**Surface Facilities for Oil and Gas Handling**

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**Desalting of Crude Oil-01**

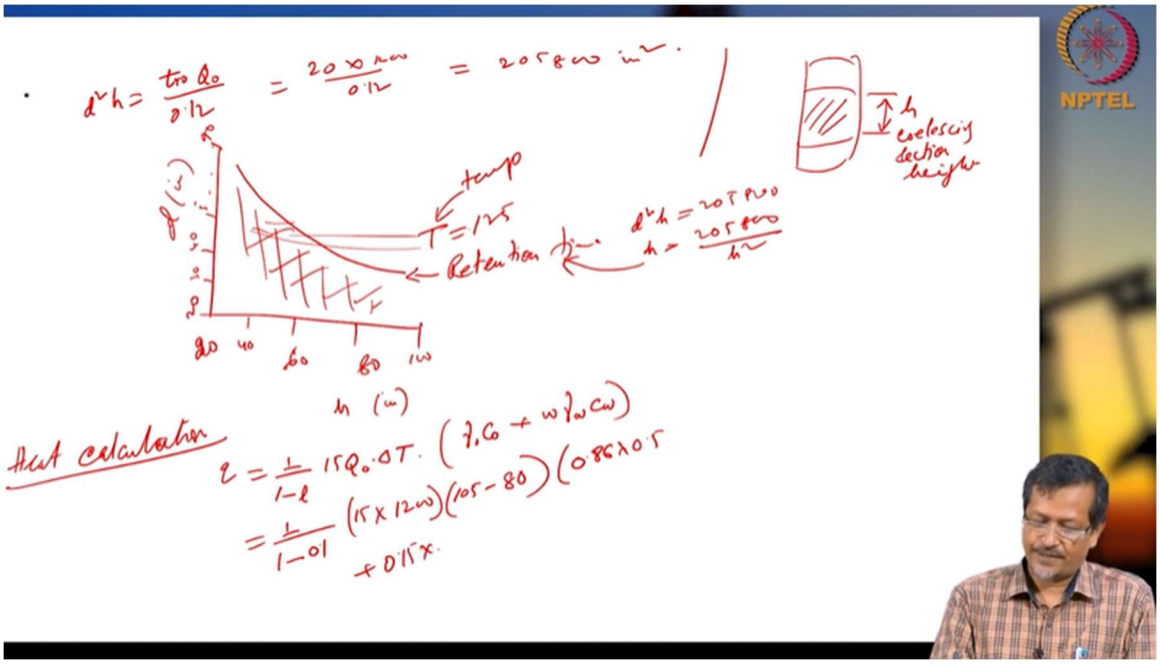
So, in previous lectures we have seen how to separate oil, water, gas ok. So, there are vertical separator, horizontal separator, spherical separator. Then we have seen there are emulsion treater where we add chemical, we add electro electrodes to remove water particle, we heat to change viscosity. So, electrostatic treater, static treater. So, electrostatic treater what does it do? It will be unstabilizing the electrostatic treater we apply high voltage AC or DC and using this one we try to separate water particle from oil. Now, heater treater, heater treater which is basically this will be changing viscosity of oil.

So, because when viscosity is changing oil particle whatever the water particle whatever there in oil. So, whatever you try to settle quickly viscosity actually resisting particle to move from oil to water zone, but whenever you are heating you are forcing oil to release water particle. So, that water particle can settle quickly or slowly and retention time will be lower. And another thing we have tried ok.

So, now, we have vertical separator, horizontal separator, two phase separator, three phase separator, we have gun barrel ok. So, main purpose of horizontal two phase three phase separator are there like you separate oil water gas. Now you got oil, oil will have lots of water particles sedimentation. So, that one have to separate. So, in previous lectures we have seen how we are separating water particle from oil.

So, when oil what oil water particle is getting settling down. So, your B s w is going down B s and w ok. B s and w, B s and w normally it will be like 0.2 to 2 percent approximately ok. Basically water will be there and some sediments and other thing will be there in that oil after separation.

