Chemical Technology
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Module - 5
Fermentation
Lecture - 1
Sugar and Fermentation Industry

We are discussing organic chemical technology course, and we have discussed module 1, module 2, module 3 and module 4 of this course. Today will be discussing module 5 and which will compromise sugar and fermentation industry, especially the alcohol, which we are getting from the molasses, which we are getting from the sugar plant.

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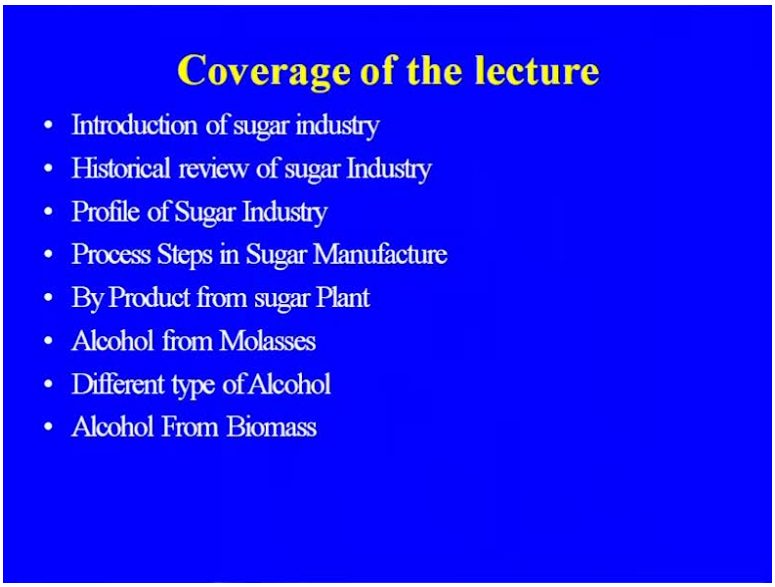

So, the coverage of the lecture that will be introduction of the sugar industry historical review of the sugar industry because this is one of the oldest industry, you can say the then the profile of sugar industry process step in the sugar manufacture byproduct from the sugar plant, alcohol from molasses different type of alcohol, alcohol from biomass.

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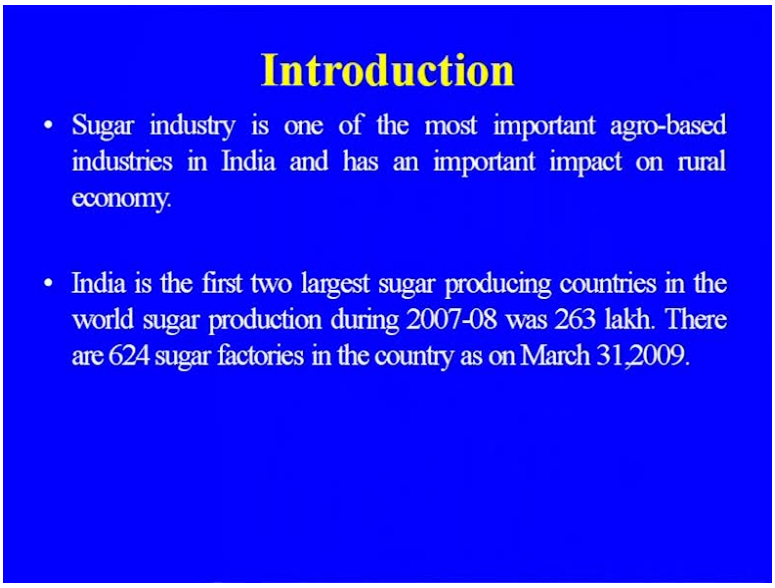

As you know the sugar industry is one of the most important agro based industry in India, and has an important impact on the rural economy. India is the first two largest sugar producing country in the world, with sugar production during 2007-08 was 263 lakh tons, there are 624 sugar factory in the country. As on 31, 2009 sector wise break up is given in other slides.

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But this is the importance of the sugar, you are saying the different type of sugar that we are making and the even that they have lot of the changes, in the quality of the sugar

from brown to white. That means, the even from the smaller particle sugar to the cubical more larger size of the crystals. So, these are the different type of the sugar that we are making.

