Surface Facilities for Oil and Gas Handling

Prof. Abdus Samad

Department of Ocean Engineering

IIT Madras

Crude Oil Storage Facilities-01

Good morning everybody. In previous lectures we have seen how to separate oil, gas, water, sand. So, whenever we are getting oil, water, gas mixture with sand also. So, we pass the fluid through separator systems. So, maybe vertical separator, horizontal separator, then there will be gas separation separately, gas heating system, amine heater or there will be water removal systems. From oil also there will be water removal system, the sand removal system, water disposing system.

Then after doing all those things you got pure oil or crude oil. So, that one you have to store before sending to your refineries. Even in refinery also when they receive from oil field crude oil they will have to store somewhere ok. Then they will be sending to this fractional distillation system.

Fractional distillation system means actually you have to separating diesel, oil, kerosene, naphtha all the things that you are getting you are separating. So, then how to store it, what are the design system required for your oil storage system, what are the criteria we will try to discuss in this lecture. So, production, refinery and distribution system of petroleum ah of petroleum products or maybe I can say oil, crude oil require storage tank ok. So, small bolted welded tank possible. So, this can be used in production field, large welded tanks, distribution terminals and refineries can be used ok.

Ah Oil storage tanks are typically made up of carbon steel, stainless steel, industrial strength, plastic, reinforced concrete ok. So, whenever talking about steel and carbon steel I think you may have idea about material science, pure iron is very much corrosive ok. So, you can create give small amount of carbon content in there like 0.5 percent something, then you can create mild steel. So, mild steel very easy to manufacture it is very much ductile malleable.

If you manufacture using mild steel anything like a pipeline system, your surface production systems anything. So, it will be very much corrosive. So, very much corrosive means that will be dangerous for your system that will be giving like contaminant of iron oxide and it can be leakage fracturing possible. So, we should not use mild steel. So, we will have to go towards stainless steel or carbon steel that area.

Carbon steel means carbon amount will be larger amount and you want to reduce corrosion ability. So, you add chromium ok sometime. So, you are adding carbon, chromium, sometime nickel, molybdenum, some other components also you are adding to change iron property. If you are not changing, if you are keeping it pure form is very much corrosive ok. So, that is not useful for your system.

So, Fe plus H2O plus ah iron plus water it will create ferrous oxide and ferric oxide. So, salt is very much softer. So, you you are you are not using mild steel actually ok and even carbon steel and stasis other steel also you are using many time you use galvanization or surface coating will be using sometime will be using painting also to protect the surface ok. For example, pumping system you are not impeller you are using. In impeller you are not using any coating, but impeller material should be such design such way or impeller material should be considered in such a way that there will be no corrosion, erosion will be minimized ok.

So, that it will be lasting longer and there will be no failure. So, there will be some life time next 2 years or 5 years or 3 years. So, within that period it should not fail or it will not get eroded or corroded. Your surface production system tank battery or tank systems also you should consider material properly otherwise there will be erosion, corrosion and a system will not last longer and that can give accidents also ok. If there is any fire source and lots of vapour going out in the atmosphere then there will be big accident.

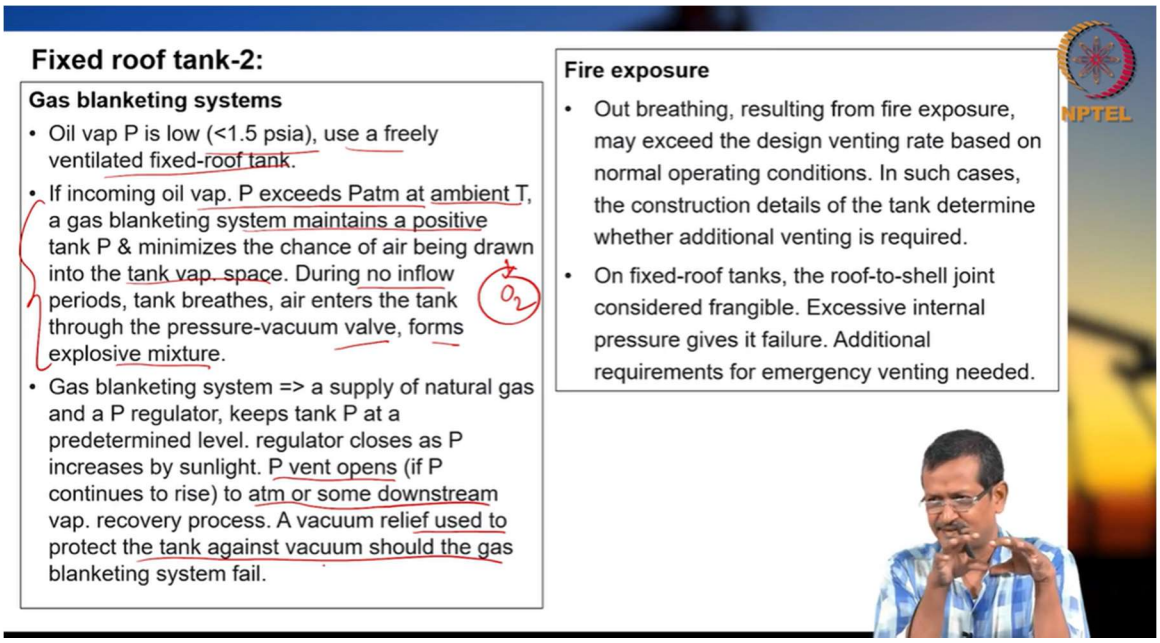
So, to avoid that one how what the parameters to consider I will try to discuss. And many cases plastic tanks also used, reinforced concrete also used and if you consider older days people were used to used to use the wood ok, wood based tanker system. So, later they thought like wood is very lower level thing it cannot withstand very much high pressure and fire also will be will be one problem. So, they moved to metal side and metal side also metal is very much heavier. So, they moved towards reinforced concrete FRP ok, a plastic made system also there, but again plastic when you are using temperature also one problem ok.

If temperature is going very high then your ductility will change or leakage can be possible or a small fire high temperature is there it will be melting quickly right. So, there are positive negative aspect in both side like metallic or non metallic you want to use, wooden people are not using these days ok. People using metal or plastic or reinforced plastics ok. So, plastic will be some metal viscous and they will be making stronger. So, plastic property they will take and metal strength also they will take.

So, together they will make reinforced plastic ok. Sometimes this FRP fiber reinforced plastic. So, lots of fiber metal fiber will be there and outside like tire if you see if you cut in a tire there will be lots of wires small small wires cotton will also be there right. So, they will make stronger, but if you see rubber tire actually made up of rubber, rubber is not having good strength like tensile strength it will break quickly. So, they will be putting like cloths or maybe metal wire.

So, it will make stronger. So, similar way the the reinforced plastic will be making like metal wires and other things will be there. So, that will be giving you high strength tensile force actually and you will get property of plastic also. So, that way they are making the tanks. And basically I did not take from any single document I have taken from many document to prepare this lecture.

So, particular engineering handbook chapter 3 also illustration system some information will be there a similar system similar information is also there petro wiki website also there. And figures I have taken from different sources I have given source also you can click there and you can read more information ok. So, type of storage tank storage tank different size and shape possible 500 barrel to 5000 5 million barrel also possible ok. Special applications rectangular horizontal cylinder possible horizontal spherical full pressure storage hydrocarbon or chemical products will be there. If a very large storage tank will be used for like refinery side, but for your production side will be smaller size normally ok.



Atmospheric low pressure tank widely used common low pressure tank means like atmospheric pressure. So, you are not giving extra pressure in the tank ok you put fluid and you are not giving extra pressure. So, that is atmospheric tank ok. So, inside tank pressure here inside pressure and outside atmospheric pressure will be almost equal ok. Second shape can be vertical cylindrical or circular shape vertical shape will be there gross capacity 100 to 1.

5 million barrel ok. So, you see this so big million barrels not 150 or 15000 ok. Cosminding tank size ranges from diameter will be 10 feet minimum to 412 feet ok. So, it is so huge. So, more than 100 meter right 412 feet means around 150 100 to 150 meter diameter. So, this is yeah diameter ok.

So, small 10 feet 200, 400, 12 feet that much of diameter possible ok. And whenever considering tank so you have to understand different fittings equipments ok. So, one thing here left side I have drawn this one this is called cat and mouse type level indicator like inside tank how much fluid is there is a complete metal you cannot see from outside ok accessing is not so easy ok. So, you put like say liquid level is here ok you have one small float ok. So, liquid level is moving up this float will be moving up and there will be some pulley system here ok.