So, that oil will be transported to your refineries. Now, if we have higher B s w. So, higher B s if B s w is there then your customer will not buy and some other issues will be there. If there is any ionic liquid, ionic salt let us say sodium chloride or calcium chloride or magnesium chloride that will be creating issue. So, that after separation also 0.




2 to 2 percent water B s w you got, still there will be certain amount of salt which will be hampering your separation and refraining process. So, in this lecture we will try to discuss how to separate that small amount of salt which is remaining still remaining in the oil. So, if salt content is more than 20 p t b, if salt content salt content is more than 20 p t b, 20 p t b pounds of salt this unit is unique unit this is called pounds of salt, pounds of salt in terms of sodium chloride, in terms of NaCl 2 sodium chloride NaCl per 1000 barrel of oil per 1000 of oil ok. So, p t b actually the full form will be pounds of salt per 1000 barrel 1000 barrel ok. So, equivalent to sodium chloride salt ok.

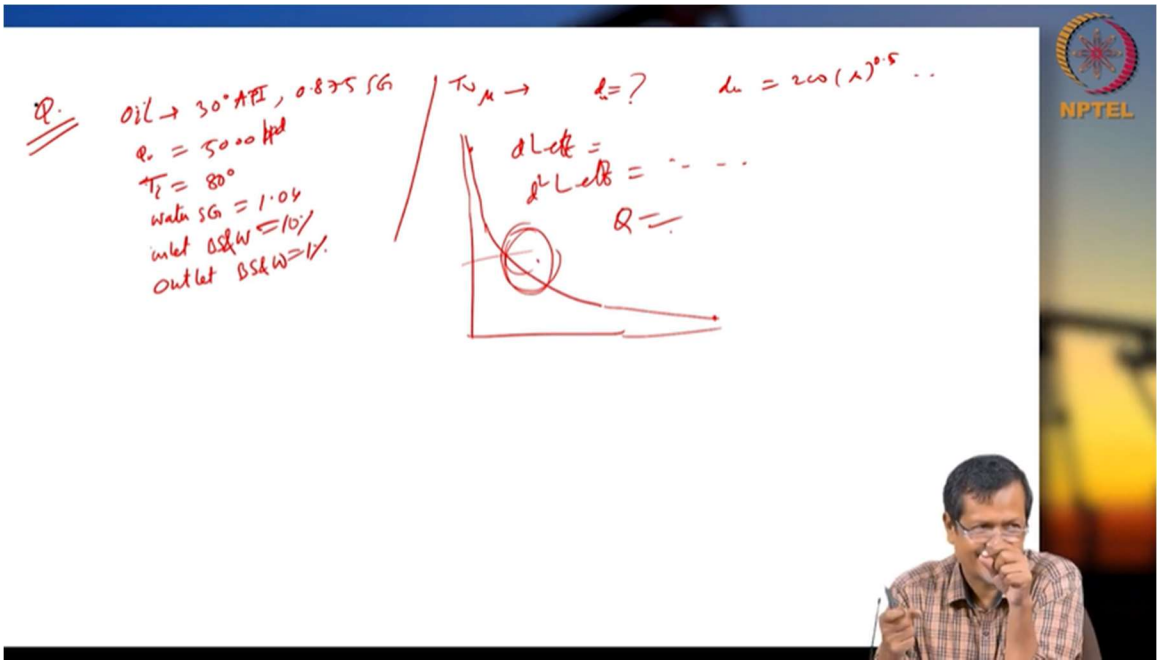
Now, can be done before refinery. So, refinery when there will be increasing temperature there will be certain issue if you have salt. So, what happens let us say if basically there will be sodium chloride salt, calcium chloride or magnesium chloride ok. Now, at high temperature calcium chloride will be broken it will be hydrolyzed let us say 350 degree centigrade temperature you have 35 degree centigrade temperature then CaCl 2 plus H 2

O it will create calcium hydroxide plus HCl ok 2 HCl and magnesium chloride plus H 2 O it will create magnesium hydroxide plus 2 HCl ok NaCl does not hydrolyze ok. If you see the periodic table periodic table NaCl potassium chloride sodium chloride it will be the top ok.