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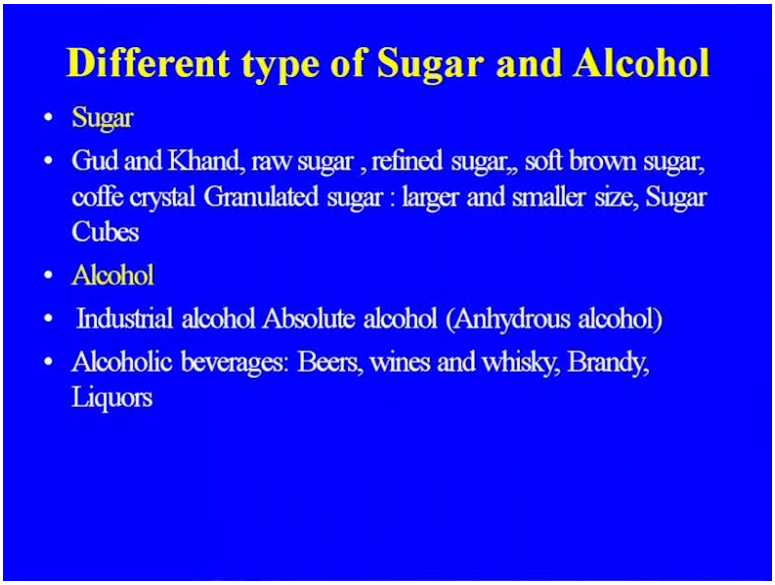

So, different type of the sugar and alcohol sugar, gud and khand, raw sugar because this was the khand, khandsari that was the oldest and that is the you can and the initial stages was there in the development of the sugar industry. And raw sugar, refined sugar, soft brown sugar, coffee crystal granulated sugar, larger and in smaller size sugar, sugar cubes different shapes that we are getting alcohol, alcohol that will be the industrial alcohol, absolute alcohol and anhydrous alcohol that we are making alcoholic beverages and beers, wines, whisky, brandy, liquors different type of the alcohol beer because that from the ancient time, we have been using the alcoholic beverage. Let us discuss about the historical review of the sugar cane and sugar manufacture in India.

It is universally acknowledged that India is the home land of the sugar cane and sugar. The reference of the sugarcane cultivation, its crushing, and preparation of the gur in Atharva veda as well as Kautaliya, Arthasatra that has been reported. It is reported as sugar came to India from New Guniea centuries before the Christ. The Indian offering the contain 5 amrits that is the during the any religious function, we use the milk, curd, ghee, honey and sugar, which shows the importance of the sugar in our daily life. And sometimes we also compare mithas that is the sugar, in our daily life.

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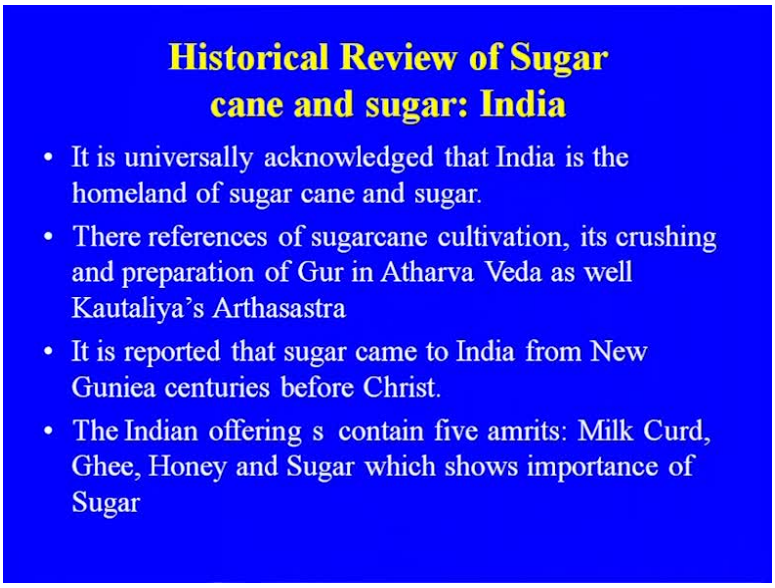

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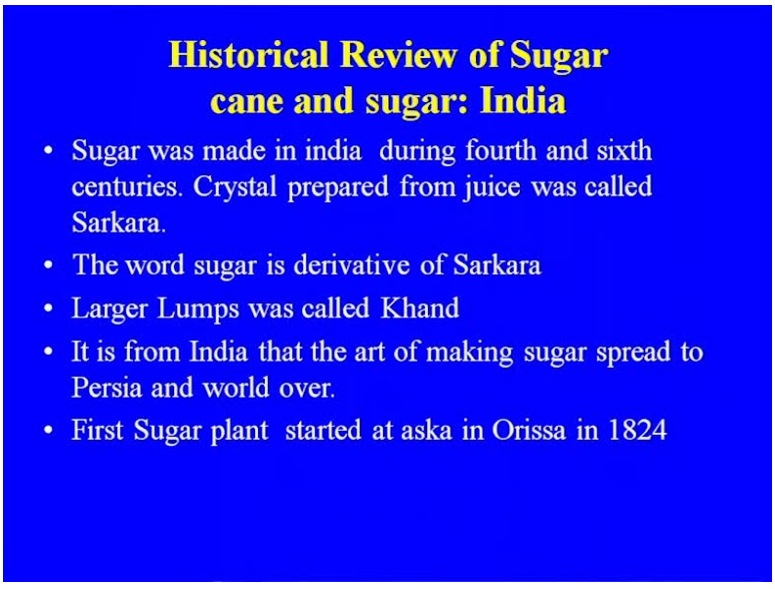

