Chemical Technology
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Module - 2
Coal Chemical
Lecture - 2
Coal Carbonization and Coke Oven plant

In module 2 lecture 1, we discussed about the coal, and coal as a chemical feed stock and what are the various technology available for the production of the chemical from the coal? In the lecture 2, we will be discussing about the coal carbonization, the process that has been used in coke oven plant and the in detail about the coke oven plant. How the coke is produced, what are the various chemicals we are recovering. We will start with the introduction part first before a starting about the coke oven plant.

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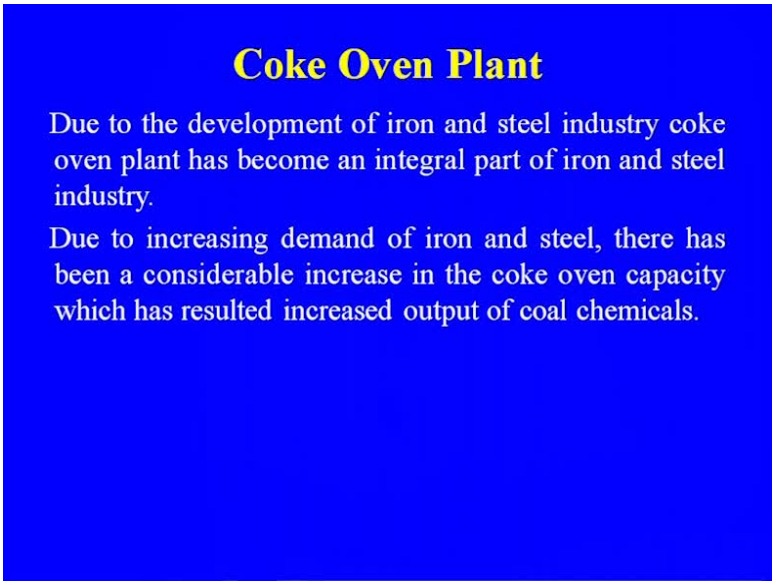

Due to the development of iron and steel, iron and steel industry coke oven plant has become an integral part of iron and steel industry, because you see the huge amount of the coal in the form of the coke that we are using in the steel industry and the steel industry. As I told you in the lecture 1, that is second largest user of the coal due to the increasing demand of the iron and steel. There has been a considerable increase in the coke oven capacity, which resulted increased output of the coal chemicals through the coke oven plant.

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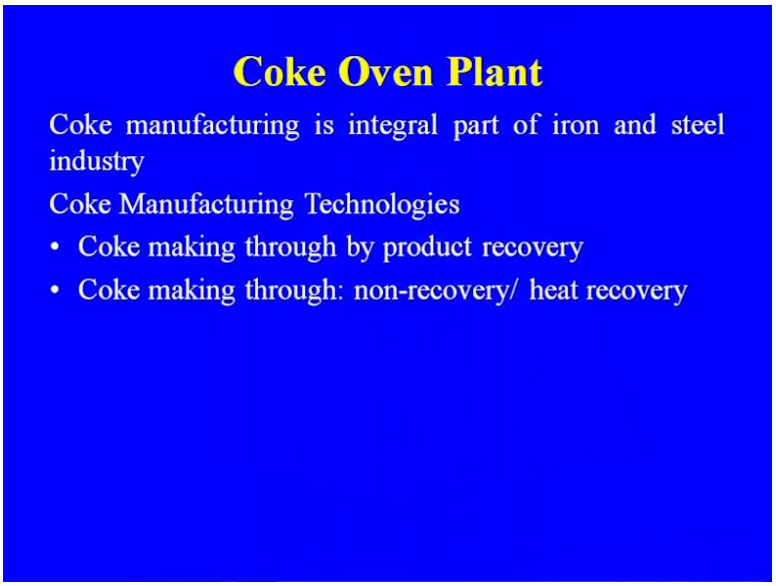

Coal manufacturing technology, cola making through by product recovery, coke making through non recovery and heat recovery.

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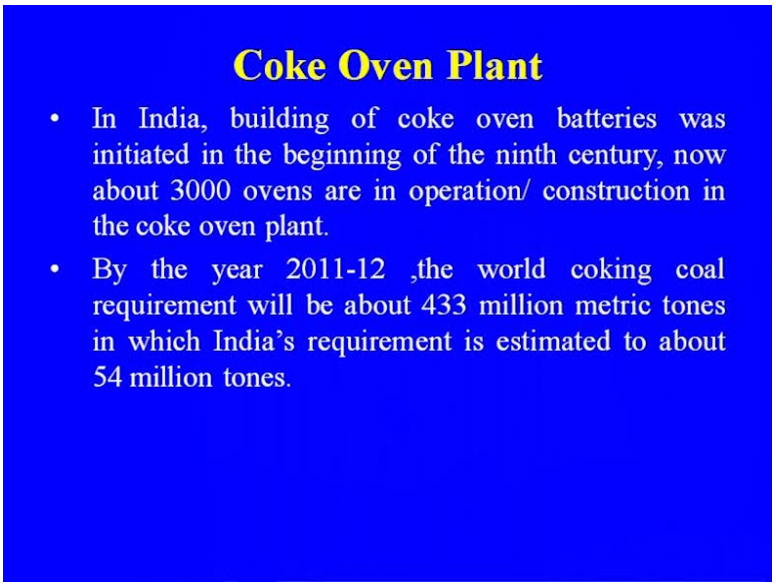

In India building block building of coke oven batteries was initiated in the beginning of the 19 th century. Now, about three thousand ovens are in operation construction in the coke oven plant. By the 2011 - 12 the world coking coal requirement will be about 433 million metric tons, in which India's requirement is estimated to about 54 million tons.

This is the huge amount of the coke that is being required, because you see the iron and steel steel industry, they are developing the congestion of the coke that is increasing.

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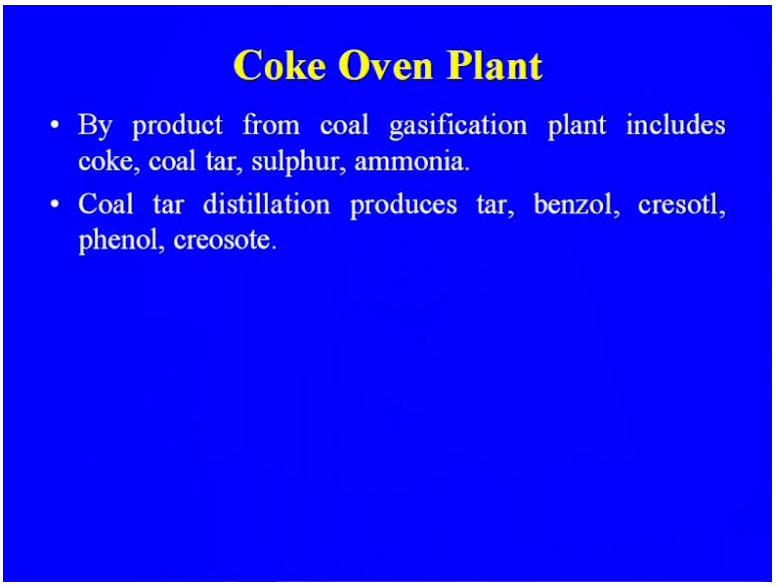

By product from the coal gasification plant includes coke, coal, tar, sulphur, ammonia. Coke is the major product, but coal tar sulphur and ammonia. These are the by products from the coke oven plant, coal tar distillation which is also very important part of the coke oven plant produces tar, benzol, cresotl, phenol and creosote.

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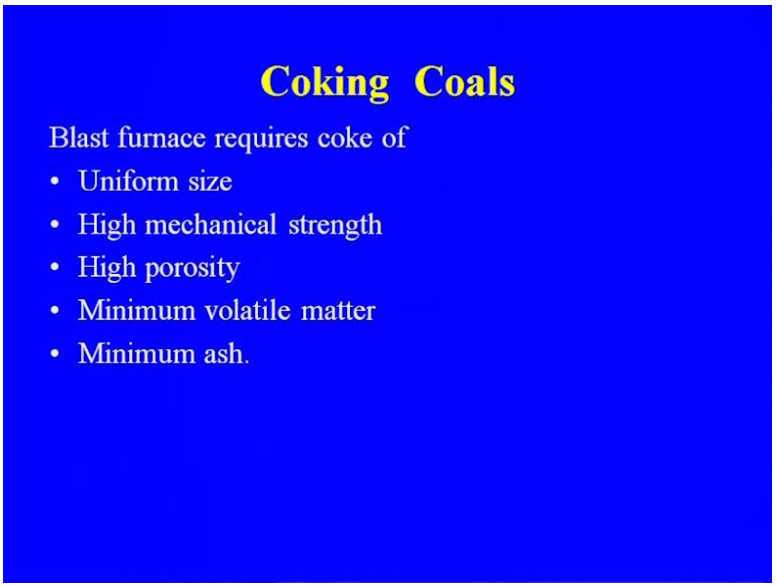

Blast furnace require coke of uniform size high mechanical strength and porosity with minimum volatile matter and minimum ash. This is the requirement and this is the why there is differentiation in the metallurgical grade coal and non-metallurgical grade coal.

