Petroleum Economics and Management
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Module - 06
Depletion and Rising Costs
Lecture - 26
Petroleum as a depleting resource

Hi everyone. Welcome to the NPTEL course, Petroleum Economics and Management. I am your instructor, Dr. Anwesha Aditya Assistant Professor in the Department of Humanities and Social Sciences of IIT Kharagpur. So, we are in module 6 of our course where we are trying to explain the nature of oil price movement from the point of view of depletion and rising cost.

Is it because oil is depleting over time and its cost of extraction and refining is increasing? Is the that why oil price is also increasing. So, that is the subject matter that we are going to address in module 6. So, in the first lecture of module 6 that is lecture 26 of our course we are going to analyse the petroleum from the point of view of resource whether petroleum is a depleting resource and not.

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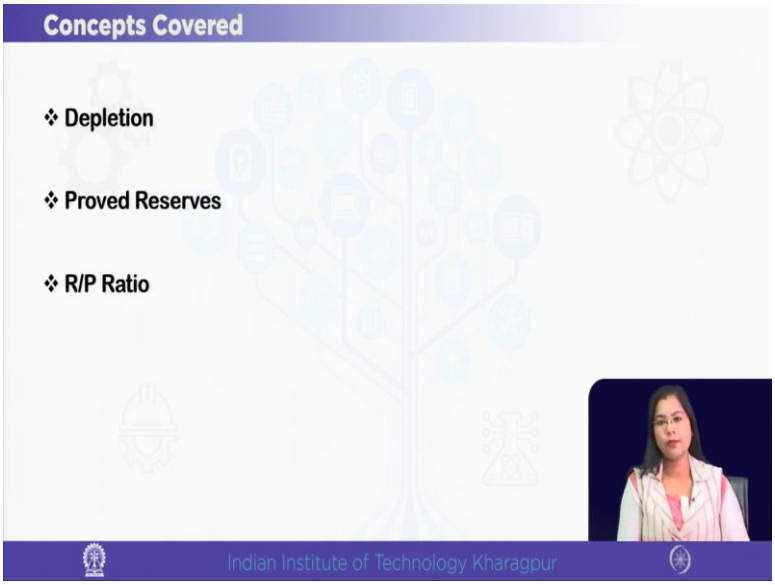

So, in today's lecture what we will start with the concept of depletion. See, if you are just do a little bit of recapitulation if you remember in module 4, we have discussed in depth

about the nature of oil price movement which is one of the motivations of our course. In the next module that is in module 5 we have analysed the oil price movement from the point of view of OPEC.

So, we discuss the structure of OPEC and OPEC plus we discuss the functionalities of OPEC. We also analyse the view of the literature the existing literature on whether OPEC is a successful cartel or not. We have analysed the characteristics of oligopoly and cartel and we found that the literature is ambiguous in that.

However, what more or less what we saw is that most of the economies conclude that OPEC is there for a long time. So, OPECs limited ambition in increasing the price can be one of the explanations for that. We also discussed the role of Saudi Arabia in particular in influencing the world oil price because we all know that inside OPEC Saudi Arabia has a major leadership position given its inexpensive oil reserve and which is also good quality.

So, given it is huge endowment of oil. So, Saudi Arabia supplies a large amount of oil demand for the total world. Even in 2021 also around 13 to 14 percent of oil demand is supplied by Saudi Arabia and overall 40 percent of oil demand is supplied by OPEC in 2021.

So, we discuss that in our module 5. But what we finally, concluded in module 5 that yeah, there are examples and instances of how OPEC and especially Saudi Arabia has led to fluctuation in oil price in both the direction increasing and decreasing. And there are also instances where Saudi Arabia's intervention actually stabilize the oil price in a more or less in a range which is not very high very close to the competitive level because Saudi Arabia given its huge production it wants to be there in the market for a long time.

So, Saudi Arabia and other low-cost suppliers of OPEC therefore, they decide to maintain the price more or less slightly higher than the competitive level because they want to be there in the oil market for a long time, they have a high reserve to output ratio right.

So, it is not that they have a very short run quick profit motive. So; that means, we cannot hold Saudi Arabia and OPEC responsible for the oil price increase alone Saudi

Arabian OPEC is not responsible too they are responsible to a large some extent, but at the same time they are also not increasing the price that much.

In other cartels, the price increase has been very high, but that is not the case for Saudi Arabia. Then how do we explain such phenomenal oil price movement right? So, that is what we need to explore more and more regarding the oil price increase. So, with this motivation we have designed our module 6, where we are discussing the petroleum as a depleting resource or not. So, we are analysing the concept of depletion. So, first we need to know what do we mean by a depleting resource.

Then we will be studying some related concept like the proved reserved, extractable resource, reserve to production ratio ok. So, first before analysing whether we actually see that petroleum is depleting or not and that is the reason for explaining the oil price movement we need to know some basic concept related to resource. So, this is the outline of the current lecture.

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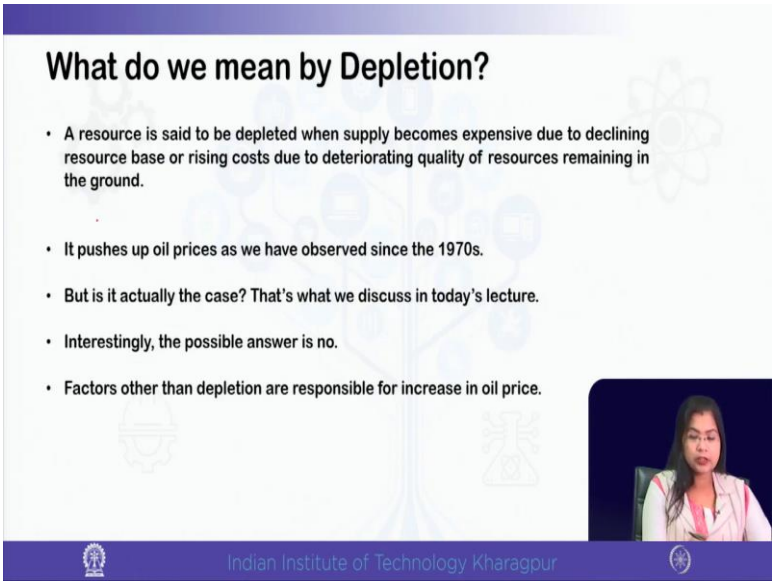

So, what do we mean by depletion? This is the first and foremost thing that we need to know in this module. So, a resource a natural resource is said to be depleted when supply becomes very costly due to the declining resource volume ok. See if the resource the non-renewable resource or the exhaustible resource it is there in a limited quantity.

