Chemical Technology
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Module - 1
Introduction
Lecture - 2
Rawmaterial for Organic Chemical Industries

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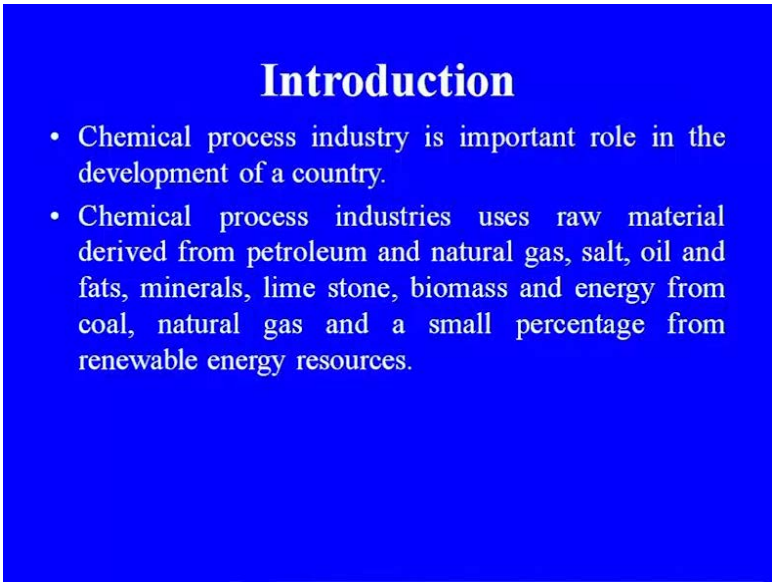

In the lecture 1, we discuss about the chemical process industry and especially with reference to organic chemical industry, what are the products, what are the development that has taken place. Now, we will be discussing about the raw martial for organic chemical industry. As you know the chemical process industry is the important role in the development of the country, chemical process industry uses raw material derived from petroleum and natural gas, salt, oil and fats, minerals, lime stone, biomass and energy from the coal, natural gas and a small percentage from the renewable energy resources. Because, energy one is the important segment in the total cost of production in the chemical industry.

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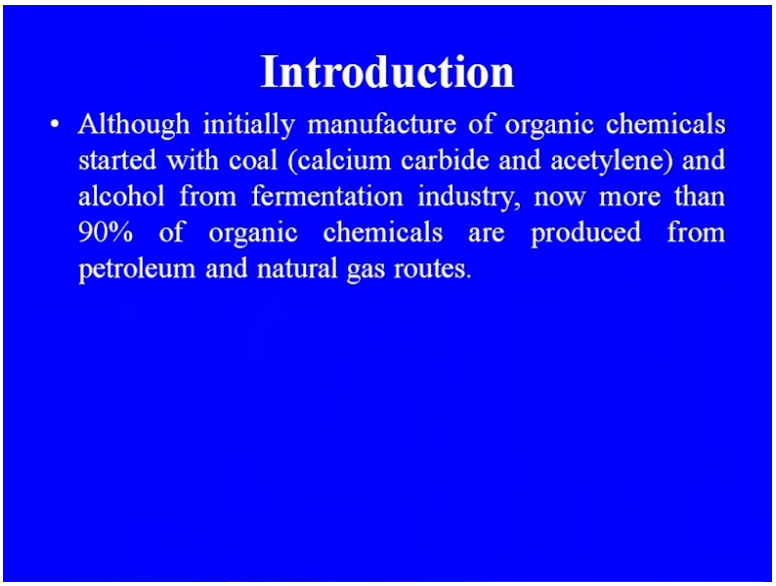

As I discuss in the earlier lecture also what are the initial manufacture organic chemicals started with the coal that was the acetylene from the calcium carbide route and alcohol from the fermentation industry. Now, more than 90 percent of organic chemicals are produced from the petroleum and natural gas route. This is the development that has taken place because of the availability of the petroleum products from the refineries. But as you see the things are all these raw materials are becoming more and more, again we are thinking rethinking to utilize our old raw materials like coal or the biomass or the alcohol for the production the organic chemical industry.

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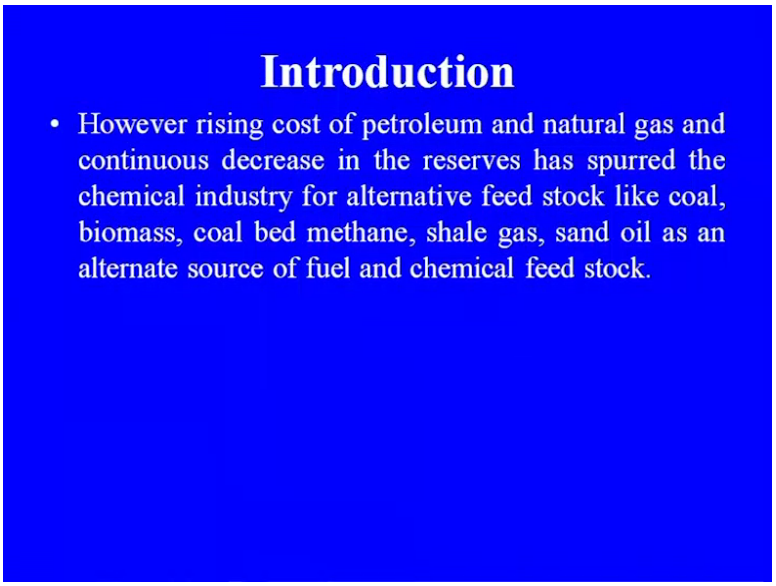

Another problem that has been rising cost of the petroleum natural gas and continuous decrease in the reserves, has a spurred the chemical industry for alternative feed stock like coal biomass, coal bed methane, shale gas, sand oil, as an alternative resource of fuel and chemical feed stock. Because, you see the shale gas and sand oil that is the one of the area where the still we are working in other part of the world, they are working to utilize more effectively to increase. Because, the sand oil is slightly heavier very heavier crude and even some of the oil which is available in the adjust. You take a case of the Rajasthan that is having the high tendency, high sulfur components are there. So, these are the some of the problems also inclusion of new raw materials.

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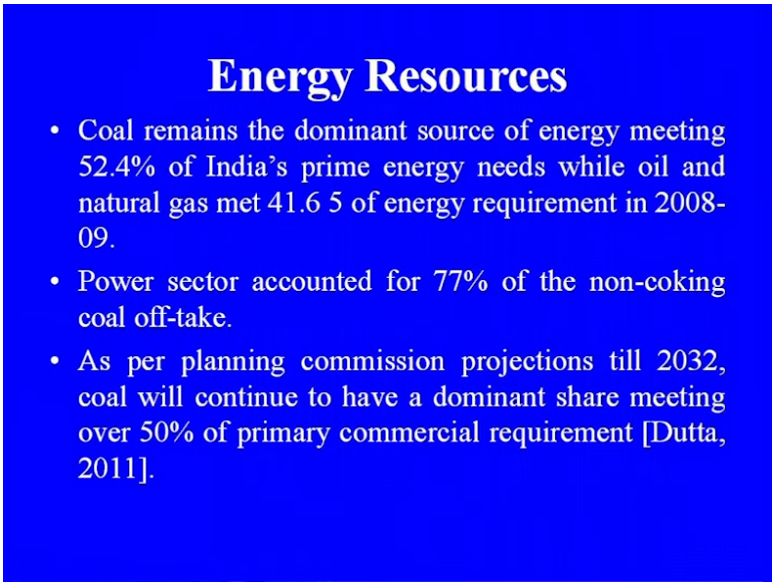

Coal remains the dominates source of energy because we are now, discuss something about the energy resource which are available for the chemical process industry. Because, you see the without energy nothing can be done, we cannot run a plant so, the energy resources that is very important.

So, coal that was the dominant source of the energy meeting about 52.4 percent of the Indian prime energy needs while oil and natural gas met 41.6 percent of the energy requirement in 2008-09. Power sector accounted for 77 percent of the non-coking coal off take. As per planning commission projection till 2032, coal will continue to have a dominant share meeting over 50 percent of the primary commercial requirement.

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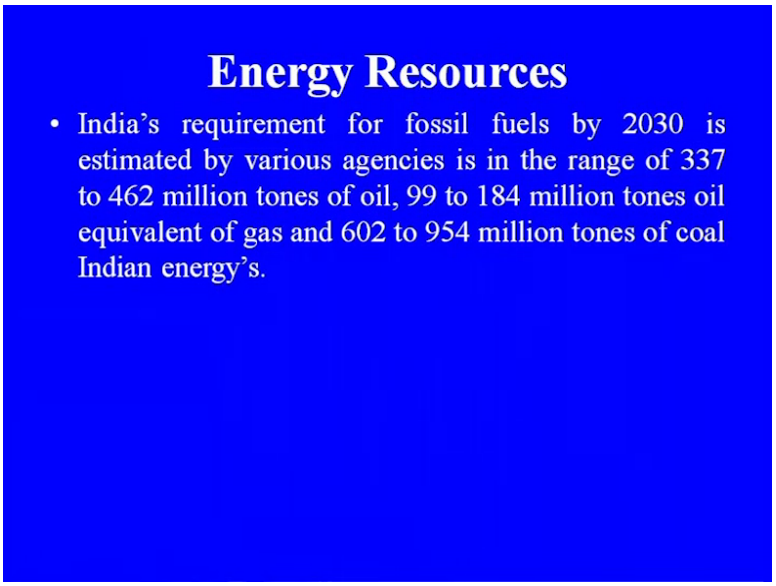

World and India energy consumption scenario that is in the figure M module 1 4 that is given that you can go through. The world energy consumption is projected to increase by 58 percent over a 24 years period from 2001 to 2025. Total energy use is projected to grow from 404 in 2001 to 640 quadrillion BTU in 2025. This is the how the changes that is taken place because of the fast development that is taking place.

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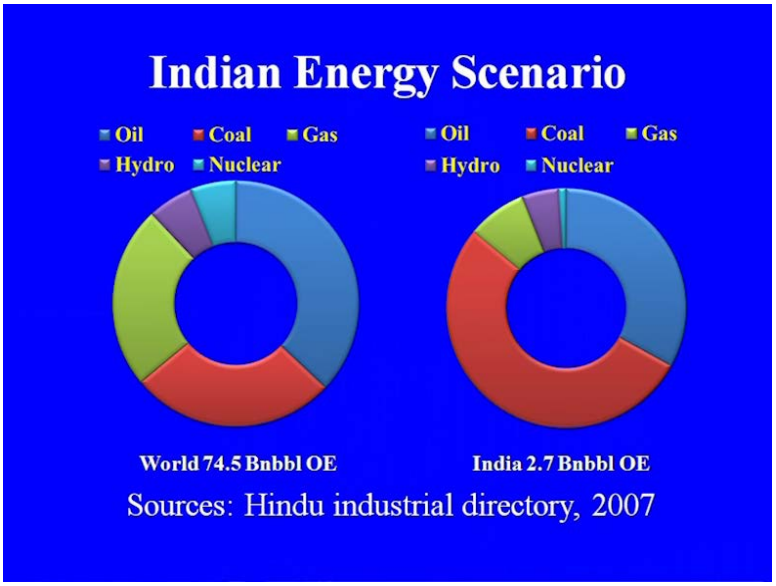

In India requirement for fossil fuels by 2030 is estimated by various agencies is in the range of 336 to 462 million tons of the oil. 99 to 184 million tons of oil equivalent of gas and 602 to 954 million tones of the coal that is the requirement that is projected.

This is the scenario of the oil and gas and the hydro power nuclear power we are using now. So, nuclear power that is actually the small position of the total energy requirement that we are having. This is the how the changes that have taken place in case of the chemical feed stock the raw material which are using.

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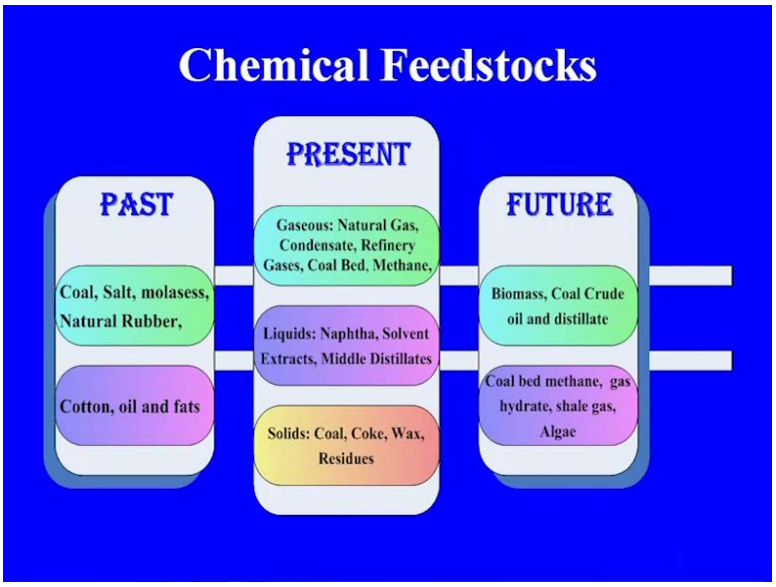

In the past we are start with the coal, salt, molasses, natural rubber, cotton and the fat. These were the some of the raw material in the past present gaseous, natural gas, condensate, refinery gases, coal bed, methane, liquids, naphtha, solvent extracts, middle distillates, solids, coal, coke, wax and residues, these are the present raw material. That were if future again we are coming in the big way fertilization of the alternative raw material at the biomass, coal crude oil and distillate, this is the coal bed methane, gas hydrate, shale gas and algae as a fuel. So, again the people are working for the production of the alcohol based on the algae. So, let the more, but the problem the cost of the production of the alcohol through the algae route. So, the now the future raw material that may be algae also.