So, top based on your activity. So, chemically very much highly active sodium then after that sodium or potassium then calcium magnesium other molecules will come. So, if sodium chloride is there it is very much active. So, breaking this bond between sodium and chlorine is very difficult you need very very high temperature very you have to give some electrical mechanism or some other mechanism you can separate, but normally increasing temperature 350 degree centigrade it will not get separated, but calcium magnesium is a lower strength then sodium chloride they will be getting separated they will be separating chlorine and it will create calcium hydroxide magnesium hydroxide and acid. So, this acid will be creating problem acid will be reacting with metal and it will be creating metal salt this iron is there in separated in all the mechanical equipment basically iron will be using all the mechanical equipment basically iron will be used.

So, iron plus HCl it will be creating ferrous or ferric chloride. So, that will be softer than original iron. So, when the salt iron salt chloride is softer. So, it will create erosion and corrosion ok. When erosion is happening so, slowly it will be rupturing or it will be creating low strength system.

So, that can create burst or leakage. So, it will be creating multiple issue. So, you have to remove calcium or magnesium chloride this sort of salt. So, that acid creation will be stopped if you are not stopping acid creation then there will be other issue and again magnesium and chloride magnesium chloride or calcium chloride these salts will be getting deposited why if you increase temperature the water the salt will be there in water in soluble form. Now, water if you it if it gets vaporized because of high temperature then the remaining part will be salt the salt will get deposited at the bottom it will be crystallizing it will be deposited.




So, it will be creating fouling on the surface of metal this heat exchanger surface or other surfaces it will be creating one layer that is called scaling or fouling ok. So, that will change your heat transfer property or it will be blocking the flow path ok, where fluid is flowing and slowly the deposition happening. So, because of deposition the pipe will be blocked heat transfer characteristic will be changed pure metal will have higher heat transfer rate, but when you have salt deposited on the metal surface heat transfer rate will be going down. So, that will be another problem. So, you have to remove the salts then you can use the oil for refining or fractional distillation in the refineries.

method of reducing PTB is referred to as a oil dehydration. So, this method is called oil dehydration ok. And normally the normally the separator the refinery people they will ask to reduce PTB ok. How much pound of salt is there? So, that you have to reduce. So, around 5 to 10 PTB ok, but if you are having very high amount of PTB.

So, in that case the surface production operation those people should be separating then they will be transferring to your customer in refineries ok. Refinery they will have also desalting equipment. So, this desalting equipment can be placed in refinery or in surface separator operation where on the surface the upstream people they will be separating. But many cases upstream people will be doing this will be doing this work and next level final level will be done by your refinery people. So, common salt specification will be 10 PTB 10 PTB in SI unit it will be like 0.

003 kg per meter cube of oil ok. So, this much of allowed maximum. Desalting removal water as much as possible. So, in your heater, teeter or gun barrel actually you remove water when you are removing water actually salt also will get removed. But still salt concentration is higher than again you have to put some extra water that water wash or washing water.

So, using water you have to dilute the salt and you have to remove the water again from oil. So, higher concentration of salt is there you add more water. So, the water whatever you are putting into your system that water should have lower amount of salt ok. So, after that lower amount of salt will be dissolving the higher amount of salt inside your separator system then remove the water again. So, that what removed water will have higher amount of salt concentration that one you dispose or you reuse for some other purposes ok.

So, whatever water you are using for washing the criteria is that it should not have any H 2 S component or it should not have any ammonia component or your ppm parts per million salt concentration or debris concentration should be lower. Otherwise this salt whatever you are putting in as fresh water and water for water washing or water bathing. So, that water will be creating further problem. So, you have to remove all the salt then you use for your water washing and remove your salt for desalting operation. Because of very low water is required the crude oil is pumped through the desalter at pressure above it bubble point pressure ok.