We already discussed that this fossil fuel or coal these are obtained from the past millenniums. These are the stored vegetation or the animals or trees which are turned into fossil fuel and coal and these are the savings from the past millennium right. So, currently also maybe fossil fuel is being formed obviously, but that current rate is very low compared to the rate at which we are using it because our present human civilization greatly depends on coal, oil, natural gas.

So, the current rate of formation of these resources are very less the non-renewable or exhaustible resources are very less as compared to the rate at which we are using those resources and at the same time it is not only less there is also huge uncertainty. We will be discussing in one of our modules if you look at our course structure we will be discussing what should be the optimal rate of extraction, what should be the pricing policy if there is uncertainty. So, we do not know with certainty how much oil or how much of a natural resource is left underground. So, there are undiscovered oil volumes also.

So, that is why if what happens if the resource base is declining from the known fields, you know the some of the fields are known. So, from the known fields if the resource base is declining do, supply will become costlier why? Because in the so, suppose you are extracting one particular field. So, as you are going down as you are going deeper into the ground what will happen? Your cost of extraction will increase right.

If you are nearer the ground your cost of extraction is less, but if you are going deeper into the ground cost of extraction will increase. So; that means, your overall total cost of production will also go up you also need more labour you need more machineries more capital equipment therefore, your overall the supply becomes costly.

So, this is one reason or this is one definition of depleting resource or the other reason of depletion is due to rising cost. When the quality of the resource underground deteriorates because if the quality fall so, what will happen? So, the crude oil if the crude oil quality is bad so; that means, your cost of refining will increase right. So, a resource is said to be depleted when? Supply becomes costly either due to a declining shrinking resource base or due to a degrading quality of the resource remaining on the ground.

In either case you see your cost of production extraction refining. So, overall, the cost of the supply becomes cost clearer cost the final cost increases. So, price will also increase.

So, this is called depletion. So, it increases the oil price because if cost increases price will of course, increase.

So, in perfect competition price or the market price is linked to the marginal cost. In imperfectly competitive market price is greater than marginal cost to an extent which is called known as the markup ok. So, price is some mark-up above the marginal cost. So, of course, if the marginal cost increases price will also increase.

So, if your supply becomes costly because the resource base is shrinking or the quality of the resource is poorer therefore, you have to refine it more. So, what will happen? The cost of production and refining and extraction goes up price will also go up. But is it actually the case that has driven the price of petroleum so, high? So, that is what we discuss in today's lecture.

And very interestingly you see as we proceed you can understand the possible answer is no ok. So, there must be other things which are responsible for the oil price movement. We cannot held a petroleum as a depleting resource and that is the reason for its increase in price. So, factors other than depletion are responsible for increase in oil price. So, that is what we are going to discuss in the next of the module.

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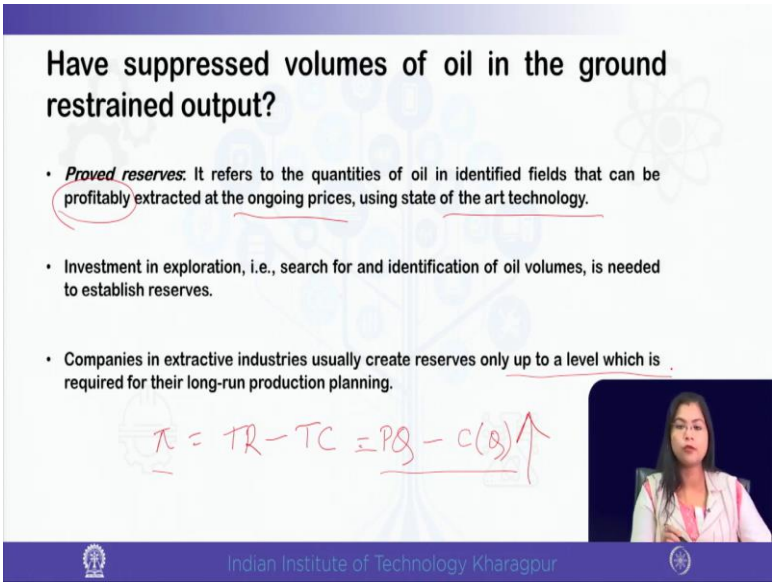

So, before proceeding further we need to know some more related concept. So, one related concept with respect to depletion is the proved reserve. What is proved reserve?

Proved reserve correspond to the quantity of oil in identified fields so, known fields. So, that we already know that suppose a particular field X that has oil. So, the quantity of oil in identified fields that can be profitably extracted.

So, what do we mean by that? Economically or profitably extracted; that means, if and if we extract. So, there will be profit so, if why? Because you see in the just in the previous slide, we discussed that a resource is said to be depleting. If the supply becomes costly when the resource base is falling or the quality is degrading.

Then your cost of production final cost of production includes the cost of extraction cost of refining. So, the refined oil price will also increase as the crude oil price also increases. So; that means, in proved reserve means the amount of oil in identified fields known fields you already know that these grounds have oil. So, that can be profitably extracted.