So, pulley will have a one mass ok when liquid level is moving up the mass will be going down ok. So, this is called a cat and mouse type level indicator ok and there will be scale around here ok. So, you put scale 0, 1, 2, 3, 4, 5 ok accordingly you can. So, so scaling also you see from opposite way you have to give from not from bottom 1 to 3 from top you have to start then you can see how much fluid is there right it will be easier to read ok. So, there will be level indicator there will be hatch, hatch means accessing there inside tank what is there how much fluid is there fluid property measuring those things should be accessed from certain point ok and this is completely metal or maybe plastic or in reinforced plastic ok.

There will be vent venting system venting system will be required because if there is vapour ok. So, vapour is will be getting accumulated. So, vapour should be vented out properly if you are not venting properly then pressure difference it will be sucking atmospheric air. So, when air is sucked and vapour is there. So, vapour and air it will be creating combustible mixture if there is any fire source from anywhere the whole thing will get busted ok.

So, vented system there may be flame arrestor ok. So, when vapour is going out and if there is any fire source. So, outside flame will be there, but the flame should not enter into the system ok. If flame is entering then done ok ah then there will be inlet port outlet port many ports will be there pressure sensor will be there temperature sensor will be there. So, all the system will be fitted in your tank tank system ok.

These things these pictures I have taken from saferac.com and instrumentation tool.com these two ok. Now, there will be different types of tanks fixed roof tank fixed roof tank is like simple cylinder and roof is fixed roof is not moving or anything ok.

So, this is called fixed roof tank. So, dynamic roof another type of tank will be there dynamic tank roof will be like this or roof will be there and liquid is here ok. So, you inject more liquid roof will be moving up ok. So, roof will be moving up again roof will be moving down if you if you were removing ah liquid or oil from there. So, roof will be going down. So, there will be floating roof ok ok and in fixed roof ah roof is not moving roof is not moving ok.

So, dynamic roof ah rises and falls depending on the oil level ok. So, this floating roof or dynamic here the term is used I will write floating also ok. So, floating roof roof is

moving up and down. So, roof will be designed such a way that will be move up and down ok the purpose I will explain later ah. So, it will be minimized wafer accumulation reducing evaporation loss evaporation when a fluid is there inside tank.

So, fluid particle will be leaving surface and it will be accumulated in the vacant space ok. Like say I have one fixed type roof and liquid is here. So, this area lots of vapour will be there ok. Now, ah if I have fixed roof ah floating type roof ok. So, this upper surface of the liquid I am not giving it free ok.

So, the vapour will not be leaving the surface, but in this case vapour is leaving the surface and how much it will be how much vapour will be leaving. So, it will be creating one liquid equilibrium what will happen let us say one vapour particle leaving one vapour. So, many vapour particle will be leaving it will be filling the space and some vapour particle because of a branion motion some vapour particle will be falling down on the liquid surface also. So, that process will be continuing just call a dynamic equilibrium condition ok. So, in that vapour space will have certain amount of vapour that fixed amount of surface ok, ah, but if you have that floating roof the floating roof means it is not allowing vapour particle to move up ok.

So, the vapour particle they they will not get any brownian motion ok. Brownian motion is you will be leaving then it will be moving randomly right, but when you have fixed floating roof touching the surface particle not leaving. So, there is no brownian motion. So, vapour ah loss will be lower ok in floating case. So, common in production facility ok use vapour pressure less than 0.

1.5 psi common it is common in production facility vapour loss can be high during tank filling during tank filling operation ok. When ah tank is getting filled let us say initially tank is half filled some portion fixed roof tank is there some portion is filled with vapour ok. Now you are filling the tank. So, that vapour must be going out because you are filling liquid right. So, 50 percent less filled with vapour 50 percent liquid you are increasing liquid level.

So, that must be going out then liquid can be filled ok. So, internal floating roof reduces the vapour loss internal floating roof is there. So, the I do not have that much free space. So, just you fill it.

So, there is no loss ok ah. Fixed roof tank low hydrocarbon vapour pressure or vapour pressure close to atmospheric pressure ok. So, for for that you are using fixed roof tank ok ah. With a very high volatile liquid you are putting in tank then in fixed roof tank actually you will have lots of vapour. So, losses will be higher ok. So, in that case you can use floating type floating roof tanking system ok.

Another system is that bundled oil tank. So, tank within a tank. So, just for safety purpose. So, one tank is there outside there will be another tank. So, if any spill or leakage is there. So, tank or system can be safe ok preventing oil from seeping into the surrounding ok.

This is called bundled oil tank. So, fixed roof tank they will have one gauge hatch. Gauge hatch means if you see the definition gauge hatches are designed to provide accessible entry for inspection, measurement and sampling inside. So, tank is here ok. So, tank there will be this this system will fitted somewhere ok. So, that handle is there just remove it then you put your probe to measure you see the liquid level how much water is there water and ah because water will be also getting deposited at the bottom.

So, that level you can check you can measure you can create you can check sample quality of oil ok. So, that you can access from this one because whole tank will be completely closed ok. So, you will have some specific because 412 meter that the fit that much of diameter you cannot access randomly here and there ok. There will be some ladder system outside from ladder you enter and you access through hatch and you check your fluid thing ok. So, gauge the tank determine water presence if water is there measure the height of the oil water interface take sample of crude oil ok.

So, basically these things will be done using your gauge hatch ok. So, filling and pumping operation oil removed from the tank air drawn into the vapour space create a hazard ok. When you are filling ah oil ah that vapour space the vapour will be getting removed right. So, that will be creating going outside. So, that can create hazard if there is any fire source anywhere.

So, that can be dangerous even you can remember few years back there was instruction in petrol pump area you should not switch on your mobile ok. And now I think things are better ah because mobile ah when if any ringing is there that will create some small spark that that spark created some fire actually in petrol pump area because petrol pump area means when it is filling you are filling in car or bike. So, some vapour will be in the atmosphere nearby ok. So, just prevent the government instructed and not to use mobile phone inside petrol pump area ok.

I think that instruction has removed most probably. Tank filling ah ok tank filling evaporative breathing increases breathing means like when tank is there. So, during daytime temperature will be very high because of direct sunlight falling on this. Again night time maybe temperature will be going down. Temperature going up and down and that vapour space vapour will be expanding and contracting again fluid temperature increasing that will be leaving more vapour. That means, some inside vapour space the pressure will change actually when pressure is changing.

So, some vapour will be going out again temperature going down air will be sucked ok. When air is sucking that you have to control actually if because air and vapour mixture will be creating combustible mixture ok. So, that will be dangerous. So, during time filling evaporative breathing increases oil added to the tank displaces air vapour mixture through the tank vent resulting significant evaporative emission ok. And yeah so you have to check hazard part and how much losses are there because of evaporation because during filling some vapour will be going out during temperature change daytime or pressure change the some vapour will be going out.

So, that also you have to consider when you are considering any tank system ok. So, fixed roof tank so, sometime they use gas blanket system. So, gas blanket system is artificially they will be increasing some pressure inside tank ok. So, that there will be no extra air, air means oxygen mixed nitrogen oxygen plus nitrogen plus all the mixture should not enter into the system.

So, inside pressure you keep little bit higher. So, outside fluid air will not enter in the system ok. So, oil vapour pressure is very low use freely ventilated fixed roof tank if incoming oil vapour exceeds atmospheric pressure at ambient temperature ok. A gas blanket system maintains positive tank pressure and minimise the chance of air being drawn into the tank vapour space ok. Air means actually basically this is the

dangerous thing ok. Oxygen in mixing nitrogen inert gas so, it will not be creating any trouble, but oxygen is trouble ok.

So, during no inflow period tank breathes air enters the tank through the pressure vacuum valve forms explosive mixture ok. So, gas blanket system a supply of natural gas at a pressure regulator keeps tank pressure at predetermined level. So, tank pressure you are keeping at higher level. So, that incoming in breathing will not happen ok. Regulator closes as P increases by sunlight, P vent opens if P continues to rise to atmospheric or some downstream vapour recovery process.

A vacuum relief used to protect the tank against vacuum should the gas blanketing system fail ok. If gas blanket system is failing then you have to have some alternative option ok. Because, gas blanketing system means you are giving extra pressure because of failure if you are getting extra air sucked. So, you have you must have an alternative arrangement for safety purpose ok.

So, you are giving all these things for safety reason ok. So, sometime losses can be allowed, but safety cannot be compromised ok. Because safety compromise there will be the severe consequences you say political and social issues may be arising. So, that will be harming whole ecosystem of your business. For example, you have one oil tanker and suddenly got burst 5 people died or 1 people died.

Now, that will be creating a political issue. So, that political issue we do not know where it will be reaching right. For example, several accidents happen chemical and other accidents in India also and you have seen the cases still going on ok. The company got bad reputation cases still many people suffering still suffering right. So, so that is why safety should not be compromised any at any level of your oil and gas industry ok.

