Surface Facilities for Oil and Gas Handling

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Drilling And Completion-01

Good morning everybody. In today's class, I will be discussing a brief drilling, completion, and production. So, this is not part of your surface separation operation, but the beginners should know how well gets drilled for oil and gas how it is being completed, and how production starts. So, I will try to discuss this in this lecture or it will be almost 1 hour. We can divide the course into like 30 minutes or 30 minutes that way. Oil and gas when you discuss you discuss upstream, midstream, and downstream.

Drilling means you are exploring means you have some area where you suspect there will be some oil and gas. So, what you do is your geologist geoscientist will go and they will try to drill, they will try to evaluate with modern equipment and they will say oil and gas is there now next drilling operation and production can be started. That will be the exploration phase. In the drilling phase after exploration scientists will say oil and gas are there drilling people will go and they will drill they will complete the well bore and they will produce.
That will be coming under upstream oil and gas technology.

At IIT Madras we are teaching upstream oil and gas we are not teaching midstream or downstream.

Midstream means a pipeline or transportation part when you have crude oil or gas you are transporting to a refinery or a customer using some pipeline systems or tanker systems. So, that will be coming under the midstream section.

Downstream whenever you are talking about downstream normally it will be the subject of the chemical engineering department or process engineering department that is called refineries will be coming.
Refinery midstream normally pipelines transportation part will be coming pipeline or transportation part will be coming.

In refining what you are doing you are doing fractional distillation at different temperatures you separate petrol, diesel, kerosene, and many other chemicals for example, wax, asphaltene peach, and naphtha all these things you are separating. So, this way you are dividing upstream, midstream, and downstream.

Here we will discuss within the upstream section we have exploration drilling, exploration, and then your surface production operations for separation and storage, and separation of production this part will be the upstream section. So, within that, I will be discussing this one separation part in this course in detail, but drilling and completion exploration that I will not cover in detail just I will give some overview. So, you can understand how things are getting working from exploration to your separation.

Whenever you are discussing your upstream section now you have an onshore wellbore and, an offshore wellbore. What is an onshore wellbore? What is offshore wellbore?

Offshore wellbore actually when you are going to the big ocean and you are drilling somewhere sea bed.
You say oil and gas there is somewhere here, for example, the reservoir is here then you have to drill this one, and water depth is here and you might you may have one drill ship here. From the drill ship, you are drilling this one or maybe you will have a semi-submersible drill ah drill shape or semi-submersible ah semi-submersible or many other platforms such as like jack-up rig and other these type of possible MODU will be there movable drilling operation systems. So, that will be for an offshore application for offshore is expensive, but people are moving offshore because onshore or land wells are very limited.

As production is limited and the ocean is very big. So, there will be lots of reservoirs available all over the world. So, people are exploring more and more they are going deeper and deeper away from the mainland to the deeper ocean. Many drill ships and semi-submersibles are drilling around 6 kilometers of water depth, but when you are talking about onshore it is very much easier than offshore applications and you have like land transportation. For example, truck loaded system equipment you bring and you drill the area where the reservoir is, but in the offshore area before you start drilling you have to prepare the whole area first and that will take several years actually and it is a very expensive process also, but many cases offshore area there will be a huge amount of reserve.

So, people will be drilling that one because they will be getting long time long-term economic benefits. Exploration so, what you do in exploration provide information provides information regarding oil and gas, how much oil and gas is there? whether oil and gas is there or not whether it will be economical or not will be ah decided by the geoscientist and geophysicist and they will be helped by drilling engineers. So, because there will be lots of exploratory drilling well bore, some drilling operations will be there, but those wells may not be completed or may not be used for production, there will be exploratory well bores, but in many cases, you find that it is economical to produce oil and gas. So, you drill further ah with the proper drilling mechanism you complete the well bore you start producing.

Drilling can be done for exploration. So, during exploration, you start drilling just to measure parameters. The next thing is that injection in some cases you inject let us say what water you inject or gas you inject in the well bore. So, in that case, again you drill. So, that will be the injection well bore.

So a good bore may not be used for your production, and in some cases, reinjection is also possible, and the drilling hole normally will be 0.12 meter to more than 1 meter. So, drill hole diameter may be possible. Drilling string or drill string is where you have drill pipes and you are drilling one by one. So, the connected drill pipes are called drilling strings.