Sugar was made in India during in the fourth and sixth century. Crystals prepared from the juice was called sarkara. The word sugar is derived from the sarkar that the word we are using large, larger lumps was called the khand. It is from India that the art of making sugar is spread to Persia and world over. First sugar plant is started at Aska in Orissa in 1824.

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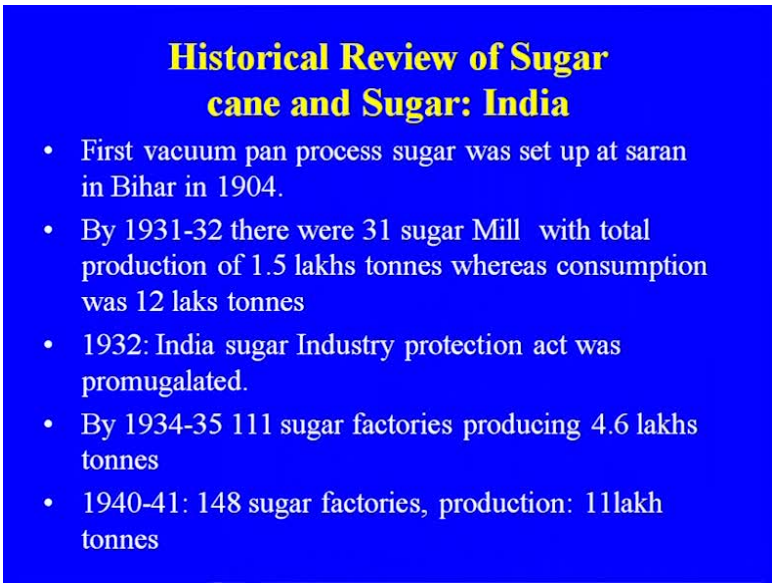

The first vacuum pan process sugar was set up at Saran district in Bihar, in 1904. By 1931-32 there was 31 sugar mills with total production of 1.5 lakh tones. Whereas, the consumption was around 12 lakh tones. So, the you can imagine the requirement of the sugar that was there. In 1932 India sugar industry protection act was promugalated and by 1935-34-34, 111 sugar factories producing 4.6 lakhs tones of the sugar came into existence. 1940-41 there were around 148 sugar factory, with production of 11 lakh tones.

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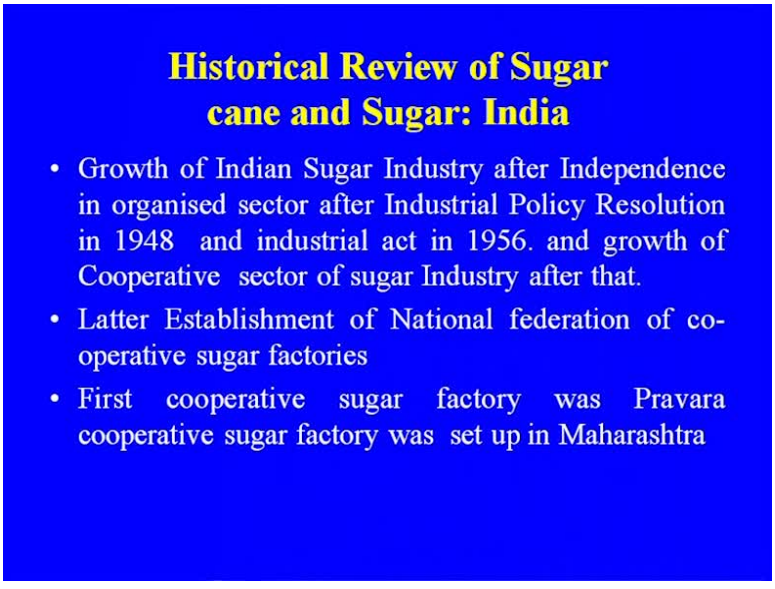

Growth of the Indian sugar industry and that was only after the independence, in the organized sector after industrial policy resolution in 1948, and industrial act in 1946 that were there and the growth of the cooperative sector of the sugar industry, after that the lot of the development in the sugar production, and the sugar mill setting of the sugar mill came into existence. Later establishment of the national federation of the cooperative sugar factory was there. And the first cooperative sugar factory was Paravara cooperative sugar factory, which is in Maharashtra. And Maharashtra is also one of the leading sugar producing state in our country. This is the profile of Indian sugar industry and the number of the sugar factory because many of the number that may vary, but this is the figure which we I got by 2012.

