Commodity Derivatives and Risk Management
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Lecture 22
Crude Oil Derivatives (Part 1)

Welcome to the next session on Commodity Derivatives and Risk Management and if you recall we discussed that in the last session we discussed that we will be starting the crude oil derivatives detail in this session, so all of us we understand the importance of petrol, diesel in our life. And this is something we cannot do away without, so the importance of crude oil and the refine product in our life has been subsequently given by this particular code.

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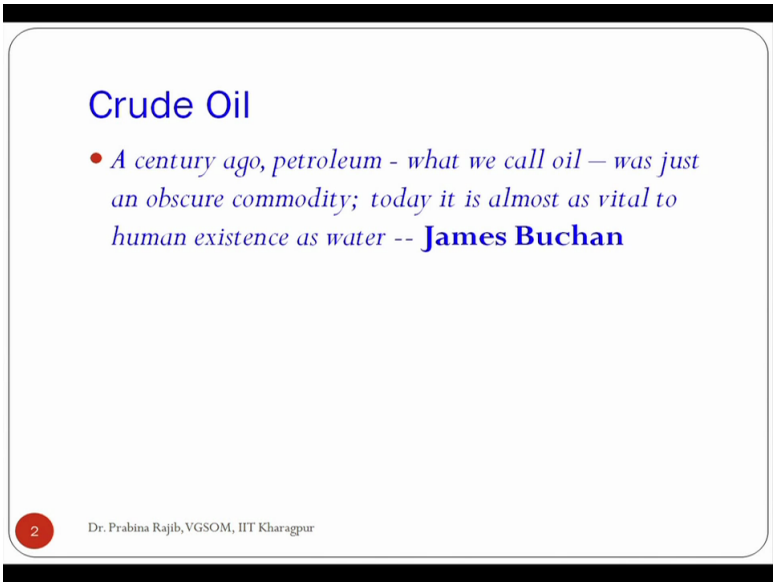

So let me start this, so a century ago petroleum what we call oil were just an obscure commodity, today it is almost as vital to human existence as water. So James Buchanan has mentioned this, so from this statement and from our daily life we understand how important crude oil is. Now all of us also as Indian citizen are people who are keeping track of what is happening in Indian economy, we know that whenever crude oil prices go up, it has significant impact on the current account deficit and other micro economic measures. So let us before we start today's discussion on how crude oil price risk can be mitigated, it is very important to understand different aspects of crude oil and in the last couple of sessions.

If you recall, I brought some beans to tell you which one is a soybean and off course the same thing I cannot do it today that I cannot bring you latter or some amount of crude oil to show you exactly what is crude oil. Ok, nevertheless let us start our understanding on what is

exactly what do you mean by crude oil, what do you mean by crude oil price, when we see that prices is increasing so which price, so every country produces crude oil. In fact there are some upstream companies in India like ONGC, Reliance and KM India who are into crude oil exploration and mining. Which crude oil is represents the global market and, so this different aspects let us first understand and then we will be proceeding to understand more about how derivative contracts are used by consumers of refined products, crude oil refined products and as well as producers of crude oil and how price volatility affects their profitability.

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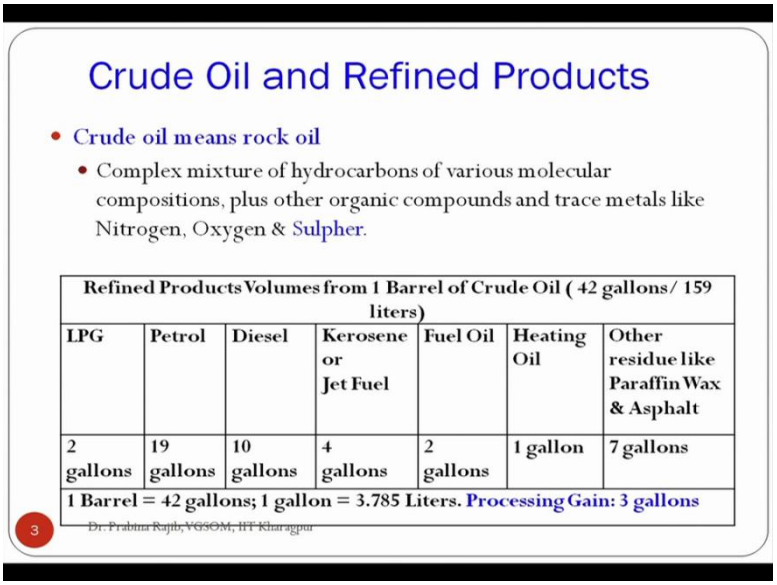