So, even after you extract there will be profits. If the cost increases very much so, profits may not be there by profit we mean a super normal positive profit. So, if you remember in one of the classes I also defined profit. Profit is generally denoted by pi. So, pi is the difference between total revenue minus total cost.

So, total revenue is price into quantity minus total cost is; obviously, the total cost of production C of Q right which depends which is a function of the amount of output that the firm is producing and the factor prices ok. So, if your cost of extraction cost of production goes up cost of refining goes up what will happen? This total cost will go up right. So, if it happens so, that the total cost goes up at a faster rate the rate of change of cost is greater than the rate of change of total revenue.

So, will there be profit? No. So, it will not be profitable to extract. So, by proved reserve we refer to the quantities of oil in known fields which can be extracted even if some profit is maintained. So, if it is not profitable to be extracted. So, that is not part of our proved reserve. So, we should have these concepts very clear.

So, the amount of oil in known fields that can be profitably extracted at the current prices that is also important because if price increases then even the low-cost fields can be profitable right. You think in this way suppose initially you have just some hypothetical example. So, you have 5 fields. The first 2, 3 fields are less costly, but the fourth and

fifth fields are more costly ok. So, at a given ongoing price let us say P_0. So, only the first 3 fields are profitable.

So, if you extract from these first 3 fields field 1, 2 and 3. So, you can make some positive profit. Pi 1, pi 2 and pi 3 are positive at the ongoing price P0, but the fields 4th and 5th they are not profitable why? Because at the ongoing price P0 profit pi 5 and pi 4 can become negative ok if the cost is very high. Suppose the total cost is greater than the total revenue. So, pi 4 and pi 5 can be negative.

Now, suppose due to some demand side shock so, demand increase sudden increase in demand ok. We have seen many instances of demand increase like the commodity boom period. So, if or the revival from the Global Financial Crisis in 2012, if there is a demand increase so, price increases suppose no longer price is P0, but now price is P1 which is greater than P0.

So, at the higher price even you can understand now if pi 4 and pi 5 becomes positive because if now the total revenue is suppose greater than the total cost at the new price P1. So, 4th and 5th field will also be now brought into extraction right. So, we are defining proved reserve at the ongoing price not with respect to a new higher price and given state of technology right because even if there is another thing.

So, apart from price increase so, due to price increase your revenue can increase, but you can see the way we have written the profit, profit is the gap between total revenue and total cost. So, profit can increase either when total revenue increases or profit can also increase if the total cost falls.

So, if the total cost falls the gap between total revenue and total cost will increase right. So, total cost can fall if we are using a better technology ok. In one of the modules in module 7 when especially we will be discussing some basic concept of production. So, we will see that even with same amount of input and in better technology can produce more amount of output or we can alternatively say that the same amount of output can be produced by using less amount of input with a better technology.

So, with that even with technological improvement also the earlier unprofitable fields can become profitable. So, when we are defining the proved reserve, we are keeping price and technology unchanged. So, at the ongoing price and given state of technology

proved reserve correspond to the no oil that is there in known fields which can be extracted by making positive profit. So, that is what is proved reserve.

Now, you see we need to invest in exploration in finding out in creating new proved reserve because you are over time you are exhausting the proved reserves. So, so; that means, when you are exhausting the proved reserve at the same time you have to also explore the new fields and how do you do that? You have to invest in exploration that is searching for an identification of oil volume to establish new reserve.

So, companies in the extractive industries they actually what we see empirically that they create reserve only up to a level which is required for their long run production planning. Actually, for any firm long run is called the production period sorry the long run is called the planning period long run is the time over which a firm plans and short run is called the operating period. So, in the short run the firm operates, but the long run is the planning period.

So, what they do the companies which are engaged in extraction they create reserve which is required for their long run production planning? Because the firm has to have a long run view. Now, see when we are talking about a firm a micro economic thing. So, in micro economic we talk about individual economic agent we know that.

So, even 20 or 15 years 20 years can be considered as a medium to long run, but so; that means, this we should be careful about one thing the concept of short run and long run they vary in micro economics and macro economics. So, when you are talking about an individual economic agent like household or one labour one consumer or even a firm. So, even 15 20 years can be long run.

But when we are talking from the macro perspective from the perspective of an aggregate economy then even 10 years 20 years is of course, a short run 100 years can be a long run. So, this definition of long run and short run the idea it varies from context to context. So, for a firm these 20 years can be a long run because the firm is producing suppose in quarterly amount.

So, in 20 years can be a long run. So, it has this idea in mind that if there is a demand side shock or supply side shock how I should respond. So, if demand increases. So, what we can do? So, I have already talked about creating excess production capacity it may

not be using that capacity if demand is less, but if demand goes up it can use the capacity.

Let us say for example, we know that hotels in the tourist spot during the peak season they have to hire additional staffs because in peak season they are burdened, but in the off-peak season then they may lay off the staffs. So, they have to create the capacity keeping in mind the increased demand in the peak season right, but they may not be using that full capacity throughout the year. So, if demand increases, they will be using the full capacity right. So, that is why the long run is called the production planning.

But at the same time you see it is not that always the firm should think about increasing output when demand increases because the COVID pandemic has also taught us is very important lesson that we should be able to also manage the supply if there is a demand side shock which is very abrupt and unexpected otherwise we experience a negative a future contract price.

So, that should not happen in future. So, we have to manage the resource very prudently, we have to respond to by change increasing the output if demand increases. At the same time if demand falls, we have to have the storage capacity to efficiently store the resource ok.