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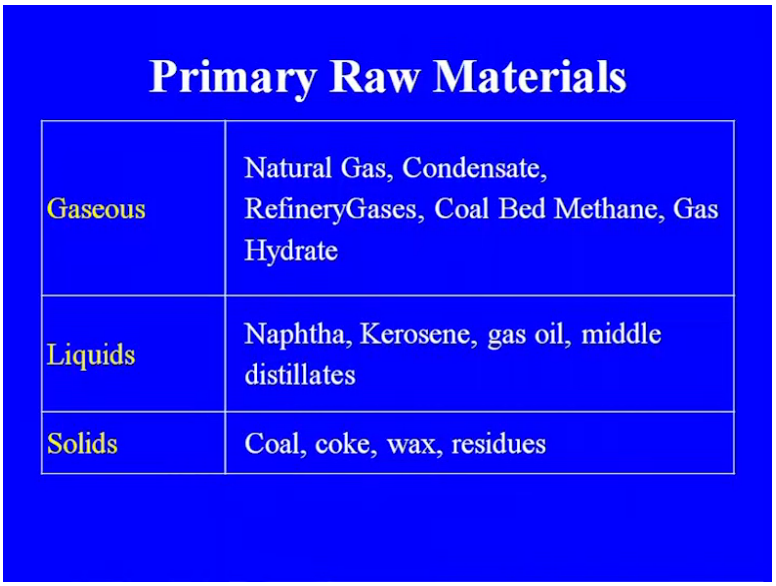

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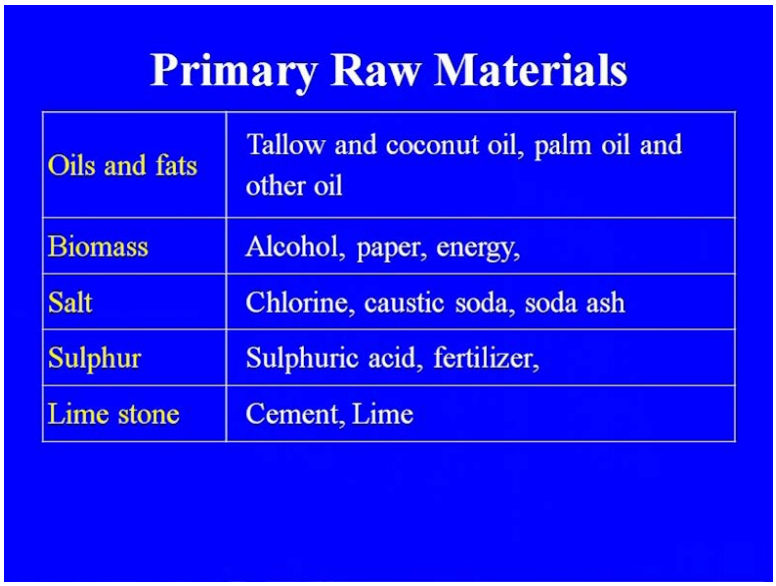

Primary raw material, because the raw material which we are using that may be primary are secondary raw material that are gaseous; natural gas, condensate, refinery. Condensate that we are getting from the heavier fraction of the natural gas while processing in the natural gas. Now, some of the units are coming from the ONGC organ to utilize the condensate. Some of the condensate are reaching the aromatics, we can extract the aromatic from the condensate. Then the refinery gasses, coal bed methane, gas hydrate, liquids; naphtha, kerosene, gas oil, middle distillates, solids; coal, coke, wax and residues.

Oil and fats; tallow and coconut oil, palm oil and other oil that we are using in case of the soap industry. Biomass; alcohol, paper, energy that we are that is the… we are using and some future scope is also there for biomass route. But the alcohol route from this your molasses that is still we are having the number of and most of the alcohol part that we are making from the biomass are the… But from the biomass to alcohol that is one of the again big challenge, because the lignin is there, removal of the lignin, pre treatment part, the cost of the pre treatment of the biomass is more, but lot of work that has been done. So, the in future we may have some biomass where alcohol plant also.

The salt from the slat as I told you earlier also the sea is a ratio in the resources. It may be whether oil or the minerals or the salt and these salts that is being used as a raw material. If we take the salt, salt is a very small you will find that what is use of the salt, it is the not only for the double proposes. Large number of the industry they are based on the salt as a raw material and product from this industry that is the backbone of the many chemical industry. Just take the chlorine, caustic soda, soda ash these are there product that we are using some or other form in most of the industry.

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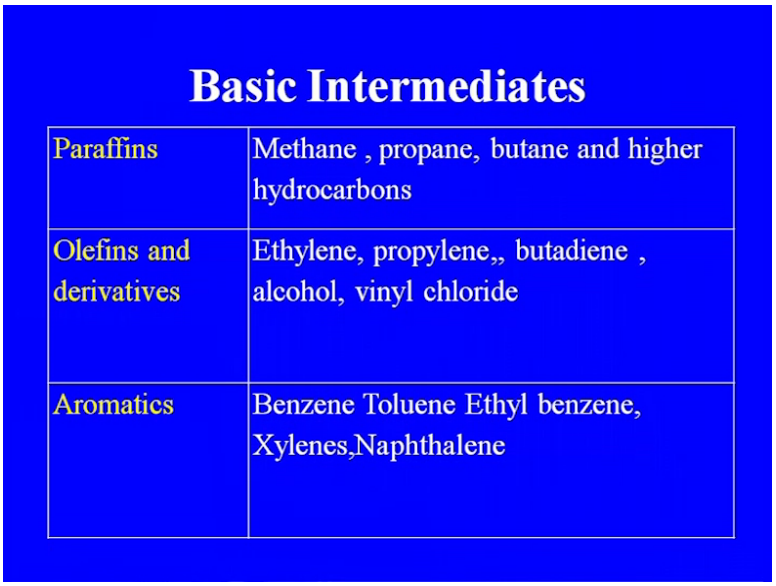

Sulfur that is the sulfuric acid now, the sulfur instead of the sulfur the pyrite is also coming in some of the units, which are the just like copper or the iron units they are using the iron the copper pyrite also for the main figure that is the. The fertilize industry they are using the sulfuric for the making of the ammonium sulphate. Lime stone for the

manufacturing cement, lime that we are using an lime that is also again a raw material for many of the chemical industry and one of the major units also in the paper industry and for during the recovering the chemicals.

Paraffins; methane, propane, butane and higher hydrocarbons, because know the paraffins are also the people because, the methane that is available in the natural gas. Propane that we are getting from the various processes even in case of the natural gas is there. So, how to convert this methane or the propane to the more valuated product? So, from the propane to propane, methane to olefins these are the things that is happening, these are the development that is taking place. Olefins and derivatives; ethylene, propylene, butadiene, alcohol, vinyl chloride these are the are the acetic acid, vinyl acetate etcetera. These are the some of the actually the chemical intermediate which are finding large application in making of the large number of the chemicals.

Aromatics; benzene, toluene, ethyl benzene, polystyrene, xylenes various, especially the ortho xylene and para xylene they are very important. Naphthalene that is some time naphthalene that are getting from the coke oven plant and so naphthalene is one after the route for making of the ethylic energy in naphthalene also. Although, we are making from the orthoxylene now, because the orthoxylene developed from the paraxylene.

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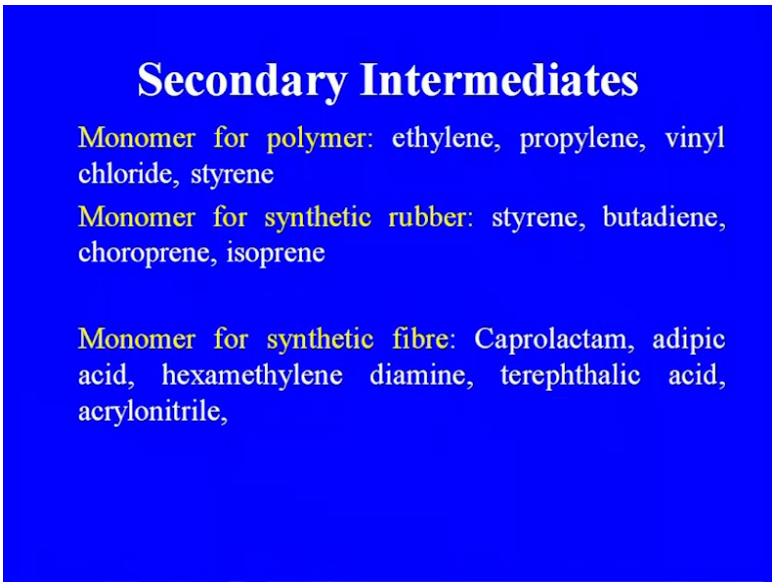

Monomer for polymer; ethylene, propylene, vinyl chloride, styrene, these are the some of the monomer from the major polymer, which are making whether the ploy thin, ploy

propylene or the PPC or the polystyrene. Are you been in case of the styrene that is being used in rubber industry. Monomer for synthetic rubber is styrene, butadiene, chloroprene, isoprene actually the isoprene that is available in the FCC are the cracker gasses. But still we are not recovering about the FCC 8 percent of the sea pipe, sea gas is isoprene, which can be recover and that can provide. A styrene because ethylene and the benzene these are the two raw material for making the ethyl benzene and ethyl benzene to styrene. And already some of the petro-chemical complex, just like the panipat refinery, they are going for the styrene butadiene rubber. And earlier we used to make the styrene through the alcohol route, the alcohol to ethylene, ethylene from styrene, ethylene to styrene.

Monomer for synthetic fiber; elastic, caprolactam, that is for nylon 6, terephthalic acid, hexamethylene diamine for the making of the nylon 66. Still we are not making of nylon 66 most of the nylon that is the based on the caprolactam that is nylon 6. The terephthalic acid and acrylonitrile that is for the making of the ployacrylonytrile that is the… Because, now you are seeing in the industry whose changes that is because of the ployacrylonite fiber, which is having the pool texture and the because of the flopping nature that the polyacrylonitrile are the acrylonitrile. Alumni acylonitrile find a application making of the some of the specialty, polymers and rubbers also.

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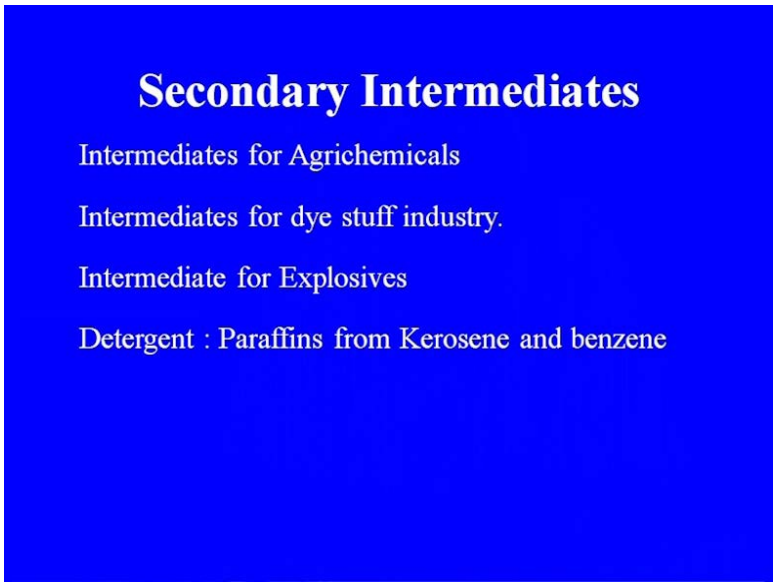

Secondary intermediates mean the products which are getting from the refinery or the petro-chemical that they are being used as intermediates for the agrochemicals,

intermediates for the dye stuff industry. You take the case of the aniline, aniline that is coming to from the arometric mass where we are using benzene and from the aniline that is the one of the major raw material for the dye stuffing. Intermediate for explosive; one of the earlier explosive used to be the TNT that was actually from the tylene and nitrotylene that will be as a explosive still we are making the explosive. So, intermediate pro or PET that is also from the there we are using this formal dehyde.

So, this is the how the in some of the primary feedstock they are playing important in providing the secondary intermediate, which are finding application as a finish product. Similarly, you take the case of detergent; paraffins, paraffins that we are extracting from the kerosene and the paraffins that is the converted to olefins and this olefins is alkylated benzene, so there were getting the liner Alco aluminium. So, these are the some of the secondary intermediate that we are using.