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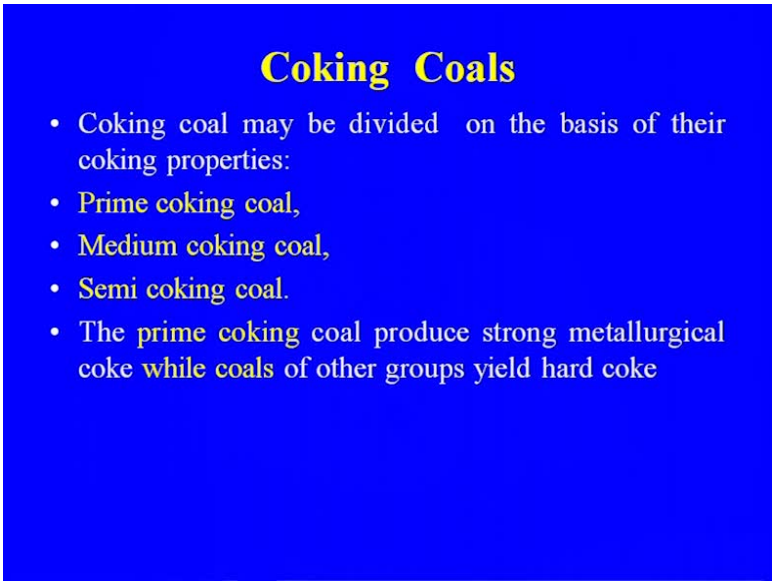

Cooking coal may be divided on the basis of their coking properties; prime coking coal, medium coking coal and semi coking coal. The prime coking coal produce strong metallurgical coke, while coals of other group yield hard coke.

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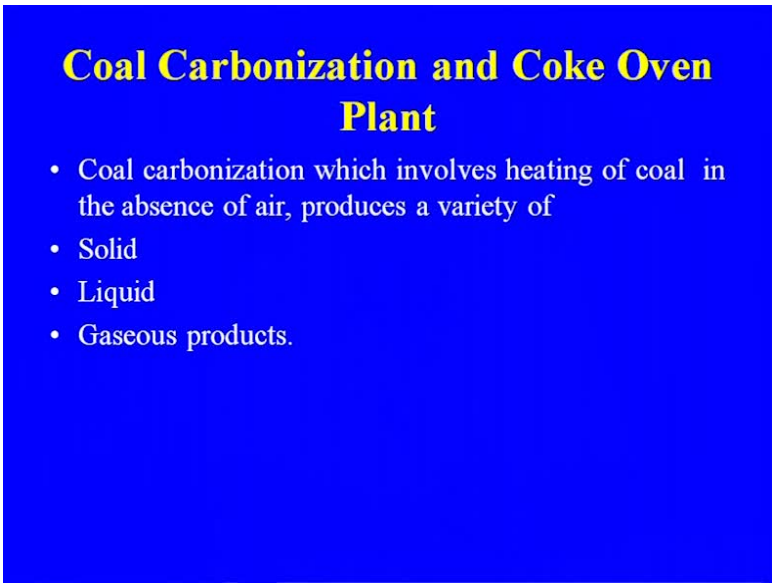

So, our requirement in case of the medical metallurgical industry is the coking prime cooking coal, coal carbonization and the coke oven plant coal carbonization, which involves heating in the absence of air because this is process of the carbonization. That itself we define as the when any substance is heated in absence of air.

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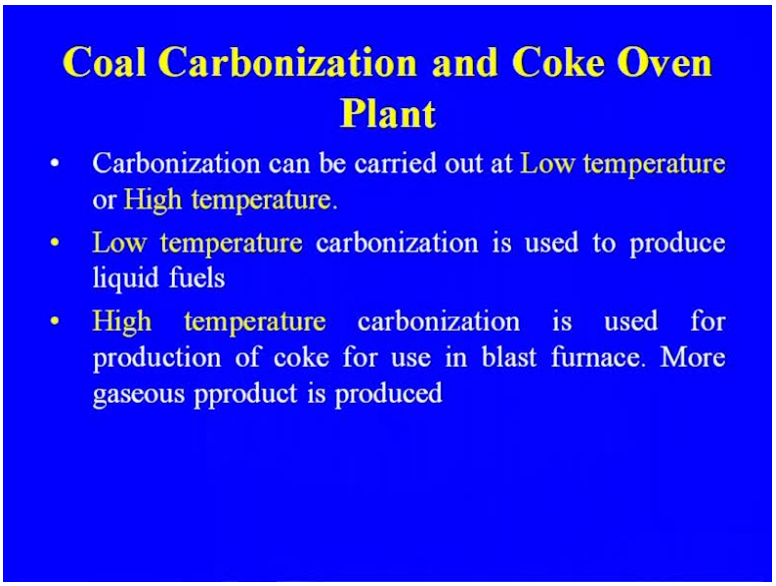

So in case of the coal carbonization, which involves heating in the absence of air produces a variety of solid liquids and gaseous products and these products are very important form the chemical point of view. Carbonization can be carried out at low temperature or the high temperature and depending upon the type of the carbonization. The temperature, the yield of the product that vary low temperature carbonization is used to produce liquid fuel, whereas the high temperature carbonization is used to produce gaseous product.

Various products from the coal carbonization in addition to coke are light aromatics that is the Benzene, Toluene, Xylenes these are the earlier source of the aromatics before coming of the petroleum refinery. Now, we are making the aerometrics from the catalytic reforming process tar as a, tar basis r p.

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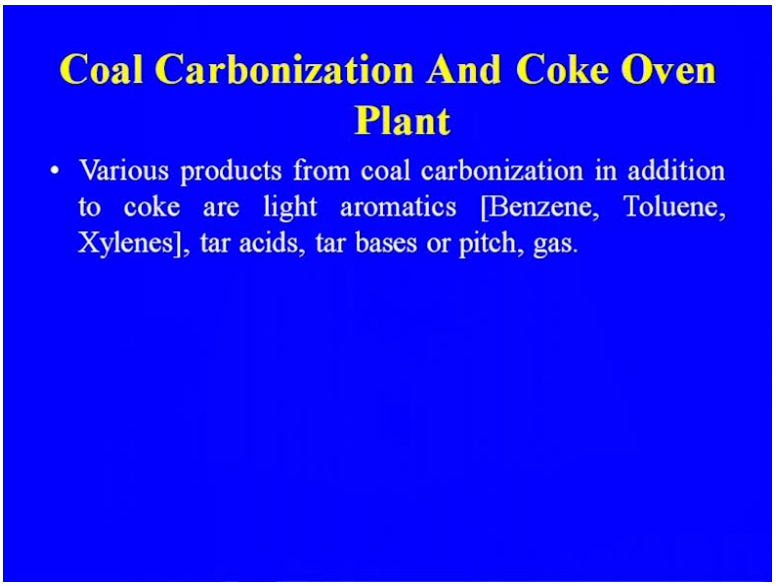

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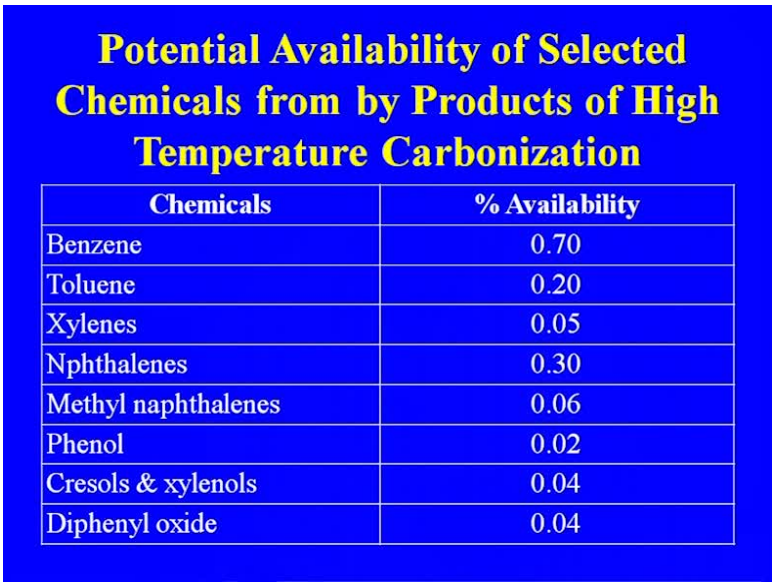

This is the actually the potential ability of the selected chemicals from by products of high temperature carbonization, where you are finding the various aerometrics benzene, toluene, xylenes, naphthalene, methyl, naphthalene's, phenol, cresol and diphenyl oxide these are present in case of the coal.