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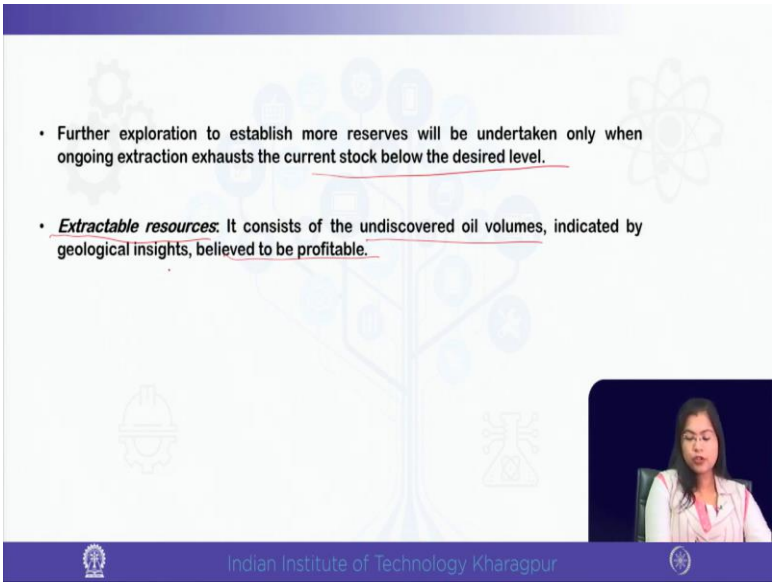

So, once the companies they start using the proved reserve, they have to find out they have to explore for new fields and they have to create reserve which is sufficient to maintain their long run production planning then what they do? The further exploration to establish more reserve will be undertaken only when the current rate of extraction exhausts the existing stock below the desired level.

So, if the existing stock falls below the desired level as you are actually you are extracting the resource more and more. So, of course, your current stock will fall suppose this is your desired level. So, current stock will fall below the desired level ok. So, this is one concept the next important and related concept is extractable resource. So, what is extractable resource?

So, it is the undiscovered oil volume you see. So, this is the first point of difference between proved reserve and extractable resource. Proved reserve is the amount of oil in the known fields identified fields and extractable resource is the undiscovered oil volume and which is indicated by geological insight ok.

So, say the scientist the geologist they may suggest that there is a prospective field which is believed to be profitable or economical; that means, they cannot say with certainty, but from their initial research or their field experiment, it seems that the a particular oil field can be profitably extracted at the ongoing price and ongoing technology at the given state of technology at ongoing price a particular field can be profitably extracted.

But of course, the amount of oil volume is uncertain that is undiscovered because we have not started digging up that field. So, we do not know the exact amount of oil remaining in the ground ok.

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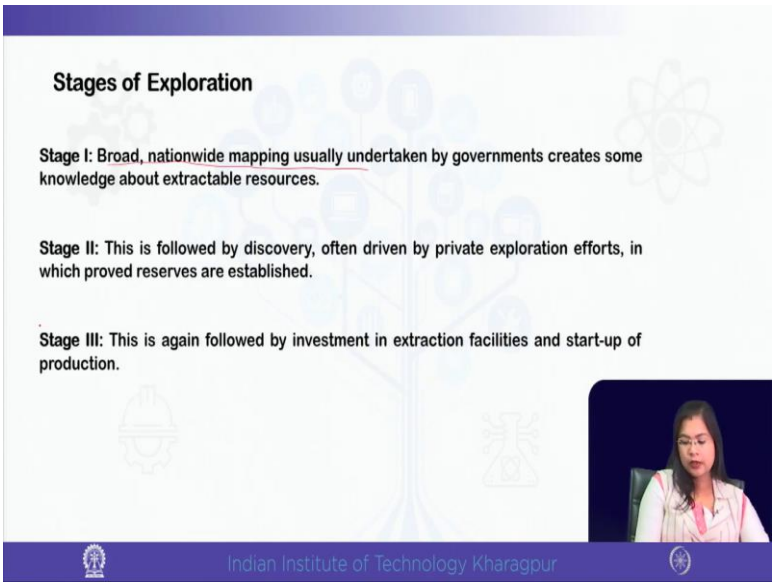

Now, what are the stages of exploration? So, what we are saying is that you start with the proved reserve and then you search for the extractable resource. Now, what are the stages of going through this phase? So, there are 5 stages of exploration. So, what happens? In the stage 1 there is a broad nationwide mapping which is done usually by the government or the government funded agencies and that create some knowledge about extractable resources you see. So, that requires lot of research it is time taking.

So, you are actually trying to identify a new reserve ok. So, extractable reserve resource so, just now we defined. So, undiscovered oil volume which can be profitable and this is indicated by geological insight. So, how this can be done? Because see a particular exploration can be a failure also so, that is why you see this stage 1 is usually undertaken by either the government or the government funded agencies the government subsidized research agencies.

Because the private firms may not be interested in doing this because you see when you are just exploring the end result suppose you are exploring a field the end result can be negative also you may not find any indication of existence of any type of resource or oil right.

So; that means, you see this research we know is more or less research is funded by either government or the government subsidized government funded agencies because this type of research and development investment it has a probability of success as well

as a probability of failure. So, this broad nationwide and you see the large scale it is done in a large scale broad nationwide mapping done by the government to create knowledge about the extractable resource.

So, the first stage is by the government second stage is followed by discovery and here you see that the private firms enter ok. So, this discovery is often driven by private exploration efforts in which proved reserves can be established. So, first the government creates the mapping it indicates what are the probable sources of oil or any type of other resource natural resource in stage 2 then after the government has identified some prospective fields which may be profitable for extraction.

So, now the private firms can enter ok. So, they start discovering the resources in the identified fields. So, the which are identified in stage 1. Now, this stage 3 what happens? There is investment in extraction. So, once you see that yeah there is a proved reserve. So, in first stage is about the extractable resource. Now, you see how these two concepts are used? In stage 1 is all about the extractable resource, in stage 2 is about finding out the proved reserve.

So, now you are certain you are sure that there is oil which is which can be extracted at a profitable rate at the current market price and given state of technology. So, after these two stages in the 3rd stage we start investing in extraction facility and we create the production unit ok.