Now crude oil means rock oil and it is a complex mixture of hydrocarbons of various molecular composition plus other organic compounds and trace metals like nitrogen, oxygen and sulphur. So crude oil is what gets extracted from the underground mine, so you have and one crude oil normally measured in terms of barrel and one barrel is equivalent to 42 gallons and one gallon is equivalent to 3.785 litres. And all as all of you must be knowing that crude oil cannot be used as it is, crude oil needs to be refined to generate refine products which we use, so one barrel of crude oil which is equivalent to 42 gallons of crude oil can be processed to generate 2 gallons of liquid petroleum gas, 19 gallons of petrol and 10 gallons of diesel and 4 gallons of kerosene or jet fuel.

And all of you I mean I do not know whether you are aware of it, the kerosene which we have seen being sold in public distribution system all over India, that kerosene is the same kerosene is used as aviation for aviation turbine fuel that ATF and of course not the same quality more finer and more superior quality of kerosene is used by airlines company as ATF. So kerosene of jet fuel is generated is 4 gallons, fuel oil fuel oil is 2 gallons, heating oil is 1

gallon and finally other residue like paraffin wax etc it is 7 gallons. So if you see if you add up all these outputs it comes out to almost it comes out to 45 gallons and whether the extra 3 gallon comes from so this is known as the processing gain of three gallons.

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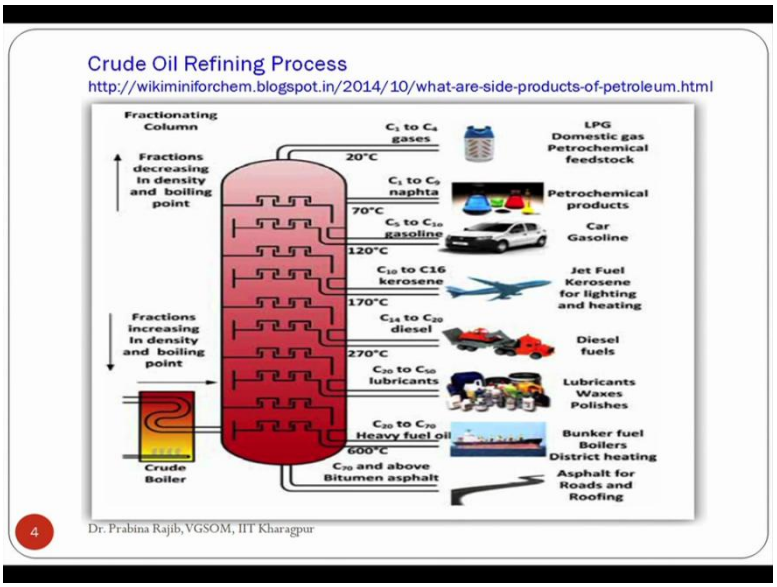

So if a company is producing or extracting 1 barrel of barrel of crude oil which is equivalent to 42 gallons of crude oil that company will be able to produce 45 gallons of this combination of outputs. So this particular picture I have taken this image I have taken from the website which is mentioned here, so there are many images available in the Google in terms explaining the process of refining, but this particular picture I personally liked, if you can see this crude oil goes into the boiler depending over the temperature you have LPG, you have different petrochemical products, you have gasoline, that is your petrol and you have jet fuel kerosene for lighting and heating and you have a diesel fuel, you have different kinds of lubricants and waxes and polishes and you have a bunker fuel and bunker fuel is the fuel which is used by big you ships for carrying different goods from one country to another country.

So you have bunker fuel and for running boilers, etc and you have also finally paraffin wax for road and roofing, so the black tar which we see on our road also comes from the process of crude oil refining process. Off course if you are more interested in understanding how exactly this happens, you can visit website different websites and you will be able to find out more information pertaining to the crude oil refining process. And if you recall we also discussed in the last class, if you are going to be a trader or if you are interested in trading

commodity derivative, the first and foremost thing to start is to understand what is the underlying commodity you are going to deal with.

