

**Chemical Technology**  
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**Module - 6**  
**Petroleum Refinery**  
**Lecture - 1**

**Introduction, Status of Petroleum Refinery, Crude Oil and Natural Gas Origin,  
Occurrence, Exploration Drilling and Processing, Fuel Norms**

We are discussing organic Chemical Technology course and we have already discussed 5 modules of this course. And today we will be discussing the module 6 of the organic chemical technology course and that is about the petroleum refining; that is one of the very important sector and whatever the revolution, green revolution one of the industrialization you have seen that is because of the petroleum refining, and the product which is available for energy, for fuel or for the petrochemical. So, the coverage of the, we will be discussing about the introduction of the petroleum refining, extraction of the petroleum refining, crude oil natural gas, origin occurrence exploration drilling and processing. This part that will be discussed in very brief and the fuel norms what are the various changes that is taking place in the refining.

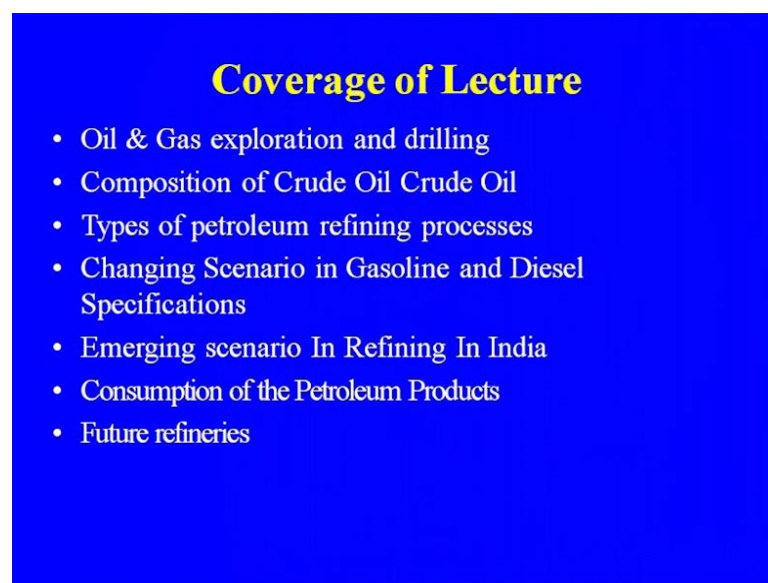
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### **Coverage of Lecture**

- Introduction
- Status of Petroleum Refining Industry and Global consumption pattern of oil
- Historical development of Petroleum Refining industry in India
- Type of crude oil processed In India
- Structure of Indian Petroleum Industry
- Crude oil and natural gas origin, occurrence

So, this is the total coverage of the lecture introduction status of the petroleum refining industry and global consumption pattern of the oil, historical development of the petroleum refining industry in India. What are the changes that has taken place during the last 50, 60 years of the petroleum refining industry in India. Type of the crude oil process in India, because we are processing here both the imported crude and the indigenous crude. So, there is mean lot of variation in the quality of crude during the last few years, then the structure of the petroleum, Indian petroleum industry crude oil natural gas origin occurrence.

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**Coverage of Lecture**

- Oil & Gas exploration and drilling
- Composition of Crude Oil Crude Oil
- Types of petroleum refining processes
- Changing Scenario in Gasoline and Diesel Specifications
- Emerging scenario In Refining In India
- Consumption of the Petroleum Products
- Future refineries

Oil and gas exploration and drilling, composition of the crude oil, types of the petroleum refining processes, changing scenario in the gasoline and diesel. Especially means lot of the changes that has taken place in the refinery configuration just to meet the environmental standards as per the euro norms or the Bharath norms and the specification of the gasoline and diesel that is changing time to time look out to the environmental condition.

Emerging scenario in the refining industry in India, because there has been lot of the changes lot of the problems, because of the non-availability of the crude volatile market of the crude oil. All those factors are affecting the overall growth of the petroleum industry we will be discussing some of the problem, which you are facing then the conjunction pattern of the petroleum products. Because the various uses of the whatever

the, because there is very important in case of the petrol, each and every drop of the oil each and every barrel of the oil that is very important and the, and if you are not utilizing properly then overall economy of the refinery that is definitely going to be affected.

And the future economy because the concept now it is changing just to have to more value added product and to incorporate the various developments which are taking place, keeping in mind of the environment keeping in mind of the availability of the raw materials all those factors that we will be discussing in the, what will be the concept of the future finding.

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### **Introduction**

- Petroleum and derivatives such as asphalt have been known and used for almost 6000 years and there is evidence of use of asphalt in building more than 600 years ago.

Let us come to the petroleum refining petroleum and derivatives such as asphalts have been know and used for almost 6000 years and there is evidence of use of asphalt building more than 6 years ago.

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## Introduction

- Modern petroleum refining began in 1859 with discovery of petroleum in Pennsylvania and subsequent commercialization. The exploration of petroleum originated in the latter part of the nineteenth century (Speight, 1999).

But only thing the it was not the actually known but, some oil that was available but, modern petroleum refining began in 1859 with the discovery of the petroleum in Pennsylvania this is near in New York. You can say, just side of the New Jersey, one side is Pennsylvania another side is the New Jersey. So, this is Pennsylvania and subsequent commercialization of the various processes, because there is lot of changes in the process of the refinery operation. And that we will be discussing the whole petroleum refinery that is continuing 8 lectures. And so, the different section what are the development we will be discussing, the exploration of the petroleum originated in later part of the 19th century.

So, far the petroleum industry is concerned, now you cannot survive you cannot imagine alive without petroleum product. Petroleum industry is playing vital role in the industrialization and urbanization and meeting the basic needs of the mankind through supplying energy for domestic purposes, for industrial purposes, for transport sectors and we are finding the revolution the automobile industry. Because of the availability of the more and more fuel and at the same time some of the products, which are available.

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## Introduction

- Petroleum industry is playing vital role in the industrialization and urbanization and meeting basic needs of mankind through supplying energy for domestic, industrial, transport sectors and as feed stocks for fertilizers, synthetic fiber, synthetic rubber, polymers, intermediates, explosives, agrochemicals, dyes, paints etc. Now the world economy runs on oil and natural gas.

And as feed stock for the fertilizer, synthetic fiber industry, synthetic rubber polymers, intermediates explosive agrochemicals dye. These are all we will be discussing in much detail while discussing the module 7 and module 8 of the where we will be discussing about the petrochemicals, which are derived from the petroleum industry. Already we discuss about the some of the chemicals which can be produced through the non-petrol root, because that was the on utilization of the bio mass utilization of the ethanol.

Or the coal gas application from coal to chemical root, all those thing we discuss but here we will be discussing in the module 7 and module 8 about the development that has taken place because of the coming of the petroleum products. So, intermediates explosive agrochemicals dyes paints all those things will be discussed. Now, the word economy runs on the oil and natural gas because, any industrialized country anywhere we cannot survive without oil and natural gas, because we are using in some or other form.

Whether you take the LPG you take the gasoline, you take the diesel, whole transportation sector is depending upon the diesel and the, because that is the only alternative root now left and the economic way of the transportation of the raw material of the various products. So, the importance of the petroleum refining you can just imagine, because it is not only the fuel or the energy but, it is also providing very important role in through the various. Actually the raw material which is available to the

fertilizer or the petro chemical industry or intermediate explosive all those industry they are using the the product produced from the petrochemical industry.

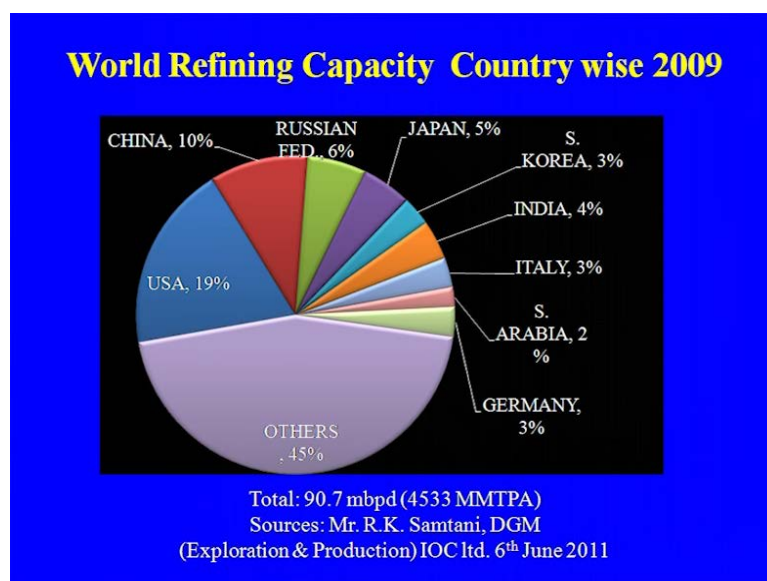
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### Global Oil Consumption And Refining Capacity