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Private sector 245, public sector 62, cooperative 317 and total number of the sugar mill are 624. Capacity is varying very widely, processed technology remaining the same, but lot of the improvement technological development that has been done in the sugar plant and the old sugar mill. If you compare the old sugar mill and the new sugar mill, there is lot of difference in the process technology, regarding the refining of the sugar and also the capacity of the plant.

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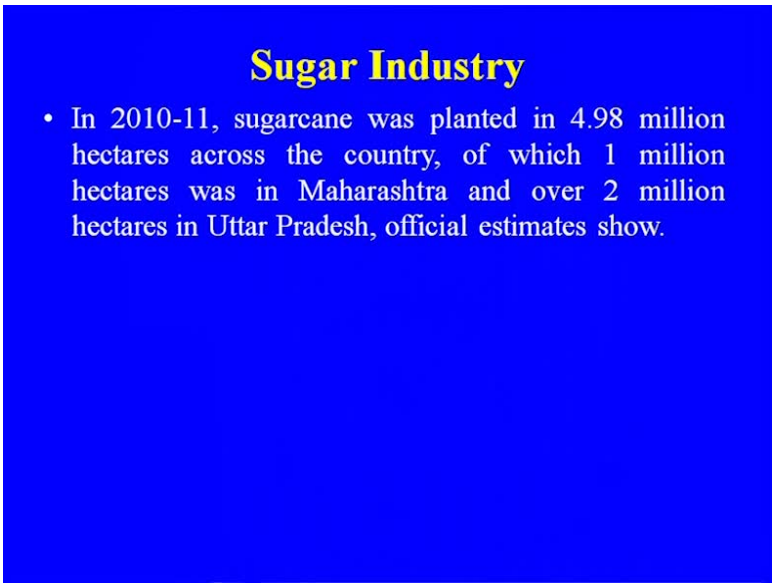

In 2010 and 11, sugar cane was planted in 4.98 million hectares across the country of which 1 million hectares was in Maharashtra, for 2 million hectares in Uttar Pradesh official estimates show. This is the actually we see Maharashtra and UP and Bihar these are the some of the major sugar producing states in India.

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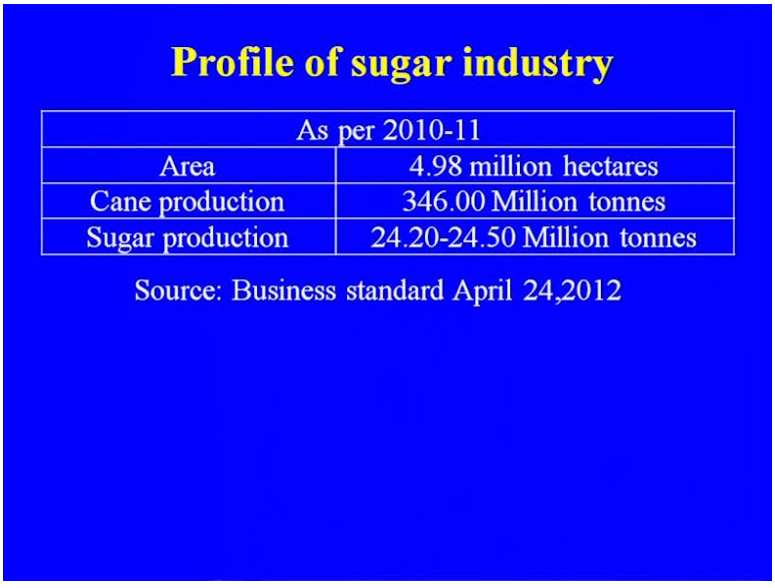

This is the cane production and sugar production figure as on 2010-11. The total cane production that was 346 million tones sugar production, 24.20-24.50 million tones.