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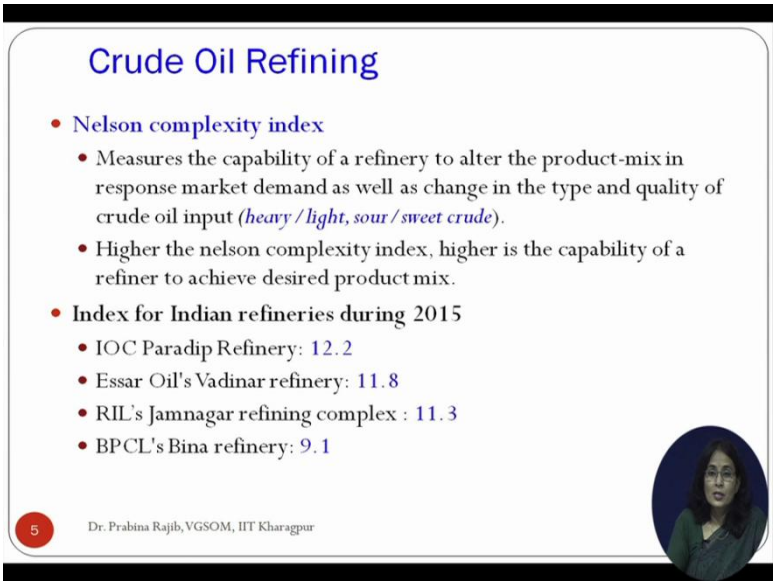

So this starts with understanding all aspects of the commodities so in today's session we are going to spend couple of minutes in understanding different aspect of the crude oil. Here the in the refining process one interesting concept I thought of sharing that is called your Neilson complexity index, so this complexity index or this index measures the capability of a refiner measures the capability of a refinery to alter the product makes in response to market demand as well as change in the type and quality of crude oil input.

So as we go along we will be discussing different types of crude oil which is produced all over the world, so this crude oil can be categorised as heavy or light can be categorised as sour or sweet crude. So depending upon the depending upon the advance refining process a refiner has which is measured by the Neilson complexity index, so higher the index better the capability of a refiner to take in all kinds of crude oil as input and also change the product needs depending upon the market demand.

Let us say all of a sudden if a company decides that aviation turbine fuel is in greater demand then it may start it may reduce the amount of petrol or diesel it is producing, it will it may focus more on producing ATFs. So depending upon the Neilson complexity index a refiner has the flexibility to change the input kind of input it is taking in as well as the product mix the output product mix also can be changed.

Now in Indian context who is the best refinery as of today, so the index for Indian refinery during 2015 is the The IOC Indian Oil Corporations Paradip Refineries stands at 12.2, Essar Oils Vadmar Refinery is 11.8, Reliance Jamnagar Refining Complex has 11.3 and BPCL's Bina Refinery is 9.1, so each and every refinery complex in the world as well as India can be the efficiency of this refinery units can be measured using the Neilson complexity index.

Now why are we discussing this, so this gives us an indication on how flexible a refiner is, it will be able to undertake its physical process such that it will be able to get benefit from the prevailing market situation? So if a commodity is lower is ruling at a low price if a refiner product is ruling at a lower price that refiner may reduce production of that product and also increase the other product in which in which it has got a possibility of getting a better return.

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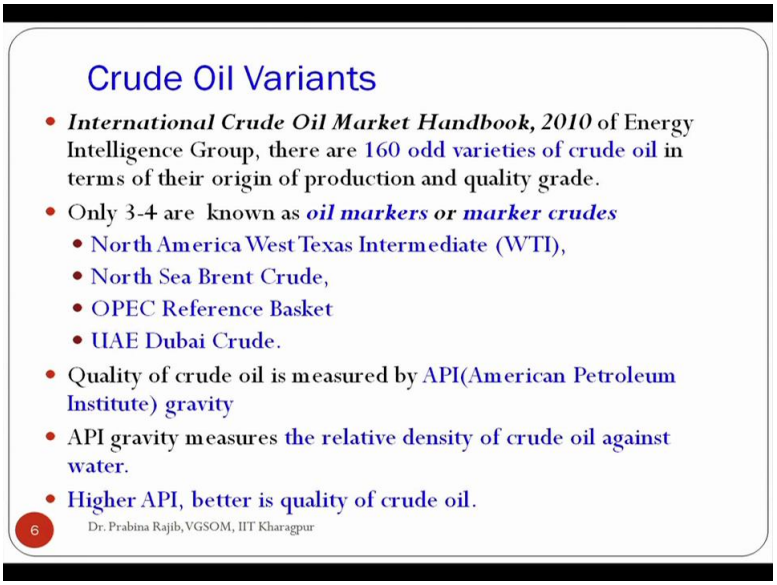