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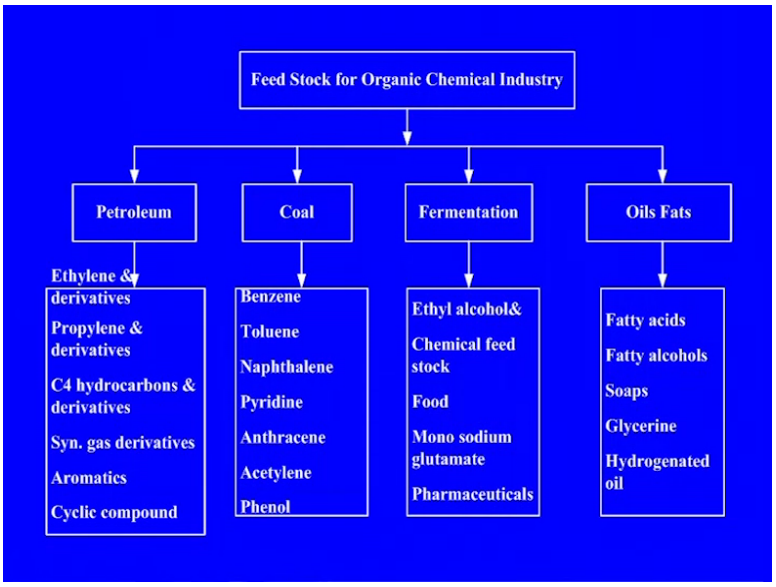

This is the how the feed stock for the organic chemical industry it may be the petroleum, coal, fermentation, oil and fats, and various product derived from the petroleum coal or the fermentation they are (( )). From the petroleum; ethylene derivative, propylene derivative, C4 hydrocarbons derivates, syn. gas derivatives, aromatics, cyclic compound.

From the coal; benzene, toluene because the earlier most of the requirement that was made through the coke oven plant. But at that time the consumption was the much less and the organic chemical industry that was not much developed and the at the same time

yield of the your aromatic from the coal is much less. So, that was the problem that was the problem in case of coal, but as a byproduct definitely still we are using that benzene styrene, naphthalene that is also peridian. Because, you see the coal is the from the coal it large number of the chemicals inorganic, organic that can be produce. And that we are producing through the only thing recovery part, how many chemicals we are recovering. Every day it is from coredact distillation, from the coke oven gasses it may be the manufacturing of the ammonium sluphate, ammonium nitrate these are all we are doing from the coal.

Fermentation industry which I discuss earlier also, alcohol that is one of the very important raw material for chemical industry, apart from the beverage, food, mono sodium glutamate. These are the some of the industry where we are using the fermentation process. Oil and fats; fatty acids, fatty alcohol, soap, glycerin, because of the glycerin that is going to be one of the very important raw material in the future for the chemical industry. Still you can produce a number of evaluated products on the glycerin.

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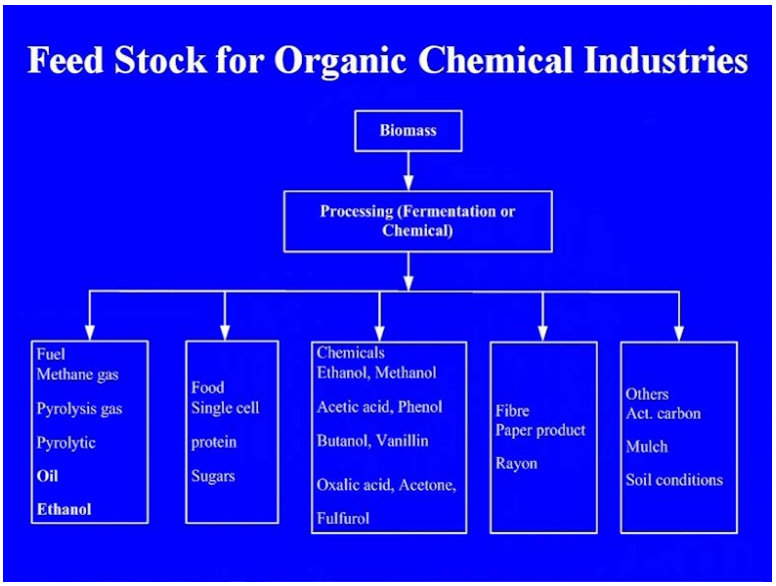

From the biomass as I told you the processing the biomass there will be some problem, because of the lig, presence of the lignin and pre treatment is required. For the number of product that we can derive from the biomass is starting from the methane, pyrolysis gas, pyrolytic, oil, ethanol, food, single cell, protein, sugars, chemicals, ethanol, methanol,

acetic acid, butane, vanillin, oxalic acid, acetone. Phenol means phenol that is the cumin road that you can go, the fiber, paper product, rayon, others activated carbon, mulch and soil condition, these are the products that you can get from the biomass.

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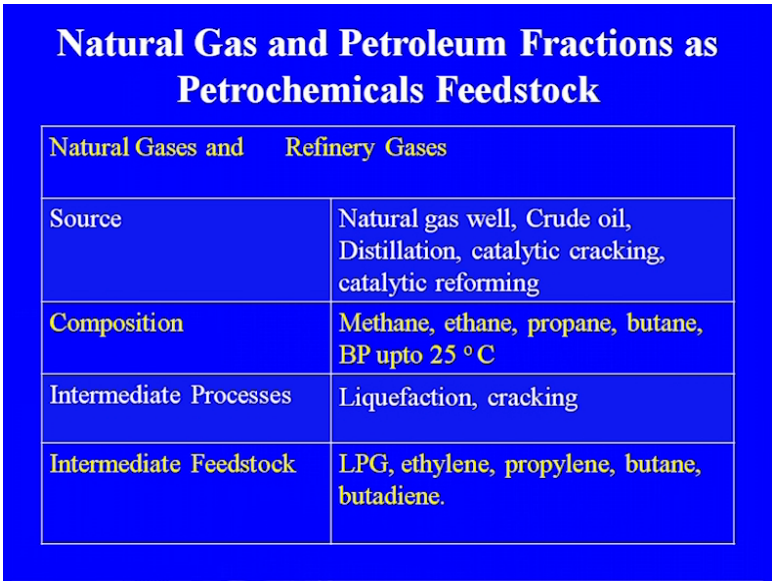

Now, I will discuss about the some of the products which are getting from the petroleum route and the various petroleum fractions, which are being used as a basic raw material in the petro chemical industry. First major problem that the natural gas and the refinery gas, because there are two sources natural gas, one we are getting directly from the natural gas. Second is the natural gas we are processing, after the processing of the crude oil which is separate that we call the associate. Third is the refinery acid which you are getting during the various processes the refines acid is contain methane.

So, these are the some of the natural gas where crude oil, distillation, catalytic cracking, catalytic refining all the process we are focusing the gases, which we are finding that is being used for the production. The chemical composition; methane, ethane, propane, butane, boiling point up to 25 degree centigrade at the fraction in the case of the refinery, here after that the gasoline fraction is there. Intermediate processes; liquefaction, cracking, intermediate feedstock; LPG, ethylene, propylene, butane, butadiene which find application in the manufacture of other. LPG is that will be used as a fuel and that can be used for the manufacture of aromatics through the cycle process. So, this is the

these are the products which are being used for the manufacture of some of the other important intermediates.

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Naphtha	
Source	Distillation and thermal & Catalytic cracking, hydrocracking, visbreaking
Composition	C_4-C_{12} hydrocarbon, BP 70 - 200 °C
Intermediate Processes	Cracking, reforming, alkylation, disproportionation, isomerisation
Intermediate Feedstock	Ethylene, propylene, butane, butadiene, benzene, toluene, xylene

Naphtha, naphtha is one of the most versatile feed stock we are getting from the refinery because, the naphtha in the various processes deploy. Because, you see the gasoline, gasoline is also a naphtha, but the gasoline higher obtain naphtha is only been used as gasoline or estaton gasoline. Rest of the naphtha will have to process to more value added product either it may be through the catalytic reforming or it may be through the catalytic cracking of the naphtha. So, these are the some of the sources from the refining, which are getting distillation and thermal and catalytic cracking, hydro cracking, visbreaking. This is the reason why we call it the satysene naphtha and the cracked naphtha, both we are getting from the various process and this is boiling point 70 to 200 degree centigrade.

As I told you in case of the a higher boiling point fraction which we are getting as a naphtha, they are having the lower octane number that is why they cannot be used as energy. Same time you see the octane number requirement that has been changing, earlier vehicle 70 octane number now we are talking about the 100 plus octane. How to meet that requirement? So, just for the improvement of the octane number that is the some secondary process that we are doing that we will be discussing while discussing the petroleum refining and the part.

So, composition of the naphtha C4 to C12 boiling point 70 to 200 centigrade, intermediate processes which are there cracking, reforming, alkylation, disproportionation, isomerisation. Intermediate feedstock that we are getting from the naphtha ethylene, propylene, butane, butadiene, benzene, toluene, xylene these are the some of the intermediate products, which we are getting either from the naphtha cracking or from the catalytic reforming of the naphtha. Or now the in the refinery we are also having the isomerisation process where we are mostly it is for the production of the high obtain gasoline form the low obtain naphtha.

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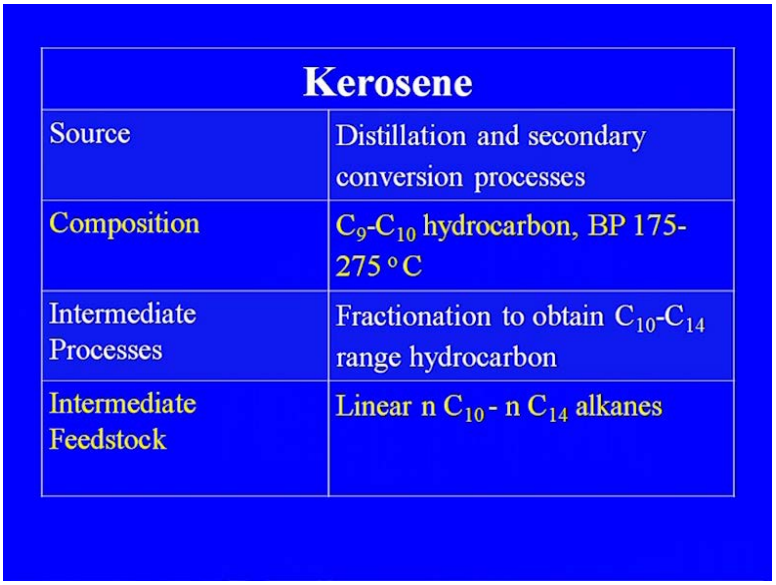

Kerosene; although that the kerosene major portion of the kerosene that is being used as a fuel, but a good amount of the kerosene that is required for the manufacture of the liner alkylene benzene. So, what we are doing we are doing the fractionation of the kerosene and after the fractionation we are taking the carbon atom from 10 to 14. Because, the for the more and more bio (( )) this carbon number is very important. So, it may be we can say this C 10 to C 14 part, but more preferably C 1 into C 13 carbon alkynes that will be required for the and that we are fractionation. What we are doing in case of the LAB plant? We have fractionating the cross n and extracting this portion of the alkylene from the kerosene and rest of the kerosene that is been recycled to the fuel system per blend.

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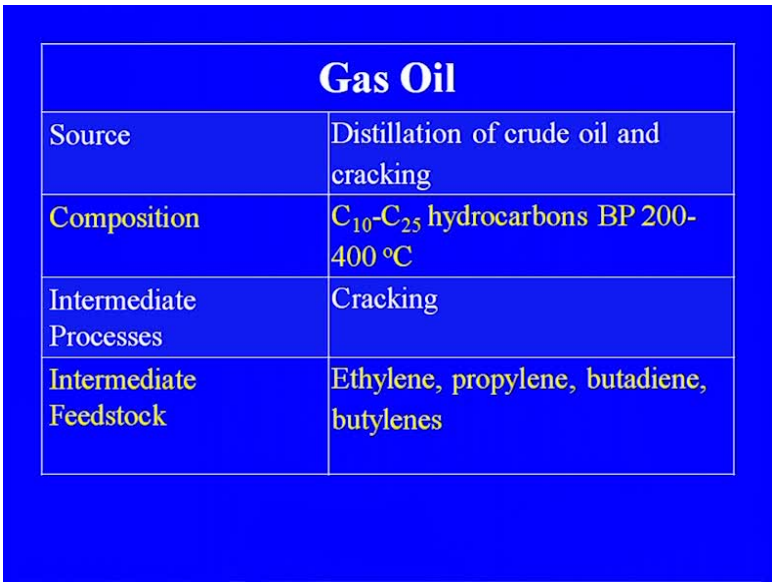

Gas oil again that is the heavier portion of the… we are getting from the crude oil distillation, distillation of the crude oil and the cracking may be during a process. Because, it is what we are doing in case of the cracking or the hydro cracking, remaining portion of the heavy residue, which are getting from the atmospheric and the your vacuum distillation. That is again further being process in the secondary convergent process for getting more value added product.

