating a big particle. So, it promotes collisions, promotes collision. Electrostatic coalescence using electrical means you are trying to create larger particles. You are not changing viscosity or density or anything you are just trying to create larger particles.

So, that V t is proportional to d m square. So, V t will be larger because of creating bigger particles and how to create bigger particles. So, I have one electrode let us say this is positive this is the negative electrode. Now, I put in an emulsion where polarized water particles are there for example, and because of electric charge you are giving very high voltage you are creating because of high voltage these will be creating negative plus plus plus minus plus minus plus. So, the particle will be getting polarized, and when it is getting polarized so negative end or negative polar pole of the water particle will be attracted

towards the positive pole. So, here negative pole electrode is so my positive side will be moving here.

So, what will happen finally, is my electrode will have lots of lots of lots of lots fluid particles nearby. When particles are nearby they will try to collide with each other they will try to make a bigger particle they will get separated. So, one formula is here taken from again K Arnold and Morris's book attractive force is attractive force K s is the constant for a system S 4 is the difference between droplets distance between droplets distance between droplet and epsilon voltage you are how much voltage you are giving voltage gradient and dim is the particle size droplet size droplet or particle whatever you say particle size. Now, if you have a larger particle so force will be larger distance will be larger if you say s is very large then we force will be lower. So, particles are long distances which means force will be very weak particles very closer force will be very close so they will be colliding with each other quickly.

So, it will work three ways one will be that the droplet will be polarized first droplet will be the next step will be that it will align the positive and negative poles positive negative positive will create a pole and will properly come together poles will come together poles will come together and collide with the coilless. Now, you are giving AC voltage AC or DC voltage AC voltage what will happen particle particle will vibrate when two particles are vibrating there is a greater chance that they will collide, and if you are giving DC so particle will be pulled towards electrodes. And when you are applying high voltage particles will be destroyed distorted particles will get distorted. So, high force will be coming if you are applying very high voltage. If you see the e square term there that means if you are applying very high voltage your force will be also very high.

So, electrostatic coalescence is also called a coalescing filter. So, this is also called coalescing filter coalescing filter coalescence coalescer, or filter coalescer. So, coalescence means coming together or agglomerating water molecules in oil-polarized water particles as dipoles water particles create dipole plus minus two poles will be there one plus pole one minus pole with positive and negative ions. dipole force is generated between neighboring droplets pressing together. So, what they do in electrostatic coalescence is polarize individual particles then they will be moving to each other then it will try to squeeze together it will be polarizing then it will be trying to squeeze together.

So, then when they are squeezed together in between the layer thin layer of chemical will be reduced. So, it will be much thinner after a certain time the thin layer will get broken

and they will fuse and they will make bigger particles. So, this way the electrostatic coalesces also will not change any viscosity or density anything just it will make bigger particles using a high voltage of electricity.