Now let us discuss little more on crude oil types. In the world as per the international crude oil market handbook 2015, which is produced by United States Energy Intelligence Group, there are 160 odd variety of crude oil in terms of their origin or production and quality grade. So all over the world there are different companies and different geographical locations produce crude oil which can be which categories can be as diverse as 160 varieties. We talk about only 3 to 4 varieties and these are known as your oil markers or marker crudes. So many times you may have heard that Brent is quoting at this much WTI is quoting at this much, so globally predominantly when people talk about crude oil price they mention the price of one of these market crudes.

So out of 160 varieties, 4 of these varieties are popularly quoted, so which are these four, you have a North America's West Textiles Intermediate or popularly known as WTI crude, you have North C Brent crude, you have OPEC Reference Basket and you have UAE Dubai crude. And how this 160 varieties can be segregated from one over the other, so this is based on 2 parameters, 1 is your API gravity measure and other one is the amount of sulphur the crude contents.

So what API stands for, API stands for American Petroleum Institute Gravity so this particular API gravity measures the relative density of crude oil against water. So if a if a particular variety of crude oil is lighter, it will have a higher API index, so higher the API index better the quality of crude oil. So it is it is thinner and it is lighter so it floats against when it is mixed with the water, it floats above the water so that is one measure of knowing which is the better quality of crude oil.

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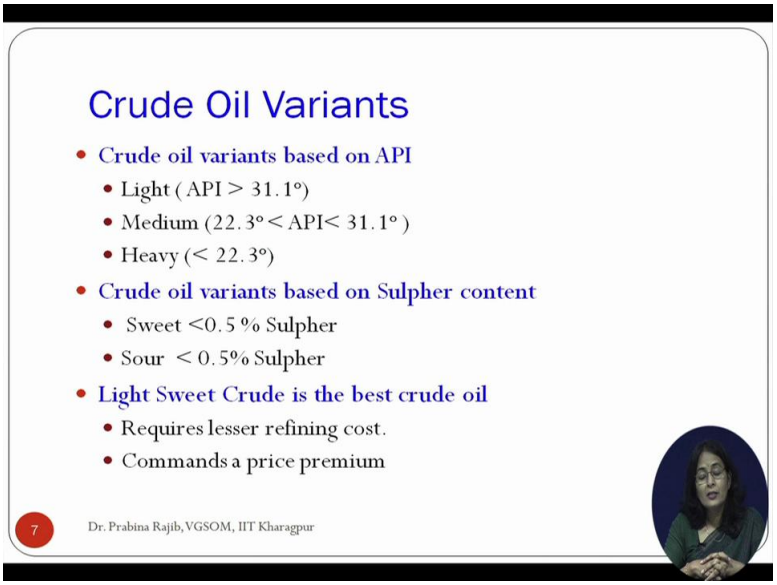

So this particular slide shows crude oil variants based on the API, when we talk about a crude oil as a light crude oil, this particular crude oil varieties should have a API measure greater than 31.1 degree. Similarly medium crude oil will be 22.3 degree to 31.1 degree and heavy crude oil is less than 22.3 degree. Similarly the second measure of second measure of knowing the quality of the crude oil is measured through the sulphur content. So if a particular crude oil variety has higher sulphur component then it is known as a sour crude oil and if it is it has got lesser sulphur component, it has it is known as a sweet crude oil.

There is slight mistake in this particular slide, so please ignore this one, the sweet will be less than 0.05 and sour will be greater than 0.05 percent. So please make note of it, when we are talking about a crude oil variety which is which is called a sour crude oil that means it has got a higher sulphur percentage. So the light sweet crude oil is the best type of crude oil, and why are we saying it is a best type of crude oil, it requires the least amount of refining cost and it also commands a price premium because all over the world crude oil is used as a input to the refiner and the refiners use this crude oil to generate refine products which are used by the consumers, so light sweet crude oil requires the least amount of refining cost