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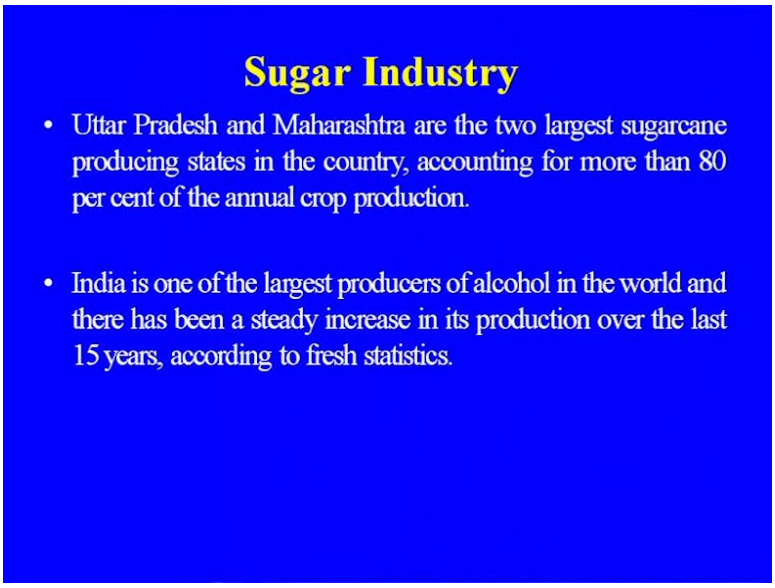

As I told you that the UP and Maharashtra are the two largest sugar cane producing states in the country, accounting for more than 80 percent of the annual crop production. India is one of the largest producer of alcohol in the world. There has been a steady increase in its production over the last 15 years according to the fresh statistics. Actually, you see the molasses to alcohol conversion. Now, that has become very important in case of and that will be discussing separately. How we are making the molasses and the importance of the alcohol from the molasses in the chemical industry.

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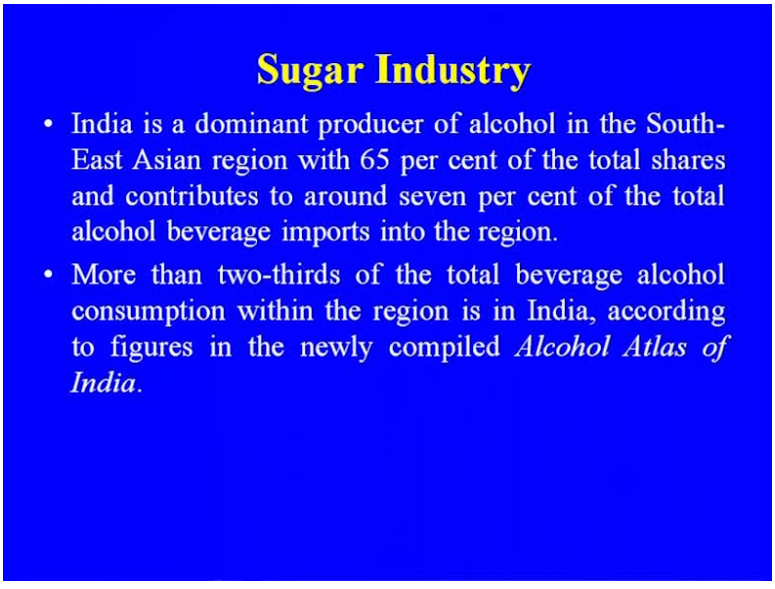

India is the a dominant producer of alcohol in South East Asia region, with 65 percent of the total shares, and contributes to around 7 percent of the total alcohol beverage imports into the region. More than two-thirds of the total beverage alcohol consumption, with the region is in India according to the figure in newly compiled alcohol atlas of India.

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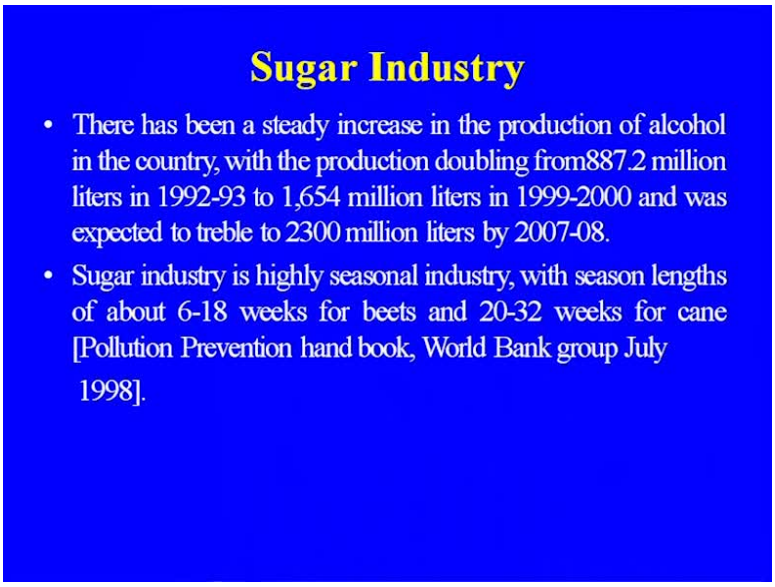

There has been a steady increase in the production of alcohol in the country, with the production doubling from 81.2 million liters in 1992-93 to 1.654 million liters in 1999-2000 and was expected to treble to 2300 million liters by 2000. The production actually the data was not available. So, that is more than this what we are having today. Sugar industry is highly seasonal industry.