Those are steel pipes connected to make a longer pipe to make longer pipe. Normally this drill string's diameter will be smaller than your well bore. Whatever drilling operation you are doing will be a little bit smaller because whenever you are drilling you are injecting mud to remove cutting from the well bore. So, for that, your drilling diameter pipe diameter will be lower than your actual wellbore diameter. There will be some angular gap.

I will discuss how this mud circulation will be occurring later. When you are going for a drilling operation whether it will be onshore or offshore sometimes the wellbore will be in the desert area or it will be mid-sea or maybe inside your IIT campus. So, in that case, you have to prepare the area. In many cases what you do you do not drill this area, for example, IIT Madras may not allow you to drill here. So, what do you do you drill maybe in ah Marina Beach area then you go horizontally and you come to IIT Madras.

Drilling a vertical well go horizontal, and extract well oil or gas whatever is there from the IIT Madras area that way you drill. In many cases that is also not possible, for example, in big desert areas like in the Middle East all countries almost they have desert areas. So, accessibility is very difficult in that case what they will do they will acquire land then they will prepare the road, they will prepare the area, they will be making smooth surface area then they will be put some pads, and mud pits they will be creating, they will be creating some houses for ah engineers or technicians they will be staying there food arrangement everything must be there like energy sources like IC engine installation or electricity connection must be there. So, that way you have to prepare that area. Then you start drilling actually because that drilling operation will be work done for several days. So, not in it is a one-day job because we have to go vertical then horizontal you have to do cementing, perforation, and maybe fracking operation then you have to put other systems, for example, completion done then you have to connect pipeline or you have to connect gas line or separator system you have to connect.

So, there are several works there. So, this is a long-term process, not a day or two days job. Then what tasks are there? The transportation of equipment is required transportation in many cases road transport is not possible. So, helicopter transport you have to do maybe. It is too much in except for this first area, the forest department may not allow you to cut the trees.

So, in that case, you use a helicopter and transportation systems. Transportation will be one challenging job actually in many cases if you have road accessibility there is very good your life is beautiful, but if road accessibility is not there then you have to see how to access that area the reservoir area and whether you will go vertically somewhere then go horizontal or helicopter transport or you construct a new road. I can tell one story in West Bengal there were some gas areas is there in the Jharkhand West Bengal border and British Petroleum they were trying to find CBM, cold bed methane they acquired land from farmers local farmers and started drilling. Finally, what happened they went back and returned the land to the farmers, and when they were returning they removed all the materials and paid money to the farmers also so, that they could again start farming in that area.

So, they invested lots of money actually for that. They made roads they made houses everything, but finally, they moved away and they returned the land to the farmers. They will have to maybe construct a road because lots of accessibility will be required cement bags will be coming engineers will be moving, and your drilling mud will be moving. So, grabbing cleaning the local area you have to grab the area then you have to clean that area maybe it will be uneven land maybe there or maybe that will be a rocky area, or maybe a water body will be there. So, you have to repair the land.

Leveling the site now comes in the role. Then pad construction CTI on constructions. A pad construction pad is a temporary drilling site usually constructed using local materials like say gravel wood or maybe mud shells or anything other available local material to make the area smooth you put you create a pad so, that it would be good for operations. Digging pits and

trenches, construction of holes, construction of holes like rat holes, mouse holes and you have to create like mud pit ok.

Some you have to create like a toiletry arrangement you have to create small houses. Lots of things are there initially you have to do all these things before you start drilling because once you start drilling you cannot stop the whole operation to do some work or you cannot go to eat food at some restaurant and everything must be arranged locally. So, that engineer can work laborers will be working there they will be getting local food they can stay there. In many cases, if it is an inaccessible area then they cannot move also in a regular basis. So, the engineers will be working there they will be working for several days maybe after that they will have some other arrangement to move from there.

And I told you that when you are drilling in an offshore area or you are getting oil and gas from the offshore area it is not an easy task. So, you should get a platform because there will be 3 kilometers, 4-kilometer, 5-kilometer, and 6-kilometer water depths our height will be less than 2 meters, but the water depths will be 3, 4, 5, and 6 kilometers. So, there if you want to work you need a proper platform. Now, if you have like say low water depth let us say 100 metres, 200 metres certain amount of certain type of platform you can use it will be easier to handle, but very deeper well bore if you go. In that case, you have to use a specialized platform normally a semi-submersible or drill ship that can go 6 kilometers, 4 kilometers, or 5 kilometers that much water depth.