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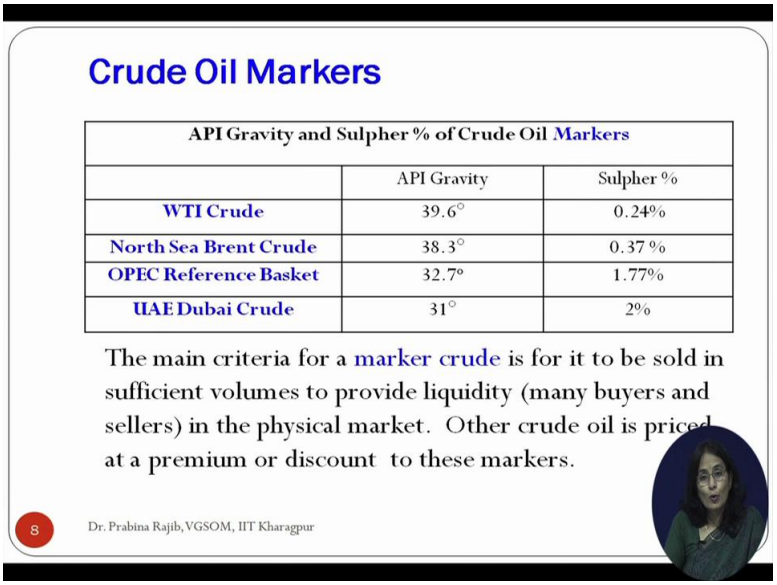

And let us go to the this two components with respect to the 4 marker crudes I mentioned, so WTI crude is has a API gravity of 39.6 degree and sulphur percentage of 0.24 percent, so WTI crude is known as a light sweet crude oil. Similarly you have a Brent crude is 38.3 degree centigrade API 38.3 degree API gravity starts at 38.3 degree and it has got a sulphur percentage of 0.37 percent. And if you see for the other tow the API gravity is reducing and the sulphur component is sulphur percentage is increasing. Now, out of these 160 crude oil varieties, how these 4 have been identified as marker crudes. So what are the criteria for a particular crude variety to be called as marker crude, so the main criteria for marker crude is to be sold in sufficient volume to provide liquidity in the physical market.

So if many people are buying and selling and the volume is volume traded for that particular variety of crude oil is higher than many people would like to know what is the price prevailing for these crudes and globally many organisation report the price of these 4 variety of crudes and slowly over the period of time this crudes come to be known as marker crudes.

And other crude oil is priced at a premium or discount to these markers, so if another if a company or a if a company is producing a crude which has got a let us say better API gravity and lesser sulphur percentage, it will be trading at a or this particular company when it is selling the crude oil to a refiner, it will be selling at a premium to the WTI crude.

So the importance of this crude oil crude oil markers could be could be understood from the facts that these highly reported widely reported crude oil prices and these 4 crude oils are consumed by many or are traded by many buyers and sellers. Let us talk about crude spot price, so when we talk about WTI spot price or Brent crude spot price, what is that I mean how do we know which price because crude oil could be crude oil could be mined by many companies at a given point of time by in a in a country.

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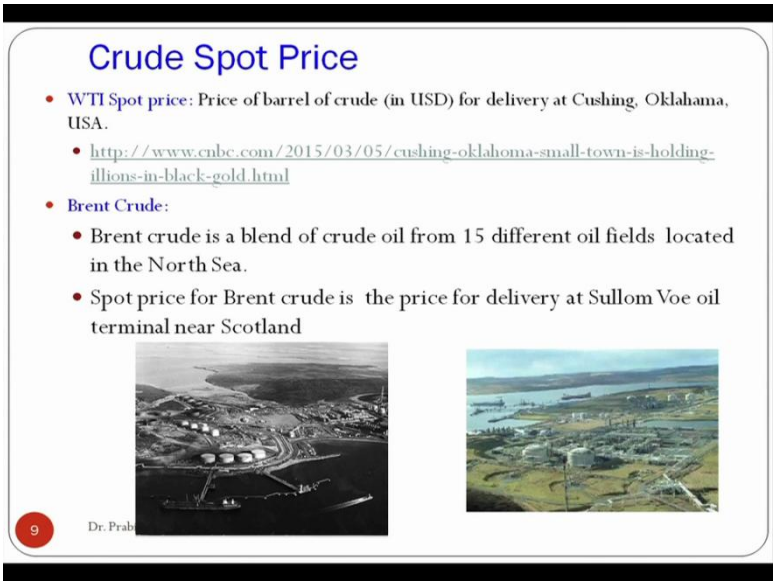

So when we talk about WTI spot price or west exercise intermediate spot price what do we mean by that. So this WTI spot price indicates the price of barrel of crude oil for delivery at crushing Oklahoma USA. So whenever the price prevailing at spot delivery at crushing Oklahoma USA is known as the WTI spot price and importance of this particular location crushing at USA can be understood from this particular video, I am going to show you this video for couple of minutes so please bear with me for some time. This is a small advertisement, so please ignore that.