So, above bubble point pressure you are pumping fresh water and crude oil ok. So, pressure you are increasing little bit then this fresh water and crude oil both water will get mixed somewhere that mixed fluid again you are giving some electrostatic teeter and other treating mechanism and you are separating the remaining salt and you are reducing salt p t b to 10 or low. Salt will be doing some more action also salt will crystals will be deactivating catalyst bed and it will be plugged down stream processing equipment in the refineries ok. So, in refineries there will be catalyst to convert crude oil to different component.

So, that will be deactivating. So, that will be another problem. So, first you have to remove salt means surface production operation people will be doing some part maybe some part will be done by a refinery people or maybe surface production operation salt removal part

will be enough for a refinery application. Desalting removal of water as much as possible a typical horizontal electrostatic heater used for desalting operation. So, electrostatic heater along with sometime along with some chemical you have to add and heater heater also will be there. So, heater heater chemical for deactivating your emulsifying agent heat to change your viscosity then electrostatic separator system you use.

So, that small small particle will get separated from the crude oil and your total salt content will be going down. So, here one example heater heater I have taken from netcode dual frequency electrostatic heater you can see this is slumberj website I have taken. So, input voltage you can see 380 to 480 voltage output voltage 74 and the ambient temperature minus 4 to 131 degree Fahrenheit you can wait it can work ok. And this netcode dual type electrostatic heater is having AC plus DC both type I think you can remember in the previous lecture I told like I will have one AC section one DC section AC DC. So, DC section small small particle will be polarized and it will move towards electrodes ok.

But in AC section you are giving alternative frequency. So, large amount of oil it will be having oil water particle will have will get distorted and it will be vibrating continuously it will get distorted when it is getting distorted in more possibilities that they will be colliding each other they will be getting making bigger particle they will be settling at the bottom. In DC section if you have very small small particle you apply very high voltage and particle will get ionized those ionized particle will move towards electrode. And when they are moving towards electrode they will be colliding more they will be getting bigger particles they will fall down slowly it will be moving down and it will come to AC section where larger water per amount they will get distorted the particle will be getting distorted and they will be colliding and they will be getting bigger particle they will be settling down. So, this netcode dual frequency system will have AC DC both system.

So, that small amount water and larger amount of water in oil both will get separated. So, mixing equipment now I said like water fresh water and oil should be mixed. So, how it will be mixed? So, normally they will be using one globe bulb globe bulb. So, how this globe bulb works? So, globe bulb will be like this it will have pipe like this then then it will have pipe cross section then like this one stem will be coming one plug this is called plug ok this is called plug. So, plug will be blocking this flow path and one stem is coming and this is called bonnet ok.

So, bonnet will be blocking the path and there will be one knob ok from where you can turn this is stem and fluid will flowing like this ok. So, inlet outlet and if you rotate the knob actually. So, if you rotate the knob. So, knob will be closing this flow path ok close 0 opening. So, you can control how much fluid you can pass through this globe bulb this is called globe bulb ok globe bulb.

So, this will be controlling flow and it will be helping in mixing of oil and fresh water. So, how this fresh water and oil will be mixing? So, normally there will be one pipe coming like this then inlet flow will be there then you can see this ok. So, oil in. So, oil with higher percentage of salt higher percentage of salt percent of salt will be coming and there will be diluting water diluting water. So, this diluting water will have lower amount of salt concentration ok.

Now we are injecting through this and this diluting water will be passing through some nozzle lots of nozzles will be there ok. So, nozzles are there. So, it will create spray. So, it you are creating spray means you are getting lots of small small particle ok. Lots of small small particle of water it will be mix up with main oil stream and it will go through this mixing chamber mixing section ok.