Region	Oil consumption	Refining capacity
Asia Pacific	25.99	26.81
N. America	22.83	21.13
Europe and Eurasia	19.37	24.92
S & Cent America	5.65	6.69
Middle east	7.15	7.86
Africa	3.08	3.26
Total	84.04	90.66

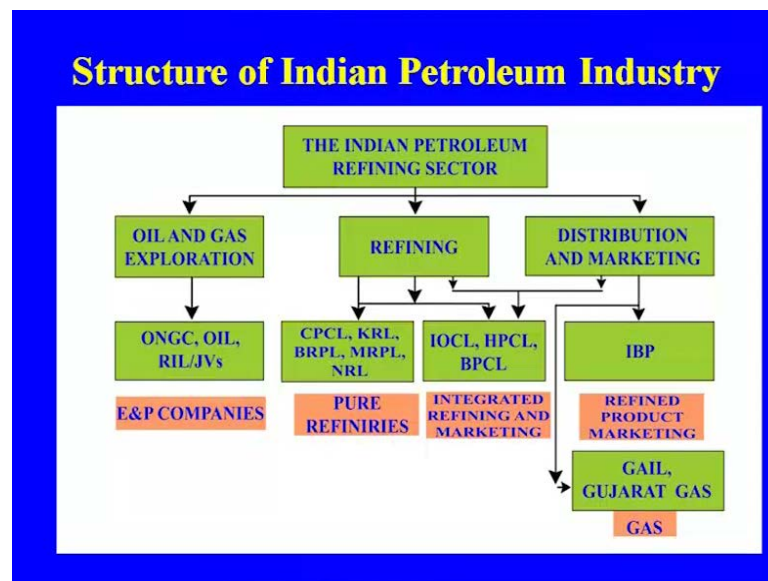
This is the global oil consumption and the refining capacity global this is global oil consumption refining capacity in the Asia, pacific, north America, Europe and other Eurasian country south. And central America, middle east Africa and total, because some it is India is also included here, so this is about the global.

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And then the world refining capacity the country wise and this is the figure that we are having about the. So, if from this figure you can see the U S is the majors, here is the U S but, but one of the interesting thing is, the although they see you are a further countries it may be the America or it may be the South East Asia. All those are having the large refining capacity they are producing but, the basic raw material, which we are producing that is only from the middle east and some other part of the world. So, the major supplier of the raw material are the middle east.

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So, this is the structure of the Indian petroleum industry. The Indian petroleum refining sector was part, because with the refinery we must have the crude oil and the first part is the oil and gas exploration. And here the major player is ONGC oil and natural gas corporation oil India, which was earlier under the Assam oil company when the oil and gas exploration was started in Assam. But, now it is under the public sector reliance J V and other these are all they are having now, they are playing important role in the oil and gas exploration.

Refining the some of the refineries here written but, they are large number of refineries we are having and the new refineries are coming. Then the marketing because the refining they are having under private sector, public sector, distribution and marketing of the product some of the actually the organization that was developed just to marketing



IBP you take the case of the IBP they are not having any refinery but, they are doing the marketing part.

Apart from these the Indian oil BPCL, HPCL they are all having their own marketing distribution system. So, this is about the structure of the your and the one of the major player in case of the gas distribution is the gail, which are supplying the gases which process at the various part of the country through the pipeline and and that is being provided no other gas pipeline, which has evolved through the gail date or with the HBJ pipeline.

Long back it was actually they started the supplying of the natural gas to some of the fertilizer plant and that is the, your Hazira to Bijaipur and Jagdishpur that is the when the fertilizer plant based on the natural gas that was started by Birla's at Jagdishpur. So, let us now discuss, because the, what are the, because we will be going in detail about the each and every process in the next few lectures. But it is just a summary introduction to the petroleum refining industry, which we are discussing in this lecture.

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### **Petroleum Refining Process**

- All steps of petroleum industry start from oil exploration to refining of crude oil
- Properties of crude oil varies from location to location.
- Petroleum Refining is a processes in which crude oil are refined to convert it to the usable fuel.
- Now more heavy crude conaining highTAN and sulphur is avaiable making refinery processes more complex

So, all steps of the petroleum industry start from the oil exploration to the refining of the crude oil and the final marketing of the products, which are producing in the refinery. Because, some of the raw material that is going as a fuel and others are going to petrochemical complexes for producing large amount of the, one of the development which has taken place in case of the chemical petrochemical chemical industry, organic



chemical industry. That has been the coming of the naphtha cracker and the LAB we discuss LAB where we are using the grassy.

These are the two major development that took place and from the cracker then it was the polymer development of the polymer industry. Because of the availability of the your ethylene, propylene all those thing that came into existence and that was only the revolution, which we are seeing in the petrochemical industries only because of the coming of the number of the petroleum refined industry in India. Then we will be discussing about the properties of the crude oil not in detail but, in the next lecture we will be discussing about the evolution of the crude.

Why it is important because the property of the crude oil where is from location to location, from one region to another region, from one country to another country and there is been continuous variation in the quality of the crude oil to the refineries. And so, that is one of the major problem but, at the same time what we are doing, we are trying to use more and more available crude oil whether it is heavier or the lighter or with the oil scent. Whatever it in the formed at the oil is from the our objective is just to utilize these available resources to maximum limit.

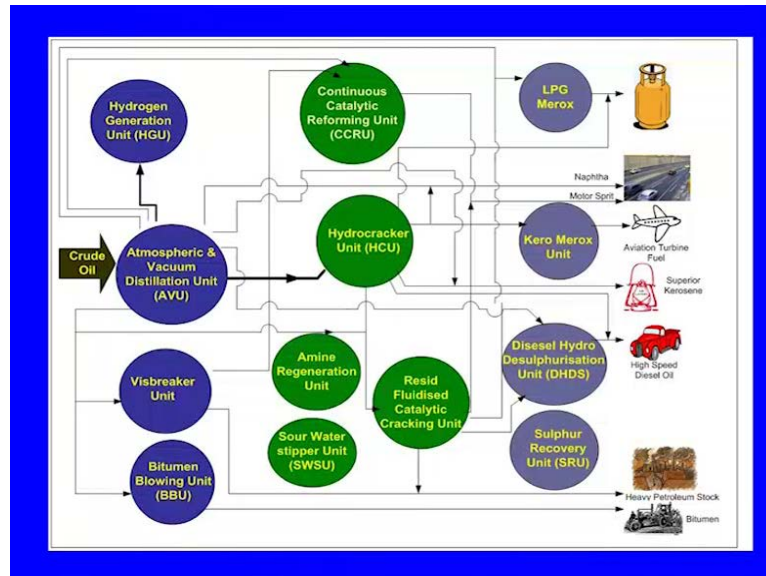
So, petroleum refining is a process in which crude oil are refined to convert it to the usable fuel and some of the product that is being used as a feed stock also for the petrochemical chain. Now, more heavy crude containing high tan high acid number and the sulfur is available making refinery process more complex, because you see the, because of the heavier crude we will have to go for the processing of the more heavier fraction which you are getting.

And the yield of the heavier fraction that will more because of the processing at the same time another problem that has been because of the use of this high tan and the sulfur, sulfur containing high sulfur containing or the what we call the sour crude, that is the desulfation process. Because the earlier the desulfation process was not there in earlier refinery, old refinery but, now that is in trigger part because just to meet the environmental standard sit may be the Euro 1, Euro 2, Euro 3.

And now we are going for Euro 4 some country they have gone for the Euro 5. So, like that because they are all environmental standards they are becoming more and more stringent with respect to the your emission of the sulfur compounds from the gases. And

other compounds just like you take the case of the benzene, benzene deduction continuous deduction the benzene emission, standards are being implemented.

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So, this is a typical refinery and the product and the, this is just a summary and this of the refining process, we will be discussing again in detail but, it is the crude oil, which we are getting. So, one more step is there here before the crude oil which is coming to the refinery the processing of the crude oil after the drilling. So, the processing of the crude oil for separation of the gases separation of the C O 2 separation of the sour gases that is being done at the site.

So, that the during the supply of the crude oil and during supply of the natural gas these contaminants are eliminated; so even desalting process pretreatment of the crude oil that is being done at the site also before drilling. So, the oil gas explosion drilling that is also one of the very important as what we call it the upstream of the refinery and this we are discussing down stream and the further down stream in the processing of the use of the various petroleum petroleum product.