Video being played from 21:31 minutes till 22:48 minutes.

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So I hope you got to see this or understand the importance of crushing Oklahoma USA with respect to WTI spot price, so the price prevailing for crude oil delivery at this pipeline centre and the storage location at crushing is the spot price of WTI. Similarly what is a Brent crude and in the couple of slides before I mentioned the word North C Brent, so Brent crude spot price indicates the it is a blend of crude oil from 15 different oil fields located near the north sea and the spot price for Brent crude is the price for delivery at SullomVoe oil terminal near Scotland. So the price prevailing for oil buying and selling at SullomVoe oil terminal near Scotland is the spot price prevailing or the North C Brent.

And in the slide you can see one black and red picture and one colour picture and both these picture say shows the same location, so you can see some oil storage locations as well as pipelines and these pipelines are projecting to the North sea, specifically if you can see these pipelines have has come into the North sea and you have a ships coming and the ships tankers crude oil tankers come to this North sea and get filled in so buyers and sellers whoever is interested to buy or sell crude oil at this North C Brent crude oil at this location, the price what they pay is the spot price prevailing for the North C Brent crude.

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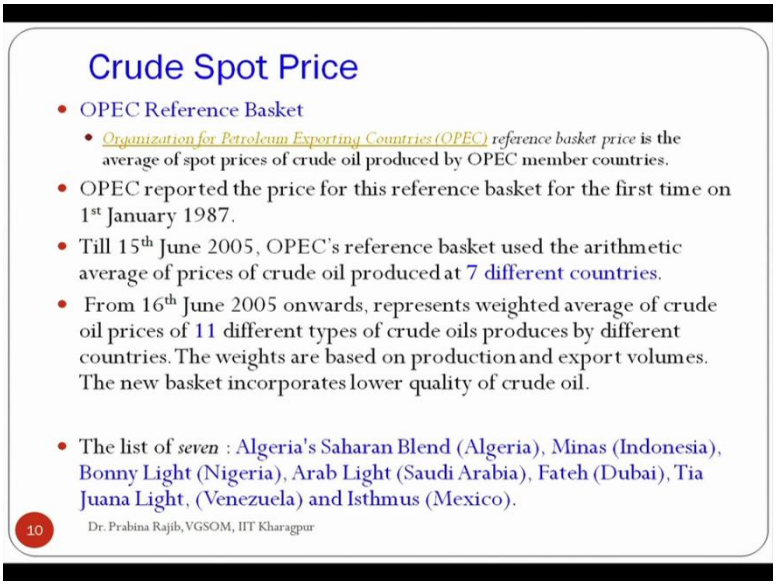

The third marker crude is your OPEC Reference Basket and I am sure all of you must have heard of organisation called Organisation Of Petroleum Exporting countries, so this OPEC Reference Basket is the is the average of spot prices of crude oil produced by OPEC member countries. So this OPEC Reference Basket is the average of the spot price of the crude oil which is produced by these OPEC members. And at this point of time I would like to just briefly discuss little bit on about OPEC and the link of this organisation of petroleum exporting countries OPEC link will if the link will be available.

You spend some time understanding the history of OPEC was formulated, what was the mandate, what how OPEC has been instrumental in controlling the production as well as the supply of crude oil all over the world, so different aspect pertaining to the crude oil prices is very very clearly given. So just to briefly discuss, OPEC reported the price for this reference basket for the first time in 1st January 1987. So it is OPEC was created if I am not mistaken OPEC was created for the first time in 1966 and but it reported the price of this reference basket for the first time in 1st January 1987 and till 15th June 2005 OPEC Reference Basket had arithmetic average of prices of crude oil produced at seven different countries.