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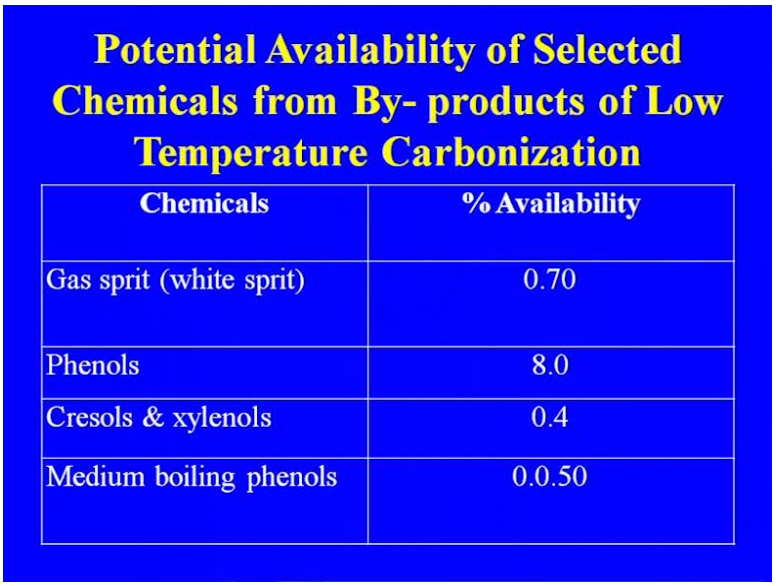

Although, the amount is less gas sprit or the white sprit phenols cresols and xylenols medium boiling phenols coke oven batteries. Now, we will discuss about the coke oven batteries and what are the process involved in case of the coke oven plant. Coke oven are the used to convert coal into coke by carbonization of the coal in absence of air and there by distilling the volatile matter out of the coal coke is taken as product, which is used as a fuel and as a reducing agent in smelting iron ore.

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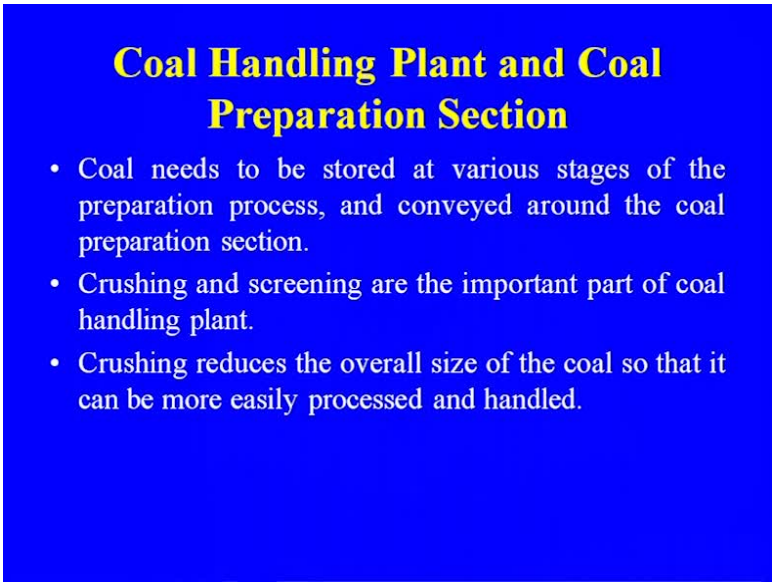

In a blast furnace and coke oven gas as by product is treated for recovery of the coal chemicals the coke oven temperature is kept as high as 2000 degree centigrade. Crushing and screening of the coke is done to obtain the suitable size of the coke for use in the blast furnace.Coal needs to be stored at various stages of the preparation process and conveyed around the coal preparation section. Crushing and screening are the important part of coal handling plant. Crushing reduces the overall size of the coal, so that it can be more easily processed and handled during the carbonation process.

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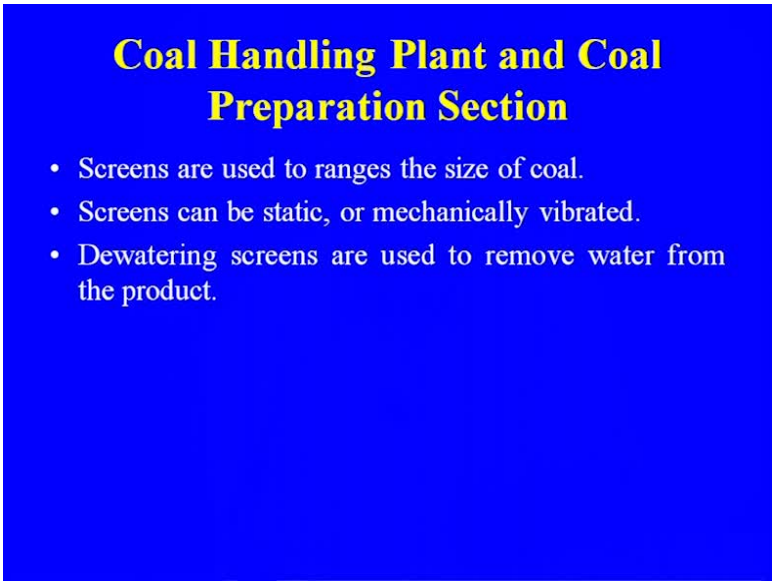

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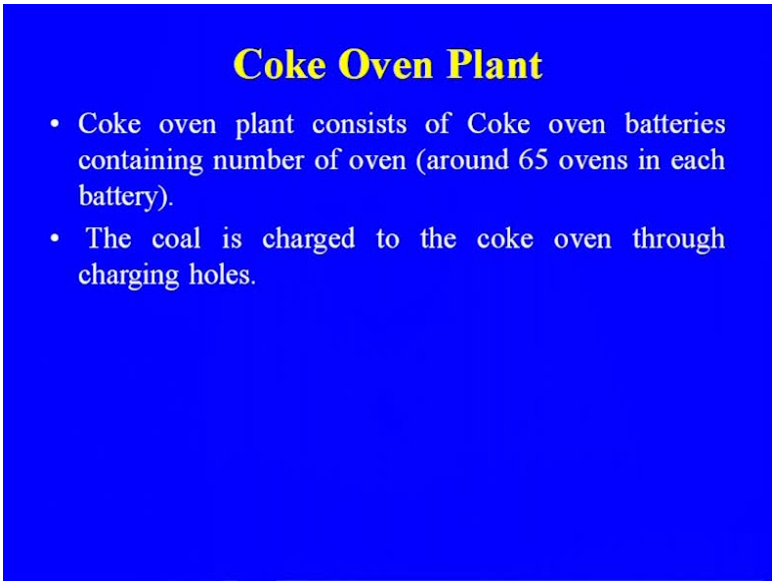

Screens are used to ranges the size of coal screens can be static or mechanically vibrated, dewatering screens are used to remove the water from the product. Coke oven plant consist of the coke oven batteries, containing number of ovens around 65 ovens in each battery.

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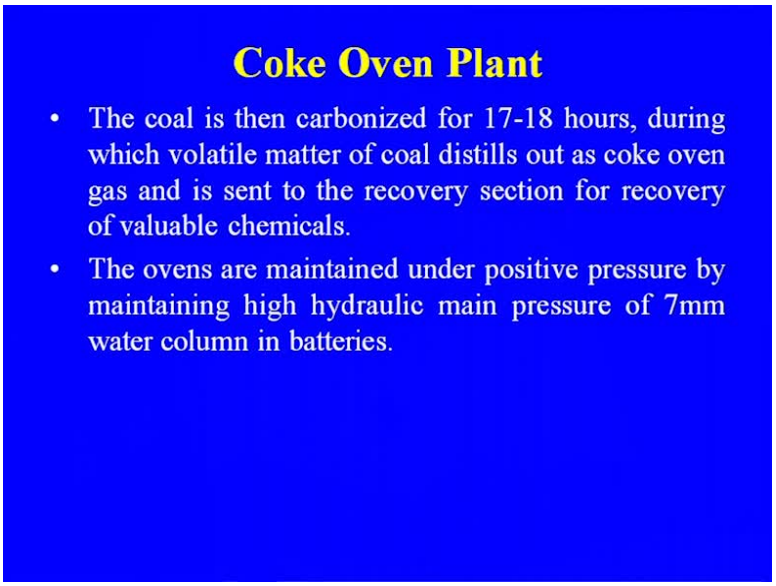

The coal is charged with the coke oven through the charging holes. The coal is then carbonized for 17 to 18 hours, during which volatile matter of coal distill out as a coke oven gas and is sent to the recovery section for recovery of the valuable chemicals.. The ovens are maintained under positive pressure by maintaining high hydraulic main pressure of seven milli meter water column in the batteries.