Safety must be first priority ok. It is not the last priority or least priority it must be the first priority. Yeah about safety when I was working in the oil industry in UK. So, that time they send me for one safety passport training. So, how to work in the laboratory the all these things 4 days training was there they gave me a certificate also. Now, whenever we will be working in the laboratory we will have to wear this hard hat, goggle, shoes and high vis dress and gloves also must be there because that was the laboratory instruction.

If I if someone is not following immediately the person can be expelled from the laboratory ok. And UK's HSE health and safety executives they will be entering laboratory anytime no one can prevent them and if someone is preventing that means, something is wrong ok. So, they can access anytime they can check system safe or not and people cannot blame like say my boss told that is why I am doing this one or boss cannot say this lower level engineer has done I did not know that ok. If you are involved you are responsible ok.

You cannot pass blame to others ok the sort of strict rules regulation is there. So, normally that will be the standard rule for all oil and gas industry operations all over the world ok because safety is the first priority part ok. So, whenever you are designing handling things also safety must be the first priority ok not the least or not the second priority ok. So, sometime this will be linked to your life also for example, offshore operation you are doing and if something is unsafe.

So, it it will be linked with your life also ok. So, fire exposure out ok. So, out breathing out breathing is when a pressure is high internal pressure. So, the vapour will be going out of the system resulting from the fire exposure may exceed design or venting rate based on normal operating condition. In such cases the construction details of the tank determine whether additional venting is required ok. So, venting is proper way you are disposing, but a venting system will have like fire ah fire catching system and other system. So, through that you can vent ok because you you know how much vapour is going and how to handle it, but it if it is exceeding your that calculation limit then you have to set maybe another venting system ok that they are saying additional venting may be required.

On fixed roof tank their roof shell joint considered frangible ok roof and shell ok. So, those joints may be a little bit frangible ok. Excessive internal pressure gives it failure additional requirement for emergency venting may be required. So, again safety safety safety like for everything is about safety.**Crude Oil Storage Facilities-01**

Good morning everybody. In previous lectures we have seen how to separate oil, gas, water, sand. So, whenever we are getting oil, water, gas mixture with sand also. So, we pass the fluid through separator systems. So, maybe vertical separator, horizontal separator, then there will be gas separation separately, gas heating system, amine heater

or there will be water removal systems. From oil also there will be water removal system, the sand removal system, water disposing system.

Then after doing all those things you got pure oil or crude oil. So, that one you have to store before sending to your refineries. Even in refinery also when they receive from oil field crude oil they will have to store somewhere ok. Then they will be sending to this fractional distillation system.

Fractional distillation system means actually you have to separating diesel, oil, kerosene, naphtha all the things that you are getting you are separating. So, then how to store it, what are the design system required for your oil storage system, what are the criteria we will try to discuss in this lecture. So, production, refinery and distribution system of petroleum ah of petroleum products or maybe I can say oil, crude oil require storage tank ok. So, small bolted welded tank possible. So, this can be used in production field, large welded tanks, distribution terminals and refineries can be used ok.

Ah Oil storage tanks are typically made up of carbon steel, stainless steel, industrial strength, plastic, reinforced concrete ok. So, whenever talking about steel and carbon steel I think you may have idea about material science, pure iron is very much corrosive ok. So, you can create give small amount of carbon content in there like 0.5 percent something, then you can create mild steel. So, mild steel very easy to manufacture it is very much ductile malleable.

If you manufacture using mild steel anything like a pipeline system, your surface production systems anything. So, it will be very much corrosive. So, very much corrosive means that will be dangerous for your system that will be giving like contaminant of iron oxide and it can be leakage fracturing possible. So, we should not use mild steel. So, we will have to go towards stainless steel or carbon steel that area.

Carbon steel means carbon amount will be larger amount and you want to reduce corrosion ability. So, you add chromium ok sometime. So, you are adding carbon, chromium, sometime nickel, molybdenum, some other components also you are adding to change iron property. If you are not changing, if you are keeping it pure form is very much corrosive ok. So, that is not useful for your system.

So, Fe plus H2O plus ah iron plus water it will create ferrous oxide and ferric oxide. So, salt is very much softer. So, you you are you are not using mild steel actually ok and even carbon steel and stasis other steel also you are using many time you use galvanization or surface coating will be using sometime will be using painting also to protect the surface ok. For example, pumping system you are not impeller you are using. In impeller you are not using any coating, but impeller material should be such design such way or impeller material should be considered in such a way that there will be no corrosion, erosion will be minimized ok.

So, that it will be lasting longer and there will be no failure. So, there will be some life time next 2 years or 5 years or 3 years. So, within that period it should not fail or it will not get eroded or corroded. Your surface production system tank battery or tank systems also you should consider material properly otherwise there will be erosion, corrosion and a system will not last longer and that can give accidents also ok. If there is any fire source and lots of vapour going out in the atmosphere then there will be big accident.

So, to avoid that one how what the parameters to consider I will try to discuss. And many cases plastic tanks also used, reinforced concrete also used and if you consider older days people were used to used to use the wood ok, wood based tanker system. So, later they thought like wood is very lower level thing it cannot withstand very much high pressure and fire also will be will be one problem. So, they moved to metal side and metal side also metal is very much heavier. So, they moved towards reinforced concrete FRP ok, a plastic made system also there, but again plastic when you are using temperature also one problem ok.

If temperature is going very high then your ductility will change or leakage can be possible or a small fire high temperature is there it will be melting quickly right. So, there are positive negative aspect in both side like metallic or non metallic you want to use, wooden people are not using these days ok. People using metal or plastic or reinforced plastics ok. So, plastic will be some metal viscous and they will be making stronger. So, plastic property they will take and metal strength also they will take.

So, together they will make reinforced plastic ok. Sometimes this FRP fiber reinforced plastic. So, lots of fiber metal fiber will be there and outside like tire if you see

if you cut in a tire there will be lots of wires small small wires cotton will also be there right. So, they will make stronger, but if you see rubber tire actually made up of rubber, rubber is not having good strength like tensile strength it will break quickly. So, they will be putting like cloths or maybe metal wire.

So, it will make stronger. So, similar way the the reinforced plastic will be making like metal wires and other things will be there. So, that will be giving you high strength tensile force actually and you will get property of plastic also. So, that way they are making the tanks. And basically I did not take from any single document I have taken from many document to prepare this lecture.

So, particular engineering handbook chapter 3 also illustration system some information will be there a similar system similar information is also there petro wiki website also there. And figures I have taken from different sources I have given source also you can click there and you can read more information ok. So, type of storage tank storage tank different size and shape possible 500 barrel to 5000 5 million barrel also possible ok. Special applications rectangular horizontal cylinder possible horizontal spherical full pressure storage hydrocarbon or chemical products will be there. If a very large storage tank will be used for like refinery side, but for your production side will be smaller size normally ok.

Atmospheric low pressure tank widely used common low pressure tank means like atmospheric pressure. So, you are not giving extra pressure in the tank ok you put fluid and you are not giving extra pressure. So, that is atmospheric tank ok. So, inside tank pressure here inside pressure and outside atmospheric pressure will be almost equal ok. Second shape can be vertical cylindrical or circular shape vertical shape will be there gross capacity 100 to 1.

5 million barrel ok. So, you see this so big million barrels not 150 or 15000 ok. Cosminding tank size ranges from diameter will be 10 feet minimum to 412 feet ok. So, it is so huge. So, more than 100 meter right 412 feet means around 150 100 to 150 meter diameter. So, this is yeah diameter ok.

So, small 10 feet 200, 400, 12 feet that much of diameter possible ok. And whenever considering tank so you have to understand different fittings equipments ok. So, one thing here left side I have drawn this one this is called cat and mouse type level indicator

like inside tank how much fluid is there is a complete metal you cannot see from outside ok accessing is not so easy ok. So, you put like say liquid level is here ok you have one small float ok. So, liquid level is moving up this float will be moving up and there will be some pulley system here ok.

So, pulley will have a one mass ok when liquid level is moving up the mass will be going down ok. So, this is called a cat and mouse type level indicator ok and there will be scale around here ok. So, you put scale 0, 1, 2, 3, 4, 5 ok accordingly you can. So, so scaling also you see from opposite way you have to give from not from bottom 1 to 3 from top you have to start then you can see how much fluid is there right it will be easier to read ok. So, there will be level indicator there will be hatch, hatch means accessing there inside tank what is there how much fluid is there fluid property measuring those things should be accessed from certain point ok and this is completely metal or maybe plastic or in reinforced plastic ok.

There will be vent venting system venting system will be required because if there is vapour ok. So, vapour is will be getting accumulated. So, vapour should be vented out properly if you are not venting properly then pressure difference it will be sucking atmospheric air. So, when air is sucked and vapour is there. So, vapour and air it will be creating combustible mixture if there is any fire source from anywhere the whole thing will get busted ok.