So, major product that may be cracking again, gas oil cracking that can be also done, but only the cost of the cracking, of the gas oil and the product complexity. Where the product less ethylene and propylene is there and more heavier pack and that is why. But some plants are there in which are operating on the based on the gas oil for the olefins. So, that may be the one of the source for the future source for the olefin in the gas cracking because, in the reactor also. For naphtha cracker what are the development that has been taken place and again that will be discuss while disusing the petro chemicals. Wax again that is part in case of the more paraphrenic crude oil we are getting wax. So, the wax after the cracking can get the alkynes, which can be used for the further cracked and used for the production of the some of the higher alcohol, higher hydrocarbons.

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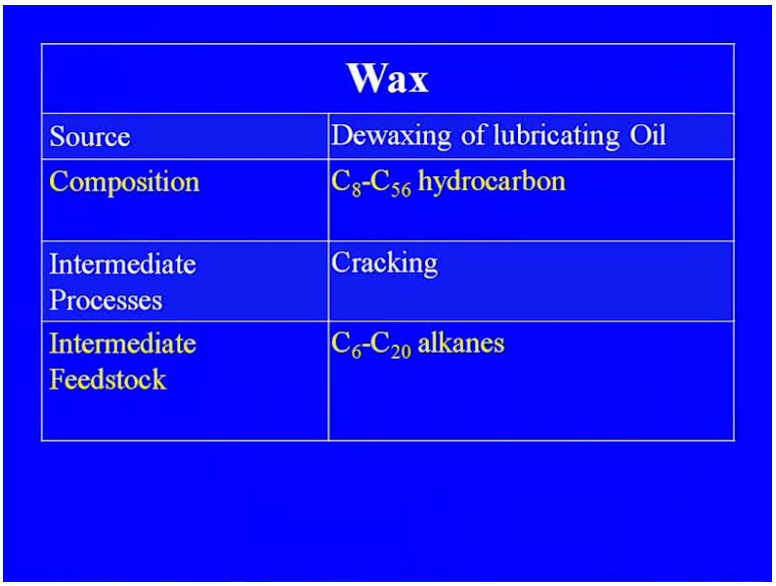

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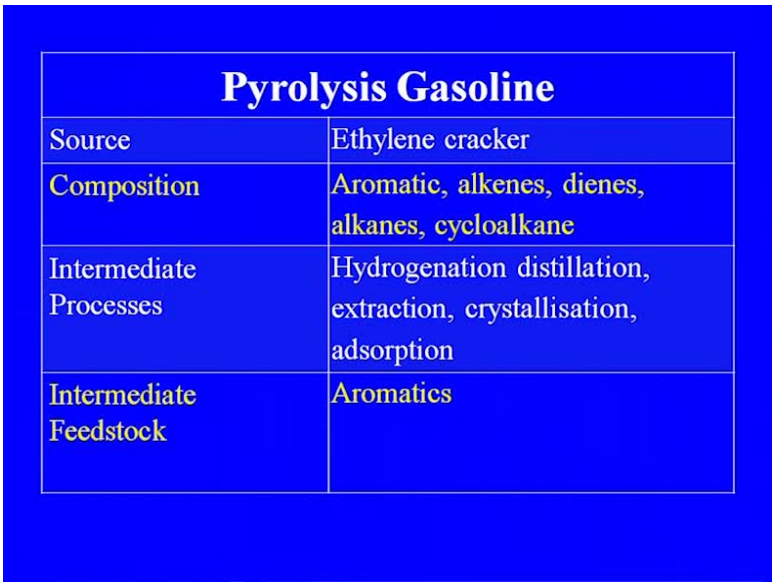

Pyrolysis gasoline that is the product from the we are getting from the clean cracker means the naphtha cracker, gas cracker. And that pyrolysis gasoline reach in the aromatics and these aromatics can be utilized effectively for the that can be actually mix with the reformate. And then it can be processed in the aerometric production part, where we are because, only additional requirement in case of the pyrolysis gasoline that will be the removal of this sulfur removal of the sulfur from the pyrolysis gasoline.

So, these are the some of the sources in case of the your pyrolysis gasoline and some of the process that is involved in case of the separation of the pyrolysis gasoline that is the distillation extraction. Hydrogenation that is the hydro desulphurization of the pyrolysis gasoline for removal the sulfur, crystallization at the option these are the process that can be normally that is crystallization edge option. That is being used for the separation of the para xylene from metal. Similarly, the extraction that we are using for the close boiling point aromatic and non aromatic and the intermediate problems of course, we are getting from the pyrolysis gasoline the benzene styrene and xylene.

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Petroleum Coke	
Source	Gas fields and crude oil stabilisation
Composition	Hydrogen, methane, ethane, propane, pentane, aromatics
Intermediate Processes	Cracking, reforming, separation
Intermediate Feedstock	Ethylene, propylene, LPG, aromatics, etc.

Petroleum coke again that as I told you earlier also you call it the petro coke or the petroleum coke with the utilization of more and more heavier fuel. Now, the petro coke production that has been increased and earlier the petro coke now because, Panipat or the Jamnagar (( )), the petro coke produce that was being used by the cement pond as a fuel. But now, the petro coke that can be use for the gasification and from the gasification you can produce the this is the you can produce the hydrogen or it can be use in the fertilizer plant along with the coal. Because, the petro coke that will have the higher carbon than the conventional coal. So, this is the composition of the petro coke the various process that can be cracking reforming and the various separation process. And the product ethylene, propylene, LPG, and aromatic from the coke, depending upon the type of the process we are using.

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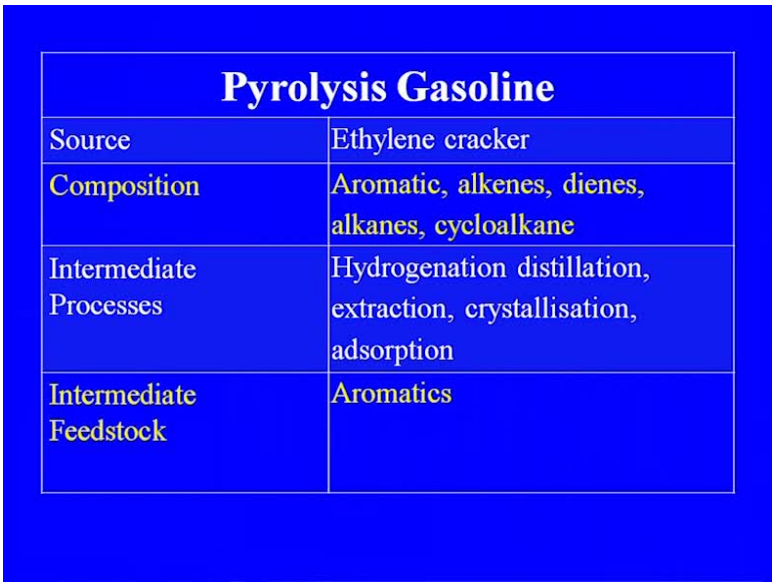

Natural gas; a natural gas condensate already have discussed some of the intermediate process residue up gradation process, gasification, especially in case of the natural gas or the heavier fraction of the natural gas, where you can go for the gasification. The product that you can carbon electrode, carbon that you can be acetylene and fuel these are the intermediate feed stock. Now, the alternative routes are also available because this is the beauty of the nature. The nature has provided the alternate sources and it is only thing how effectively economically we can use this raw material for the production of the organic chemicals. Because, from the ancient time even when the no refining was there some of the organic chemical that was being made, that was through the natural.

So similarly, some of the products which we are getting from the alternative route for the your production of the chemicals that is the methane from the natural gas refinery, light gas that we are using alternative route. That may be coal as a byproduct of the separation of the coke oven gases, because incase of the coke oven gases is your… This ethylene is there, so that you can be separated from there, methane that can be separated from there. Of the coal hydrogenation ammonia from coal via water gas because the here we are making the synthesis gas synthesis gas to CO 2 and then, but even in case of the coke oven gases also we are getting the ammonia and that ammonia that has been used for the making of the fertilizers. So, coal base plants also that can be used for the manufacture of the ammonia.

Similarly, methyle alcohol methane and the from coal synthesis gas, from synthesis gas to again from reform methane is steam reforming or the from the partial oxidation. You can go for the manufacture of synthesis gas and that synthesis gas CO plus S 2 that can be used for the production of the methanol. Because, lot of the importance that has been given for the manufacture of methanol because, methanol that is not only a raw material for chemical industry that is also as a future fuel people are seeing in methanol, even the methanol as a blend as a oxinale we are looking for. So, that is the development that has taken place, but alternative routes are there from where you can get the methanol.

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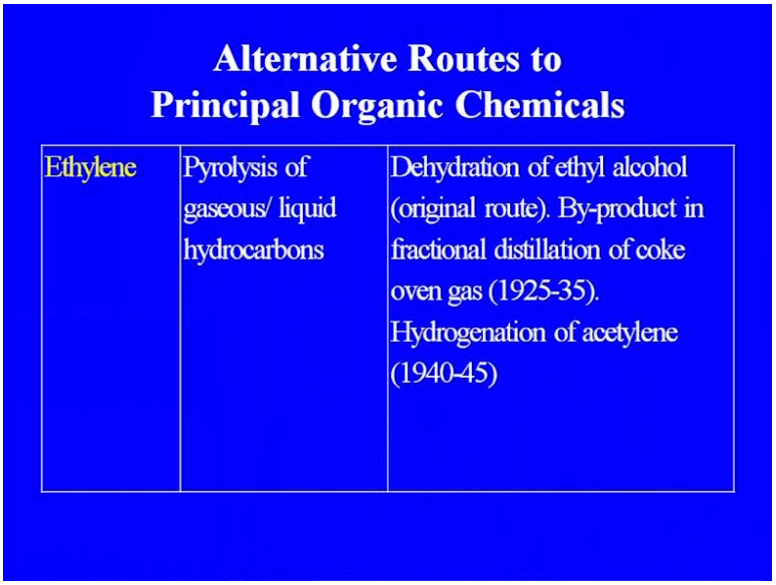

Similarly, ethylene, pyrolysis of gaseous/ liquid hydrocarbons, dehydration of ethyl alcohol this is the original route. And even in India we started the ethylene manufacturer with the alcohol route, byproduct in the fractional distillation of the coke oven gasses, hydrogenation of the acetylene. So, these are the some of the as I told the acetylene that is one of the resource of the many of the product, that you can even synthesis gas that can be converted to olefin. The technologies are available, but only thing that economic part that we will have to see.

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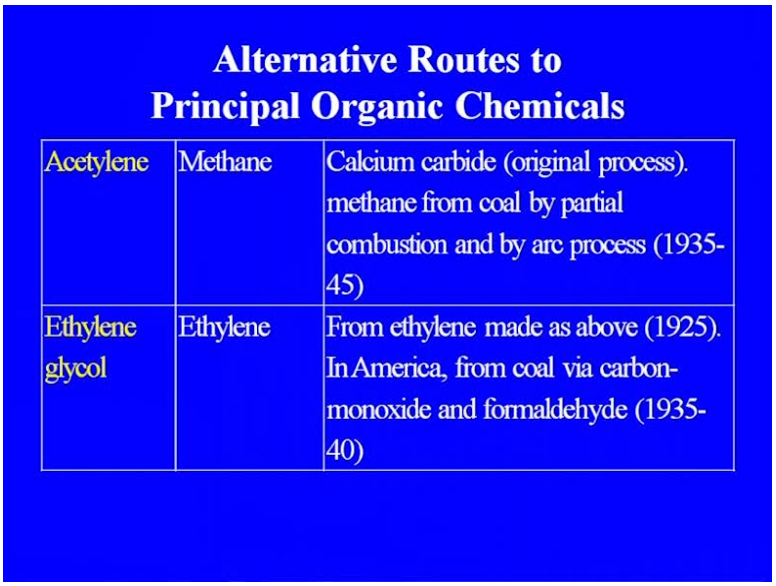

Acetylene, calcium carbide and calcium carbide because, the two routes are there, one is the acetylene can get from the methane route, second is from the calcium carbide to a (( )) route. Both the routes are available, but only earlier it was the calcium carbide now, you can have the methane from the natural gases and that can be used for the production of the acetylene and then further acetylene that can be used as a chemical feedstock. Because, this is the only alternative route that is available in case we are not having the petroleum products, then we can go for the acetylene and from the acetylene only it is the cost of production is higher, in case of the chemicals derived from the acetylene. Then ethylene glycol, also from the processes ethylene that you can get from the processes earlier developed or the coal via carbon monoxide and then formaldehyde to, these were the route for the ethylene glycol.