The coking is complete when this central temperature in the oven is around 950 to 100 degree centigrade. At this point the oven is isolated from the hydraulic, from hydraulic. Means and after proper vending of the gases the doors are open for coke pushing. At the end of the coking period the coke mass has a high volume shrinkage, which leads to the detachment of the mass from the walls ensuring easy pushing. The coke is then quenched and transferred to the coke plant. This in brief about the various stages that is involve in making of the coal.

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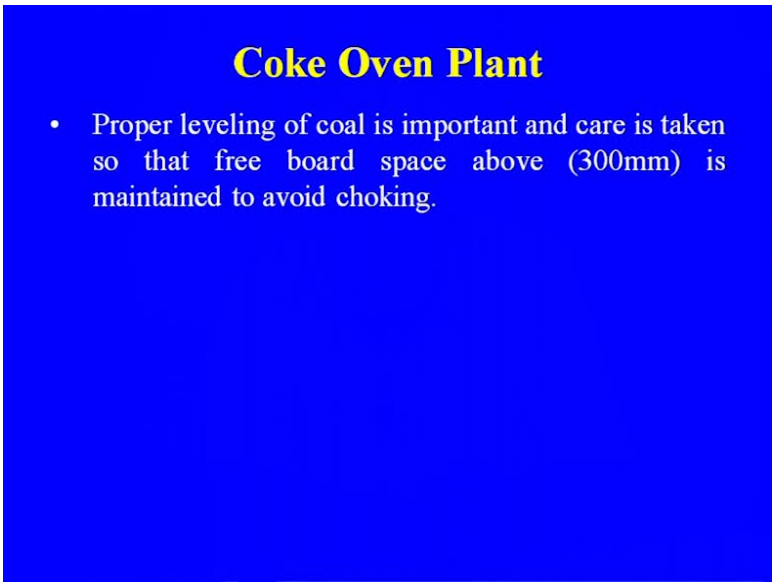

Some of the operating parameters are very important the control of the oven pressure is quite important because of the lower pressure leads to air entry, while the higher pressure leads to excessive gassing, leakage of the door stand pipe etcetera. Proper levelling of the coal is important and care is taken, so that the free board space is maintained to avoid choking coke oven plants are integral part of the steel plant to produce coke, which is used as a fuel in the blast furnace coke oven plant. What it says, some of the by products. Already we have discussed these products, these are the various section in case of a coke oven plant.

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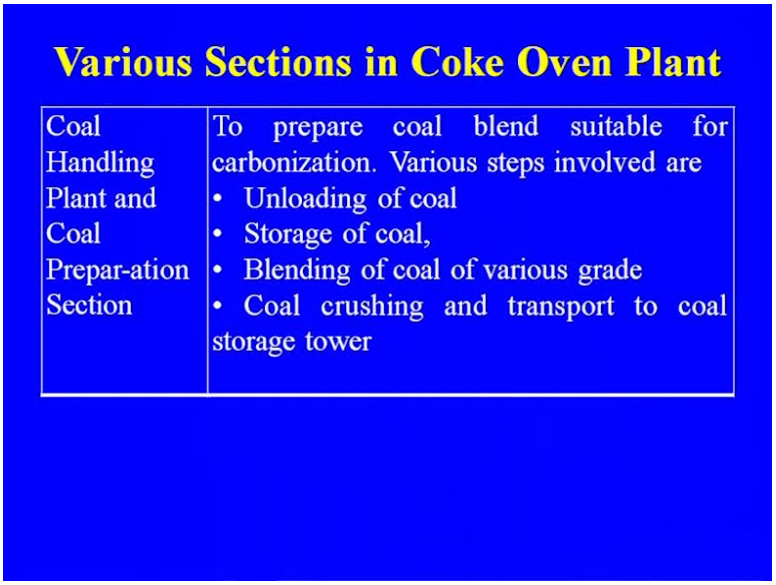

That is the first as I told you earlier, the coal handling part and the coal preparation plant. To prepare coal blend suitable for carbonization various steps involved are unloading and storage of the coal, blending of the coal of the various grade, coal crushing and transport to the coal, storage tower partial briquetting to prepare briquette of coal to charge along with the coal into the coke oven.

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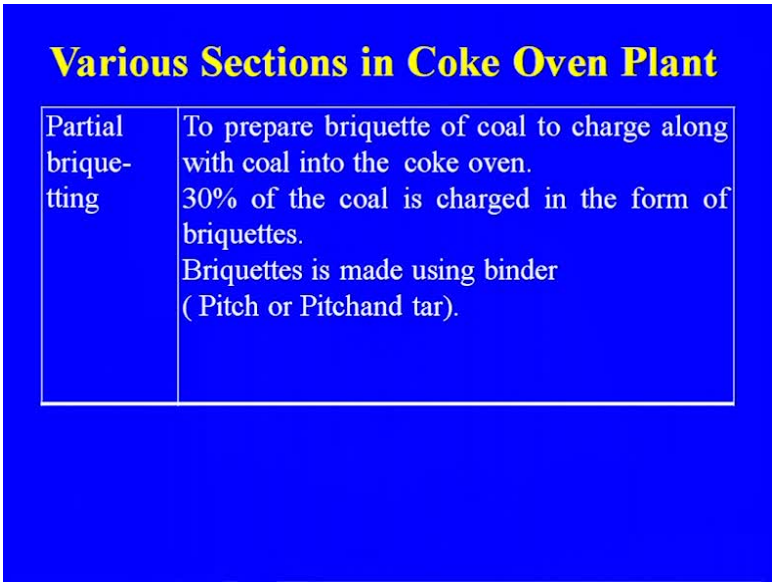

Coke oven batteries to convert coal into coke by carbonizing coal in absence of air, the process steps involved are coal charging and coal carbonization.

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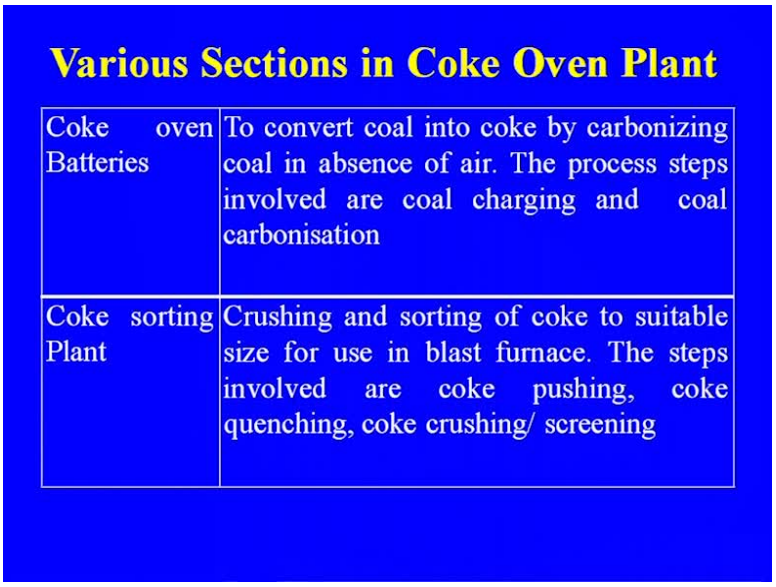

Coke sorting plant crushing and sorting of coke to suitable sizes for use in the blast furnace. The steps involved are coking, coke pushing, coke quenching coke crushing and screening.

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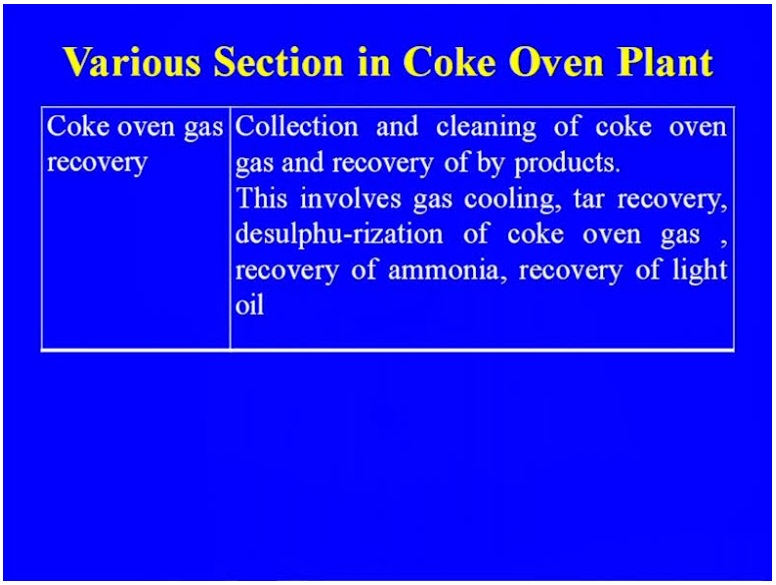

Coke oven gas recovery because this is one of the very important operation. In case of the coke oven plant collection and cleaning of the coke oven gas and recovery of the by product this involves gas cooling tar recovery Desulphurization of the coke oven gas, recovery of the ammonia recovery of the light oil ammonia recovery.