So, vented system there may be flame arrestor ok. So, when vapour is going out and if there is any fire source. So, outside flame will be there, but the flame should not enter into the system ok. If flame is entering then done ok ah then there will be inlet port outlet port many ports will be there pressure sensor will be there temperature sensor will be there. So, all the system will be fitted in your tank tank system ok.

These things these pictures I have taken from saferac.com and instrumentation tool.com these two ok. Now, there will be different types of tanks fixed roof tank fixed roof tank is like simple cylinder and roof is fixed roof is not moving or anything ok.

So, this is called fixed roof tank. So, dynamic roof another type of tank will be there dynamic tank roof will be like this or roof will be there and liquid is here ok. So, you inject more liquid roof will be moving up ok. So, roof will be moving up again roof will be moving down if you if you were removing ah liquid or oil from

there. So, roof will be going down. So, there will be floating roof ok ok and in fixed roof ah roof is not moving roof is not moving ok.

So, dynamic roof ah rises and falls depending on the oil level ok. So, this floating roof or dynamic here the term is used I will write floating also ok. So, floating roof roof is moving up and down. So, roof will be designed such a way that will be move up and down ok the purpose I will explain later ah. So, it will be minimized wafer accumulation reducing evaporation loss evaporation when a fluid is there inside tank.

So, fluid particle will be leaving surface and it will be accumulated in the vacant space ok. Like say I have one fixed type roof and liquid is here. So, this area lots of vapour will be there ok. Now, ah if I have fixed roof ah floating type roof ok. So, this upper surface of the liquid I am not giving it free ok.

So, the vapour will not be leaving the surface, but in this case vapour is leaving the surface and how much it will be how much vapour will be leaving. So, it will be creating one liquid equilibrium what will happen let us say one vapour particle leaving one vapour. So, many vapour particle will be leaving it will be filling the space and some vapour particle because of a branion motion some vapour particle will be falling down on the liquid surface also. So, that process will be continuing just call a dynamic equilibrium condition ok. So, in that vapour space will have certain amount of vapour that fixed amount of surface ok, ah, but if you have that floating roof the floating roof means it is not allowing vapour particle to move up ok.

So, the vapour particle they they will not get any brownian motion ok. Brownian motion is you will be leaving then it will be moving randomly right, but when you have fixed floating roof touching the surface particle not leaving. So, there is no brownian motion. So, vapour ah loss will be lower ok in floating case. So, common in production facility ok use vapour pressure less than 0.

1.5 psi common it is common in production facility vapour loss can be high during tank filling during tank filling operation ok. When ah tank is getting filled let us say initially tank is half filled some portion fixed roof tank is there some portion is filled with vapour ok. Now you are filling the tank. So, that vapour must be going out because you are filling liquid right. So, 50 percent less filled with vapour 50 percent liquid you are increasing liquid level.

So, that must be going out then liquid can be filled ok. So, internal floating roof reduces the vapour loss internal floating roof is there. So, the I do not have that much free space. So, just you fill it.

So, there is no loss ok ah. Fixed roof tank low hydrocarbon vapour pressure or vapour pressure close to atmospheric pressure ok. So, for for that you are using fixed roof tank ok ah. With a very high volatile liquid you are putting in tank then in fixed roof tank actually you will have lots of vapour. So, losses will be higher ok. So, in that case you can use floating type floating roof tanking system ok.

Another system is that bundled oil tank. So, tank within a tank. So, just for safety purpose. So, one tank is there outside there will be another tank. So, if any spill or leakage is there. So, tank or system can be safe ok preventing oil from seeping into the surrounding ok.

This is called bundled oil tank. So, fixed roof tank they will have one gauge hatch. Gauge hatch means if you see the definition gauge hatches are designed to provide accessible entry for inspection, measurement and sampling inside. So, tank is here ok. So, tank there will be this this system will fitted somewhere ok. So, that handle is there just remove it then you put your probe to measure you see the liquid level how much water is there water and ah because water will be also getting deposited at the bottom.

So, that level you can check you can measure you can create you can check sample quality of oil ok. So, that you can access from this one because whole tank will be completely closed ok. So, you will have some specific because 412 meter that the fit that much of diameter you cannot access randomly here and there ok. There will be some ladder system outside from ladder you enter and you access through hatch and you check your fluid thing ok. So, gauge the tank determine water presence if water is there measure the height of the oil water interface take sample of crude oil ok.

So, basically these things will be done using your gauge hatch ok. So, filling and pumping operation oil removed from the tank air drawn into the vapour space create a hazard ok. When you are filling ah oil ah that vapour space the vapour will be getting

removed right. So, that will be creating going outside. So, that can create hazard if there is any fire source anywhere.

So, that can be dangerous even you can remember few years back there was instruction in petrol pump area you should not switch on your mobile ok. And now I think things are better ah because mobile ah when if any ringing is there that will create some small spark that that spark created some fire actually in petrol pump area because petrol pump area means when it is filling you are filling in car or bike. So, some vapour will be in the atmosphere nearby ok. So, just prevent the government instructed and not to use mobile phone inside petrol pump area ok.

I think that instruction has removed most probably. Tank filling ah ok tank filling evaporative breathing increases breathing means like when tank is there. So, during daytime temperature will be very high because of direct sunlight falling on this. Again night time maybe temperature will be going down. Temperature going up and down and that vapour space vapour will be expanding and contracting again fluid temperature increasing that will be leaving more vapour. That means, some inside vapour space the pressure will change actually when pressure is changing.

So, some vapour will be going out again temperature going down air will be sucked ok. When air is sucking that you have to control actually if because air and vapour mixture will be creating combustible mixture ok. So, that will be dangerous. So, during time filling evaporative breathing increases oil added to the tank displaces air vapour mixture through the tank vent resulting significant evaporative emission ok. And yeah so you have to check hazard part and how much losses are there because of evaporation because during filling some vapour will be going out during temperature change daytime or pressure change the some vapour will be going out.

So, that also you have to consider when you are considering any tank system ok. So, fixed roof tank so, sometime they use gas blanket system. So, gas blanket system is artificially they will be increasing some pressure inside tank ok. So, that there will be no extra air, air means oxygen mixed nitrogen oxygen plus nitrogen plus all the mixture should not enter into the system.

So, inside pressure you keep little bit higher. So, outside fluid air will not enter in the system ok. So, oil vapour pressure is very low use freely ventilated fixed roof tank if incoming oil vapour exceeds atmospheric pressure at ambient temperature ok. A gas blanket system maintains positive tank pressure and minimise the chance of air being drawn into the tank vapour space ok. Air means actually basically this is the dangerous thing ok. Oxygen in mixing nitrogen inert gas so, it will not be creating any trouble, but oxygen is trouble ok.

So, during no inflow period tank breathes air enters the tank through the pressure vacuum valve forms explosive mixture ok. So, gas blanket system a supply of natural gas at a pressure regulator keeps tank pressure at predetermined level. So, tank pressure you are keeping at higher level. So, that incoming in breathing will not happen ok. Regulator closes as P increases by sunlight, P vent opens if P continues to rise to atmospheric or some downstream vapour recovery process.

A vacuum relief used to protect the tank against vacuum should the gas blanketing system fail ok. If gas blanket system is failing then you have to have some alternative option ok. Because, gas blanketing system means you are giving extra pressure because of failure if you are getting extra air sucked. So, you have you must have an alternative arrangement for safety purpose ok.

So, you are giving all these things for safety reason ok. So, sometime losses can be allowed, but safety cannot be compromised ok. Because safety compromise there will be the severe consequences you say political and social issues may be arising. So, that will be harming whole ecosystem of your business. For example, you have one oil tanker and suddenly got burst 5 people died or 1 people died.

Now, that will be creating a political issue. So, that political issue we do not know where it will be reaching right. For example, several accidents happen chemical and other accidents in India also and you have seen the cases still going on ok. The company got bad reputation cases still many people suffering still suffering right. So, so that is why safety should not be compromised any at any level of your oil and gas industry ok.

Safety must be first priority ok. It is not the last priority or least priority it must be the first priority. Yeah about safety when I was working in the oil industry in UK. So, that

time they send me for one safety passport training. So, how to work in the laboratory the all these things 4 days training was there they gave me a certificate also. Now, whenever we will be working in the laboratory we will have to wear this hard hat, goggle, shoes and high vis dress and gloves also must be there because that was the laboratory instruction.

If I if someone is not following immediately the person can be expelled from the laboratory ok. And UK's HSE health and safety executives they will be entering laboratory anytime no one can prevent them and if someone is preventing that means, something is wrong ok. So, they can access anytime they can check system safe or not and people cannot blame like say my boss told that is why I am doing this one or boss cannot say this lower level engineer has done I did not know that ok. If you are involved you are responsible ok.