So, the crude oil that is going to the atmospheric vacuum distillation column and from the atmospheric distillation column, we are getting the various product the lighter products, it may be the some of the product that will go for the hydrogen's generation. Because the hydrogen use of the hydrogen in all many of the process we are using hydro

processes hydro treatment, in the reforming and many of other hydro cracking in all the process we are using hydrogen in the refinery.

And so, the use of the again the use of the hydrogen that is not easy because of the coming of the more and more heavier crude. So, this is the production of the hydrogen that is integral part but, still that is you see the many of the processes they are generating oxygen during the whether it may be the distillation or the other process it may be catalytic forming or the FCC. And the hydro manage hydrogen management that has become very important in case of the petroleum refining industry.

And the all the refinery they are working how to best utilize the hydrogen, which is available in the gas steam, gas steam of the refinery. So, the that was about the hydrogen usage and the why the hydrogen that is important. And then so on as a product here and there actually we are what we are doing we are having the steam reforming of the naphtha. But, earlier we discuss about the petro coke gasification, because some of the mills they are going refineries they are going for the petro coke gasification, because the petro coke that is being produced in the refinery operation.

And that petro coke, till now that was that is being used as a fuel in the some of the mills especially these M A mills they are using. So, the now the all the refinery they are working to utilize their petro coke for hydrogen production and refinery that is and then comes rest of the processes you see the we are having the separation process. Another is the ore further processing of the products which we are getting from the atmospheric and your this vacuum distillation column.

So, this breaker that is for the heavy residue which you are getting and bitumen blowing unit these are the from the video the products which you are getting the Arabia they have to further process. Because our objective is just to utilize maximum amount of the crude oil every barrel, every drop of the oil is important. And now the other process which you are one is the continuous catalytic reforming or the catalytic reforming, because you see the we start with the thermal cracking.

And then it was the your the fixed bed cracking, fixed bed cracking to FCC, FCC to now many of the refinery they are having the FCC and hydrocracker. Both catalytic reforming because in the various processes of the refinery, whether it is the straight run naphtha or the cracked it may be from the FCC from the hydrocracker or from the thermal cracking

units. These some of the naphtha because the if you are having the cut below e 0 or the higher octane number naphtha it is that can go to the directly straight run gasoline that what we call it.

So, that will go to the gasoline pole but, the rest of the naphtha is a major portion of the naphtha, which is having very low octane number. So, that is not suitable for use as a gasoline part, so that has to be further processed. So, this is the process which you are using the catalytic reforming and we will be discussing in detail about the catalytic reforming hydrocracker what are the various parameter, thermal cracking. All those thing that will be discussed here only I am saying the what are the product that we are using.

So, the LPG that is going for your domestic use kerosene and diesel the fuel for the jet fuels naphtha that is going as for the gasoline. So, gasoline that may be the your straight run, which you are directly getting from the atmospheric column or the cracked gasoline, which is having the higher, higher octane number. It may be the hydro cracker or the FCC because here only I have shown the hydrocracker but, FCC and hydrocracker, now it has become a integral part of the many of the refinery.

So, the kerosene, diesel, diesel again you see the from the we are getting diesel that may be straight run or the cracked from the cracking process that we may get a fraction. So, that diesel for the, because the availability of the diesel and why the importance of the middle is there, because huge amount of these products or the especially of the diesel we are using the transportation sector, this is the alternative to the railway transport.

And so, this is the reason why the importance of the diesel but, the in all the cases we are having the whether it is kerosene LPG or the gasoline we are having the diesel polishing process just to meet the environment. Sulfur recovery that is again the integral part of the refinery, because the lot of the sulfur compounds are emitted that sulfur that and compound they are converted to more useful product with the sulfur and that sulfur that can be used in the chemical process industry.

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So, this is the actually if you see the various products, which we are getting that is the octane number. You see the octane number requirement that has changed like anything, because the initial stage requirement of the octane number that was low but, with the new upgrade of the your vehicles. The requirement of the octane number that has increased we are getting the LPG, naphtha, motor spirit all for do you call it the gasoline or the petrol.

Because the petrol is not the actually the way of producing as such the this is the actually the commercial name of the gasoline and the blend of that is blended gasoline or reformulated gasoline itself, where we adding also the various additive anti-oxidants all those things that is being added. And finally, the product which you are getting that is the petrol or the sometimes earlier it was also called the motor spirit, efficient turbine fuel that we are using kerosene still huge amount of the kerosene that is being used for the illumination purpose.

Especially in the rural area because of the electricity is not available 24 hours people are using lot of the kerosene for illumination purposes as a fuel. And then the your heavy petroleum stock like the bitumen that we are using for in the making of the road. And so, these are the some of the products which are directly that is being used others are just like you take the case of the naphtha or the kerosene that is going to the petrochemical complexes, where we are using the naphtha for the drill, for naphtha cracking and

kerosene for separation of the paraffins for making. So, these products are being even one of the products which is not shown here, here also heating the wax from the petroleum.

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<b>Growth of Indian Petroleum</b>	
Year	Growth
1866	Oil discovery at Nahorpung.
1882	Assam Railway & Trading Corp. (AR & TC) acquired rights for oil exploration.
1889	Oil production started at Digboi.
1893	Right were granted to Assam Oil syndicate to start refining and first refinery started at .
1899	Digboi Refinery commissioned supplanting above refinery with a capacity of 500 barrel.
1921	Burmah Oil Corporation (BOC) started oil exploration.
1931	Crude oil production; 250,000 tonnes.
1947-57	Multinational oil companies Burmah Shell, Esso Stanvac set up two refineries at Mumbai and Caltex set up at . Exploration of oil in at Naharkatia and Moran by BOC.

So, we call it the petroleum wax that is only where we are possibly more paraffinic crude just like Assam, Assam oil company depot they are having the your wax unit. And so, they are producing from very beginning they have being producing the wax. So, if the more paraffinic more wax content will be there, this is the growth of the Indian petroleum industry, you see the that was not, it is not very old the it is the last 200 years you can see whatever the development that was the mostly we started the in 19th century.

So, it is hundred 50 years of the development you can say most and even the discovery of the oil that was the first we discovered the oil at the Nahorpung and then it was the Digboi where the oil production started. And the even the name of the Digboi that dig boy dig means the while moving in the forest the, because it was rule at that time by the Britisher they found that the oil is there on the leg of the elephant. And so, they he started crying dig boy dig and so, the name come to Digboi.

And so, the oil production even the first refinery in India that was started at Digboi and lot of the crude oil and the natural gas that available this part of the country in Assam right were granted to Assam oil company in 1993. 1890 Digboi refinery was

commissioned with the 500, mere 500 even see the even still that is the lowest capacity plant we are having in the Assam around 0.6 million tons capacity. Even that is after the in free of the capacity after the modernization of the plant this is the and now you cannot imagine a refinery with this capacity.

Then it was the Burma oil BOC which I was telling they started oil exploration in India and that was part of the same Assam oil company, Burma oil company crude oil production in 1931 that was very less and 1947 to 1957 lot of the development in oil exploration. The multinational oil company Burma shell Esso set up two refinery at the Mumbai. And you see the, we are earlier it was the first the Assam oil company and then the Burma shell this started now the BPCL and the, another for the Hindustan petroleum by the Esso, that is the now Hindustan petroleum. So, these were the some of the earlier refinery which was started.

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<b>Growth of Indian Petroleum</b>	
<b>Year</b>	<b>Growth</b>
1967-77	Discovery of oil and gas at Dabka, Santhal and Balol in , Amguri, Charali; and Borholla in , and Baramura in Tripura.
1977-87	Discovery of oil in large quantity at Bombay High.
1974	IOBL became part of IOCL.
1977-87	Discoveries of oil & gas in the offshore area (Panna field, Bassein field Mumbai offshore, Heera, Ratna, South and Mid Tapi). Oil and gas reserves discovered at Gandhar and Dahej (Cambay basin).
1981	Oil & Gas found in Krishna-Godavari-Cauvery basin.
1995	Oil was found in Cachar () and Nagaland.

And exploration of oil in the Naharkatia and the Moran this is the place near your (( )) where the again one large cracker plant is coming, because lot of the gas is available. And that gas still it was not being utilized and the because of the political reason, there was no cracker plant no petrochemical complex except Assam petrochemical. Where they are using the gas natural gas for making of the methanol the really that was started during the initial state at that was the norm fertilizer where they are using the they are making the fertilizer.



So, this is the, another the development that was there these all in Assam and the when in Tripura also the oil and gas that was found. Discovery discovery of the oil in large quantity at Bombay high that was actually the change which took place and the offshore drilling that was started. And then the name of the IOBL which was there it became part of the IOCL. Discovery of the oil and gas in the offshore area of the various places in the that is the Panna field, Bassein field, Mumbai offshore, Heera, Ratna all those thing that is there in the Maharashtra.