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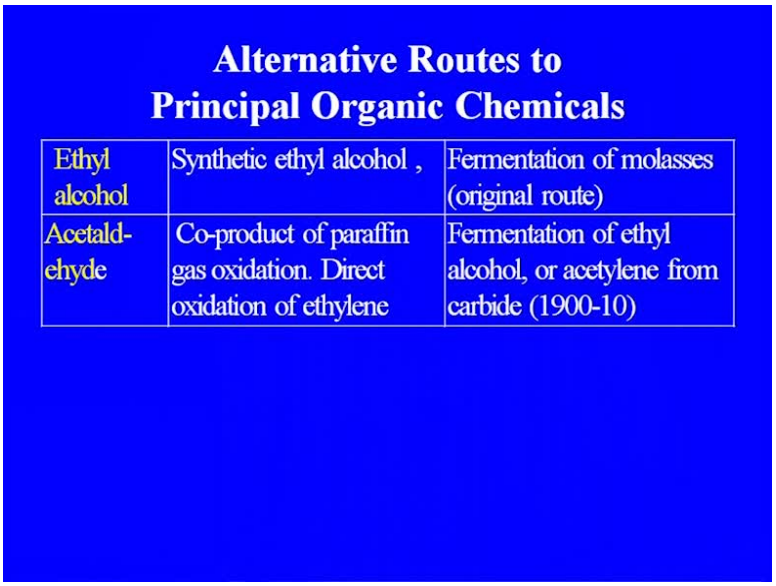

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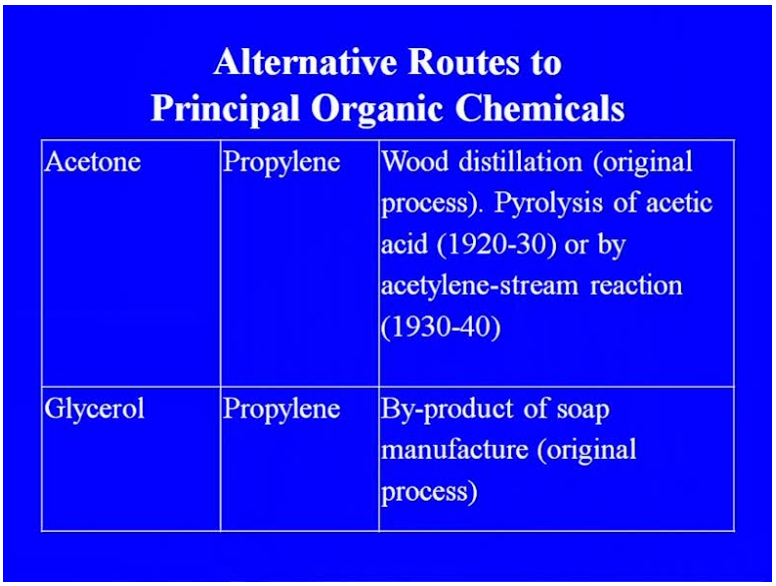

Similary, the acetald-ehyde, co-product of paraffin gas oxidation, direct oxidation of ethylene, fermentation of the ethyl alcohol and from the ethyl alcohol or acetylene from carbide these are the alternative route available for acetald-ehyde. Acetone again the wood distillation or from the propylene normal the acetone that we are getting is the byproduct. Then on the propylene or the propylene to acetone that can be there. But alternative route is there wood distillation, pyrolysis of acetic acid from where you can get the acetone. Glycerol, propylene route is there and by product of soap manufacture.

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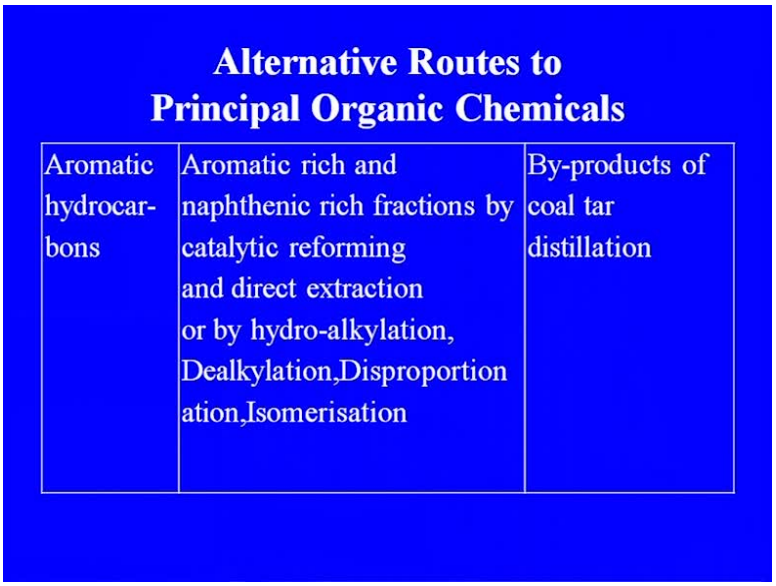

Aromatic hydrocarbons, aromatic rich and the naphthenic rich fractions catalytic reforming and direct extraction or by hydro alkylation, dealkylation, disproportionation, isomerisation these are the some of the aromatic conversion process that is available for the production of the aromatic and that is being used. But another alternative route is the byproduct of coal tar distillation, which was the earlier actually the route for getting the aromatics when the refine is one there are the crude oil availability was there.

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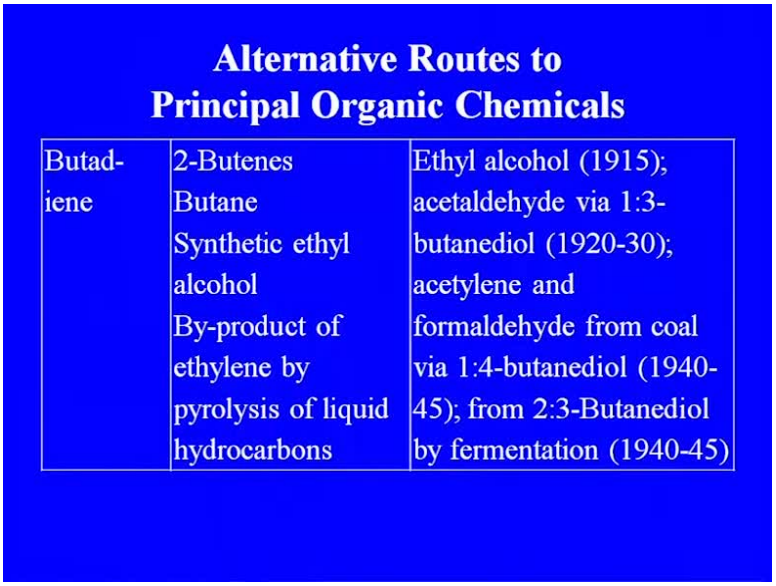

Butadiene again the butadiene the original route was the ethyl alcohol route. But now, we are getting butadiene as a byproduct from the cracker plant. So, ethanol because you see the styrene butadiene upon we started manufacturing during the 60s in the synthetic chemical bareili plant that was the now that plant is closed. But they are manufacturing the butadiene through the alcohol route. So, this is the how the still the actually your, these alternative raw materials that can be used for the putting some of the important organic chemicals, which are being used as a feedstock.

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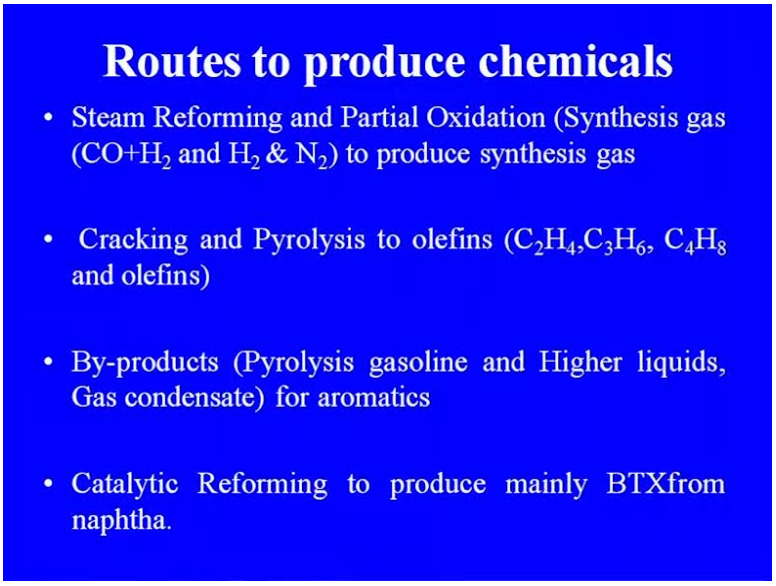

Routes to produce chemicals various actually routes, which are available for the steam reforming in partial oxidation to produce synthesis gas cracking and pyrolysis to olefins, byproducts, pyrolysis gasoline and higher liquid, gas condensate for aromatics, catalytic reforming to produce mainly BTX from naphtha.

So, that is the process we are using for the manufacture of that is similar to catalytic reforming which is being used for the production of the your high octane gasoline that is the reforming that is been blended with the gasoline. But the same process that we are using only the choice of the feedstock depending upon the whether our requirement worthy. Benzene, tylene or the more xylene depending upon that we are taking the naphtha fraction.

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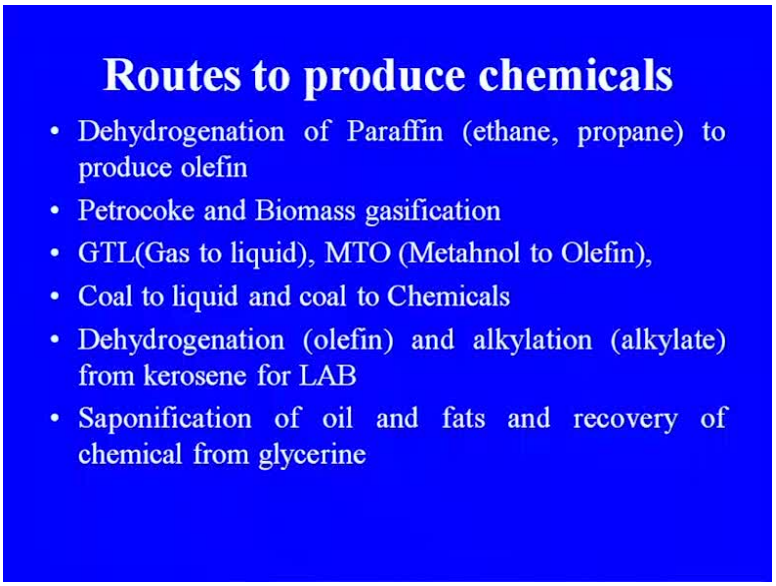

Dehydrogenation of paraffin ethane, propane because this is one of the process this will be used for the manufacture the propylene. That is the alternate route and a considive portion of the propylene that we are manufacturing dehydrogenation of the paraffin. And then on purpose actually the propylene that can be other than the cracking route. Petrocoke and biomass gasification, gas to liquid technology, methanol to olefin technology, coal to liquid and coal to chemicals, dehydrogenation and alkylation from kerosene, saponification of oil and fats and recovery of the chemical from the glycerine, these are the some of the routes available.

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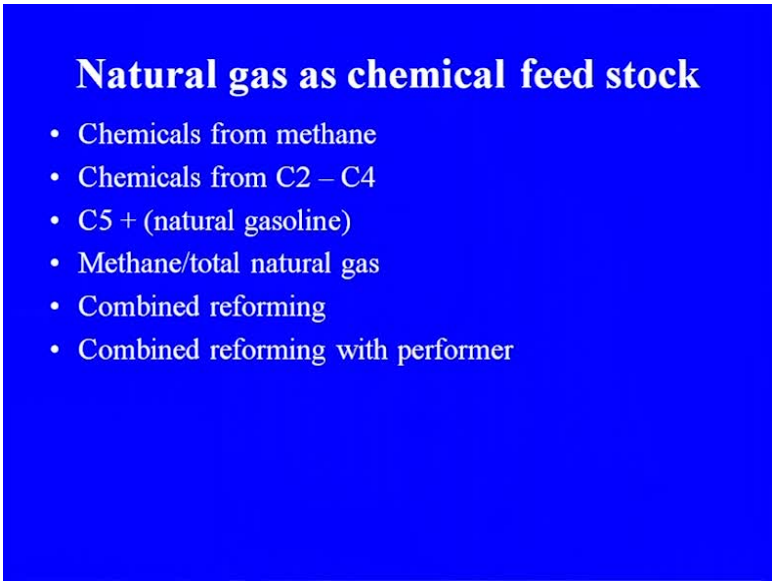

Natural gas, now we will discuss in detail about the individual component which discussed earlier. Chemicals from the methane, chemicals from C 2 – C 4, because different fraction we are having incase of natural gas, methane and total natural gas, combined reforming, combined reforming with the reformer. These are the some of the alternative for the reforming auto reforming process where the combination of the partial oxidation and reforming is there.