You cannot pass blame to others ok the sort of strict rules regulation is there. So, normally that will be the standard rule for all oil and gas industry operations all over the world ok because safety is the first priority part ok. So, whenever you are designing handling things also safety must be the first priority ok not the least or not the second priority ok. So, sometime this will be linked to your life also for example, offshore operation you are doing and if something is unsafe.

So, it it will be linked with your life also ok. So, fire exposure out ok. So, out breathing out breathing is when a pressure is high internal pressure. So, the vapour will be going out of the system resulting from the fire exposure may exceed design or venting rate based on normal operating condition. In such cases the construction details of the tank determine whether additional venting is required ok. So, venting is proper way you are disposing, but a venting system will have like fire ah fire catching system and other system. So, through that you can vent ok because you you know how much vapour is going and how to handle it, but it if it is exceeding your that calculation limit then you have to set maybe another venting system ok that they are saying additional venting may be required.

On fixed roof tank their roof shell joint considered frangible ok roof and shell ok. So, those joints may be a little bit frangible ok. Excessive internal pressure gives it failure additional requirement for emergency venting may be required. So, again safety safety safety like for everything is about safety.**Crude Oil Storage Facilities-01**

Good morning everybody. In previous lectures we have seen how to separate oil, gas, water, sand. So, whenever we are getting oil, water, gas mixture with sand also. So, we pass the fluid through separator systems. So, maybe vertical separator, horizontal separator, then there will be gas separation separately, gas heating system, amine heater or there will be water removal systems. From oil also there will be water removal system, the sand removal system, water disposing system.

Then after doing all those things you got pure oil or crude oil. So, that one you have to store before sending to your refineries. Even in refinery also when they receive from oil field crude oil they will have to store somewhere ok. Then they will be sending to this fractional distillation system.

Fractional distillation system means actually you have to separating diesel, oil, kerosene, naphtha all the things that you are getting you are separating. So, then how to store it, what are the design system required for your oil storage system, what are the criteria we will try to discuss in this lecture. So, production, refinery and distribution system of petroleum ah of petroleum products or maybe I can say oil, crude oil require storage tank ok. So, small bolted welded tank possible. So, this can be used in production field, large welded tanks, distribution terminals and refineries can be used ok.

Ah Oil storage tanks are typically made up of carbon steel, stainless steel, industrial strength, plastic, reinforced concrete ok. So, whenever talking about steel and carbon steel I think you may have idea about material science, pure iron is very much corrosive ok. So, you can create give small amount of carbon content in there like 0.5 percent something, then you can create mild steel. So, mild steel very easy to manufacture it is very much ductile malleable.

If you manufacture using mild steel anything like a pipeline system, your surface production systems anything. So, it will be very much corrosive. So, very much corrosive means that will be dangerous for your system that will be giving like contaminant of iron oxide and it can be leakage fracturing possible. So, we should not use mild steel. So, we will have to go towards stainless steel or carbon steel that area.

Carbon steel means carbon amount will be larger amount and you want to reduce corrosion ability. So, you add chromium ok sometime. So, you are adding carbon, chromium, sometime nickel, molybdenum, some other components also you are adding to change iron property. If you are not changing, if you are keeping it pure form is very much corrosive ok. So, that is not useful for your system.

So, Fe plus H2O plus ah iron plus water it will create ferrous oxide and ferric oxide. So, salt is very much softer. So, you you are you are not using mild steel actually ok and even carbon steel and stasis other steel also you are using many time you use galvanization or surface coating will be using sometime will be using painting also to protect the surface ok. For example, pumping system you are not impeller you are using. In impeller you are not using any coating, but impeller material should be such design such way or impeller material should be considered in such a way that there will be no corrosion, erosion will be minimized ok.

So, that it will be lasting longer and there will be no failure. So, there will be some life time next 2 years or 5 years or 3 years. So, within that period it should not fail or it will not get eroded or corroded. Your surface production system tank battery or tank systems also you should consider material properly otherwise there will be erosion, corrosion and a system will not last longer and that can give accidents also ok. If there is any fire source and lots of vapour going out in the atmosphere then there will be big accident.

So, to avoid that one how what the parameters to consider I will try to discuss. And many cases plastic tanks also used, reinforced concrete also used and if you consider older days people were used to used to use the wood ok, wood based tanker system. So, later they thought like wood is very lower level thing it cannot withstand very much high pressure and fire also will be will be one problem. So, they moved to metal side and metal side also metal is very much heavier. So, they moved towards reinforced concrete FRP ok, a plastic made system also there, but again plastic when you are using temperature also one problem ok.

If temperature is going very high then your ductility will change or leakage can be possible or a small fire high temperature is there it will be melting quickly right. So, there are positive negative aspect in both side like metallic or non metallic you want to use, wooden people are not using these days ok. People using metal or plastic or reinforced plastics ok. So, plastic will be some metal viscous and they will

be making stronger. So, plastic property they will take and metal strength also they will take.

So, together they will make reinforced plastic ok. Sometimes this FRP fiber reinforced plastic. So, lots of fiber metal fiber will be there and outside like tire if you see if you cut in a tire there will be lots of wires small small wires cotton will also be there right. So, they will make stronger, but if you see rubber tire actually made up of rubber, rubber is not having good strength like tensile strength it will break quickly. So, they will be putting like cloths or maybe metal wire.

So, it will make stronger. So, similar way the the reinforced plastic will be making like metal wires and other things will be there. So, that will be giving you high strength tensile force actually and you will get property of plastic also. So, that way they are making the tanks. And basically I did not take from any single document I have taken from many document to prepare this lecture.

So, particular engineering handbook chapter 3 also illustration system some information will be there a similar system similar information is also there petro wiki website also there. And figures I have taken from different sources I have given source also you can click there and you can read more information ok. So, type of storage tank storage tank different size and shape possible 500 barrel to 5000 5 million barrel also possible ok. Special applications rectangular horizontal cylinder possible horizontal spherical full pressure storage hydrocarbon or chemical products will be there. If a very large storage tank will be used for like refinery side, but for your production side will be smaller size normally ok.

Atmospheric low pressure tank widely used common low pressure tank means like atmospheric pressure. So, you are not giving extra pressure in the tank ok you put fluid and you are not giving extra pressure. So, that is atmospheric tank ok. So, inside tank pressure here inside pressure and outside atmospheric pressure will be almost equal ok. Second shape can be vertical cylindrical or circular shape vertical shape will be there gross capacity 100 to 1.

5 million barrel ok. So, you see this so big million barrels not 150 or 15000 ok. Cosminding tank size ranges from diameter will be 10 feet minimum to 412

feet ok. So, it is so huge. So, more than 100 meter right 412 feet means around 150 100 to 150 meter diameter. So, this is yeah diameter ok.

So, small 10 feet 200, 400, 12 feet that much of diameter possible ok. And whenever considering tank so you have to understand different fittings equipments ok. So, one thing here left side I have drawn this one this is called cat and mouse type level indicator like inside tank how much fluid is there is a complete metal you cannot see from outside ok accessing is not so easy ok. So, you put like say liquid level is here ok you have one small float ok. So, liquid level is moving up this float will be moving up and there will be some pulley system here ok.

So, pulley will have a one mass ok when liquid level is moving up the mass will be going down ok. So, this is called a cat and mouse type level indicator ok and there will be scale around here ok. So, you put scale 0, 1, 2, 3, 4, 5 ok accordingly you can. So, so scaling also you see from opposite way you have to give from not from bottom 1 to 3 from top you have to start then you can see how much fluid is there right it will be easier to read ok. So, there will be level indicator there will be hatch, hatch means accessing there inside tank what is there how much fluid is there fluid property measuring those things should be accessed from certain point ok and this is completely metal or maybe plastic or in reinforced plastic ok.

There will be vent venting system venting system will be required because if there is vapour ok. So, vapour is will be getting accumulated. So, vapour should be vented out properly if you are not venting properly then pressure difference it will be sucking atmospheric air. So, when air is sucked and vapour is there. So, vapour and air it will be creating combustible mixture if there is any fire source from anywhere the whole thing will get busted ok.

So, vented system there may be flame arrestor ok. So, when vapour is going out and if there is any fire source. So, outside flame will be there, but the flame should not enter into the system ok. If flame is entering then done ok ah then there will be inlet port outlet port many ports will be there pressure sensor will be there temperature sensor will be there. So, all the system will be fitted in your tank tank system ok.

These things these pictures I have taken from saferac.com and instrumentation tool.com these two ok. Now, there will be different types of tanks fixed roof tank fixed roof tank is like simple cylinder and roof is fixed roof is not moving or anything ok.