So, when it is going through mixing section lots of mix mixing will happening lots of small small particle will be create oil and water and oil water will be mixed up ok. So, this is nozzle or injecting nozzle injecting nozzle ok. So, water water is coming here it will be spread from here. So, it will be you are injecting water a small small particle. So, it will be washing the oil which is having lots of salt.

So, salts will be diluted when diluted it will be settling down and your total amount of salt will be going down. So, this schematic spray nozzle system spray nozzle system ok. This is mixing section or mixing valve. Now, from mixing valve mixing section it will go to your yeah.

So, this valve section actually this one ok. Now, how this fluid mixed fluid is coming out from your globe valve how it will be mixed into your separator. So, your separator is like

this ok. Separator will be going like this and it will be spreading inside separator electrode will be there this is electrode ok. Electrode is here one electrode is here ok and this water crude crude is going through this ok and water will be going out from here electrodes are there then desalted desalted oil. So, desalted oil it it will going out from here and maybe in some cases you can inject steam also.

So, you can control temperature ok. So, this is water layer. So, water oil interface this one water oil interface ok. So, you can see this crude oil moving through this pipe and it will be getting spreading here when spreading here there will be two electrode positive and negative using the positive electric negative you are separating small small particle and oil will be creating layer over here ok. So, the oil you can take out from the top section and water heavier. So, that will be creating a layer at the bottom from bottom you take water out.

So, this is simplified diagram of a electrostatic treater. So, these electrodes are there. So, electrodes are separating ok. This is figure simplified diagram of a electrostaticdissolter ok. So, here fresh water or dilutant water is inevitable actually.

So, that you can dilute and you can remove the water and you are removing amount of salt and B S double also going down. Pressure drop through the mixing valve varies from 10 to 15 psi ok. Pressure drop through pressure drop pressure drop through mixing valve is 10 to 50 psi ok 10 to 50 psi required pressure drop can decrease by installing pre mixing device. So, in that case we have pre mixing device like nozzle we have put.

So, this will be this is reducing your pressure drop ok. So, valve will be shearing the droplet. So, pre mixing is you are mixing oil and water, but valve will be shearing the droplet will make very small particle, but if it is too small particle too small particle again you can remember the settlement formula V T. So, too small particle will have difficult in separation ok. So, there is also one negative. So, your intention should not be to create very small particles other smaller particles.

So, that proper mixing can be possible and fresh water or low salt concentrated water can interact with the higher constant of water and they can get settled out. So, properties of crude oil if you see water in crude by percentage volume 0.

1 to 2 percent, average 0.3 to 0.5 percent ok. This section I have taken from one book Nelson petroleum refinery engineering and salt content P T B 10 to 250 ok and average will be 60 to 130 salt concentration 0.4 to 25. So, in PPM if you see 4000 to 250000 average value of the P T B some typical oil Middle East oil 8 Eastern is Texas Texas is higher actually Gulf Coast and Canada there is heavy oil is having very much high salt content 200 P T B ok. In that case you may need very higher amount of temperature increase ok.

One problem is here ok. So, find P T B of a crude oil crude oil having 10 percent volume of remnant water. If it is concentration is estimated to be it is concentration is estimated for 40000 PPM at 25 degree centigrade ok. So, to find this P T B actually there are some charts some formula also there. So, we can use chart also ok.

So, 0 to 20, 40, 60, 0, 40, 60, 80, 120, 40, 80, 120, 160 ok. Y x this is salinity of 0.5 percent of brine 10 power 3 into PPM equivalent NaCl ok. Now, y axis is 20, 40, 60, 80. So, this equivalent NaCl in P T B equivalent NaCl in P T B P T B.

So, this curve goes like this. So, 160 is just crossing and ok it is going like this. Now, this figure shows salt concentration of crude oil concentration of some concentration of crude oil P T B as a fraction of salinity of it is remnant water. Remnant water 0.1 percent or 1 by 1000 by volume remnant water ok. So, P T B of crude oil having 10 percent remnant water with 40000 PPM salinity is found to be 14 P T B.