This is one of the problem in case of the sugar industry with the season lengths of the about 6-18 weeks for beets, and 20 to because beet is also one of the source of the sugar, but it was here. We will be discussing mostly about the sugar and from the sugar to alcohol and 20-32 weeks for the cane. So, processing in the sugar manufacture, what are the various steps involved in case of the. Now, let us discuss this manufacture of the sugar.

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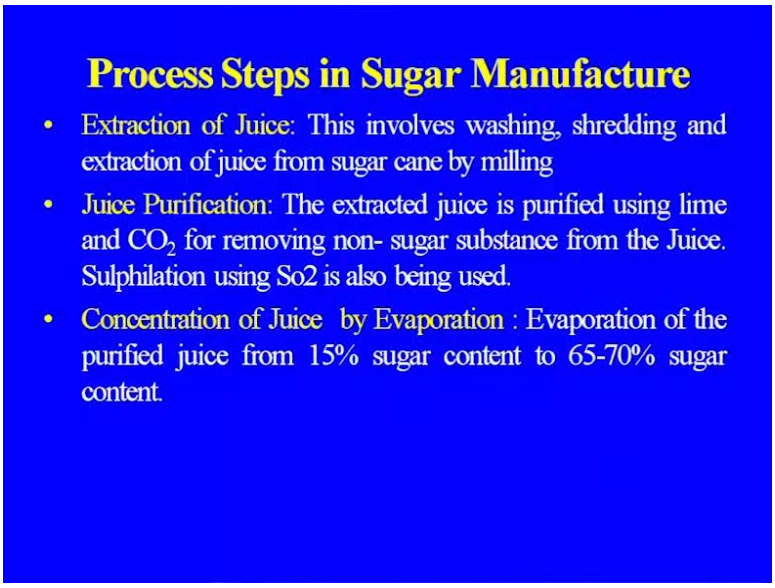

Extraction of the juice, this involves washing shredding and extraction of the juice from sugar cane by milling. Here you find lot of the development that has taken place in milling to increase the extraction of juice from the cane because the overall economic sugar recovery that is one of the very important factor. In case of the economic just to have more and more economic. Next, step after the extraction of the juice the juice purification here also lot of the development earlier it was the carbonation.

Now, we are also having we are using the sulphilation using this S O 2 that is also being used. So, the extractive juice is purified using lime and C O 2 for removing the non sugar substances from the juice sulphilation using S O 2 is also being used. Then the next, step after the juice purification, the concentration of the juice by evaporation, we are having the number of multiple effective operator for evaporation of the purified juice, which we are getting that is around 15 percent. So, that it may be crystallized so, the after the concentration of the juice that is going to from the evaporation, it is going to crystallization.

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Crystallization of the concentrated sugar solution to sugar crystal here that the crystallization part that is very important, because the growth of this crystal size, that is very important which is keeping. Actually, the product better product quality centrifugation because the separation of the sugar crystal from the molasses, at the residue.

So, centrifuges separation of the crystallize sugar molasses are left behind after the centrifuging, which is used for the production of the alcohol. So, the molasses which is that is one of the very important by product of the sugar manufacture. Then the further refining of the raw sugar, the raw sugar is dissolved filtered and crystallized again to get high grade refined sugar. Let us discuss slightly more detail about the sugar refining part, sugar refining part.

Actually, affination raw sugar mixed with the saturated syrup. Then centrifuged. Surface impurities are dissolve and removed carbonation using milk of lime and C O 2, removal of impurities color and other impurities, which are present in the juice. Sulphilation process it may be the cold sulphilation, or the sulphilation of the after the after liming. Here in case of the cold sulphilation that is the acid sulphilation, we call it because the pH lower, in the second when it is along with the lime it is the alkaline sulphilation that is these are the other extraction, involve in case of the sugar refining.