So, this is called fixed roof tank. So, dynamic roof another type of tank will be there dynamic tank roof will be like this or roof will be there and liquid is here ok. So, you inject more liquid roof will be moving up ok. So, roof will be moving up again roof will be moving down if you if you were removing ah liquid or oil from there. So, roof will be going down. So, there will be floating roof ok ok and in fixed roof ah roof is not moving roof is not moving ok.

So, dynamic roof ah rises and falls depending on the oil level ok. So, this floating roof or dynamic here the term is used I will write floating also ok. So, floating roof roof is moving up and down. So, roof will be designed such a way that will be move up and down ok the purpose I will explain later ah. So, it will be minimized wafer accumulation reducing evaporation loss evaporation when a fluid is there inside tank.

So, fluid particle will be leaving surface and it will be accumulated in the vacant space ok. Like say I have one fixed type roof and liquid is here. So, this area lots of vapour will be there ok. Now, ah if I have fixed roof ah floating type roof ok. So, this upper surface of the liquid I am not giving it free ok.

So, the vapour will not be leaving the surface, but in this case vapour is leaving the surface and how much it will be how much vapour will be leaving. So, it will be creating one liquid equilibrium what will happen let us say one vapour particle leaving one vapour. So, many vapour particle will be leaving it will be filling the space and some vapour particle because of a branion motion some vapour particle will be falling down on the liquid surface also. So, that process will be continuing just call a dynamic equilibrium condition ok. So, in that vapour space will have certain amount of vapour that fixed amount of surface ok, ah, but if you have that floating roof the floating roof means it is not allowing vapour particle to move up ok.

So, the vapour particle they they will not get any brownian motion ok. Brownian motion is you will be leaving then it will be moving randomly right, but when you have fixed floating roof touching the surface particle not leaving. So, there is no brownian

motion. So, vapour ah loss will be lower ok in floating case. So, common in production facility ok use vapour pressure less than 0.

1.5 psi common it is common in production facility vapour loss can be high during tank filling during tank filling operation ok. When ah tank is getting filled let us say initially tank is half filled some portion fixed roof tank is there some portion is filled with vapour ok. Now you are filling the tank. So, that vapour must be going out because you are filling liquid right. So, 50 percent less filled with vapour 50 percent liquid you are increasing liquid level.

So, that must be going out then liquid can be filled ok. So, internal floating roof reduces the vapour loss internal floating roof is there. So, the I do not have that much free space. So, just you fill it.

So, there is no loss ok ah. Fixed roof tank low hydrocarbon vapour pressure or vapour pressure close to atmospheric pressure ok. So, for for that you are using fixed roof tank ok ah. With a very high volatile liquid you are putting in tank then in fixed roof tank actually you will have lots of vapour. So, losses will be higher ok. So, in that case you can use floating type floating roof tanking system ok.

Another system is that bundled oil tank. So, tank within a tank. So, just for safety purpose. So, one tank is there outside there will be another tank. So, if any spill or leakage is there. So, tank or system can be safe ok preventing oil from seeping into the surrounding ok.

This is called bundled oil tank. So, fixed roof tank they will have one gauge hatch. Gauge hatch means if you see the definition gauge hatches are designed to provide accessible entry for inspection, measurement and sampling inside. So, tank is here ok. So, tank there will be this this system will fitted somewhere ok. So, that handle is there just remove it then you put your probe to measure you see the liquid level how much water is there water and ah because water will be also getting deposited at the bottom.

So, that level you can check you can measure you can create you can check sample quality of oil ok. So, that you can access from this one because whole tank will be

completely closed ok. So, you will have some specific because 412 meter that the fit that much of diameter you cannot access randomly here and there ok. There will be some ladder system outside from ladder you enter and you access through hatch and you check your fluid thing ok. So, gauge the tank determine water presence if water is there measure the height of the oil water interface take sample of crude oil ok.

So, basically these things will be done using your gauge hatch ok. So, filling and pumping operation oil removed from the tank air drawn into the vapour space create a hazard ok. When you are filling ah oil ah that vapour space the vapour will be getting removed right. So, that will be creating going outside. So, that can create hazard if there is any fire source anywhere.

So, that can be dangerous even you can remember few years back there was instruction in petrol pump area you should not switch on your mobile ok. And now I think things are better ah because mobile ah when if any ringing is there that will create some small spark that that spark created some fire actually in petrol pump area because petrol pump area means when it is filling you are filling in car or bike. So, some vapour will be in the atmosphere nearby ok. So, just prevent the government instructed and not to use mobile phone inside petrol pump area ok.

I think that instruction has removed most probably. Tank filling ah ok tank filling evaporative breathing increases breathing means like when tank is there. So, during daytime temperature will be very high because of direct sunlight falling on this. Again night time maybe temperature will be going down. Temperature going up and down and that vapour space vapour will be expanding and contracting again fluid temperature increasing that will be leaving more vapour. That means, some inside vapour space the pressure will change actually when pressure is changing.

So, some vapour will be going out again temperature going down air will be sucked ok. When air is sucking that you have to control actually if because air and vapour mixture will be creating combustible mixture ok. So, that will be dangerous. So, during time filling evaporative breathing increases oil added to the tank displaces air vapour mixture through the tank vent resulting significant evaporative emission ok. And yeah so you have to check hazard part and how much losses are there because of evaporation because during filling some vapour will be going out during temperature change daytime or pressure change the some vapour will be going out.

So, that also you have to consider when you are considering any tank system ok. So, fixed roof tank so, sometime they use gas blanket system. So, gas blanket system is artificially they will be increasing some pressure inside tank ok. So, that there will be no extra air, air means oxygen mixed nitrogen oxygen plus nitrogen plus all the mixture should not enter into the system.

So, inside pressure you keep little bit higher. So, outside fluid air will not enter in the system ok. So, oil vapour pressure is very low use freely ventilated fixed roof tank if incoming oil vapour exceeds atmospheric pressure at ambient temperature ok. A gas blanket system maintains positive tank pressure and minimise the chance of air being drawn into the tank vapour space ok. Air means actually basically this is the dangerous thing ok. Oxygen in mixing nitrogen inert gas so, it will not be creating any trouble, but oxygen is trouble ok.

So, during no inflow period tank breathes air enters the tank through the pressure vacuum valve forms explosive mixture ok. So, gas blanket system a supply of natural gas at a pressure regulator keeps tank pressure at predetermined level. So, tank pressure you are keeping at higher level. So, that incoming in breathing will not happen ok. Regulator closes as P increases by sunlight, P vent opens if P continues to rise to atmospheric or some downstream vapour recovery process.

A vacuum relief used to protect the tank against vacuum should the gas blanketing system fail ok. If gas blanket system is failing then you have to have some alternative option ok. Because, gas blanketing system means you are giving extra pressure because of failure if you are getting extra air sucked. So, you have you must have an alternative arrangement for safety purpose ok.

So, you are giving all these things for safety reason ok. So, sometime losses can be allowed, but safety cannot be compromised ok. Because safety compromise there will be the severe consequences you say political and social issues may be arising. So, that will be harming whole ecosystem of your business. For example, you have one oil tanker and suddenly got burst 5 people died or 1 people died.

Now, that will be creating a political issue. So, that political issue we do not know where it will be reaching right. For example, several accidents happen chemical and other accidents in India also and you have seen the cases still going on ok. The company got

bad reputation cases still many people suffering still suffering right. So, so that is why safety should not be compromised any at any level of your oil and gas industry ok.

Safety must be first priority ok. It is not the last priority or least priority it must be the first priority. Yeah about safety when I was working in the oil industry in UK. So, that time they send me for one safety passport training. So, how to work in the laboratory the all these things 4 days training was there they gave me a certificate also. Now, whenever we will be working in the laboratory we will have to wear this hard hat, goggle, shoes and high vis dress and gloves also must be there because that was the laboratory instruction.

If I if someone is not following immediately the person can be expelled from the laboratory ok. And UK's HSE health and safety executives they will be entering laboratory anytime no one can prevent them and if someone is preventing that means, something is wrong ok. So, they can access anytime they can check system safe or not and people cannot blame like say my boss told that is why I am doing this one or boss cannot say this lower level engineer has done I did not know that ok. If you are involved you are responsible ok.

You cannot pass blame to others ok the sort of strict rules regulation is there. So, normally that will be the standard rule for all oil and gas industry operations all over the world ok because safety is the first priority part ok. So, whenever you are designing handling things also safety must be the first priority ok not the least or not the second priority ok. So, sometime this will be linked to your life also for example, offshore operation you are doing and if something is unsafe.