Oil and gas this reserve discovered at the Gandhar and Dahej this is the in Gujarat where the we are having the petrochemical complex by reliance earlier it was the IPCL. Now, we are going to have the one petrochemical complex by ONGC also here, because lot of the gas is available oil and gas found in the Krishna Cauvery that was the every time there is dispute of the reliance. And and so, that was the actually the although it was started earlier by the ONGC and then also the reliance they discovered the gas in in this region and the real actually the change in the oil. And, and the especially the natural gas that was by the availability of the gas in this region. And then the, this was also oil 1995 in Cachar and this Nagaland area.

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<b>Growth of Indian Petroleum industry</b>	
<b>Year</b>	<b>Growth</b>
1954	Indian oil exploration with Russian geologists.
1956	Formation of Oil & Natural Gas Commission and production of crude oil and gas. Discovery of Cambay Oil field.
1958	Public sector Indian Refineries Ltd. (IRL) came into Oil field (to create refining & pipe line infrastructure).
1959	Oil India Ltd. formed as joint venture between Government of India and Burmah Oil Company.

1954 Indian oil exploration with the help of the Russian geologists 1956 formation of the oil and natural gas commission public sector, Indian refineries that came into oil field, oil India that was the joint sector, earlier it was under the Assam oil company.

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Year	Growth
1962	First public sector refinery started at Guwahati by Indian Oil Refinery Ltd.
1962	Indian Oil Blending Ltd. (IOBL) was formed for manufacture of lube oil & greases (Joint venture between Indian Oil Company and Mobil Petroleum Corp.).
1964	IRL and Indian Oil Company merged to form Indian Oil Corporation Ltd.
1965	Engineers India Ltd. started.

So, 1962 first public sector refinery started at Guwahati because there this pipeline where the crude oil that is being supplied from Assam, Naharkatia, Duliajan to Guwahati and it was also being supplied to the Barauni. Barauni refinery earlier they were using all the assam crude. So, these these two refinery came and the later it was the (( )) refinery and petrochemical and as far as Assamica that was the (( )) refinery that was started in Assam.

So, this is about the Indian oil company Indian oil company merged which I told you the IRL engineers India 1965 that was started in you see the engineer India. They have actually played a very important role in the development of the especially the petroleum refinery and the petrochemical. Although they are also involved in the fertilizer sector but, these are the three major sector, where the role of the public sector and engineers India they have played important role in election commissioning some are indeed center is also there of the higher.

And they did lot of the research work in the extraction development the some capital, development of the some of the processes in collaboration with the Assam oil company sorry Indian oil corporation are in division Faridabad.

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Year	Growth
1998	Assam Oil Co. vested in IOCL as Assam Oil Division.
1999	First joint sector refinery MRPL commissioned.
2000	Panipat Refinery of Indian Oil Corporation commissioned. Reliance Petroleum Refinery commissioned at , Numaligarh refinery in commissioned.
2006	Indian oil first linear alkyl benzene plant commissioned at IOC Vadodara
2006	Indian oil first terephthalic acid plant commissioned at IOC Panipat refinery

So, this was the 1998 that the Assam oil company became the Indian oil, then now the Indian oil the Assam oil earlier it used to be named as Assam oil company, now it is IOCL Indian oil corporation. First joint sector that was started Mangalore refinery and petrochemicals that was, now it has been taken over by the ONGC that was started Mangalore by Birla. Then the it was the 2000 and the Panipat refinery of the Indian oil corporation commission, reliance petroleum refinery commission, Numaligarh refinery. In between other refineries also came into 2006 Indian oil first linear alkyl benzene plant was commissioned at the IOC Vadodara. We discussed by discussing the LAB that was the first plant based on this that was started in between Mathura refinery and other refinery also came into existence. Indian oil first (( )) plant that was started by IOC Panipat refinery.

This is the 2006 ONGC entered in the petroleum refinery by which I was telling about the acquiring the MRPL. And it was 2010 I think the now the 2011 you can say the HPCL Bhatida refinery with the collaboration of mister mittal and mittal that was there BPCL, Bina refinery that was at the in the Madhya Pradesh that has been commissioned. That is again in the 2010 2009 ONGC to start mega petrochemical complex at Dahej. So, that was actually now the plant that is expected to be commissioned at Dahej and the where the reliance petrochemical complex that is there earlier it was the IPCL that the four unit after the coming of the Nagothane it came at the Kandhari.

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<b>Growth of Indian Petroleum</b>	
<b>Year</b>	<b>Growth</b>
2006	ONGC entered in Petroleum & refinery sector by acquiring MRPL
200	HPCL Bhatida refinery
200	BPCL Bina refinery commissioned
2009	ONGC to start mega petrochemical complex at Dahej Gujrat to be commissioned in 2012
2009	HPCL Mittal energy to set up Petrochemical hub to produce 400tpd polypropylene at
2009-10	IOC Panipat Refinery commissioned Naphtha cracker, polyethylene and poly propylene plnt

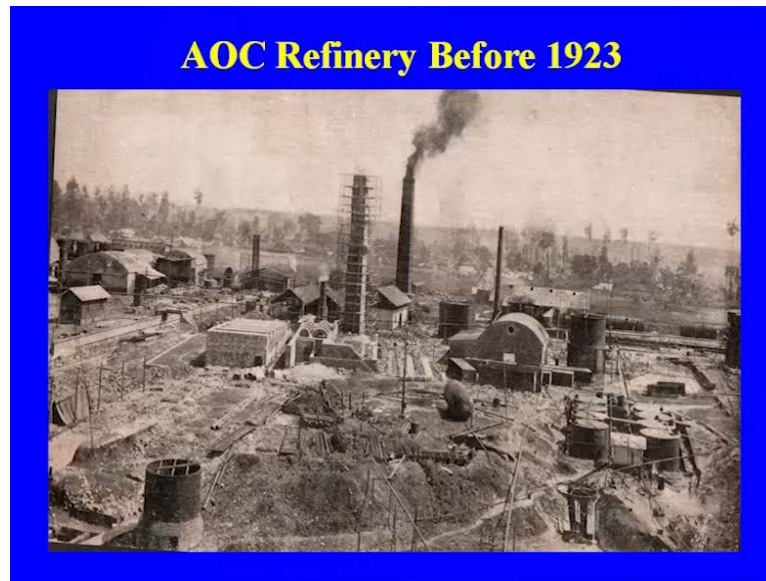
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**Crude Oil and Natural Gas Origin, Occurrence**

- Oil and natural gas were formed hundred years ago from the prehistoric plant and animals. it is believed that hydrocarbon formed by the thermal maturation of organic matter buried deep in earth.

So, now let us come to the just brief history of the oil and natural gas origin and the occurrence. You see the oil and natural gas are formed hundred years ago from the prehistoric plant and animals it is believed that the hydrocarbon formed by the thermal maturation of the organic matter buried deep in earth and that too cloud this is just like the coal formation was there. So, that took 100 years, 1000 years you can say they for make transforming from the, it is original form to the oil.

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This is the typical refinery when we started first refinery in India AOC Assam oil company the, that was the name and 1923 you can see the condition. How the refinery that was started and the unorganized way, after that the lot of the changes that took place in Assam oil company also, some of the process which we are not there. Many of the refinery which we are started earlier they were not having the secondary function, many of the function just like your catalytic reforming process, many of the refinery it was started later on that was not part of the refinery in the earlier stages. So, this is the how the old refinery.

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And now if you see now a modern refinery, there it was the capacity 0.5 to 0.6; and here it is around plus 60 million tons capacity. Reliance when the first reliance refinery in Jamnagar that was started it was with the, they started with the thinking of the 18 million tons. Even at that time it was considered very high when it was compared with the capacity the existing capacity refinery in India. So, that was the 18 to 30 and 30 to 60 that was the how the development of the reliance took place and the, they were able to develop the petrochemical complexes and at the same time the capture the market of the petroleum products.

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### **Crude Oil And Natural Gas Origin, Occurrence**

- Over the millions of years under extreme pressure and high temperature these organic matter converted to hydrocarbons consisting of oil and gas. Hydrocarbons are present in the variety of forms: koregen, asphalt, crude oil, natural gas, condensates, and coal

So, the crude oil and natural gas, which I was telling about the origin and occurrence, over the millions of years under the extreme pressure and high temperature, these are organic matters converted into hydro carbon consisting of the oil and gas, hydrocarbons are present in the variety of the form, because this is the first stage koregen, asphalt, crude oil natural gas condensate and the coal. So, this is the how the even the what is there in all these will find C and H, Carbon and Hydrogen and combination of in case of the crude oil, it may be the oil, it may be the air oxygen, it may be nitrogen sulfur compound, which are inertly present even in case of the coal sulfur compounds are present. So, this is the how the hydrocarbons that has in made and it took thousands of years for making of this final material, which is now available as a fuel as a petroleum feedstock.