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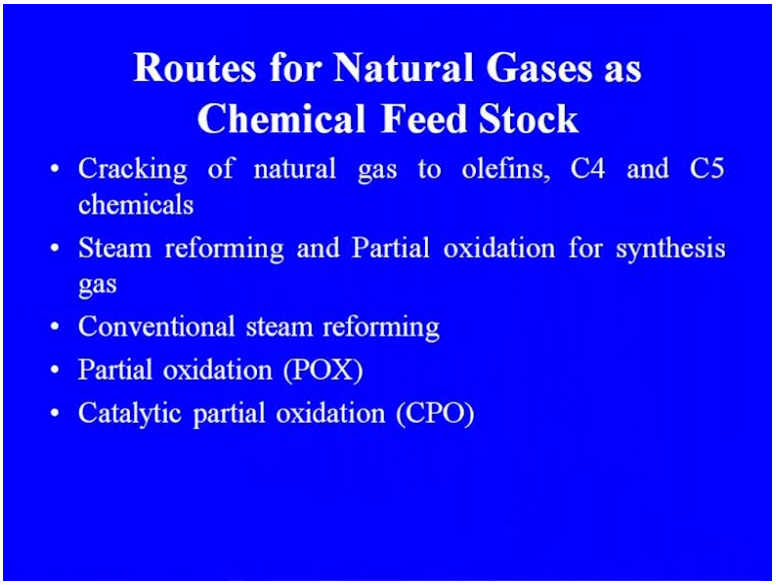

Cracking of the natural gas to olefin and the from the gasses which are getting C 4 and C 5 gasses that we can recover the chemical. Very variable product, one is the from the FCC propylene C 4 – C 5 gasses, we are getting butane, isobutylene, butane one, butane two and then the C 4 – C 5. C 5 we are getting cyclopentadiene, we are getting asopine and some of the other variable products C 5 gasses we are getting from the cracking part. Steam reforming and partial oxidation for the synthesis gas convince these are the some of the actually the methods, which are being used for. Because, looking to the energy consumption because they are very high in this (( )). Some of the development that has taking place in case of the steam reforming also conventional steam reforming partial oxidation.

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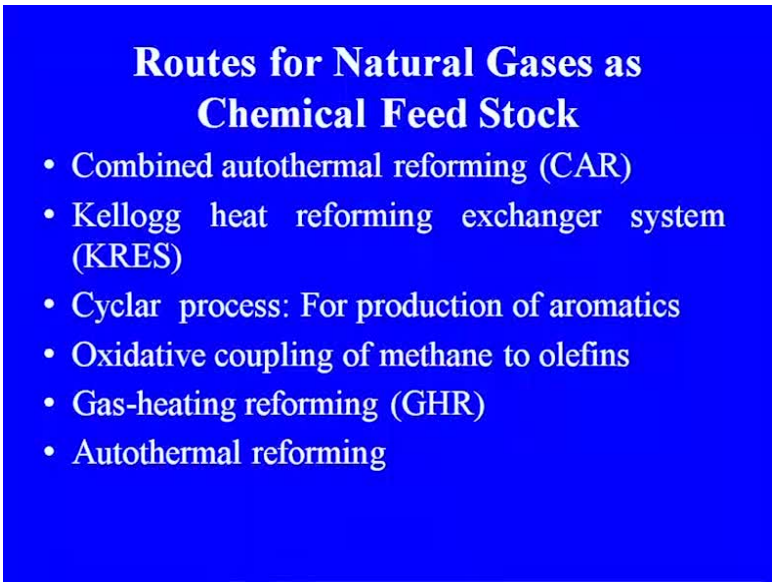

Now, we are talking about the catalytic partial oxidation, combined auto thermal reforming, kellogg heat reforming exchangers, cyclar process. Here is we are using the propane and butane for the production of the aromatics, oxidation coupling of methane to olefins. This is also the process technology that is available, but only thing that has been not commercialized by still we are the getting olefins through the other cheaper routes, gas heating reforming, autothermal reforming.

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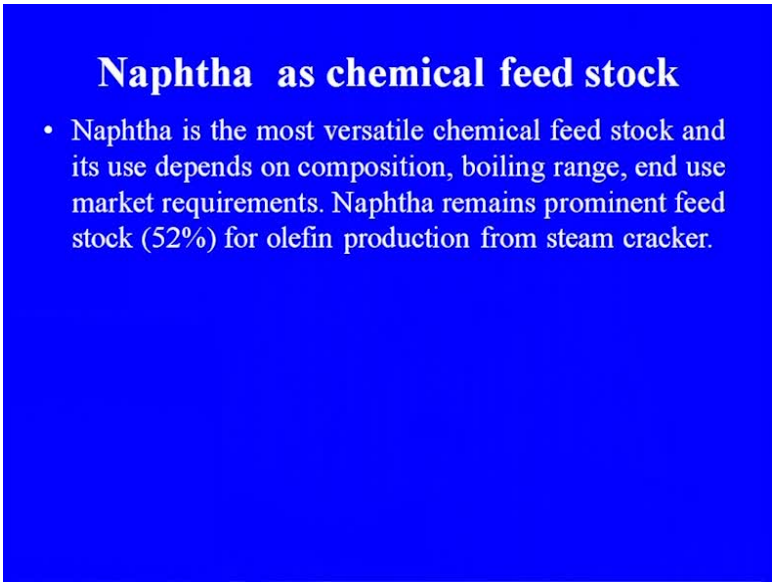

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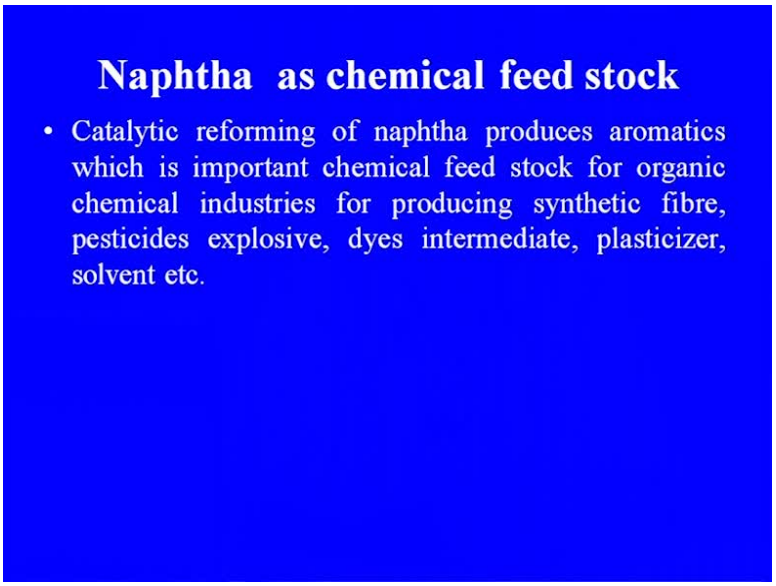

As we discuss about the naphtha because naphtha that is available low grade, low octane number naphtha is available on the petrol refining. And this is the most versatile chemical feedstock and its use depends upon the composition, boiling, end use market requirements. Naphtha remains prominent feedstock now the whatever the cracker plants we are having still 52 percent of the cracker plant and based on the naphtha cracking for the olefin production. So, catalytic reforming of the naphtha produces a aromatics which is important chemical feedstock for organic chemical industry for producing synthetic fiber, pesticides explosive, dyes intermediate and plasticizer.

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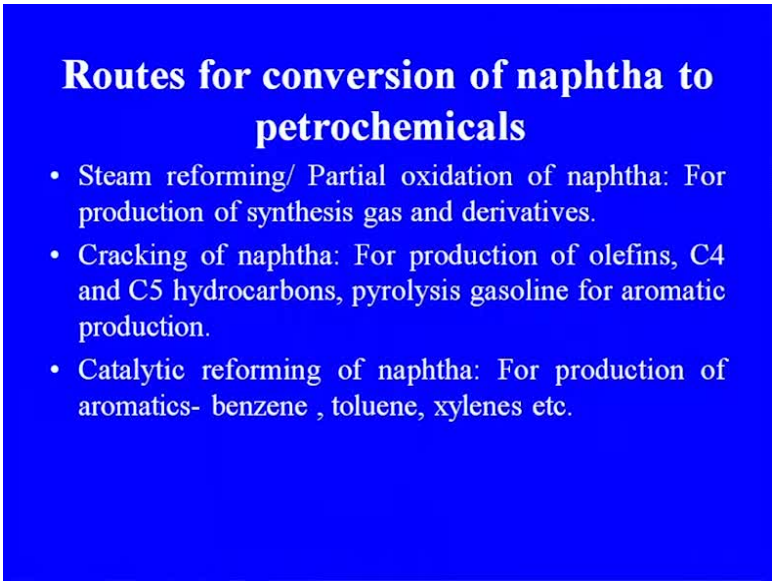

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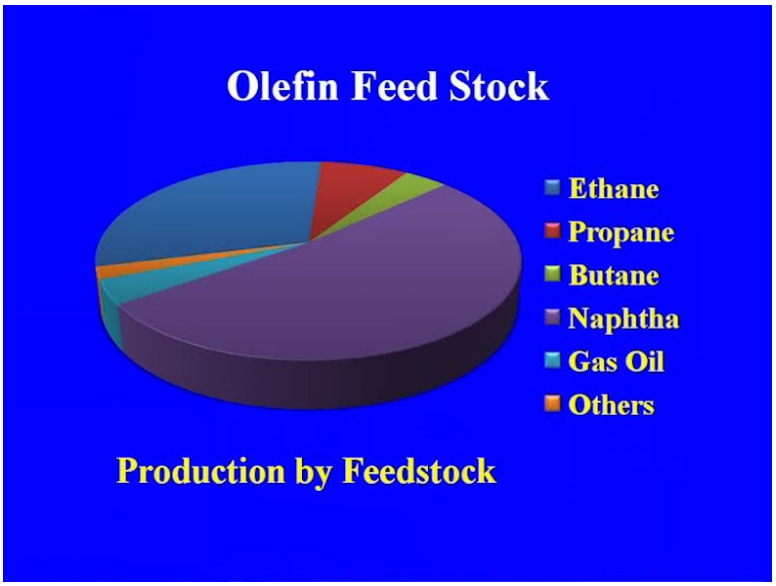

Steam reforming are the partial oxidation normally the both the process that have been used for the conversion of the naphtha to synthesis gas. Cracking of the naphtha, catalytic reforming of the naphtha, this is the how the feedstock. You see the still major share of the primary feed stock is the naphtha for the cracker plant, rest of the component are less.

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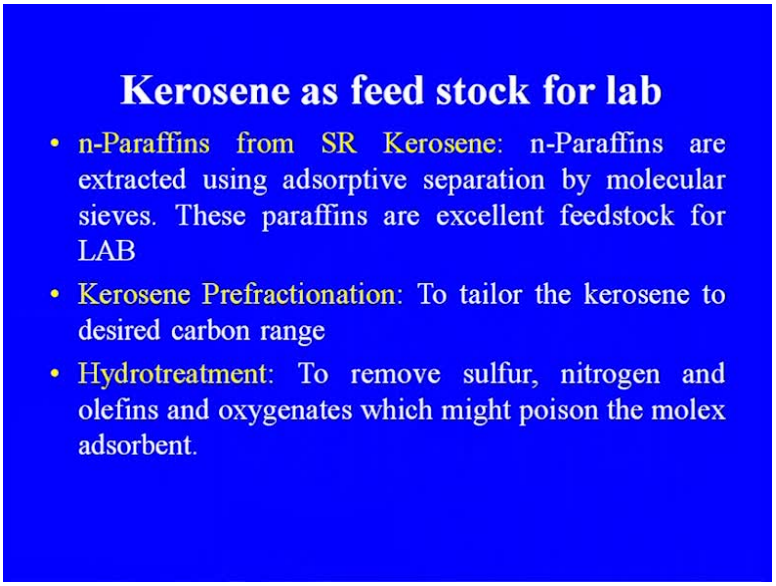

Kerosene already I have told earlier that the normal paraffins we are extracting from kerosene and that is being used for the manufacture of the your linear alkyl benzene, here

the process for the paraffin. Kerosene paraffin, prefractionation to produce the required carbon number in the paraffins and that paraffin hydro treatment then it is going for further processing for making olefins and then the for the alkylation process.