So 7 different OPEC members they were producing different varieties of crude oil and this spot prices were depending upon the different variety and OPEC Reference Basket was the arithmetic average of the price of crude oil produced at seven different countries. And which were the 7 different countries, so you have Algeria's Saharan Blend, you have Minas from Indonesia, you have Nigeria, you have Arab Light, you have Fateh Dubai, you have Tiajuana Light Venezuela and Isthmus Mexico. And so these 7 different varieties of crude oil price

was the arithmetic average was calculated and reported as the spot price of OPEC Reference Basket. However, with the other members joining OPEC from 16th June 2005 onwards this list was expanded to 11 different types of crude oil.

And from simple arithmetic average it became OPEC started using the weighted average crude oil price for these 11 different crude varieties to arrive at the spot price and the weights were based on the production and export volume. So if a country is producing more and exporting more than that country will have a higher weightage in the calculation of OPEC Reference Basket.

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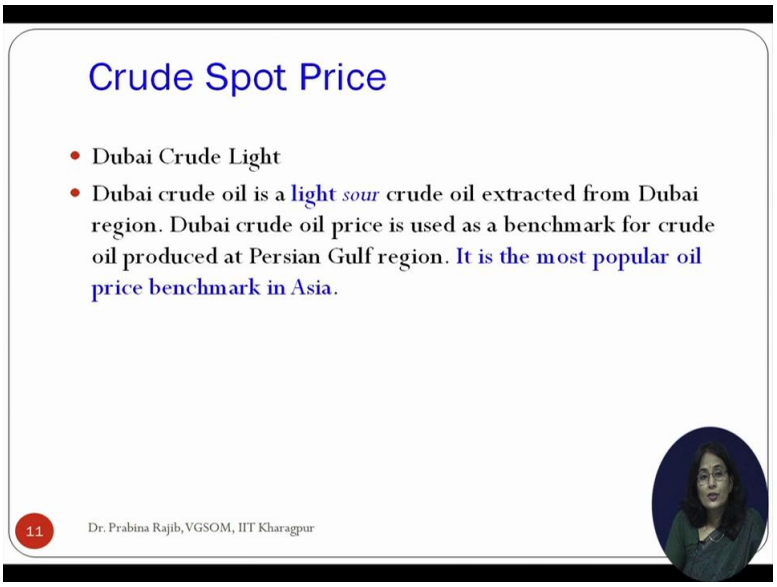

Ok, the fourth crude marker is the Dubai Crude Light, so Dubai crude light is if you see the light sour crude extracted from the Dubai region and this particular crude oil price is used as a benchmark for crude oil produced from the Persian Gulf region and this is one of the most popular oil price benchmark in Asia. So most of the buyers and sellers from the Asia price their crude output most of the uh, specifically most of the sellers from Asia price their crude output with respect to the Dubai crude Light.

Besides these 4 oil markers there are other couple of other benchmarks which are also reported on regular basis, one is your Argus sour crude index, if you recall these 4 crude markers were light light sweet, first 3 crude markers were light sweet and the last one was light sour, but this Argus sour crude index is a volume oriented average price index of medium sour crude. Let me report, let me highlight it is the medium sour crude, it is not a light sour crude, so it is a volume oriented average price index of medium sour crude oil

trading at US gulf of Mexico and many companies use this one as a benchmark price for pricing their crude oil. For example, Saudi Arab's national oil company Saudi Aramco started using this particular benchmark this particular index to price all its crude oil exports to USA from July 2010 onwards. Prior to this date Saudi Aramco was using WTI crude oil price as the reference price.

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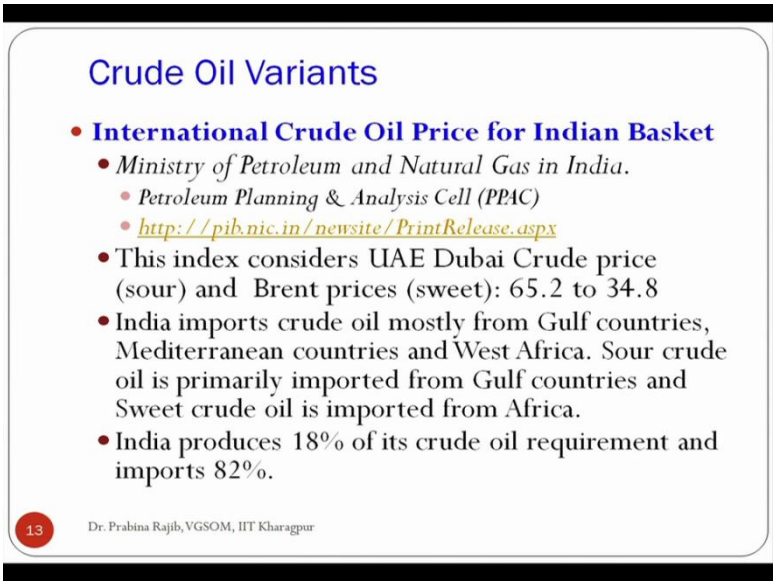