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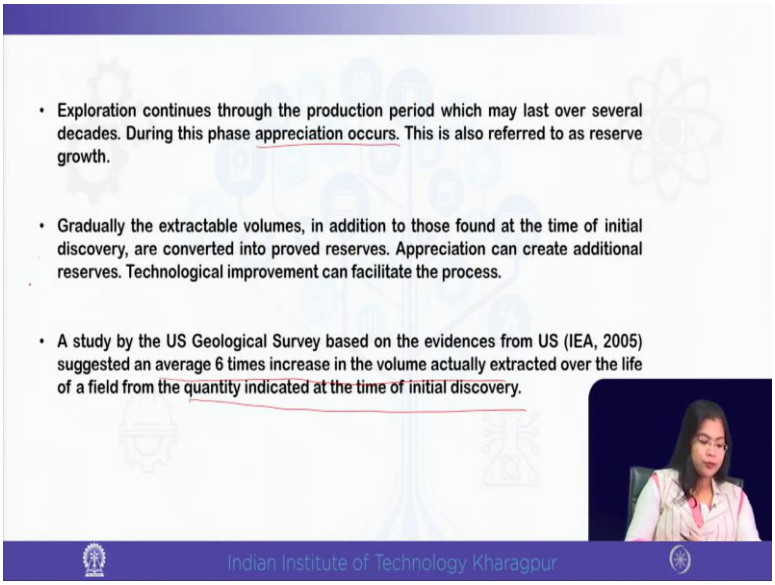

So, exploration continues through the production period and this can last over several decades. So, you can consider this as stage 4 though I have not mentioned it explicitly. So, this is basically the stage 4. So, once you start investing in extraction facility and start-up of production in the 4th stage what you do? You continue to explore that field throughout the production period and that can be several decades.

So, I told you that long run is the planning period which can last over few decades. So, during this phase appreciation also occurs because during this phase what will happen? We know that as I just told at the beginning of today's lecture currently also oil is being formed oil or any other resource because you see these concepts can be related to other resources also. At current stage also the resource is being formed underground, but the rate is less ok.

So, when you explore over some decades so, 2, 3 decades, 4 decades. So, reserve growth also takes place. So, reserve actually appreciates. So, increases in amount. So, gradually the extractable volume addition to those which are found at the time of discovery ok are also converted into proved reserve ok. So, which are the good quality fields? So, when the exploration goes on.

So, additions are also made. Therefore, the extractable volume are actually converted into proved reserve throughout this phase of exploration and this appreciation of reserve growth can also create or add to the new reserve. So, technological improvement can actually facilitate the process.

So, you need a technological improvement to upgrade the process. So, we can here cite some evidence from the US geological survey. So, the evidence tells that there has been 6 times increase in the volume actually extracted over the life of a field from the quantity which was indicated at the time of discovery in US. So, this is this data is from IEA 2005 report. So, you see it is a very interesting observation. So, in US what happened? So, you start with some quantity indicated at the initial time of discovery so; that means, this stage 1. But in the 4th stage what happens?

In 4th stage you see finally, the amount actually increases by almost 6 times. So, this is the average increase. Sometimes it was even greater. So, during this exploration in stage 4 in stage 5 so, this stage you can name this reserve growth stage. This you can consider as the stage 5.

So, in stage 5 you actually end up having more reserve and you also think another aspect that though I assume that technology is fixed in defining the proved reserve, but we cannot deny the fact that over time there has been huge technological improvement right because the countries are investing in research and development which leads to improvement in technology.

So, with the technological improvement now if you are going deeper and you are getting poorer quality reserve, but your cost of extraction and refining can also fall with technological improvement. So; that means, over time there has been huge growth in reserve when the exploration in a particular field goes up.

So, in US it has been around 6 times ok. So, you start at the time where you have some x quantity of proved reserve, but when you explore you end up having 6x amount which is the final amount of volume which is actually extracted ok. So, we have to keep in mind these aspects of reserve growth.

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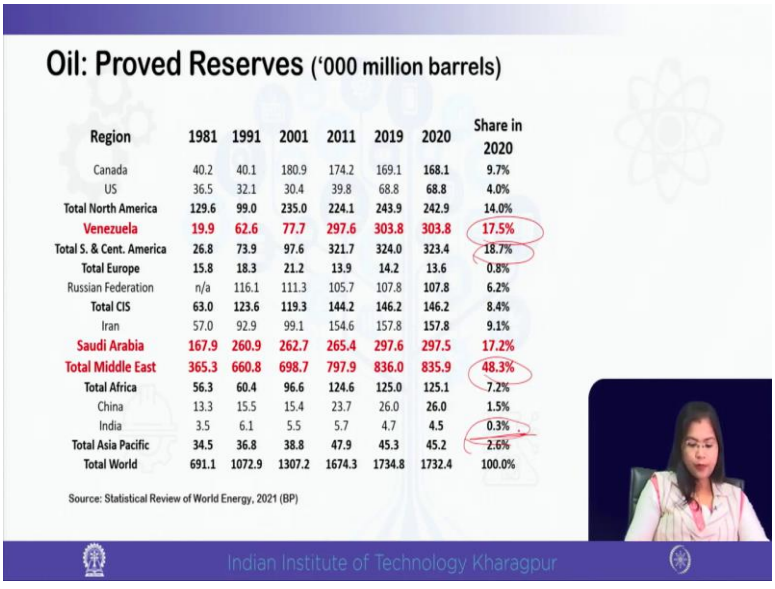

Now, we show some data and we also have plotted in the world map the amount of oil reserve over time and region wise also.