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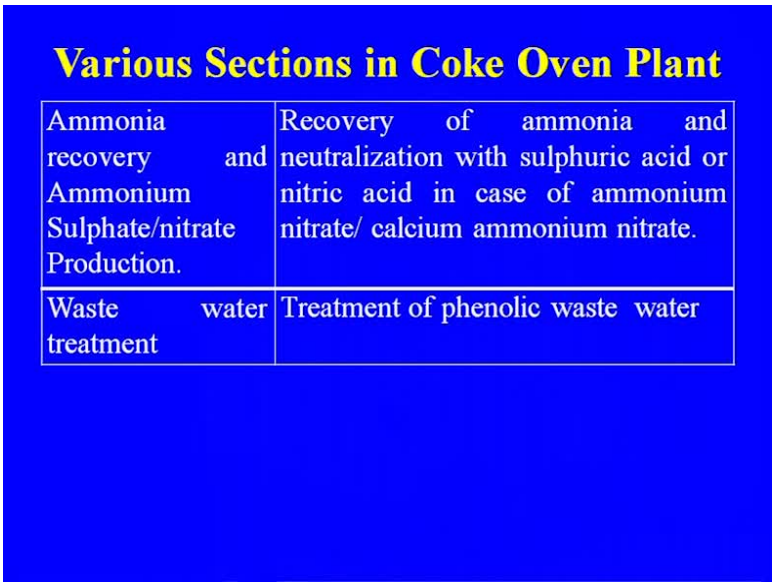

Ammonium sulphate production recover of the ammonia and neutilization with the sulphuric acid or nitric acid. In case of the ammonium nitrate or calcium ammonium nitrate because in earlier we are making in this steel plant ammonium nitrate and that was again, it was they started making calcium ammonium nitrate. As you know the ammonium nitrate that is also one of the explosive, but ammonium sulphate in steel plant we are making ammonium sulphate and the and the all the steel plant they are having the ammonium sulphate or the ammonium nitrate plant.

Waste water treatment that is the treatment of the phenolic waste, because the coke oven plant is one of the major source of the phenols and the treatment of the waste water from the coke oven plant. That is very important partial briquetting of low grade coal are prepared using a binder up to 2 to 3 present of the charge. This partial briquetting of the coal is charged with the coal into coke oven with second briquetting improve the quality of the coke.

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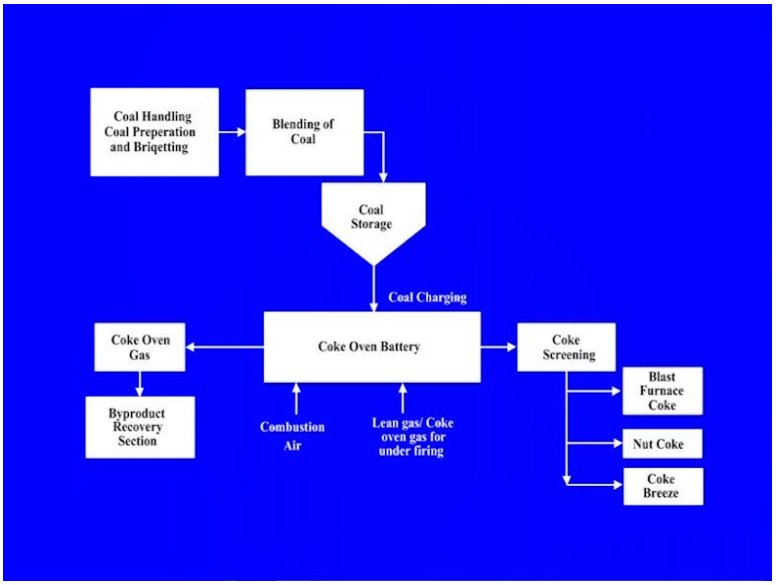

This is the various steps that is involved coal handling, coal preparation, briquetting, bending of the coal, coal storage and from the coal storage it is going to the coke oven batteries. Coke oven batteries, one of the requirement in case of the coke oven plant that is the here and so here that is going to the coke oven battery, coke screening, blast furnace, nut coke or the coke breeze. These are the some of the different quality of the coke that you are getting from the coke oven plant.

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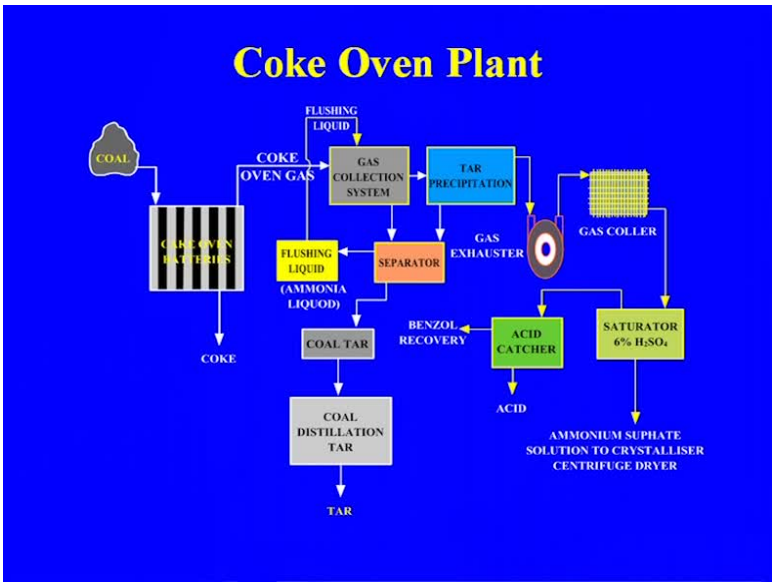

This is the flow diagram of a difficult coke oven plant at the coal after various that is the free treatment and after briquetting and all those thing that is going to the coke oven batteries and from the coke oven batteries the coke oven gas that is going for the further processing. Coke that is going to the pure for the blast furnace and then the coke oven gas it is going to the gas collection system, gas collection separation of the flushing liquids, and then is the flushing liquid here actually the ammonia liquid that we are using as a flushing liquid and separation.

Then we are going to the coal we are getting coal tar. This coal tar going to the coal distillation product plant, the after the coal tar distillation we are getting a number of the aromatic compounds, the gas that is going to the acid catcher, saturator where we are using sulphuric acid. In case of the ammonium nitrate, that may be the nitric acid. The crushing coke oven battery in oven heating coke oven gas by products phase gases and this is the screen and then you are getting different already we have discussed this flow diagram.

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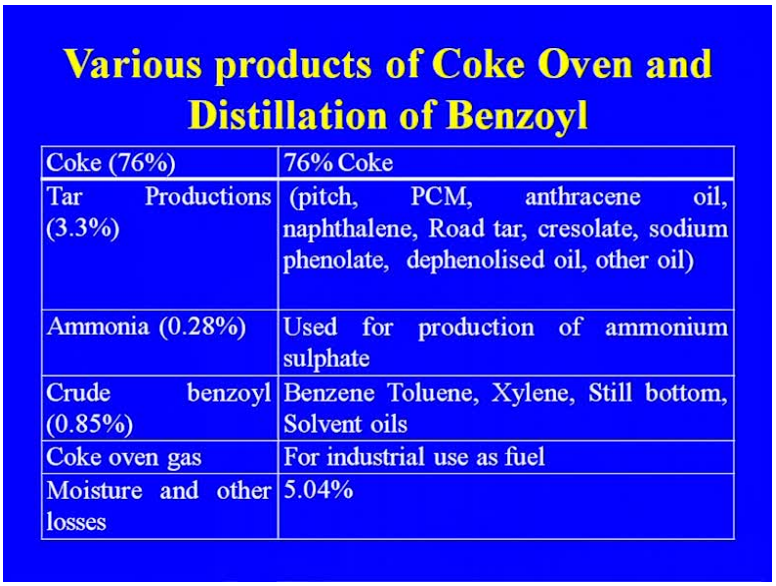

Various products from the coke oven distillation of the benzoyl, these are the products which are getting after the distillation of the benzoyl, tar products with pitch PCM anthracene, oil, napthelin, road tar, cresolate, sodium phenolate and dephenolised oil. Ammonia used for the production of ammonium sulphate, crude benzoyl, benzene toluene, xylene still bottom and the solvent oil coke oven gas for industrial is used as a fuel.