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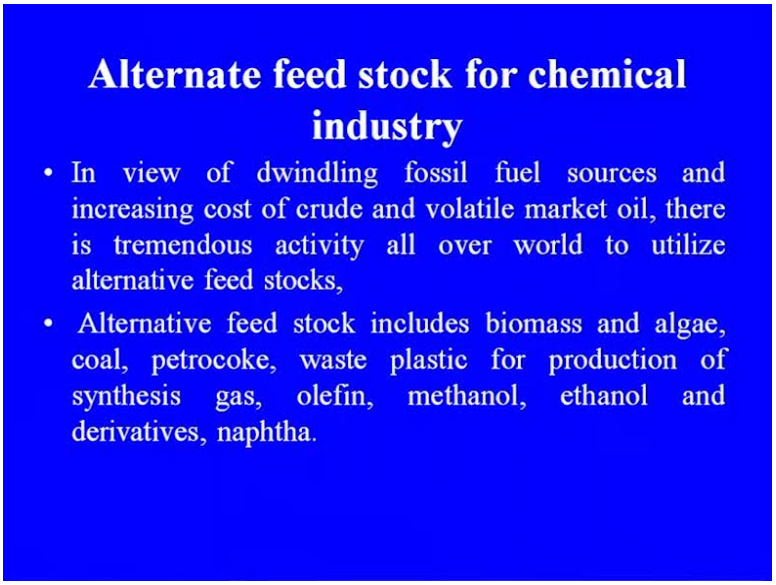

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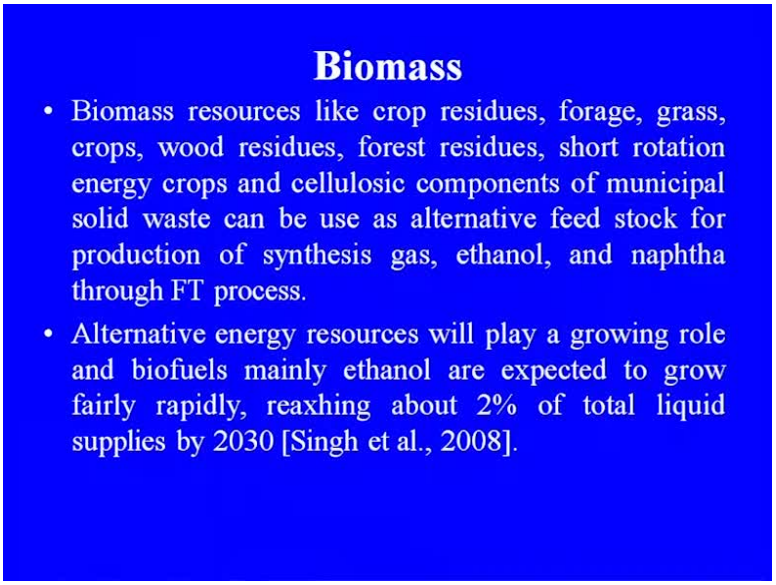

In view of the dwindling fossil fuel sources and increasing cost of crude and volatile market oil, there is a tremendous activity, all over the world to utilize the alternative feedstock. And some of the alternative feedstock already I have discussed earlier that is the bio mass algae, coal, petrocoke, waste plastic. Because, pyrolysis of the plastic some

of the units are now working for the recovery of the maneuver from the waste plastic and that can be also used for the production synthesis gas olefin and other products.

Bio mass again I have already discussed about the importance of the biomass, because of huge availability from the agriculture, from the forest residue, there is a lot of scope for using the bio mass. As energy resource through the gasification, for the production of the oil, through the pyrolysis first pyrolysis or through the synthesis or through the ethanol route for the manufacture of large number of the petrochemical, or the chemical not the petrochemical because, as always we are using the term petrochemical. But the some of the chemicals, which are derived from the petroleum route.

Alternative resources will play a growing role and biofuels mainly ethanol are the expected to grow fairly rapidly. Because, using the biofuels ethanol and the biodiesel they are they are the alternative source of energy also they are being used. And so, the lot of scope is there in case of utilization of these resources. Again the same the biomass conversion of the route for the biomass to heat and power transport fuels I told you. It may be fast pyrolysis, it may be the gasification various routes are available.

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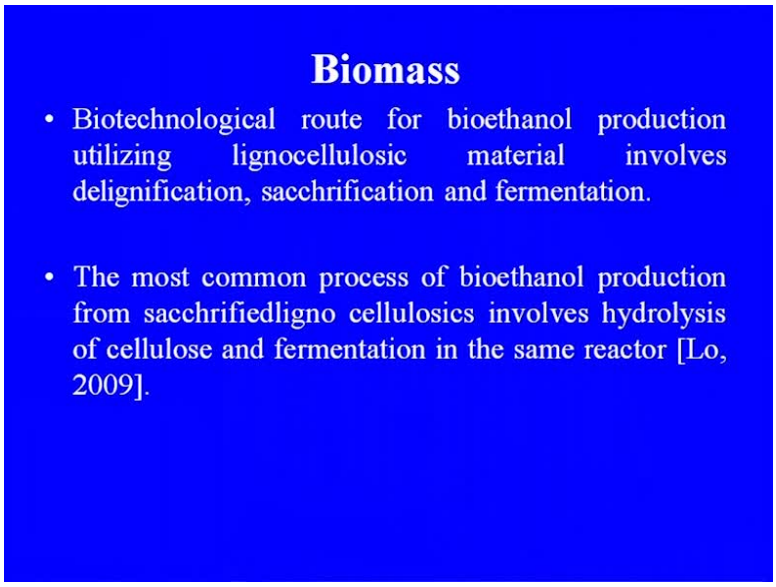

Bio technological route for bioethanol production utilizing lignocellulosic material involves delignification. Because, this is the one of the problem pre treatment that is required in case of the bio mass the sacchrification and the fermentation. So,

delignification was very important and that is raising the cost of the alcohol production and even the lignin, which is present that make a pro problem in the fermentation.

The most common process for bioethanol production from sacchrification of the ligining, cellulosics involves hydrolysis of cellulose. Because, the sacchrin that you are after removal of the lignin, we are going further hydrolysis of cellulose and the fermentation of in the same reactor. Then the simultaneous hydrolysis and fermentation that is taking place and rest of the process that is the rectification other thing that is same as we are doing in case of the alcohol. Only thing here the same type of the distillation come that will be used.

Option for the conversion of biomass to fuel and power and chemical feedstock that is in figure you can see here that figure is discussed when in the ethanol part when we will be discussing in detail about the ethanol as the chemical feedstock. In the module 3 of sugar and not module 3, but module 5, this sugar and ethanol industries there various alternative routes are there.

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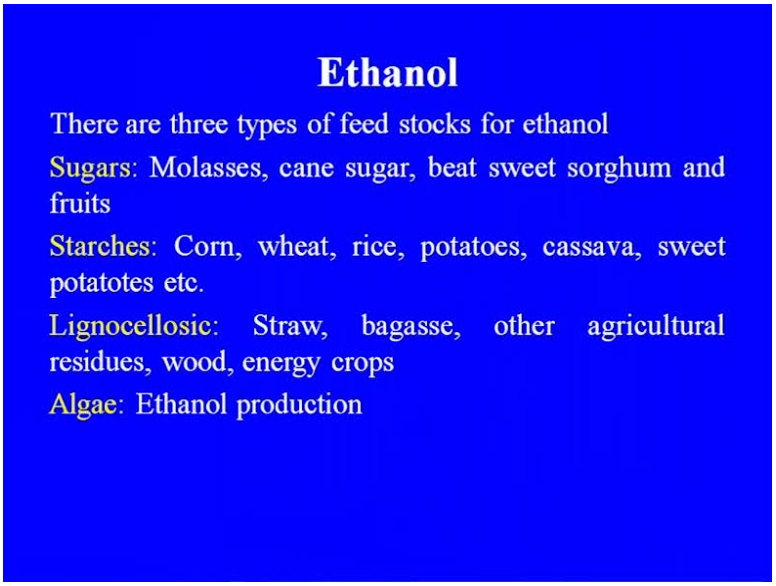

So, ethanol; there are three types of feedstock for ethanol sugar, starches, lignocellosic and algae. So, these are the some of the raw materials that can be used, but mostly the molasses that we are using for the industrial alcohol. Again it is not only the ethanol, but biomass that can be used as a feedstock for the production of methanol and hydrogen also through the synthesis gas route, the synthesis gas from the gasification of the

biomass. Ethanol from the algae that can be another as I told you earlier also we are working when the reliance is also working, IIT Dehradun they have work for production of the algae from the ethanol only thing the commercial application commercialization of this process is yet to be done.

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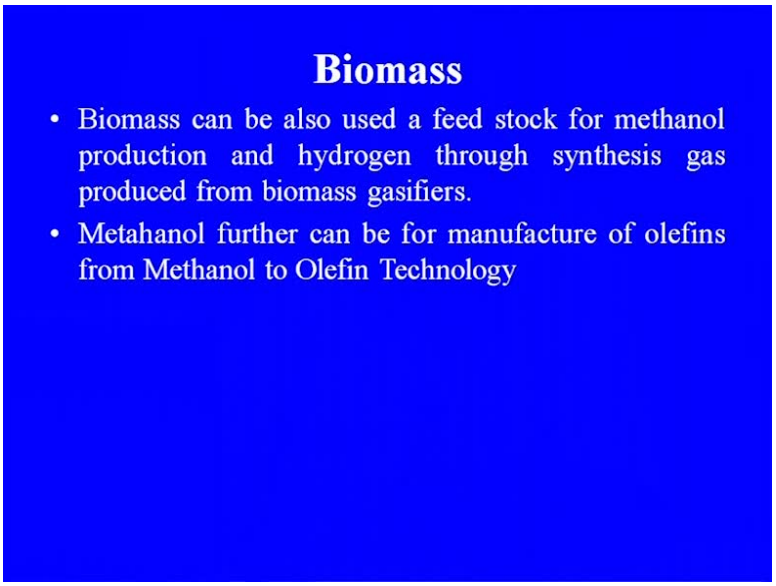

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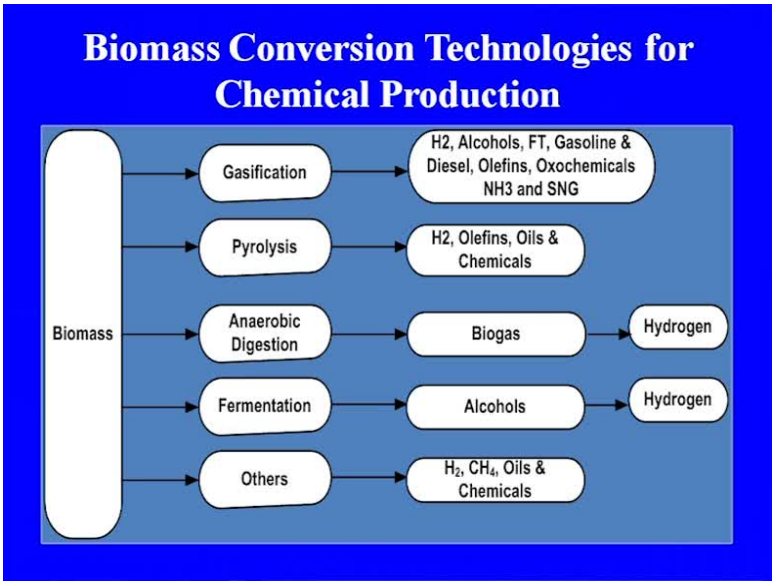

This is process which I was discussing about the biomass various routes are available gasification, pyrolysis, anaerobic digestion, fermentation, other process. And so, these are the some of the final product that you are getting from the your bio mass.

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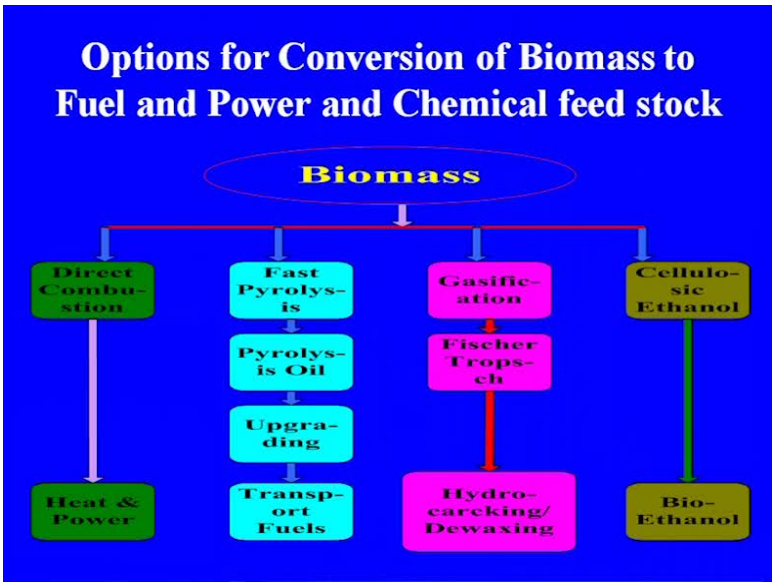

This is the process option for conversion of biomass to fuel and power and chemical route. So, as I was saying direct your combustion, fast pyrolysis, gasification or through hydrolysis route. So, you can produce either it can be used as energy or it can be used for the production of the chemical.

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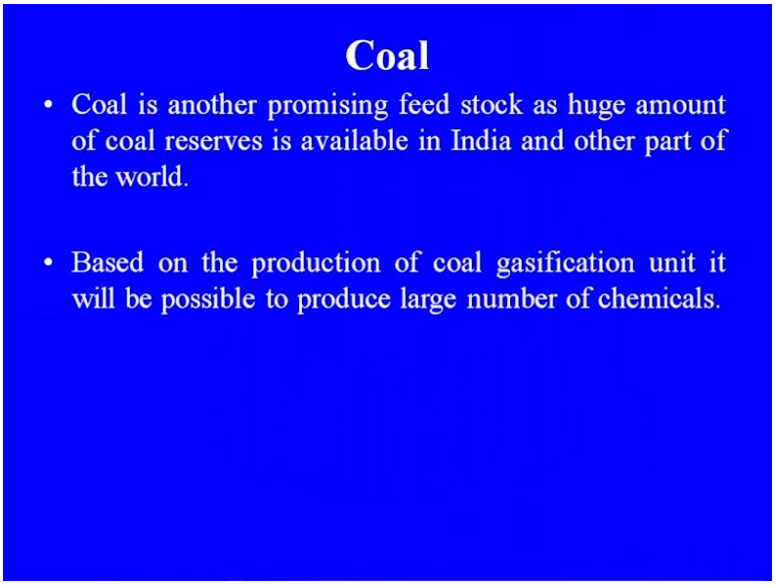

Coal again it is a promising feed stock as huge amount of the coal reserves available in India and other part of the world. And already china they are started one plant coal to olefin that has been started, commercial production that has been started, because the

availability of the coal is there. Based on the production of the coal gasification it is it will be possible to produce large number of the chemicals from the coal.