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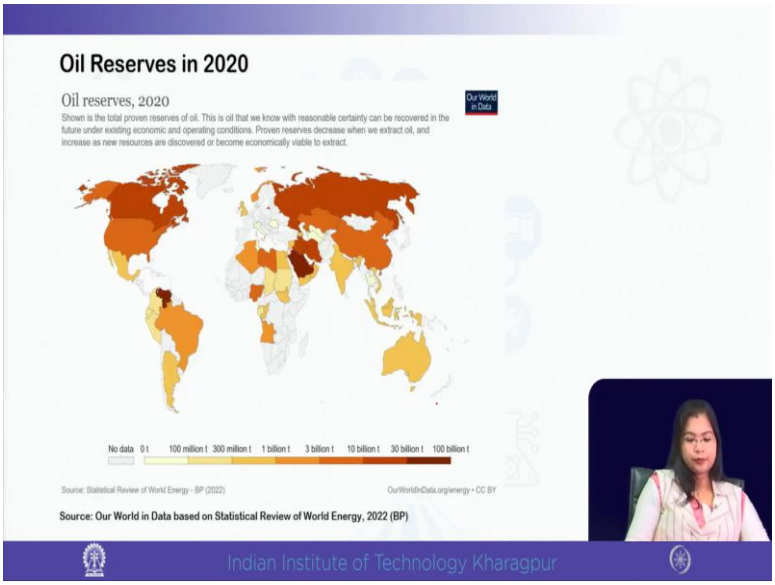

So, you can see the amount of oil reserve and from 1980s 1981 onwards. So, we have plotted the we have represented the data of 1981, 1991, 2001, 2011 and 2020 and we have also represented the regions and the countries in as a share in 2020. So, this data is from the statistical review of World Energy 2021 BP report ok.

So, we can see that Saudi Arabia accounts for almost 17.2 percent share in 2020 and overall total Middle East accounts for almost 50 percent you see 48.3 percent share in total supply of oil and this is in 1000 million barrel. And Venezuela is also a major supplier of oil you see 17.5 percent though in between it when it had it entered into a recession in 2018 there was also some sanctions against a Venezuela, but again it has revived it has a very high reserve into output ratio in Venezuela.

And you can also see for other countries and total South and Central America accounts for around 18 percent and total Europe is less 0.8 percent and Russian Federation is 6.2 percent; whereas, you can see over here very interesting China and India. So, India is only India share in the proved reserve in 2020 is only 0.3 percent and this shows the importance of oil in importance of oil in India's import basket India has to import huge amount of oil ok.

And for China it is 1.5 percent, but we have also seen with data if you remember in China, they rely more on coal than on oil, but in India we rely more on oil. So, large part of India's energy demand is made by oil and you can see the India's very miniscule

domestic endowment in 2020 and that explains why we have to import a large part of oil and why we actually need to have proper strategies of importing oil ok.

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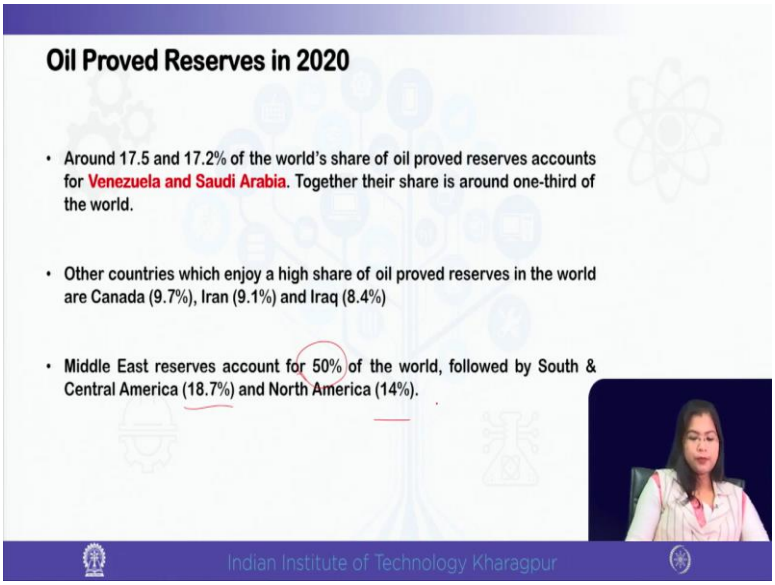

So, what we can see if we summarize this table and if this same table data is represented in the world map geographically. So, that I am not explaining. So, this is this world map with the oil reserve in 2020 is from our world in data this is the very relevant data source for our purpose. So, this is our world in data based on statistical review of world energy 2022 BP. So, we are providing the sources you can check you can browse. So, I am not explaining the world map again.

So, what we can conclude? We can see that Saudi Arabia and Venezuela they account for a large share of a proved reserve of oil. So, it is 17.5 percent for Venezuela is see it is even greater than Saudi Arabia. So, for Saudi Arabia it has been 17.2 percent in 2020. So, together they are share actually accounts for almost one third. So, 34 percent you can see almost 34.7 percent.

So, other countries which are having a high share is Canada around 10 percent, Iran is also 9 percent and Iraq is 8.4 percent. So, overall Middle East countries together they account for 50 percent of the world total proved reserve in 2020. So, you see till Middle East has a very dominating position and this is followed by South and Central America in 18 with 18.7 percent and North America 14 percent.