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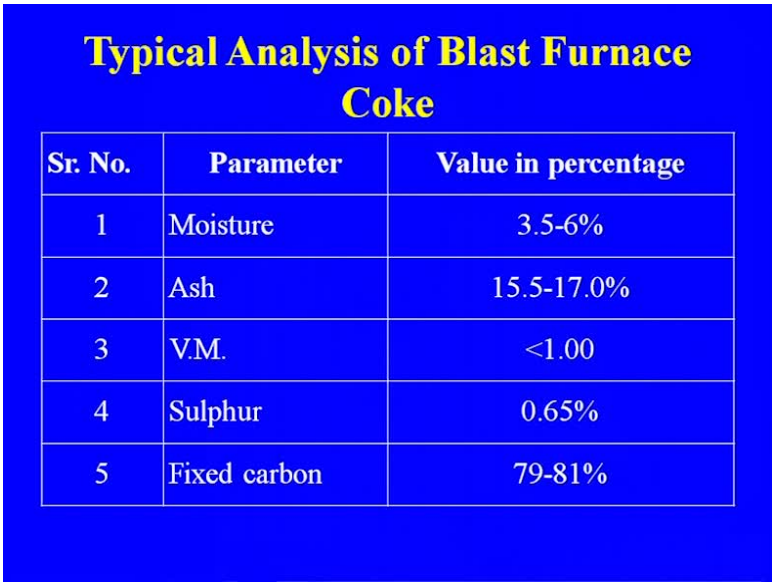

Typical analysis of the blast furnace coke, which we are getting here you see the ash is reduced 15 to 17 percent because ash is very high in case of the Indian coal and so the this is from one typical steel plant that. I have taken the data volatile matter is less than 1 sulphur 0.65 and fixed carbon is 79 to 81 percent. Coke oven gas produced during the process of coking of coal or using the coke oven plant for recovery of the various value of like tar ammonia and the benzoyl. The high temperature carbonization is used for the production of the coal for using the blast furnace various product. Already we have discussed these are the products, we are getting typical yield of the some important by product tar 3.2 percent, ammonium sulphate 1.1 percent crude benzoyl is 0.9 percent.

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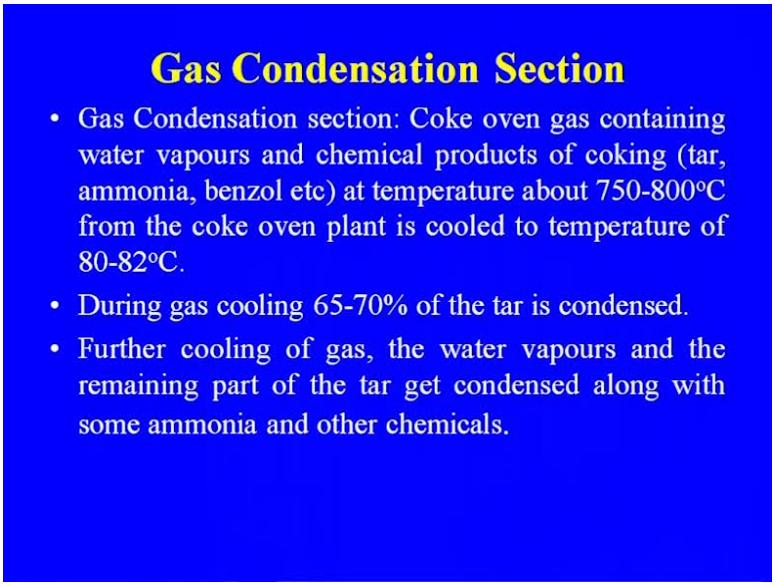

Gas condensation section coke oven gas containing water vapours and chemical products of coking, these are the products from the coke oven pant is cooled to a temperature of 80 to 82, 80 to 82 degree centigrade during gas cooling, 65 to 70 per cent of the tar is condensed. Further cooling of the gas the water vapours and the remaining part of the tar get condensed along with the some of the ammonia and other chemicals, that we discussed in the flow diagram, while discussing of the coke oven plant where the ammonia at the liquor that we are using.

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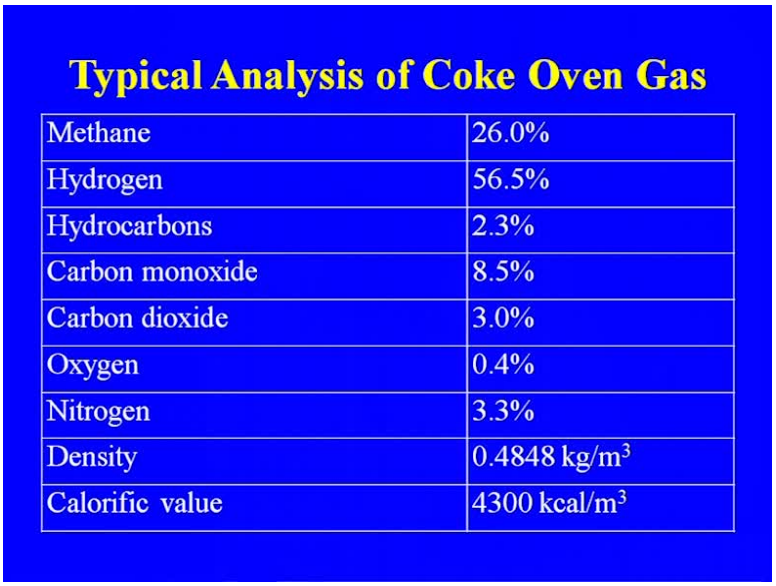

This is the typical analysis of the coke oven gas methane, hydrogen, hydrocarbons, carbon monoxide, carbon dioxide, oxygen, nitrogen, density and the calorific value this gas that can be utilized as a fuel ammonium sulphate plant. This is the actually the gases from the exhaust goes to the electro static precipitator where tar is separated and the tar free gases goes to for this making of the sulphuric acid, where they bubble through the dilute solution of the sulphuric acid.

In saturators ammonia is absorbed by sulphuric acid and ammonium sulphate is formed. If you are interested in case of the if you are interested in ammonium nitrate, then it will be nitric acid. In the saturator 1 ton of the coal yields about 0.3 tonnes of the tar and 5 to 8 gram of ammonia per cubic meter of the gas. So, ammonium nitrate can be produced by using the nitric acid. Benzoyl recovery because this is one of the very important part in case of the coke oven plant, where we are recovering the gasses from the saturator goes to the series of coolers.

Then to benzoyl scrubber where benzoyl is scrubbed with the wash oil benzoyl crude oil goes to the benzoyl recovery section where benzoyl is removed and the wash oil after treatment is sent to the scrubbers crude benzol. Thus recovered goes to the benzoyl rectification plant light crude benzol contains low boiling sulphur component BTX solvent and still bottom residue. Benzol after washing and neutralizing with caustic soda is sent to the benzol column for fractionating into different sections.

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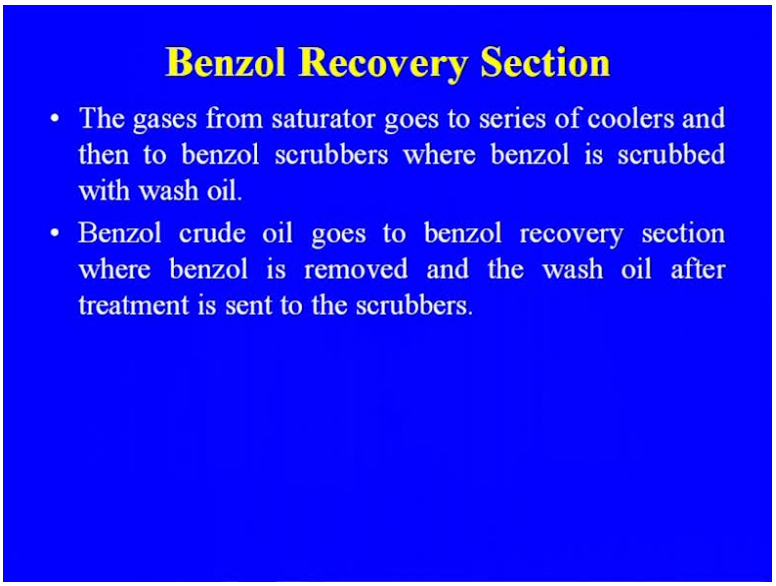

Various product from the coke oven and distillation of the benzol, this is the coke which you are getting of course, from the tar then the ammonia crude benzoyl that is about 0.85 percent that the benzoyl, toluene, zylene in steel bottom solvent that 0.85 percent. But you see the amount of the whole that we are using for the coking that is huge. So this percentage that is actually you are seeing less. But that we are using this the amount total amount that is used coke oven gas for industrial used as a fuel.