So, it it will be linked with your life also ok. So, fire exposure out ok. So, out breathing out breathing is when a pressure is high internal pressure. So, the vapour will be going out of the system resulting from the fire exposure may exceed design or venting rate based on normal operating condition. In such cases the construction details of the tank determine whether additional venting is required ok. So, venting is proper way you are disposing, but a venting system will have like fire ah fire catching system and other system. So, through that you can vent ok because you you know how much vapour is going and how to handle it, but it if it is exceeding your that calculation limit then you have to set maybe another venting system ok that they are saying additional venting may be required.

On fixed roof tank their roof shell joint considered frangible ok roof and shell ok. So, those joints may be a little bit frangible ok. Excessive internal pressure gives it failure additional requirement for emergency venting may be required. So, again safety safety safety like for everything is about safety.**Crude Oil Storage Facilities-01**

Good morning everybody. In previous lectures we have seen how to separate oil, gas, water, sand. So, whenever we are getting oil, water, gas mixture with sand also. So, we pass the fluid through separator systems. So, maybe vertical separator, horizontal separator, then there will be gas separation separately, gas heating system, amine heater or there will be water removal systems. From oil also there will be water removal system, the sand removal system, water disposing system.

Then after doing all those things you got pure oil or crude oil. So, that one you have to store before sending to your refineries. Even in refinery also when they receive from oil field crude oil they will have to store somewhere ok. Then they will be sending to this fractional distillation system.

Fractional distillation system means actually you have to separating diesel, oil, kerosene, naphtha all the things that you are getting you are separating. So, then how to store it, what are the design system required for your oil storage system, what are the criteria we will try to discuss in this lecture. So, production, refinery and distribution system of petroleum ah of petroleum products or maybe I can say oil, crude oil require storage tank ok. So, small bolted welded tank possible. So, this can be used in production field, large welded tanks, distribution terminals and refineries can be used ok.

Ah Oil storage tanks are typically made up of carbon steel, stainless steel, industrial strength, plastic, reinforced concrete ok. So, whenever talking about steel and carbon steel I think you may have idea about material science, pure iron is very much corrosive ok. So, you can create give small amount of carbon content in there like 0.5 percent something, then you can create mild steel. So, mild steel very easy to manufacture it is very much ductile malleable.

If you manufacture using mild steel anything like a pipeline system, your surface production systems anything. So, it will be very much corrosive. So, very much corrosive means that will be dangerous for your system that will be giving like contaminant of iron

oxide and it can be leakage fracturing possible. So, we should not use mild steel. So, we will have to go towards stainless steel or carbon steel that area.

Carbon steel means carbon amount will be larger amount and you want to reduce corrosion ability. So, you add chromium ok sometime. So, you are adding carbon, chromium, sometime nickel, molybdenum, some other components also you are adding to change iron property. If you are not changing, if you are keeping it pure form is very much corrosive ok. So, that is not useful for your system.

So, Fe plus H2O plus ah iron plus water it will create ferrous oxide and ferric oxide. So, salt is very much softer. So, you you are you are not using mild steel actually ok and even carbon steel and stasis other steel also you are using many time you use galvanization or surface coating will be using sometime will be using painting also to protect the surface ok. For example, pumping system you are not impeller you are using. In impeller you are not using any coating, but impeller material should be such design such way or impeller material should be considered in such a way that there will be no corrosion, erosion will be minimized ok.

So, that it will be lasting longer and there will be no failure. So, there will be some life time next 2 years or 5 years or 3 years. So, within that period it should not fail or it will not get eroded or corroded. Your surface production system tank battery or tank systems also you should consider material properly otherwise there will be erosion, corrosion and a system will not last longer and that can give accidents also ok. If there is any fire source and lots of vapour going out in the atmosphere then there will be big accident.

So, to avoid that one how what the parameters to consider I will try to discuss. And many cases plastic tanks also used, reinforced concrete also used and if you consider older days people were used to used to use the wood ok, wood based tanker system. So, later they thought like wood is very lower level thing it cannot withstand very much high pressure and fire also will be will be one problem. So, they moved to metal side and metal side also metal is very much heavier. So, they moved towards reinforced concrete FRP ok, a plastic made system also there, but again plastic when you are using temperature also one problem ok.

If temperature is going very high then your ductility will change or leakage can be possible or a small fire high temperature is there it will be melting quickly right. So, there

are positive negative aspect in both side like metallic or non metallic you want to use, wooden people are not using these days ok. People using metal or plastic or reinforced plastics ok. So, plastic will be some metal viscous and they will be making stronger. So, plastic property they will take and metal strength also they will take.

So, together they will make reinforced plastic ok. Sometimes this FRP fiber reinforced plastic. So, lots of fiber metal fiber will be there and outside like tire if you see if you cut in a tire there will be lots of wires small small wires cotton will also be there right. So, they will make stronger, but if you see rubber tire actually made up of rubber, rubber is not having good strength like tensile strength it will break quickly. So, they will be putting like cloths or maybe metal wire.

So, it will make stronger. So, similar way the the reinforced plastic will be making like metal wires and other things will be there. So, that will be giving you high strength tensile force actually and you will get property of plastic also. So, that way they are making the tanks. And basically I did not take from any single document I have taken from many document to prepare this lecture.

So, particular engineering handbook chapter 3 also illustration system some information will be there a similar system similar information is also there petro wiki website also there. And figures I have taken from different sources I have given source also you can click there and you can read more information ok. So, type of storage tank storage tank different size and shape possible 500 barrel to 5000 5 million barrel also possible ok. Special applications rectangular horizontal cylinder possible horizontal spherical full pressure storage hydrocarbon or chemical products will be there. If a very large storage tank will be used for like refinery side, but for your production side will be smaller size normally ok.

Atmospheric low pressure tank widely used common low pressure tank means like atmospheric pressure. So, you are not giving extra pressure in the tank ok you put fluid and you are not giving extra pressure. So, that is atmospheric tank ok. So, inside tank pressure here inside pressure and outside atmospheric pressure will be almost equal ok. Second shape can be vertical cylindrical or circular shape vertical shape will be there gross capacity 100 to 1.

5 million barrel ok. So, you see this so big million barrels not 150 or 15000 ok. Cosminding tank size ranges from diameter will be 10 feet minimum to 412 feet ok. So, it is so huge. So, more than 100 meter right 412 feet means around 150 100 to 150 meter diameter. So, this is yeah diameter ok.

So, small 10 feet 200, 400, 12 feet that much of diameter possible ok. And whenever considering tank so you have to understand different fittings equipments ok. So, one thing here left side I have drawn this one this is called cat and mouse type level indicator like inside tank how much fluid is there is a complete metal you cannot see from outside ok accessing is not so easy ok. So, you put like say liquid level is here ok you have one small float ok. So, liquid level is moving up this float will be moving up and there will be some pulley system here ok.

So, pulley will have a one mass ok when liquid level is moving up the mass will be going down ok. So, this is called a cat and mouse type level indicator ok and there will be scale around here ok. So, you put scale 0, 1, 2, 3, 4, 5 ok accordingly you can. So, so scaling also you see from opposite way you have to give from not from bottom 1 to 3 from top you have to start then you can see how much fluid is there right it will be easier to read ok. So, there will be level indicator there will be hatch, hatch means accessing there inside tank what is there how much fluid is there fluid property measuring those things should be accessed from certain point ok and this is completely metal or maybe plastic or in reinforced plastic ok.

There will be vent venting system venting system will be required because if there is vapour ok. So, vapour is will be getting accumulated. So, vapour should be vented out properly if you are not venting properly then pressure difference it will be sucking atmospheric air. So, when air is sucked and vapour is there. So, vapour and air it will be creating combustible mixture if there is any fire source from anywhere the whole thing will get busted ok.

So, vented system there may be flame arrestor ok. So, when vapour is going out and if there is any fire source. So, outside flame will be there, but the flame should not enter into the system ok. If flame is entering then done ok ah then there will be inlet port outlet port many ports will be there pressure sensor will be there temperature sensor will be there. So, all the system will be fitted in your tank tank system ok.

These things these pictures I have taken from saferac.com and instrumentation tool.com these two ok. Now, there will be different types of tanks fixed roof tank fixed roof tank is like simple cylinder and roof is fixed roof is not moving or anything ok.

So, this is called fixed roof tank. So, dynamic roof another type of tank will be there dynamic tank roof will be like this or roof will be there and liquid is here ok. So, you inject more liquid roof will be moving up ok. So, roof will be moving up again roof will be moving down if you if you were removing ah liquid or oil from there. So, roof will be going down. So, there will be floating roof ok ok and in fixed roof ah roof is not moving roof is not moving ok.

So, dynamic roof ah rises and falls depending on the oil level ok. So, this floating roof or dynamic here the term is used I will write floating also ok. So, floating roof roof is moving up and down. So, roof will be designed such a way that will be move up and down ok the purpose I will explain later ah. So, it will be minimized wafer accumulation reducing evaporation loss evaporation when a fluid is there inside tank.