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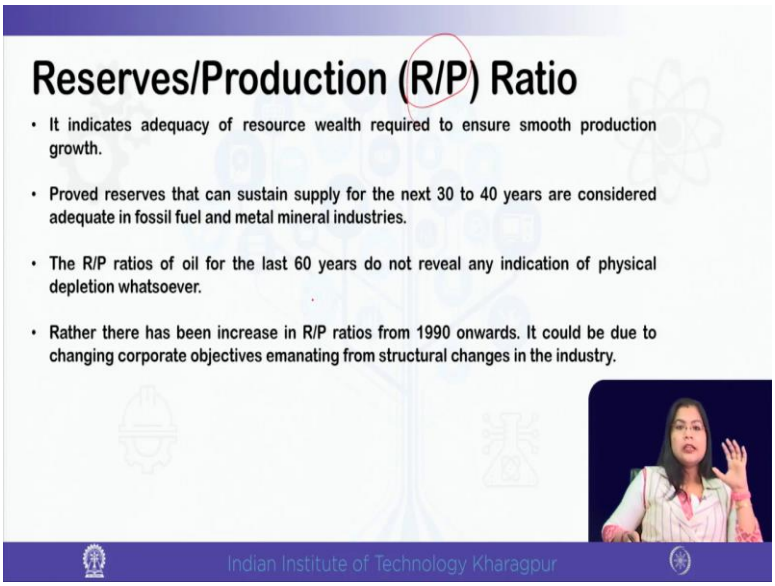

Now, another related concept which is used to judge the whether we have a resource in sufficient amount or not that is the reserve to production ratio. So, this reserve to production ratio indicates the adequacy or sufficiency of resource wealth which is required to ensure smooth production growth. So, how much of a resource is required. So, that in the next few decades you can ensure a smooth production smooth supply.

So, there should not be any supply side disruption. So, you should not run out of the resource. So, that is what is indicated by this R by P ratio. So, proved reserve that can sustain supply for the next 3 to 4 decades, next 30 to 40 years is considered to be adequate in the fossil fuel and metal mineral industry. Now, we will be looking at the R by P data for oil and we will compare the R by P data of oil with other industries, other metal and minerals.

Now, we see that the R by P ratio for oil over the last 60 years do not reveal any indication of physical depletion. So, this very interesting you see because in this module what we are discussing? We are discussing whether it is because petroleum is a depleting resource is it because of that oil price is increasing, but we can see that it is not the case ok.

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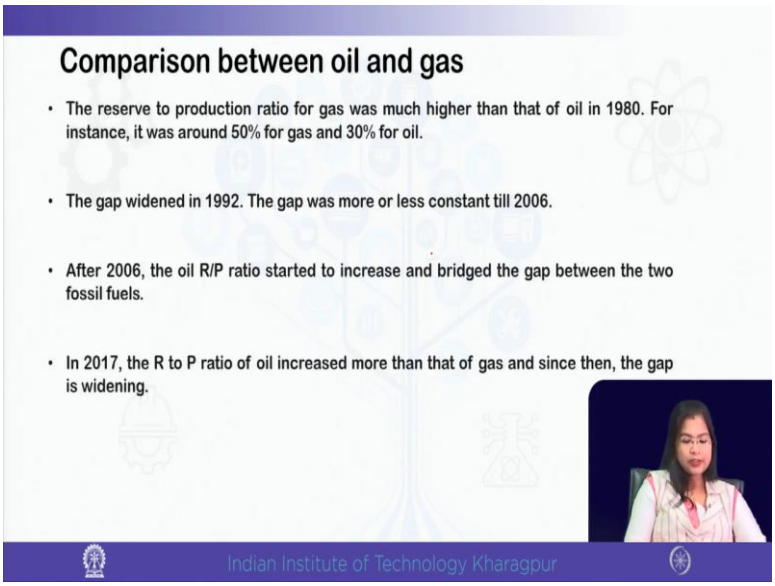

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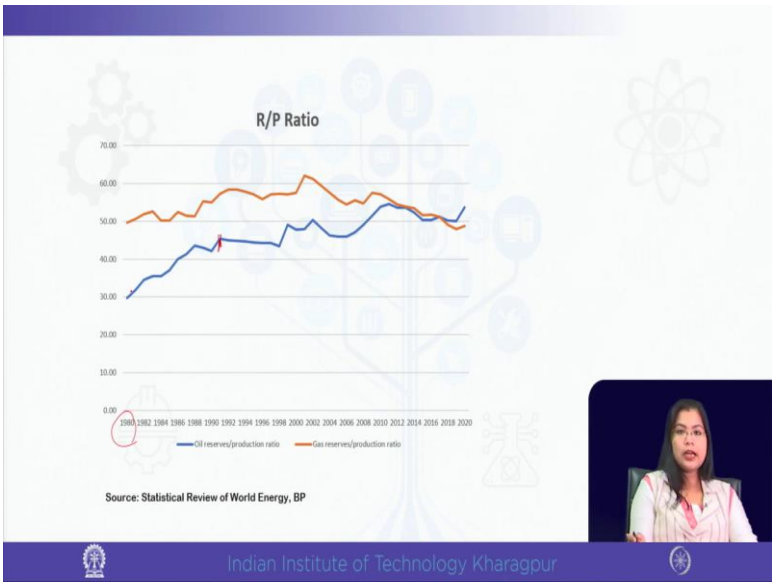

So, we can see the data and we can compare the R by P ratio of petroleum products and natural gas. So, oil reserve to production ratio and the gas reserve to production ratio we have plotted over here. So, this is from the data source is statistical review of world energy. So, you can see the blue line correspond to the oil reserve to production ratio.

So, we have plotted this from 1980 to 2020 and the orange line corresponds to the gas reserve to production ratio. Now, you see the conclusion. So, you can find out that the

gas reserve to production ratio has been exceeding the oil production to reserve ratio, but up to which level?

Towards the mid of the means the initial 2 decades of the 21st century you see there is a change in the pattern of the reserve to production ratio of oil right. So, this is very interesting. So, what we can conclude is that there has been increase in the reserve to production ratio from 1990 onward you see from 1990 onward. Reserve to production ratio and oil has started increasing you can see from here right.

It could be due to the changing corporate objective resulting from structural changes in the industry because we have already discussed that OPEC and Saudi Arabia wanted to be there in the oil market for a long run. They did not have the very short run quick profit earning motive. So, that is why they maintained the oil price at a stable range because they and for that what happened?

So, because they wanted to make the oil price very close to the competitive level, they supplied enough amount of oil over time right. So, that is why you see after 1990 till mid 1980s they restricted their supply, but they abandoned the high price policy and after that they actually increase the supply.