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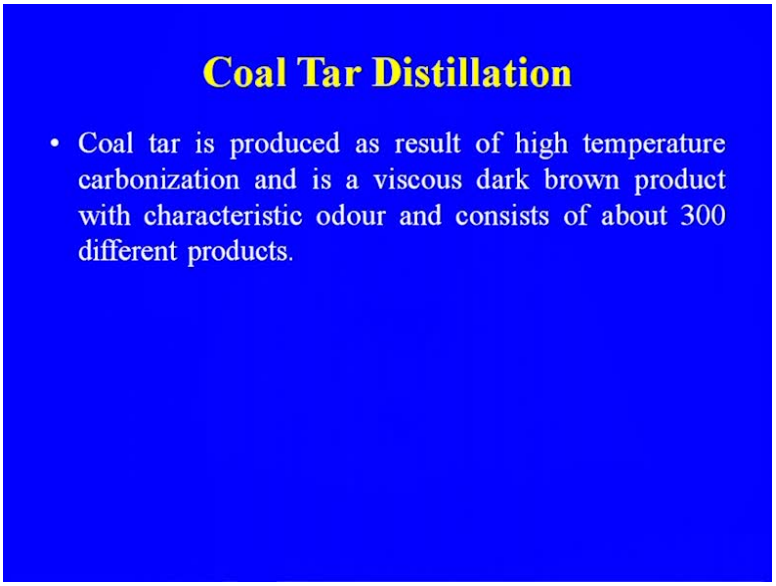

This is the moisture contained coal tar distillation as I told you the coal tar after separating from the coke oven gas the coal tar is produced as a result of high temperature carbonization and is viscous dark brown product with characteristic odour and consists of about 300 different products and that is why the importance of the coal tar distillation.

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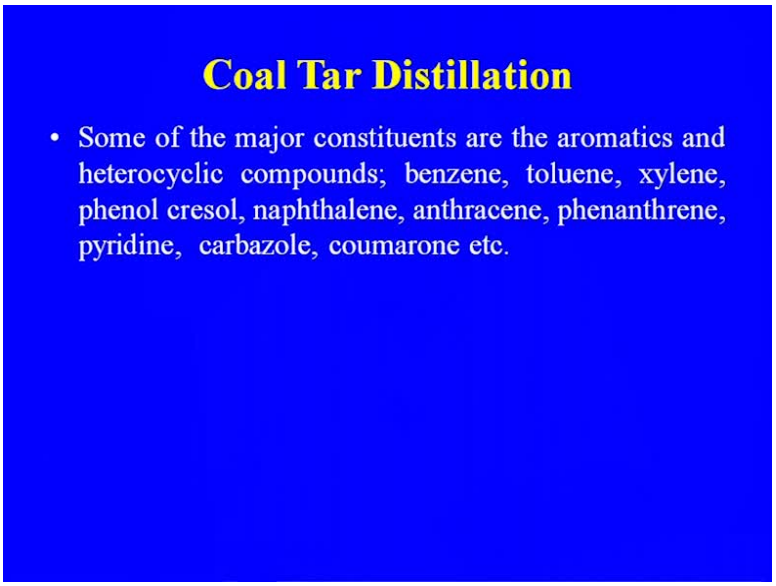

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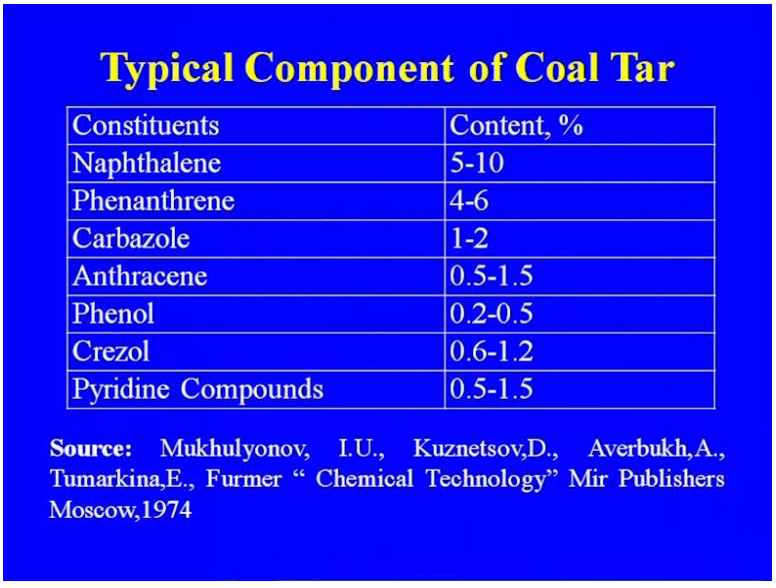

Some of the major constituents are aromatic heterocyclic compounds, benzene, toluene, xylene and the light aromatic cresol, naphthalene, anthracene, phenanthrene, pyridine, carbazole, piculine is also there.

Typical composition of the, this is a typical composition of the coal tar, there may be variation in the various constituent varying from depending up on the coal quality and the coke oven plant, naphthalene, phenanthrene, carbazole, anthracene, phenol, cresol and the pyridine compound, this is the content of the which you are getting after the coal tar distillation.

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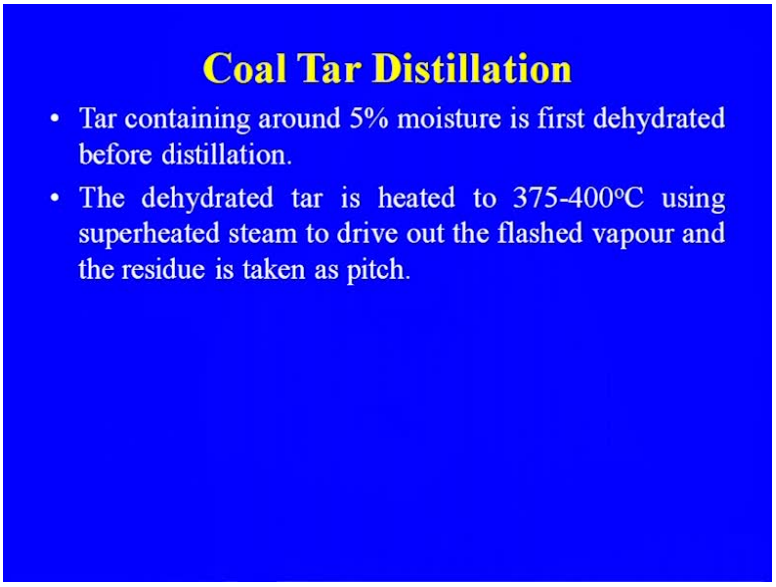

Coal tar is deduced as result of the high temperature carbonization the coal tar distillation which you are using that consists of the distillation section fractional crystallization and

washing section combustible mixture preparation section, phenol rectification section and dolomite tar preparation unit, extra hard pitch preparation. The tar containing around 5 per cent moisture is first dehydrated before distillation the dehydrated tar is heated to 375 to 400 degree centigrade using superheated steam to drive out the flashed vapour.

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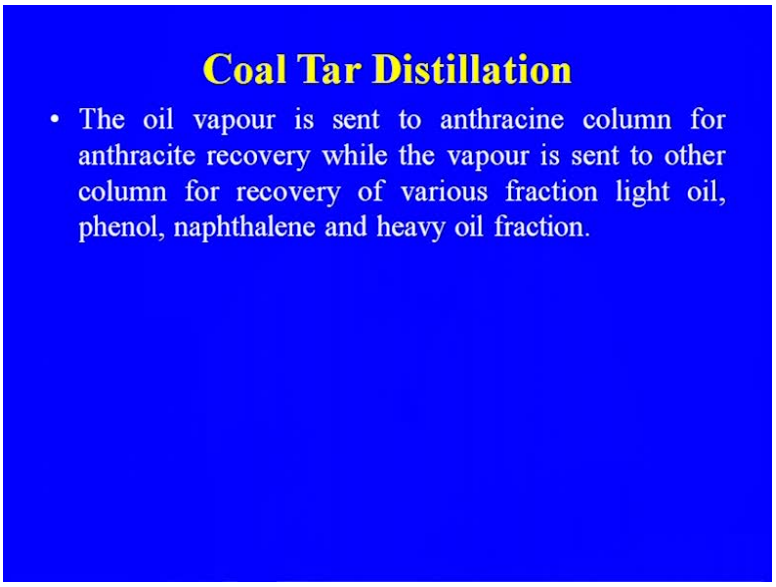

The residue is taken as pitch the oil vapour is sent to the anthracite column for anthracite recovery, while the vapour is sent to other column for recovery of the various fraction light oil phenol naphthalene, the heavy oil fraction.