For example, the jack-up rig is there. A jack-up rig like a metal structure will be there and your platform can be raised up and down using some mechanism.
I think Bombay High those platforms are using jack-up platforms in India. And semi-submersible platform I think you have heard the name deepwater horizon, deepwater horizon, the semi-submersible which was developed by Samsung -the South Korean company, that manufactures and they were drilling in Mexican water. British Petroleum was drilling and suddenly something happened BOP did not work and the whole semi-submersible sank into the seabed. I think 11 engineers died immediately ah ok so much risk. So, huge platform, but because of this fire and BOP non-stop functioning things got done dead and lots of political issues, and still I think cases are going on even I think one movie also made Water Horizon. So, if you are interested you can watch that. Drill ships are also similar to the way big platforms drill ships you can move and it can drill. It is like this you have water and you have seabed.

So, the drillship will be here somewhere and you are drilling here vertically. Semi-submersibles also can do the same thing semi Semi-submersible will be like this. There will be legs and they will be blasted so that some portion of the semi-submersible will be outside water. So, engineers will be working helipad will be there houses will be there and some portions will be submerged. When there is a submerged portion, it will be blasted I think they say like some air balloon sort of thing.

So, using that one they will be changing buoyancy and they will maintain things. And they need one more thing station keeping, station keeping equipment. The station-keeping equipment means whenever you have a semi-submersible or any other equipment. So, what happens because of wind load slowly it can move on the left side or right side or forward-backward. Although because it is working water vertical motion will be there and they will have other motions also and vertical motion forward backward left right all motions will be there.

So, to stop that motion there will be station keeping. So, the station will be like this they will have a thruster or propeller system. Therefore, let us say we have 4 legs one leg is here one leg is here one leg is here, and floating in water where 4 legs are there. And here one propeller will be there if it is moving in this direction this propeller will work it will be stationing properly. Again if it is moving too much there again another propeller will be working like ships moving that propeller one turbine that sort of thing right.

Their propeller will be again repositioning it in all several propellers will be there. So, they will be fixing it proper location like a few meters they can move only not very high. Then how this distance will be fixed say you are assuming that because my hand is there that is why you are saying this much, but in the big ocean how can you fix it? So, it will be connected to a satellite. So, the satellite will say ok this degree is 2 degrees or 0.

1 degree has moved. So, again you have to reposition which means one thruster will be working to reposition it. If you are going in this direction again one thruster will be working there. So, the thruster will be there ok The thruster propeller ok will create the thrust load actual load and it will be connected to the satellite. So, satellite and thruster propeller will be making this station keeping or positioning system will be working there ok. Similarly, drill shapes also should have, but certain types of offshore platforms are there for example, barge, gravity structure, and backups which are fixed on the seabed.

So, they do not need station keeping because they are already fixed on the seabed ok? They will be drilling the seabed and they will be fixing with metal structure or concrete structure and the platform will be fixed and if the water level is changing then you create a jackup sort of thing. So, the platform you raise a little bit using some ah gearing mechanism up or maybe you can down also even many cases you can move the whole platform you can make up and down. So, that also you can do. So, the jackup normally will be fixed on the bottom.

You do not need a positioning system or station-keeping mechanism. Semi-submersible will be required because it is completely floating, drill ship also completely floating, and barge gravity structure ah barge also actually floating, but may be connected with some rope. The gravity base structure is fixed on the sea bed. So, it is also not moving.

In some cases, if it is moving, in that case, you need a sea-keeping system that is satellite-connected in some cases it is already fixed on the sea bottom. So, you do not need that one, but if you go to deep water. So, in that case, gravity structure or something fixed on the bottom and you are moving to the top is very difficult. It will break actually because of the water load. So, in that case, you give a completely floating semi-submersible and you have leg only and maybe some in drill ship, or some cases there will be some rope fixing on the sea bed. So, it can move a little bit, but the rope is there, but drill ship in these cases, may not be there it will be positioned using station keeping mechanism.