So, we can see a steady growth in oil reserve to production ratio from 1990 ok and you see after the shale oil revolution now you know the events right. After the shale oil revolution actually, you can see that oil reserve to production ratio has exceeded the gas reserve to production ratio.

So, the reserve to production ratio of gas has been higher than that of oil in 1980 we can already see from this figure. So, for instance you can see that it was around 50 percent for gas and 30 percent for oil in the starting period of 1980 ok. But how they have changed over time you can now see?

The gap started widening from 1990 onward and it widened in 1992 and more or less this gap was constant till 2006. So, the gap started increasing from 1990 onward until 2006 the gap the difference between the oil and natural gas R by P ratio was more or less same, but the trend changed ok.

After 2006 you see the oil reserve to production ratio started to increase and it bridge the gap between the two fossil fuels. In 2017 the R by P ratio of oil increased more than that of gas and since then the gap is widening right you can see from this. So, now with this figure with this data should we now conclude that oil is a depleting resource.

In that sense if the R by P ratio falling and the natural resource is depleting in that sense the natural gas price should increase fast further because here we can see that natural gas price has fallen means, sorry the natural gas R by P ratio has fallen below the R by P ratio of oil, but the price trend is not the same. So, we cannot and we should not conclude that oil is a depleting resource at least the R by P the empirical data does not reveal that ok.

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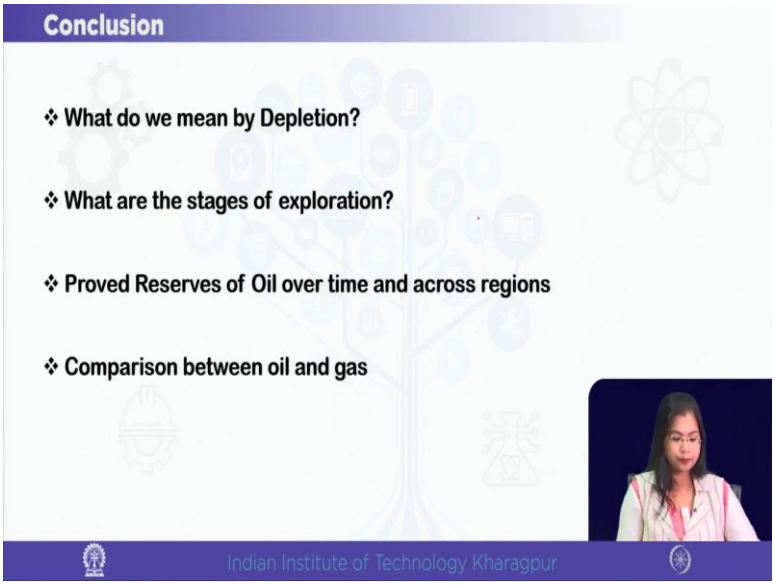

So, there must be other factors in play which leads to this type of price increase in oil. So, in this lecture what we have discussed? We discussed what do we mean by a depleting resource we also discussed some concept of resource if you remember.

So, we compared and we defined proved reserve and extractable resources and we also discussed about the stages of exploration and we compared the proved reserve of oil over time and across region and we saw the importance of Saudi Arabia and overall the Middle East countries, but we also saw that Venezuela also is having high share of reserve of oil, but India has a very low miniscule share of oil reserve for the with respect to the world endowment.

And we defined the reserve to production ratio which is an indicator to judge the adequate supply of a natural resource over the next 30 to 40 years and we saw that if we compare between oil and gas at least as far as the R by P ratio is concerned in oil the R by P ratio has increased recently ok.

Initially from 1980 to 2006 the R by P ratio of gas was greater, but after that the oil is started increasing the R by P ratio of oil has increased and in 2007 the trend actually reverse the oil R by P ratio has actually surpassed the natural gas R by P ratio. So, we cannot and we should not conclude that depletion is the reason for increase in oil price at least we cannot see any indication of depletion of oil in the very near future in the long run.

Obviously, over time; obviously, if we are using oil too much then we will be running out of oil, but at least as far as the next 30 to 40 years the reserve to production ratio is concerned then we do not have any indication of depletion. So, there must be other factors in explaining the oil price.

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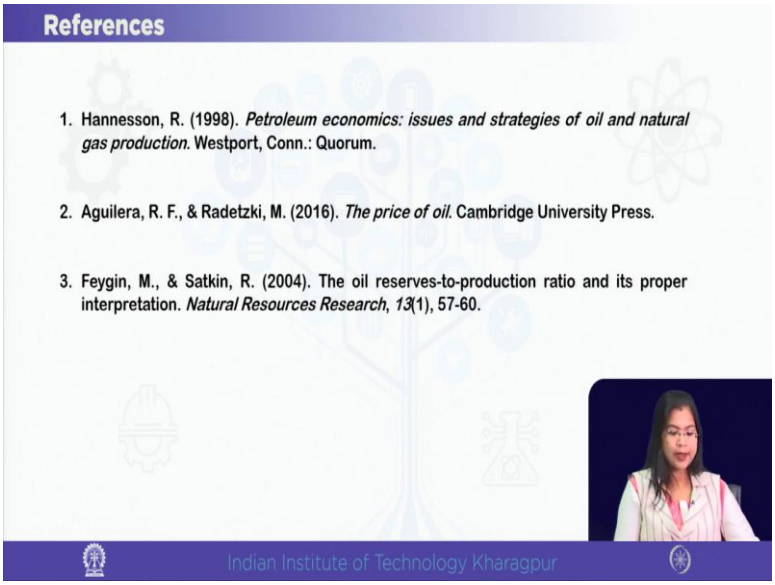

So, you mainly follow the two books of Petroleum economics and another research paper on explaining the concepts of depletion and proved reserve and extractable resource.

So, thank you with this we end the today's lecture.