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## **Crude Oil And Natural Gas Origin, Occurrence**

- Oil and gas production includes exploration, drilling, extraction, stabilization.
- The underground traps of oil and gas are called reservoir.
- Various types of traps are structural traps, stratigraphic traps and combination traps. Most reservoir contain water also along with oil and gas.

Oil and gas production includes first thing that the exploration that is one of the very important part of the crude oil production. Because you see the this is the lot of the investment is there on the exploration part by various multinational companies also and the in India it is the ONGC, who is the major player in the exploration. And the whatever the availability of the oil and gas that is only because of the coming of the ONGC otherwise, even if we see the slumbers they are doing lot of the exploration part.

And now and especially the search of oil in the ocean, that is one of the important activity that is being done by the oil sector, because our sea that is reaching the resources in which I told you that is the just like shedding of the ocean, which it was been done in the ancient time by the over guard that is means initially because to get the resources. So, that was the how the all the companies multinational companies and our even ONGC they are making lot of the force to get the oil from the various part of the sea.

The underground traps of oil and gas are called the reservoir, because there where the you are getting the reservoir. Here also the reservoir different type of the reservoir and the drilling that create problems, various types of the traps are structure trap stratigraphic traps and the combination traps. Most reservoirs contain water also along with the oil and gas and that is the separation of the oil, separation of the condensate from the gases that is being done at the site of the processed before it is being processed to the refinery.



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### **Oil and Gas Exploration**

- Earlier finding of oil and gas was matter of luck and hit and miss process.
- Tools used for oil and gas exploration are based and dependent on gravity change, magnetic field change, time, change and electrical resistance.

Earlier finding of the oil and gas because as I tell you the exploration of the oil that is a very costly operation. So, the earlier finding of the oil and gas was matter of luck and hit and miss process. So, the it was chance that you are getting oil, if you are getting oil then the you are everything you have got, if you are not getting then lot of the money that is. So, tools used for the oil and gas exploration are based and dependent on the gravity change magnetic field change time change and the electrical resistance. I am not going in detail because some of the things that will be we are by already the part of the NPTEL program refinery petroleum refinery there it will be discussing more detail.

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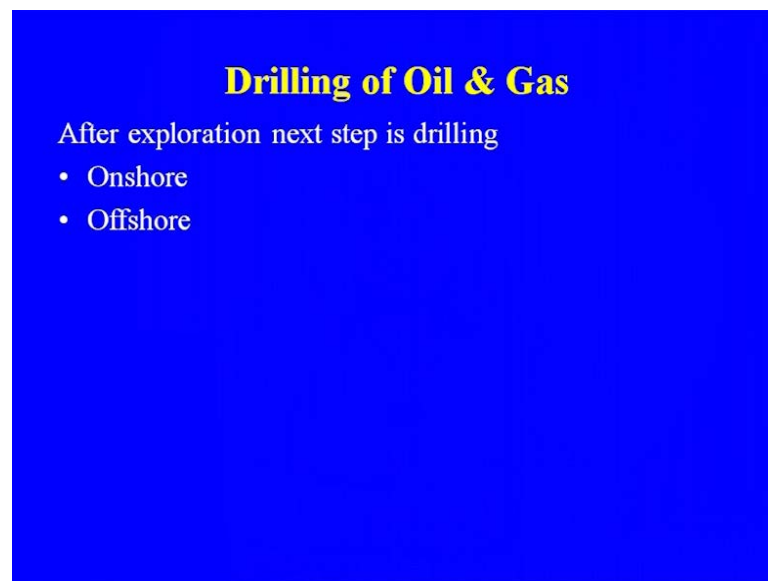
### **Oil And Gas Exploration**

- With advent of three dimensional seismic technology which is based on the sound waves, identify the subsurface formation by reflection of sound, there has been much improvement in identification of oil and gas traps and reservoirs.
- Seismic technology significantly improves the method of estimating the oil and gas deposits.
- However it has become now more challenging and complex.

Oil and gas exploration with the advent of the three dimensional seismic technology which is based on the sound wave, there has been lot of revolution in the oil and gas exploration. So, this identify the subsurface formation by reflection of sound there much improvement in the identification of this oil and gas trap and reservoir. Seismic technology significantly improves the method of estimating the oil and gas deposit, because you see this is the reason why oil that is very important a whole economy is dependent upon the availability of the oil.

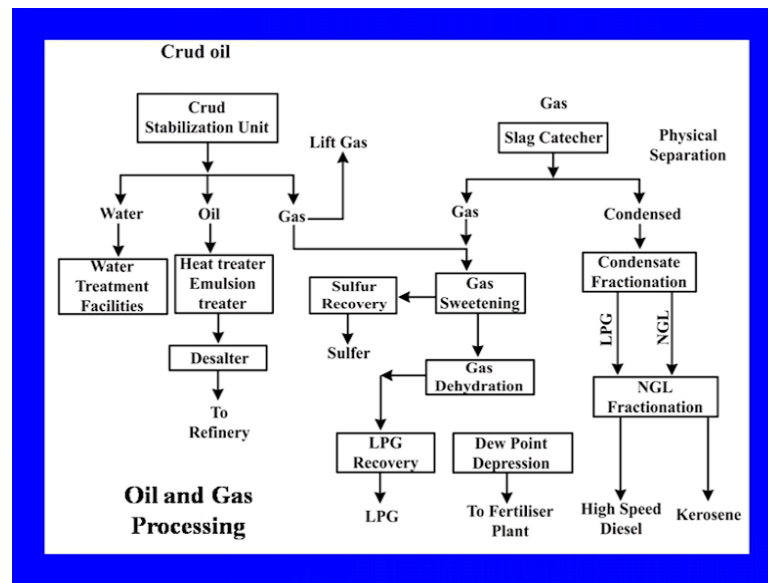
And this is the reason why the people middle east all the country they are very rich, because the major portion of the oil resources are there in the middle east. However, it has become now more challenging and complex because of the cost that is involved, because of the depth is involved, because even you see the here dealing of the oil and gas after exploration.

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Next step is drilling on shore and off shore, on shore drilling and mostly it was the vertical drilling that was there. But, now the another revolution that has taken place in case of the drilling, that is the horizontal drilling or the hydro fracturing and because of that reason. Now we have been able to get the shell gas because this whatever the changes are there availability of the shale gas in US or the Canada is there only it is because of the horizontal drilling, that has been possible now more economical way of the producing the shell gas.

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This is the I was telling that the on oil and gas which is coming from the well that is been process at the site, this crude oil crude oil stabilization section, oil, water that is separated oil that is going for the further after the desalting. It is going to refinery gases that we are separating that is the lift gas and then the part of the gas the gas if which is natural gas slag, catcher gas, condensate gas, sweetening that we are doing. Condensate the heavier fraction of the natural gas.

And the now the because of the huge amount of the natural gas that we are processing lot of the condensate is available and the fractionation of the condensate that will yield the some of the important aromatics also that is present in the condensate. Gas hydration these all the process that is being done by the gail or the ONGC at the site. And so, the gas dehydration because mostly it is the ONGC whichever the even from during the initial stage LPG recovery from the natural gas. And then the NGL fractionation which I was telling for getting the some of the important part of because they are containing heavier hydrocarbon.

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### **Composition of Crude Oil**

- ❖ Paraffin Base
  - ❖ Intermediate Base
  - ❖ Naphthenic Base.
  - ❖ Aromatic base
  - ❖ Asphaltic Base
- Heavy crude, sour crude, high TAN crude, opportunity crude, oil sand.

Composition of oil we are having the paraffinic base, intermediate base, naphthenic base, aromatic base, asphaltic base, heavy crude, sour crude, high tan, crude opportunity, crude oil sand. Because this is one of the another important because very thick highly thick actually the your crude oil which now the lot of the work that is being done especially in the Canada where it is available. And so, to how to rig about because the distillation that is difficult lot of the heavy residues are there.

Similarly, in case of the opportunity crude that is the your more sour crude is available heavier crude is there and you see the you have got the crude oil in Rajasthan, which is that is also high tan crude. And so, the processing definitely because that will depend the type of the crude oil, which the base because depending upon the yield of the various product that will depend on the from the refinery. This will also play very important role in the total cost of this, because aromatic, so intermediate naphthenic base if you are having the paraffinic octane number that will be low naphtha that has to be processed aromatic base. If you are interested in the aromatic from the reformer suppression of the benzene to aromatic base or the more heavier crude that the asphaltic base.