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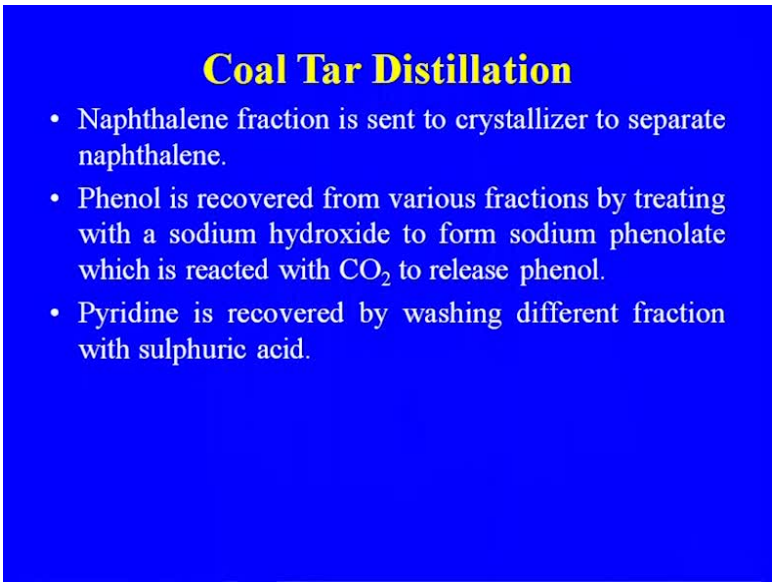

Naphthalene in fraction is sent to the crystallizer to separate naphthalene as I told you earlier also the naphthalene earlier. We are making the ethylic anhyde, which is being used as plasticizer that was the naphthalene rule, where from where we are getting the ethylic anhyde. Now, the most of the ethylic anhyde that is we are making or you can say the all the ethylic anhyde that we are making through the orthoxylene crude, because the orthoxylene that is produced in the paraxylene plant paraxylene, which is major row material of the making of the polyester.

So, wherever you are having the this your paraxylene plant, we are producing huge amount of the your orthoxylene and that is being used for the making of the (( )). Phenol is recovered from the various fraction by treating with a sodium hydroxide to form sodium phenolate, which is reacted with C O 2 to release the phenol, but a still that is as I told you that because some of the phenols remain in the water also the phenol contained in the water, that is vary again.

So, the phenol treatment of the... That is the reason, why the phenolic waste water we are producing the from the coke oven plant that has to be treated before it is being discharged to the water. Steam pyridine is recovered by washing different fraction with the sulphuric, you see that was the route for the light aromatics and the pyridine.

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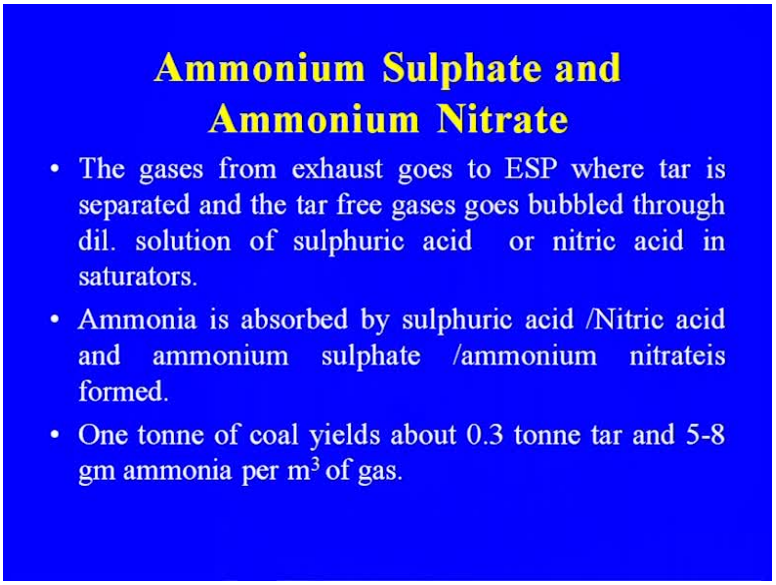

Now, we are making the pyridine from the Ethylene route and that ethylene from the ethanol to ethylene and one of the unit which making the pyridine and because you see

the pyridine is having the white scope for making the pyculine. Pyculine which is been used in manufacture of the especially in the agrichemicals and the process that is been used in case of the jubiliant organization formed that is from the ethylene route, ethylene to pyridine and pyridine to pyculine. That is the but earlier it was the only route available before coming of this processes.

So, already I discussed something about the ammonium sulphate ammonium nitrate the gases from the exhaust goes to ESP where tar is separated and the tar free gases go the dilute sulphuric acid and saturators where we are getting the ammonium sulphate. It is further crystallized dried and then it is going for the use as a fertilizer. Cleaner technology in the coke oven plant because that is in quiet concern about the environmental problem because of the coke oven plant.

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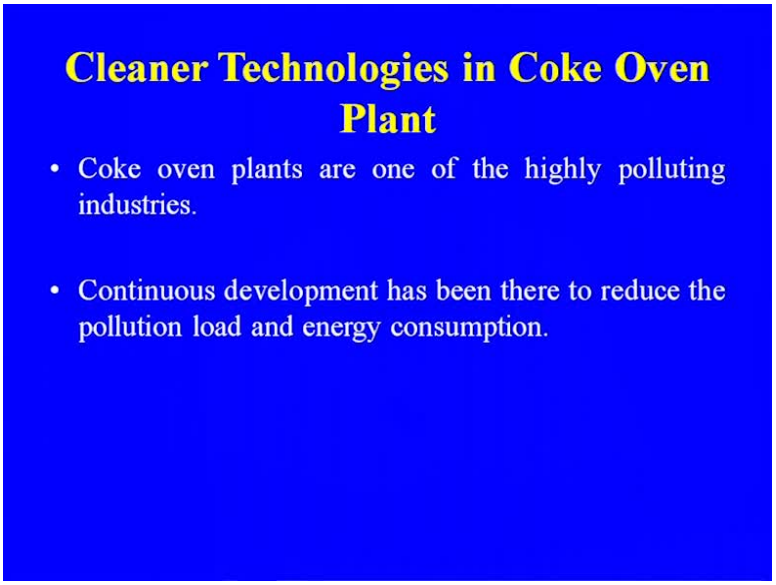

Coke oven plants are one of the highly polluting industries continues development has been there to reduce the pollution load and the energy consumption because these are the two energy consumption earlier used to be i. So, lot of the technological development that has taken place or the cleaner technology that is being implemented due to the position load from the coke oven plant.

These are the some of the cleaner technology because the concept of the cleaner technology or the greener chemistry came just for the deduction of the pollution load from the and now the cleaner technology in all it is not only the coke oven part, it may be

the paper industry, it may be the fertilizer industry. Number of the process that has is being developed and the modification in the process that is being done to have the less and less pollution load.

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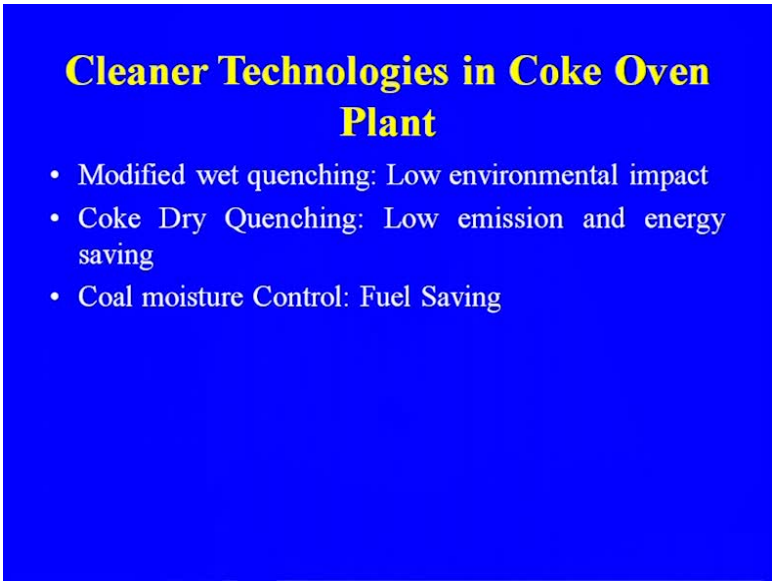

So, these are the some of the technology that is being used in case of the coke oven plant, that is the modified wet quenching low environmental impact, coke dry quenching, low emission and energy saving, coal coal moisture control fuel saving, because if is the moisture is high that moisture has to be driven out. So that is the, we will be losing our fuel. So, that will incurred, if you are having the moisture control.

Then fuel saving will be there high pressure ammonia as present system for control of the charging emission modern leakage proof doors, minimization of the door leakage, advanced technology for the desulphurization of the coke oven plant. So, this was about the coke oven plant the lecture 3 of the module 2, that we will include about the gasification of the coal and along with the gasification of the coal will be also discussing about the gasification of the petro coke, which is being produced from the petroleum industry.

Because now the huge amount of the petrol coke that we are producing in the refinery, because of the use of the heavier crude oil, which is more and more coke formation is there. So, the that is one of the very important aspect. Third part in the case of the coal in the gasification the bio mass gasification because huge amount of the bio mass that is

available. The now, the bio mass gasification even along with the coal or the bio mass gasification combine or the bio, the this bio mass to alcohol technology that is getting importance. Just to have the alternative feed stock, alternative fuel from the, because the bio from the gasification we can produce this. That may be used as a fuel, that may be used as the, for the production of the large number of the chemicals.