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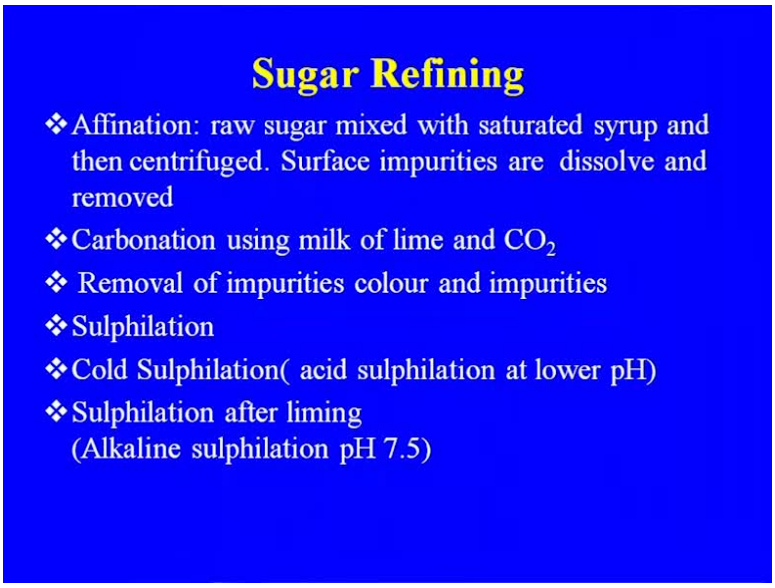

Because now, you seen the market wide variety of the sugar crystals available larger size, smaller size more whitish in nature, colorless even the in color also will find the different category of the and so, that that also the how the cost of the sugar that is fixed that is the purity of the product, color of the product larger size, lower size, smaller size of the crystal. So, for that the further refining that is very important.

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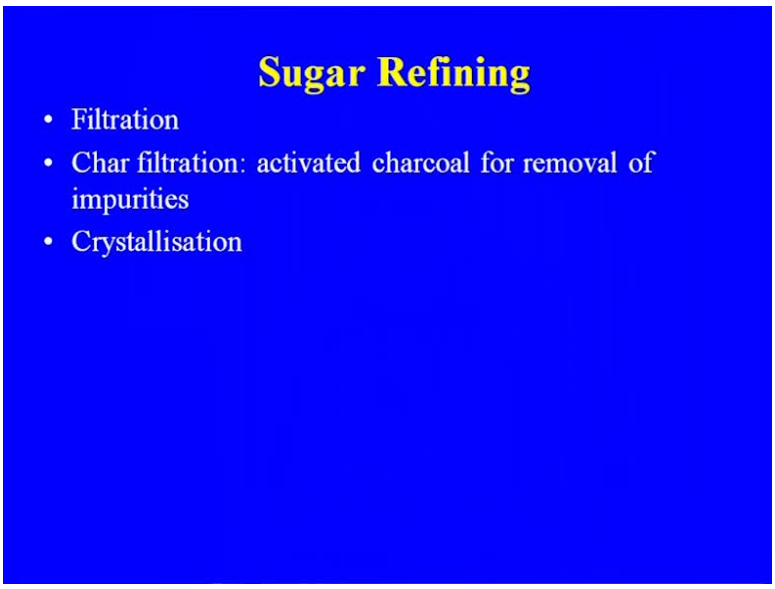

So, what we are doing? Filtration, char filtration is where we are using the activated carbon for removal of the impurities, and then crystallization.

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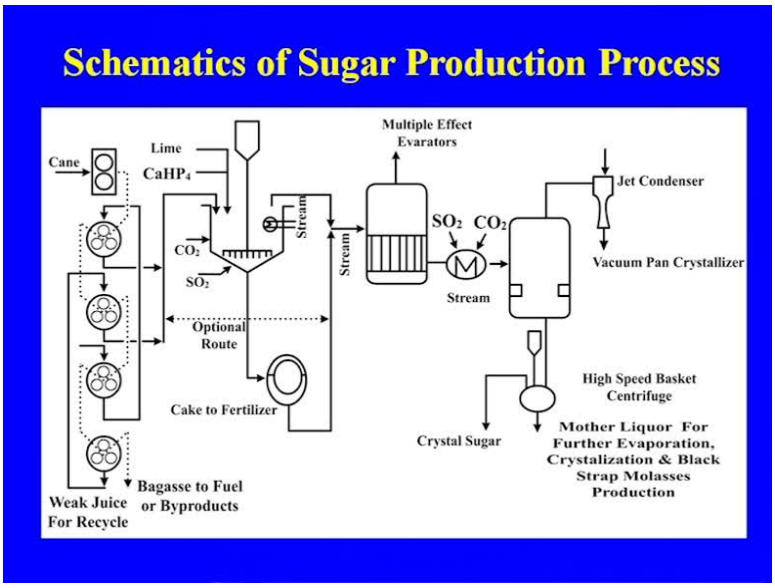

This is the flow diagram of the sugar manufacture of the cane sugar, cane that is going to the various crusher from where we are getting the juice, and that is going where we are adding the lime C O 2, S O 2 and purification that is taking place and here we are that is going to separation, removal of the press mud from this. And so, after the filtration or through the washer, the cake is separated and the filtrate that is going to the multiple effective evaporator.