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## Composition of Crude Oil

### Impurities:

- ❖ Salt Chlorides of Na, Mg and Ca
- ❖ Sulphur compounds:  $H_2S$ , Mercaptan, Thiophene,
- ❖ Nitrogenous compound
- ❖ Naphthenic acid
- ❖ Metals
- ❖ Sand Minerals and water

These are the actually the impurities present in the crude oil and this is the reason why the evaluation of a crude oil that is very important. Because just to know this content that will be discussed in the lecture 2, these are the salt chlorides of the sodium, magnesium, calcium, sulfur compound  $H_2S$ , Mercaptan, Thiophene, nitrogenous compound and oxygen. Oxygen that is also actually found in naphthenic acid, metals sand minerals and water, these are the various constituents which are separated and our basic objective in the refinery is to remove the impurities. But, inside from all those deserting and the pretreatment that we are doing some of the impurities that remains and again those are removed during the various refinery operations.]

These are the primary process that we are doing in case of the refinery separating of the crude into the various fractions. Secondary processing residue from the primary process and upgrading them to the distillate FCC, as I tell you the and the iodo cracker in it. Now you are having the your integral part earlier because the fluidization technology that were and developed during the 1940's. And that was the by IOP the FCC came to exist in the refinery and now it has become the, because it was the fixed bed technology that was being used for the catalytic cracking it was fixed bed to fluidized bed.

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## **Types of Petroleum Refining Processes**

**Primary Processes:** Separating crude into its various fractions e.g. CDU/VDU

**Secondary Processes:** Processing residues from primary processes and upgrading them to distillates e.g. FCCU, HCU

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## **Types Of Petroleum Refining Processes**

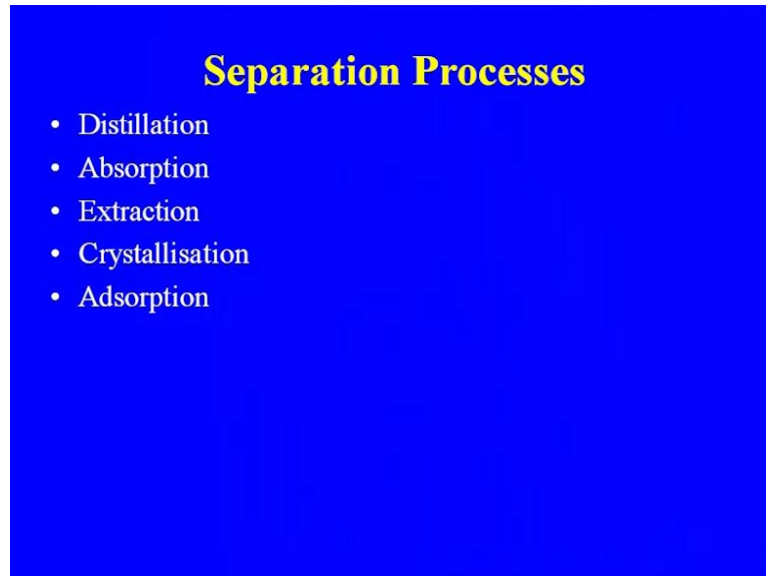
**Residue Upgradation Processes:** Bottom of the barrel upgradation eg. RFCCU, DCU, DCC

**Finishing/ Product Quality Improvement Processes:** Processes to improve product quality and meet stringent product quality specifications eg. DHDS, DHDT, CRU

Then the residue up gradation technology are there bottom the barrel up gradation that is the even the residue crude catalytic cracking. Where the heavier fraction, deep catalytic units DCC all those thing that is the for upgrading of the residue, which you are getting there then the another part in the case of the refining the finishing processes. The finishing of the product because the for the improvement of the product quality and the one of the thing, which I told you the desulfation, process depending on the which type of the crude you are processing more sour, less sour, sweet sour, sweet crude. So,

depending upon that we will have to go for the treatment of the various product, before it is being marketed.

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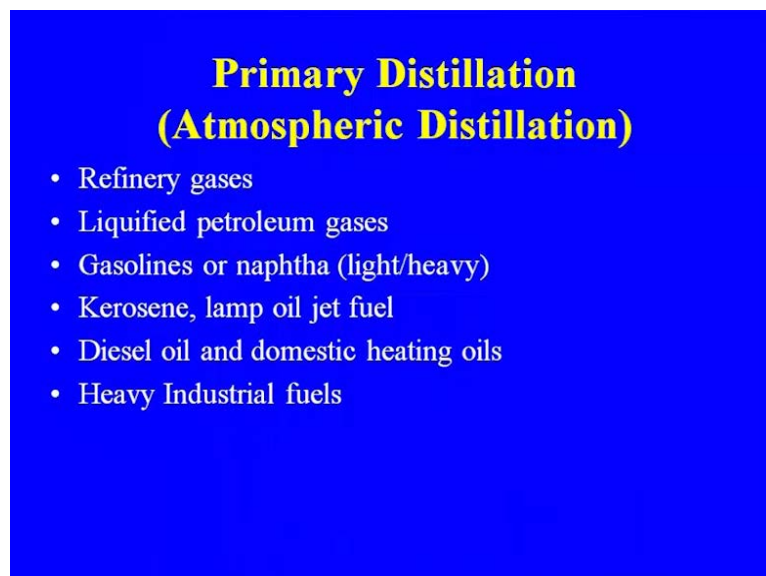


**Separation Processes**

- Distillation
- Absorption
- Extraction
- Crystallisation
- Adsorption

These are the some of the separation process that is commonly used distillation, absorption, extraction, crystallization and adsorption. Refinery gas these are the products which you are getting from the primary or the you can say the atmospheric distillation column; again you will be discussing detail while discussing about the crude oil distillation the lecture 3.

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**Primary Distillation  
(Atmospheric Distillation)**

- Refinery gases
- Liquefied petroleum gases
- Gasolines or naphtha (light/heavy)
- Kerosene, lamp oil jet fuel
- Diesel oil and domestic heating oils
- Heavy Industrial fuels



So, these are the some of the product that the refinery gases liquid petroleum gas gasoline or the naphtha which I was telling that the because in some of them is they are saying the light naphtha, medium naphtha, heavy naphtha. So, kerosene lamp oil jet fuel, diesel oil and the domesticating oils, heavy industrial fuels, that is just like bitumen even the lubricating oil also the second from the we are getting from the vacuum distillation.

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### **Secondary Distillation (Vacuum Distillation)**

- Light gas oil
- Heavy gas oil
- Reduced crude oil
- Light vacuum gas oil
- Vacuum slop
- Vacuum Residue

Light gas oil that is being for the further cracking heavy gas oil it is also going for the cracking, reduced crude oil, light vacuum gas oil and the vacuum slop, vacuum residue lubricating part also there. Where the more paraffinic are there, we are separately lubricating oil or wherever in some of the refinery, we are having the three refineries. We are we are having the separate your lube refinery, where they are processing the heavier crude for producing the lubricating oil.

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## **Process for Improvement of Properties**

- Catalytic reforming
- Isomerisation
- Alkylation
- Polymerisation

These are the process for the improvement of the properties catalytic reforming as isomerization, alkylation, polymerization again all these processes in the various lectures you will be discussing.

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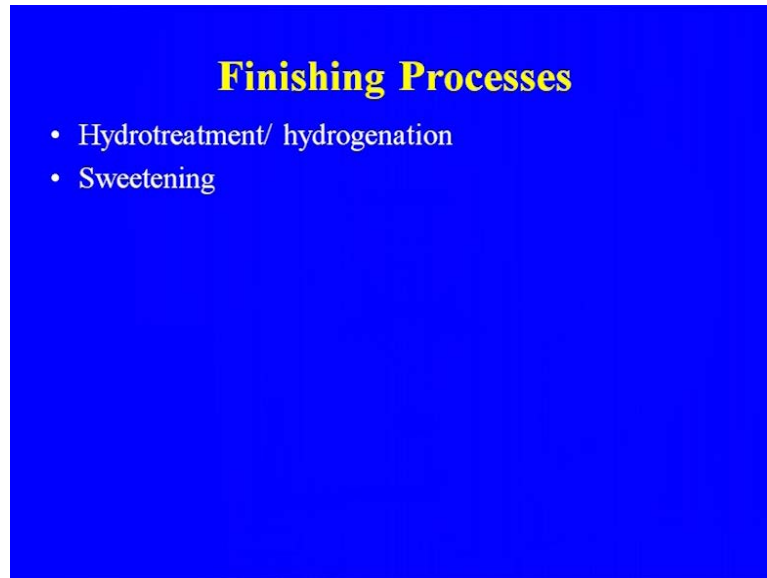
## **Conversion Processes**

- **Thermal processes**
  - Visbreaking
  - Delayed Coking
- **Catalytic processes**
  - Catalytic cracking(FCC)
  - Hydrocracking
  - Steam reforming
  - Hydroconversion