## Properties of Crude Oils Shipped to Refineries

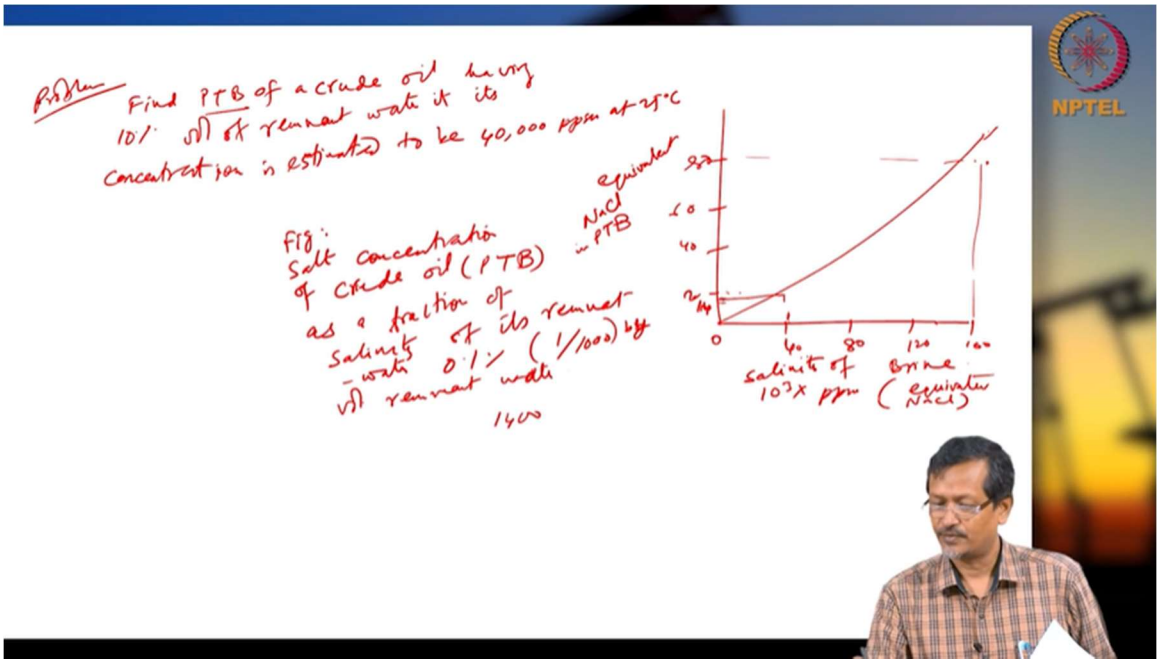
| | Range | Average |
|---|---|---|
| Water in crude, % by volume of crude | 0.1–2.0 | 0.3–0.5 |
| Salt content in crude, PTB | 10–250 | 60–130 |
| Salt concentration in brine, wt% | 0.4–25 | — |
| Salt concentration in brine, ppm | 4,000–250,000 | — |

## Average Values for the PTB for Some Typical Crude Oils

| Source of oil | Avg. salt content (PTB) |
|---|---|
| Middle East | 8 |
| Venezuela | 11 |
| United States | |
| Pennsylvania | 1 |
| Wyoming | 5 |
| East Texas | 28 |
| Gulf Coast | 35 |
| Oklahoma and Kansas | 78 |
| West Texas | 261 |
| Canada | 200 |

Nelson, Petroleum Refinery Engineering, 4th ed., McGraw-Hill, New, York, 1958.

You can see this figure this is 14 actually. In actual drawing in book it is 14 ok. So, my drawing little bit different. So, 14 right here within that one. For crude oil containing 10 percent eminent water the value P T B is coming 14. So, given crude oil is 1400 P T B ok, because here you have to multiply by 100.




So, it is coming 1400 P T B P T B ok. So, they have written that you have to multiply by 100. So, it will be 1400 P T B.