So, fluid particle will be leaving surface and it will be accumulated in the vacant space ok. Like say I have one fixed type roof and liquid is here. So, this area lots of vapour will be there ok. Now, ah if I have fixed roof ah floating type roof ok. So, this upper surface of the liquid I am not giving it free ok.

So, the vapour will not be leaving the surface, but in this case vapour is leaving the surface and how much it will be how much vapour will be leaving. So, it will be creating one liquid equilibrium what will happen let us say one vapour particle leaving one vapour. So, many vapour particle will be leaving it will be filling the space and some vapour particle because of a branion motion some vapour particle will be falling down on the liquid surface also. So, that process will be continuing just call a dynamic equilibrium condition ok. So, in that vapour space will have certain amount of vapour that fixed amount of surface ok, ah, but if you have that floating roof the floating roof means it is not allowing vapour particle to move up ok.

So, the vapour particle they they will not get any brownian motion ok. Brownian motion is you will be leaving then it will be moving randomly right, but when you have fixed floating roof touching the surface particle not leaving. So, there is no brownian

motion. So, vapour ah loss will be lower ok in floating case. So, common in production facility ok use vapour pressure less than 0.

1.5 psi common it is common in production facility vapour loss can be high during tank filling during tank filling operation ok. When ah tank is getting filled let us say initially tank is half filled some portion fixed roof tank is there some portion is filled with vapour ok. Now you are filling the tank. So, that vapour must be going out because you are filling liquid right. So, 50 percent less filled with vapour 50 percent liquid you are increasing liquid level.

So, that must be going out then liquid can be filled ok. So, internal floating roof reduces the vapour loss internal floating roof is there. So, the I do not have that much free space. So, just you fill it.

So, there is no loss ok ah. Fixed roof tank low hydrocarbon vapour pressure or vapour pressure close to atmospheric pressure ok. So, for for that you are using fixed roof tank ok ah. With a very high volatile liquid you are putting in tank then in fixed roof tank actually you will have lots of vapour. So, losses will be higher ok. So, in that case you can use floating type floating roof tanking system ok.

Another system is that bundled oil tank. So, tank within a tank. So, just for safety purpose. So, one tank is there outside there will be another tank. So, if any spill or leakage is there. So, tank or system can be safe ok preventing oil from seeping into the surrounding ok.

This is called bundled oil tank. So, fixed roof tank they will have one gauge hatch. Gauge hatch means if you see the definition gauge hatches are designed to provide accessible entry for inspection, measurement and sampling inside. So, tank is here ok. So, tank there will be this this system will fitted somewhere ok. So, that handle is there just remove it then you put your probe to measure you see the liquid level how much water is there water and ah because water will be also getting deposited at the bottom.

So, that level you can check you can measure you can create you can check sample quality of oil ok. So, that you can access from this one because whole tank will be

completely closed ok. So, you will have some specific because 412 meter that the fit that much of diameter you cannot access randomly here and there ok. There will be some ladder system outside from ladder you enter and you access through hatch and you check your fluid thing ok. So, gauge the tank determine water presence if water is there measure the height of the oil water interface take sample of crude oil ok.

So, basically these things will be done using your gauge hatch ok. So, filling and pumping operation oil removed from the tank air drawn into the vapour space create a hazard ok. When you are filling ah oil ah that vapour space the vapour will be getting removed right. So, that will be creating going outside. So, that can create hazard if there is any fire source anywhere.

So, that can be dangerous even you can remember few years back there was instruction in petrol pump area you should not switch on your mobile ok. And now I think things are better ah because mobile ah when if any ringing is there that will create some small spark that that spark created some fire actually in petrol pump area because petrol pump area means when it is filling you are filling in car or bike. So, some vapour will be in the atmosphere nearby ok. So, just prevent the government instructed and not to use mobile phone inside petrol pump area ok.

I think that instruction has removed most probably. Tank filling ah ok tank filling evaporative breathing increases breathing means like when tank is there. So, during daytime temperature will be very high because of direct sunlight falling on this. Again night time maybe temperature will be going down. Temperature going up and down and that vapour space vapour will be expanding and contracting again fluid temperature increasing that will be leaving more vapour. That means, some inside vapour space the pressure will change actually when pressure is changing.

So, some vapour will be going out again temperature going down air will be sucked ok. When air is sucking that you have to control actually if because air and vapour mixture will be creating combustible mixture ok. So, that will be dangerous. So, during time filling evaporative breathing increases oil added to the tank displaces air vapour mixture through the tank vent resulting significant evaporative emission ok. And yeah so you have to check hazard part and how much losses are there because of evaporation because during filling some vapour will be going out during temperature change daytime or pressure change the some vapour will be going out.

So, that also you have to consider when you are considering any tank system ok. So, fixed roof tank so, sometime they use gas blanket system. So, gas blanket system is artificially they will be increasing some pressure inside tank ok. So, that there will be no extra air, air means oxygen mixed nitrogen oxygen plus nitrogen plus all the mixture should not enter into the system.

So, inside pressure you keep little bit higher. So, outside fluid air will not enter in the system ok. So, oil vapour pressure is very low use freely ventilated fixed roof tank if incoming oil vapour exceeds atmospheric pressure at ambient temperature ok. A gas blanket system maintains positive tank pressure and minimise the chance of air being drawn into the tank vapour space ok. Air means actually basically this is the dangerous thing ok. Oxygen in mixing nitrogen inert gas so, it will not be creating any trouble, but oxygen is trouble ok.

So, during no inflow period tank breathes air enters the tank through the pressure vacuum valve forms explosive mixture ok. So, gas blanket system a supply of natural gas at a pressure regulator keeps tank pressure at predetermined level. So, tank pressure you are keeping at higher level. So, that incoming in breathing will not happen ok. Regulator closes as P increases by sunlight, P vent opens if P continues to rise to atmospheric or some downstream vapour recovery process.

A vacuum relief used to protect the tank against vacuum should the gas blanketing system fail ok. If gas blanket system is failing then you have to have some alternative option ok. Because, gas blanketing system means you are giving extra pressure because of failure if you are getting extra air sucked. So, you have you must have an alternative arrangement for safety purpose ok.

So, you are giving all these things for safety reason ok. So, sometime losses can be allowed, but safety cannot be compromised ok. Because safety compromise there will be the severe consequences you say political and social issues may be arising. So, that will be harming whole ecosystem of your business. For example, you have one oil tanker and suddenly got burst 5 people died or 1 people died.

Now, that will be creating a political issue. So, that political issue we do not know where it will be reaching right. For example, several accidents happen chemical and other accidents in India also and you have seen the cases still going on ok. The company got

bad reputation cases still many people suffering still suffering right. So, so that is why safety should not be compromised any at any level of your oil and gas industry ok.

Safety must be first priority ok. It is not the last priority or least priority it must be the first priority. Yeah about safety when I was working in the oil industry in UK. So, that time they send me for one safety passport training. So, how to work in the laboratory the all these things 4 days training was there they gave me a certificate also. Now, whenever we will be working in the laboratory we will have to wear this hard hat, goggle, shoes and high vis dress and gloves also must be there because that was the laboratory instruction.

If I if someone is not following immediately the person can be expelled from the laboratory ok. And UK's HSE health and safety executives they will be entering laboratory anytime no one can prevent them and if someone is preventing that means, something is wrong ok. So, they can access anytime they can check system safe or not and people cannot blame like say my boss told that is why I am doing this one or boss cannot say this lower level engineer has done I did not know that ok. If you are involved you are responsible ok.

You cannot pass blame to others ok the sort of strict rules regulation is there. So, normally that will be the standard rule for all oil and gas industry operations all over the world ok because safety is the first priority part ok. So, whenever you are designing handling things also safety must be the first priority ok not the least or not the second priority ok. So, sometime this will be linked to your life also for example, offshore operation you are doing and if something is unsafe.

So, it it will be linked with your life also ok. So, fire exposure out ok. So, out breathing out breathing is when a pressure is high internal pressure. So, the vapour will be going out of the system resulting from the fire exposure may exceed design or venting rate based on normal operating condition. In such cases the construction details of the tank determine whether additional venting is required ok. So, venting is proper way you are disposing, but a venting system will have like fire ah fire catching system and other system. So, through that you can vent ok because you you know how much vapour is going and how to handle it, but it if it is exceeding your that calculation limit then you have to set maybe another venting system ok that they are saying additional venting may be required.

On fixed roof tank their roof shell joint considered frangible ok roof and shell ok. So, those joints may be a little bit frangible ok. Excessive internal pressure gives it failure additional requirement for emergency venting may be required. So, again safety safety safety like for everything is about safety.