Similarly you have another index called Japan Crude Cocktail index, so petroleum association of Japan produces calculates this Japan crude cocktail index, it is the monthly average import price of customs clear crude oil imported to Japan. So this index is again used by many crude producers from the Asian region the finally with respect to India you have international crude oil price for Indian Basket, and this is prepared by ministry of this index is reported by Ministry of Petroleum and Natural Gas of India and it has a sale called petroleum planning and analysis sale. This sale on a daily basis it reports the price of this basket and it considers the UAE Dubai crude price as well as Brent North C Brent crude price in a ratio of 65.2 to 34.8 percent so this the logic of this ratio is India imports majority of crude oil from gulf countries gulf and Mediterranean countries West Africa.

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So so sour crude oil is primarily imported from gulf countries and sweet crude oil is imported from Africa and all sweet crude oil from Africa is back to the North C Brent crude oil price, so Ministry of Petroleum and Natural Gas of India uses the ratio ratio of sour and sweet crude prices that is UAE Dubai crude price and Brent prices in the ratio of 65.2 to 34.8 to arrive at the international crude oil price for Indian Basket. So I will just take you through, this is how, this is website of this is the website of Ministry Of Petroleum and yes, I hope you are able to see this particular detail.

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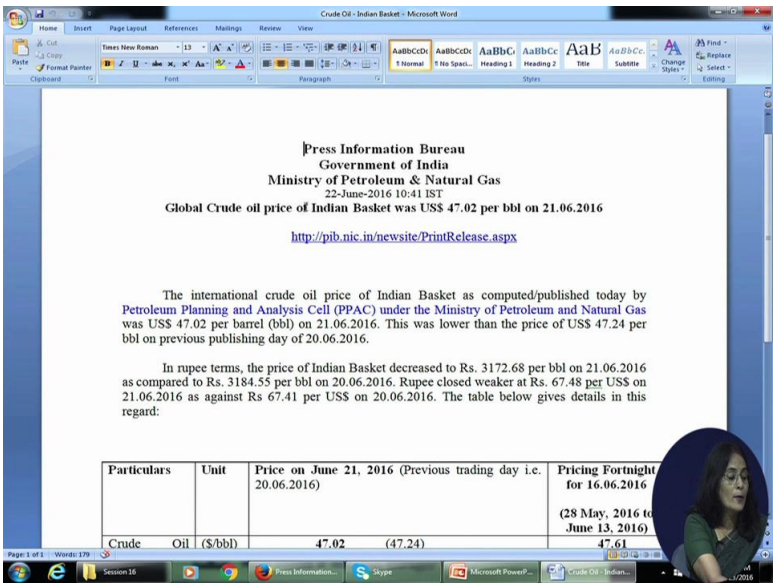

So you have on a daily basis press information bureau releases the crude oil for the Indian basket, so this is the detail which is available on 22nd June 2016, so what is a crude oil price it

it has taken 47.02 this is the price prevailing on June 21st 2016 and multiplied by the exchange rate prevailing on that day RBI reference rate prevailing on that day, so 67.48 rupees per US dollar, so this two multiplied by 47.02 multiplied by 67.48 gives the INR price rupee price of barrel of crude oil.

So with this I would like to summarise the this session on crude oil, so we started discussing the importance of crude oil, we also briefly discussed how crude oil is refined to arrive different kind of different products and 1 barrel of crude oil which is equivalent to 42 gallons can be refined to generate 45 gallons of different refined products. We also started discussing how the spot price is arrived or how to we get to know what is the spot price how this spot price gets arrived and how the spot prices are reported for 4 global important crude oil and these 4 important crude oil is your USA WTI crude oil, North C Brent Crude oil, OPEC Reference Basket and also United Arab Emirates Dubai Light.

Besides this 4 important crude oil also other industry bodies report different indices, so some of the important indices is the Argus sour crude index and Japan Crude Cocktail index and India's Reference Basket for India's Reference Basket for crude oil. So I would like to end up the session here today and looking forward to meeting you all in the next session, thank you all of you.