One constraint in Indian coal that is the highest constraint, but in case of the China that advantage there they are having the low as content and high carbon content of coal. So, that is most suitable for the gasification. Gasification of the production of the coal, but one route is already available that is the when we are making the coal, but only thing yield of the chemicals that is much less than the other person.

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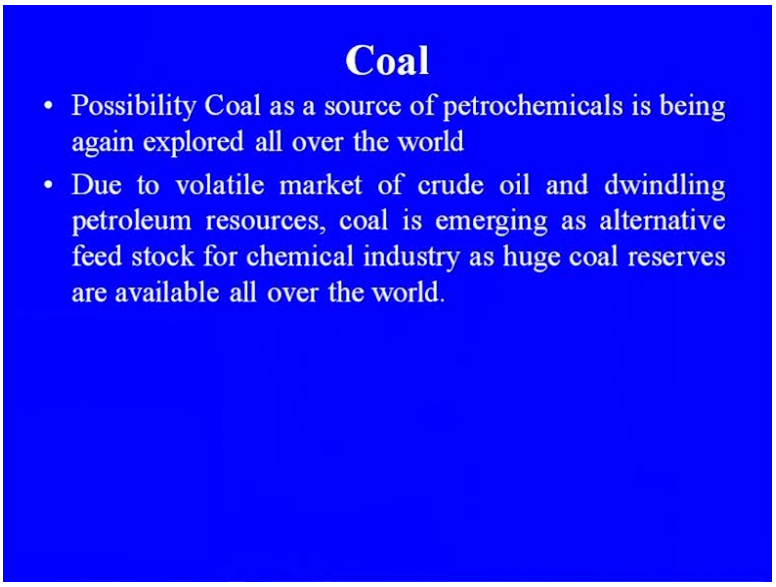

As I told you the again we are working in the allover the because this work for the utilization of the coal as a source of petrochemical work is started in the 1929 in 30. And again people are exploring just to utilize this coal as raw material. Due to the volatile market of the coal dwindling petroleum resources, coal is emerging as alternative feed stock for chemical industry as huge coal reserves are available all over the world.

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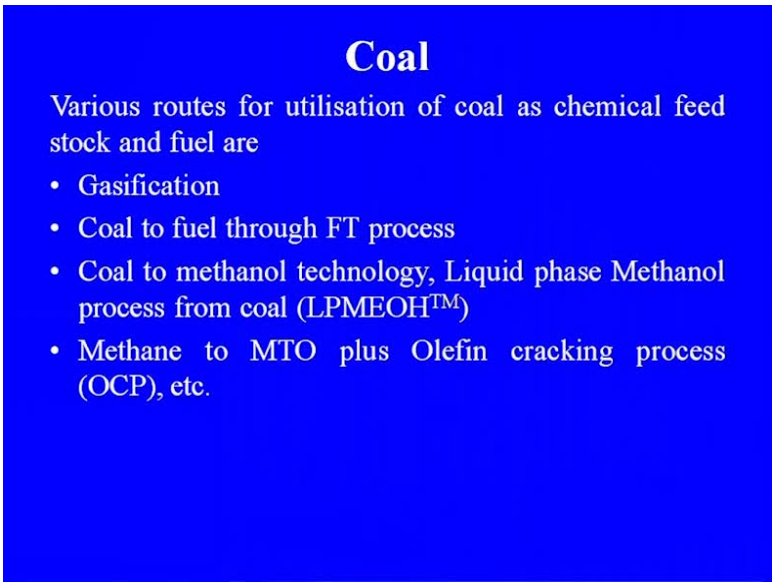

These are the some of the processes that can be used for the production of the various intermediate, which can be used for production of the finished product. Gasification, coal to fuel through FT process, fisher top process, coal to methanol technology, liquid phase methanol process from coal, these are the some of the new technology that is available. Now, methane to MTO and MTO plus olefin cracking process, these are the some of the another upcoming that can be used when the coal is feedstock.

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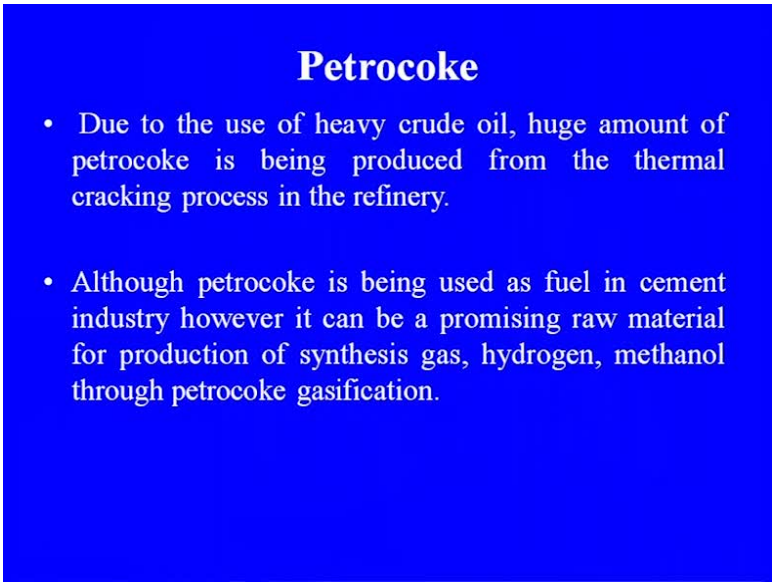

Again I have already discussed about the petrocoke because petrocoke that is available from the refinery. And its amount is increasing because of the use of more and more heavier crude oil. So, this petro coke that can be a good raw material for the gasification, for the production of synthesis gas, for the production of the hydrogen and that can be used in the refinery.

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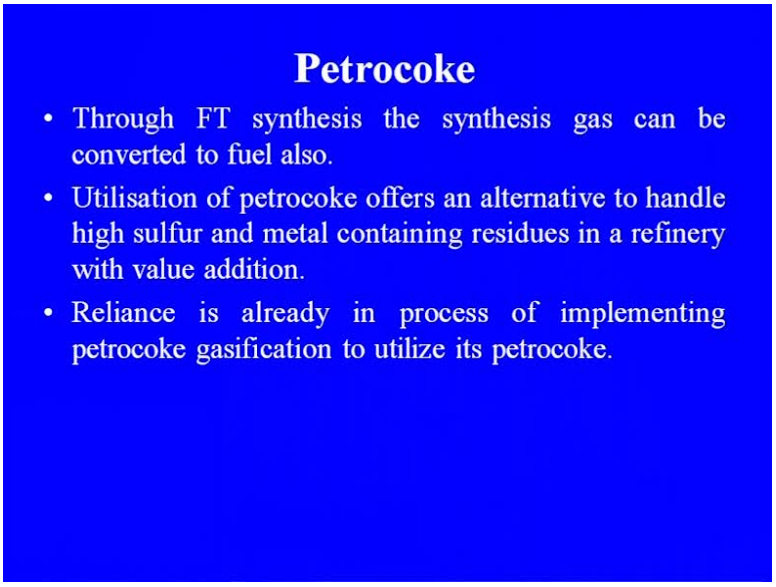

And the petrocoke that can be through the fisher top synthesis that can be also converted if your… utilization of the petrocoke offers an alternative to handle high sulfur. Because, you see the heavier coal means higher sulfur and the metal contain that will also high, in a refinery with a value addition. So, that is the why the people even reliance there is going for the petrocoke gasification, reliance already in process of implementing petrocoke gasification to utilize its petrocoke.

These are the some of the references that you can go through the…

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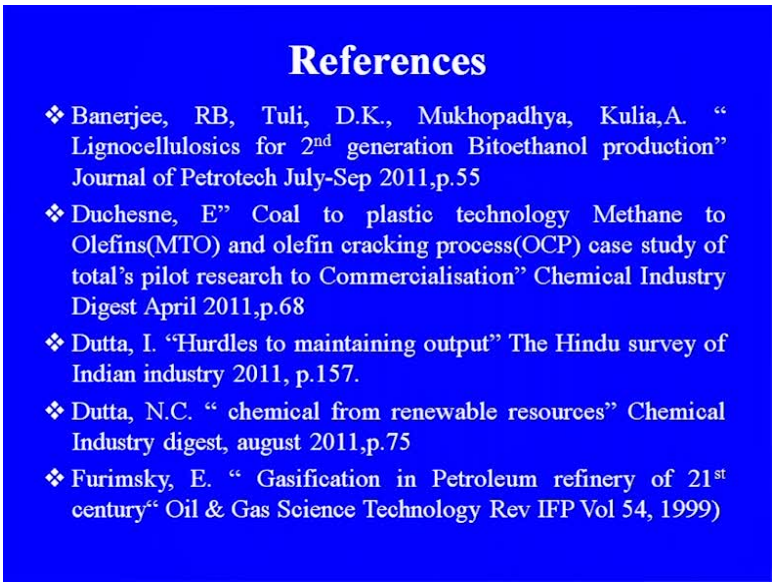

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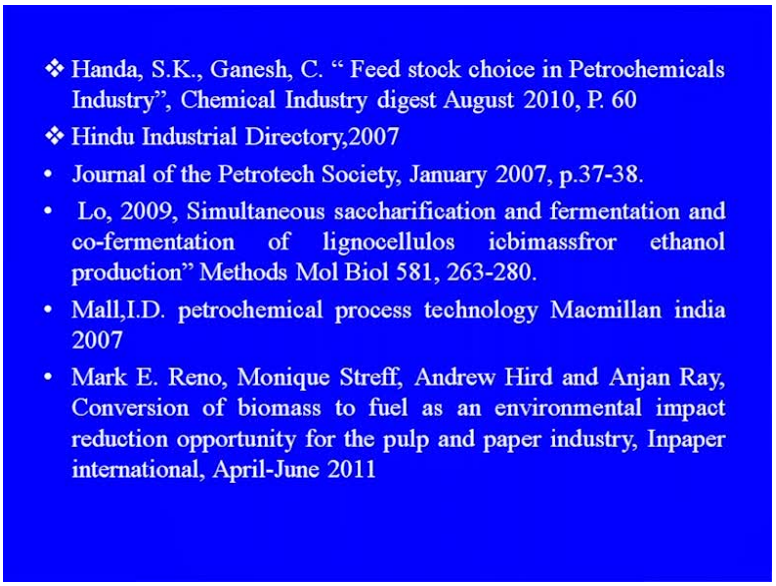

The next lecture will be discussing about the various unit processes (( )) operation and what are the chemical technological development? Which has lead to the development of the evolution of the chemical industry? There has been a sheer change in the process technology and the separation processes, which was being used in the early or in the 19 th century and now, in the 21 century. So, even in the separation process there have been lot of changes. So, we will be discussing in the third lecture about the various unit process unit operation. And that was also the how the development in the chemical engineering curriculum took place and the how the chemical engineering was evolved in

the industry. Because, it was the chemistry to industrial chemistry, industrial chemistry to chemical technology and from chemical technology to chemical engineering.

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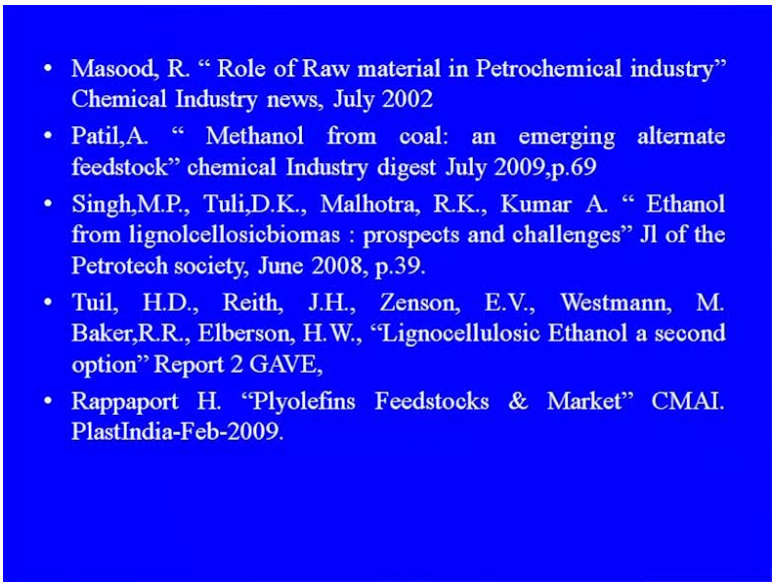

This was the big role of the chemical engineer and because of their contribution there has been lot of the changes in the process condition, purification processes, quality of the product, improving the economy of the process, through energy conservation measures. That has been incorporated in the development of the various processes, low capacity plants to high capacity plant that has been done. So, this is the will be discussing in the third lecture.