These are the conversion process thermal processes, catalytic process and as I told you the our objective is to use each and every drop of the each and every barrel of the oil. So, is breaking delayed, coking and some advancement in the thermal process that has taken

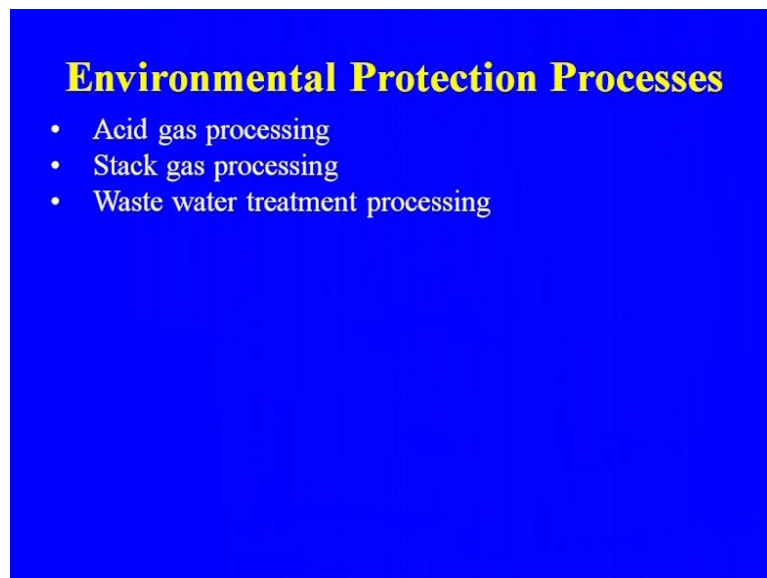
place catalytic process that is the these are the some of the process catalytic cracking, hydro cracking, steam reforming and some of the hydro conversion process.

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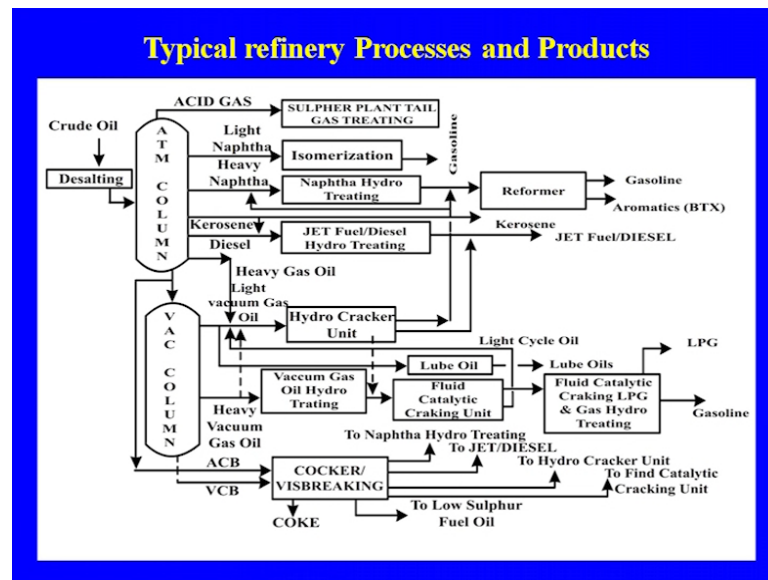
Finishing process hydro treatment and sweetening.

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This is the from the environmental protection point of view, acid gas processing, stack gas processing, waste water treatment processing.

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This is a typical refinery already I have discuss the products which you are getting the crude oil after desalting it is going to atmospheric vacuum distillation column. And then the various fraction which you are getting from the atmospheric and the vacuum column that is going for the further processing to have the more value added product. Means the suppose the octane number you take the case of the naphtha, some of the portion of the naphtha that is having the low octane number.

So, how to improve there are various processes isomerization process there already it was the catalytic reforming, now many they have added the isomerization process also that is for the improving the octane number. Like that the various process that is similar to the vacuum the product which we are getting from the vacuum vacuum distillation come these are also the low value product.

And so, we are having the various processes they are just it was I was telling the about the efficient hydrocracker that is we are using these processes then the these are typical a refinery configuration. Where the various process that is involved reformer isomerization, hydro treating for the removal of the sulfur, cracker, vacuum gas, fluid caralytic cracking, LPG and gas hydro treating, cocker visbreaker, visbreaker. All those units are there and the now a modern refinery that will look like this.

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<b>Imported Crude Sources</b>	
Middle East	Gulf – Kuwait, Dubai, Arabian, Iraq, Abu Dhabi; Neutral Zone-between Iraq & Kuwait : Ratawai ; Egypt - Gulf of Suez
Mediterranean	Libya - Es Sider
West Africa	Nigeria-Bonny Lt, Escravos, Forcados, Penington, Quioiboe ; Angola, -Cabinda, Palanca, Girassol ; Eq. Guinea-Ceiba, Zaffiro ; Congo-Nikossa, Kitina
Far East	Malaysian, -Labuan, Miri Light; Australia-Barrow Island, Cooper Basin; Brunei-Seria Light

These are the some of the crude which you are using from the middle East and this West Africa and the far East. So, from the various places that we are, because our major portion of the crude oil requirement alone you can say 70 percentage met through the imported crude.

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<b>Characteristics of Various Crude Oil</b>	
Sources of indigenous crude	Salient features
Assam Crude Nahorkatia/ Moran	31 ° API, Sulphur 0.3%, Pour point +30 °C, High aromatics, Total distillate yield 65%.
ONGC, Lawkwa, Rudrasagar	27 ° API, Sulphur 0.3%, High aromatics, Distillate yield 57%.
Ankleshwar Crude	48 ° API, Sulphur 0.1%, Pour point +18 °C, Distillate yield 80-82% (Light distillates 24%, Middle distillate 47%), Wax content 9.9%, total sulphur 0.02%.

This is again the indigenous which you are having from the Assam ONGC and other part of the country and these are the some of the salient features the characteristic of these. Because the crude oil evolution that is very important that is why we have kept one

separate lecture on the crude oil. Evolution that will be discuss in the next lecture that is lecture 2.

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<b>Characteristics of Various Crude Oil</b>	
North Gujarat Crude	28 ° API, Sulphur content 0.1%, Pour point +27 °C, Distillate yield low 33-35%, High organic acidity.
Bombay High Crude	38 ° API, Sulphur 0.2%, Pour point +30 °C, Distillate yield 65-70% (Light distillate 24%, Middle distillates 46%), High aromatics.
Narimanam Crude	46 ° API, Sulphur 0.1%, Pour point 3 °C, Distillate yield 80%.
KG Basin Ravva Crude	36 ° API, Sulphur 0.1%, Pour point +30 °C, Distillate yield 61%.

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<b>World wide Crude quality</b>					
Properties	1985	1990	1995	1999	2010
Sulphur, Wt %	1.14	1.12	1.31	1.41	1.51
API gravity	32.7	32.6	32.4	32.2	31.8
Residue in crude ,vol %	19	19.4	19.8	20.2	21.3
'S' in residue ,Wt %	3.07	3.26	3.61	3.91	4.0
Metals in residue, Wppm	275	286	297	309	320

**Source:** Samanti,R.K. "Refining challenges and Trends" 6<sup>th</sup> summer School on "Petroleum refining and petrochemicals" June 6,2012, Organised by New Delhi.

This is the another sources from where you are getting the north Gujarat crude, Bombay high crude, Narimnam crude and the KG basin, ravva crude. So, and this is the actually the characteristic of this crude. Because if you see these characteristic it is widely changing. So, whether it is sulfur or the a PI gravity it is just reverse of the density a PI

gravity, this is very commonly use in the characterization of the crude oil and which again we are going to discuss in detail.

This is the old crude oil quality and if you see the sulfur from 1.14 crude oil becoming more and more sour because now the supply is more sour crude than the sweet crude. Similarly, if we are a PI gravity there is not variation but, changes is there in some of the place, now we are having the this is the 32 to 31 similarly, the residue that is increasing. So, this is the how the sulfur and the residue this is just the residue sulfur also that is increasing. So, these are the some of the changes that is we are facing, because of the variation in the quality of the crude even in the refinery.

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<b>Characteristics of Some Indian basin Crude Oil</b>					
Basin	°API	Sulphur	Pour Point	Distillate Yield	Salient Features
Assam Crude Nahorkatia/Moran	30	0.3%	+30 °C	65%	High Aromatics
ONGC, Lawkwa, Rudrasagar	27	0.3%	-	57%	High Aromatics
Ankleshwar Crude	48	0.1%	+18 °C	80-82%	LD-24%; MD-47%

*LD-Light Distillate; MD-Middle Distillate; NA-Not Available;*  
*Source: Mishra & Unnikrishnan, 1996, p.22*

Characteristic of the some of the crude Indian crude that is the API sulfur pour point distillate and the higher aromatic, Assam crude, higher aromatic and low ankleswhar low light and middle distillate. This is the percentage of the 24 percent, 47 percent and API gravity.



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Basin	°API	Sulphur	Pour Point	Distillate Yield	Salient Features
North Gujarat Crude	28	0.1 %	+27 °C	33-35 %	High Organic Acidity
Bombay High Crude	38	0.2 %	+30 °C	65-70 %	High Aromatics; LD-24%, MD-46%
Narimanam Crude	46	0.1 %	3 °C	80 %	NA
KG Basin Ravva Crude	36	0.1 %	+30 °C	61 %	NA

*LD-Light Distillate; MD-Middle Distillate; NA-Not Available;*  
*Source: Mishra & Unnikrishnan, 1996, p.22*

This is the characteristic of the North Gujarat, Bombay high, Narimanam KG basin these are the API sulfur 4.0 and distillate yield now the changing scenario, because you see the I told you the the refinery of the fifties and refinery of today there is it lot of changes in the process condition. It is only just to there are two factors one is just to increase the productivity, at the same time just to meet the requirement of the market and the environmental standard.

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Changing Scenario in Gasoline Specifications
<ul style="list-style-type: none"><li>• Lead phase out</li><li>• Lower RVP</li><li>• Lower benzene &amp; aromatics</li><li>• Lower olefin content</li><li>• Limited Oxygen content</li><li>• Lower Sulfur content</li></ul>

So, that was the first phase when we are using the tetra ethylate for the improving the octane number, completely phase out of the your lead lower R V P reid vapor pressure lower benzene. Now, there has been continuous increase in decrease in the benzene content of the gasoline as per the euro-norm lower olefin content limited oxygen content lower sulfur content.

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**Changing Scenario in Gasoline and Diesel Specifications**

- Low sulfur
- Low aromatics
- High cetane number
- Lower density
- Lower distillation end point

Low sulfur low aromatics high octane number because the requirement of the octane number that is also change lower density lower distillation end point.

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**Changing Gasoline Specification**

Specification	BIS 2000	BIS-II	Euro-III Eqv.		Euro-IV Eqv .	
			Regu-lar	Prem-ium	Regu-lar	Prem-ium
Sulphur, ppmw (max)	1000	500	150	150	50	50
RON,Min	88	88	91	95	91	95
MON,Min	No spec.	No spec.	81	85	81	85
AKI,Min	84	84	81	85		
Benzene vol%(max)	5	3	1	1	1	1
Aromatics vol%(max)	No spec.	No spec.	42	42	42	35
Olefins vol%(max)	No spec.	No spec.	21	18	21	81

This is the euro-norms and if you see the euro-norms, how the euro-norms that is now we are going for the fifty sulfur content. So, how to maintain similarly, if you see the your octane number 88 to 91 even before that it was less than 88. So, this is the how the change benzene three to one now the 1 percent benzene that is only. So, this some portion we are losing, which is which was going to the gasoline part. So, this is the how the changes in the gasoline that is taking place.

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<b>Fuels norms For High Speed Diesel</b>				
Specification	BIS2000	BS-II	Euro-III Equ.	Euro III Equiv.
Density@15°C Kg/m <sup>3</sup>	820-860	820-860	820-845	820-845
Sulphur content ppmw(max)	2500	500	350	50
Cetane number(min)	48	48	51	51
Distillation 99% Vol (°C max)	370	370	360	360
Polycyclic aromatics hydrocarbons (PAH), % massmax	No spec.	No spec	11	11
Specification	BIS2000	BS-II	Euro-III Equ.	Euro III Equiv.

Source : Rajgopal,S “ Refining challenges and Trends.6<sup>th</sup> summer School on “ Petroleum refining and petrochemicals” June 6,2012, Organised by New Delhi.

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<b>Consumption of the Petroleum Products</b>	
•	Petroleum products are consumed in two ways: for energy production (85-90%) and for non-energy production (10-15%).
•	Energy Products include: LPG, gasoline, ATF/SKO, high speed diesel oil, low speed diesel oil, fuel oil/LSHS. Non-energy products include:
1.	Naphtha - Fertilizer/ Petrochemical feedstock.
2.	Lubes - Engines & Machines.
3.	Waxes - Food packaging and others.
4.	Bitumens - Highways, Airfields.
5.	Petroleum coke- Metallurgical industry.
6.	Solvents and others.

Then the fuel norms similarly, in the case of the fuel norms for the sulfur content. Now it is the only the fifty PPM that is maximum allowable and so, the this is the reason why we are having the number of the sulfation process in the refinery.

This is the how the consumption of the petroleum products and which I told you in the beginning of the lecture and the from why the importance of the petroleum in our life is there. This is for energy for non-energy production, so major portion still it is going for the energy sector. So, the energy is in the form of the LPG gasoline aviation turbine fuel kerosene, high speed diesel oil, low speed diesel oil fuel oil various variety of the fuels that we are having.

Then the naphtha that is being is it is being used by the fertilizer and petrochemical complex lubes for engines and machines, waxes for food packaging other uses also there bitumen for airfields. Highways, petroleum coke, metallurgical industry and the solvents and others, these are the some of the broad applications of petroleum product. This is the some of the stream that will be again discuss, while discussing the integration of the petroleum and refinery with the petrochemical coming.

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<b>Maximizing Value Addition to Refinery Streams</b>	
Streams	Utilization
Fuel Gas	H <sub>2</sub>
FCC	-
Ethylene	Ethyl Benzene to Styrene
Propylene	Cumene, Iso-Propanol
Butylene	Methyl Ethyl Keton, MTBE, Xylenes
C <sub>3</sub>	Propylene + H <sub>2</sub>
C <sub>4</sub>	Discussed Separately

And these are the stream which are available fuel gas from the FCC that is ethylene propylene that we are recovering, from the ethylene that is the although the concentration of ethylene is less. So, but, that can be recovered and that can be utilized for making of

the ethyl benzene, propylene that is already we are operating the some of the FCC also and the propylene mode between C 4 C 5 gases. Are there that we are recovering.

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Streams	Utilization
LPG	BTX
C <sub>5</sub>	TAME
Light naphtha	LPG, BTX
Heavy Naphtha	Aromatics
Kerosene	n-paraffins to LAB
LCO (FCC unit)	Mixed Naphthalenes
Coker Kerosene	$\alpha$ -Olefins

Sources: M. O. Garg Director Indian Institute of Petroleum, Dehradun 23 rd National Convention of Chemical Engineers IIT Roorkee, 5 – 7 October 2007

The LPG C 5 steam light naphtha heavy naphtha kerosene, these are all actually the petrochemicals where we are using as a petrochemical feedstock, benzene toluene, xylene team as a your LPG.

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Emerging Scenario in Refining in India
❖Deregulation of oil & gas sector in India
❖Widening gap in crude oil demand and production
❖ Increasing heavy crude with high TAN and sulphur
❖Rising cost of crude oil

So, this is the actually some of the merging scenario just to conclude that the deregulation of the oil and gas in India widening gap in the crude oil demand and the



production increasing heavy crude with the high tan and sulfur crude. Rising cost of the because the cost of the crude oil it has become more world.

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### **Emerging scenario In Refining In India**

- ❖ Ever increasing crude oil prices
- ❖ Shrinking refinery margins resulting in
- ❖ Stringent product specifications
- ❖ Environmental regulations and Stringent standards
- ❖ Growth in demand of light and middle distillates

Ever increasing crude oil prices shrinking refinery margins resulting in the stringent product specification to meet the environmental standard, environmental regulation and stringent standard, which is changing time to time, it was Euro one to Euro five, now we are going. So, growth in the demand of light and the middle distillate, because coming of the more and more vehicles automobiles and the trucks another thing for the transportation.

This is the concept of the future refinery, which we are going to I am not going in detail but, the changes which is taking place in the refinery in the future for integrating for you that may be the petrochemical refinery, bio refinery, bio fuel which already discuss. How the ethanol five to ten percent of the ethanol that can be blended or from the bio mass we can have the alcohol or the bio mass gas classification we can go for the methanol natural gas refinery based on the natural gas.

The various product that will be get especially through the GTL technology and now we are talking about the zero gasoline refinery, because the concept earlier it was the objective of the refinery was to have the gasoline and diesel, Now we are talking about the zero gasoline technology; so these are the some of the development that is taking place in the refinery just to have the more and more economy. Just to utilize each and

every barrel of the oil and to utilize all the by product from the refinery for more value added product.