So, in the multiple effective evaporator, the juice is concentrated and the further refining again it is being done, and then the vacuum pan crystallizer we are using. And the finally, in the process we are getting the crystal sugar and the mother liquor for the further evaporation, crystallization and black liquor, strap molasses for the production of the alcohol. So, this is the flow diagram and the even here also the number of development that has taking place in case of the refining as I told.

Now, we are also using in addition to activated carbon ion exchange resign has been also used for the purification of the sugar, what are the major development has done. Because the one of the major problem that has been as you know that the recovery of the sugar that is decreasing especially, in the when at the last sixties of the sugar cane production means the, during the summer at the end of the around the March and April the so, recovery date goes on. So, what has been done in case of the sugar industry they have

continuously modified development that has taken place to increase the recovery of the sugar.

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So, for that the new mills they are having the installation of the fiberliser, which is resulting in the reduce energy in milling, and increased extraction of the juice because that is very important, we cannot afford to lose the juice because if you are losing the juice it means, you are losing the sugar. So, increase the number of the rollers, so that the more and more milling and crushing that may be there, and extraction of the juice is more. Reduction in the crushing RPM of the roller, sulphilation process, activated charcoal filtration and then as I told you the use of the ion exchange resin, for the further purification hydrogen peroxide, sugar remelt ion exchange decolouristion process that has been added into some of the sugar mill, where they are extra purified sugar they are making.

These are the some of the commonly term used in the sugar industry that is the first, which I told you at the first step in case of the sugar manufacture; that is the milling process of extraction of juice from the sugar cane, breaks you need to used to express concentration of the sugar solution. This is the just to measure a the concentration of the sugar solution, which we are getting.

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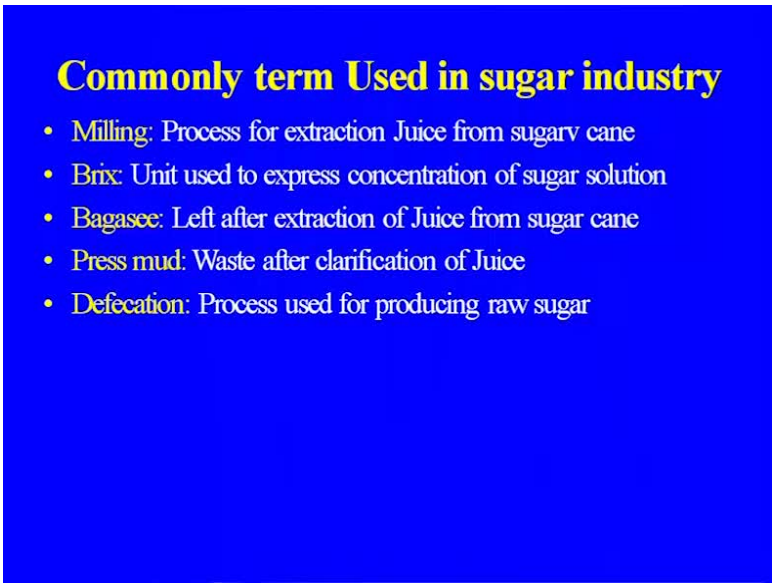

Bagasse that is left after the extraction of the juice from sugar cane, and this is also one of the very important bio-product of the sugar industry and normally, all the sugar industry they are using bagasse for the power generation in their bagasse based power boiler, but now there is in lot of discussion. Why not to use these bagasse for other purpose? Because you can produce paper from this, and let the other fuel be made available to the sugar industry.

So, that the more and more bagasse and that we are getting for the making of the paper another waste that we are getting from the during, the after the clarification of the juice that is the press mud waste after clarification of the juice, that we are getting that is containing line. Now, they have suggested because for making some of the bio fertilizer. So, press mud along with the concentrated waste from the memory separate process. They are mixing they are that is going for the composing. And defecation process is used for producing raw sugar, these are the some of the commonly term used.

Then the sulphilation purification using sulfur dioxide, carbonation and that term we are using purification using carbon dioxide. Massecuite the mixture of the sugar crystal syrup produced by crystallization. Molasses syrup of left after centrifuging, and separating sugar crystal, then the spent wash was after separation of the alcohol from the fermenter. Let us come discuss in more detail about the process step.

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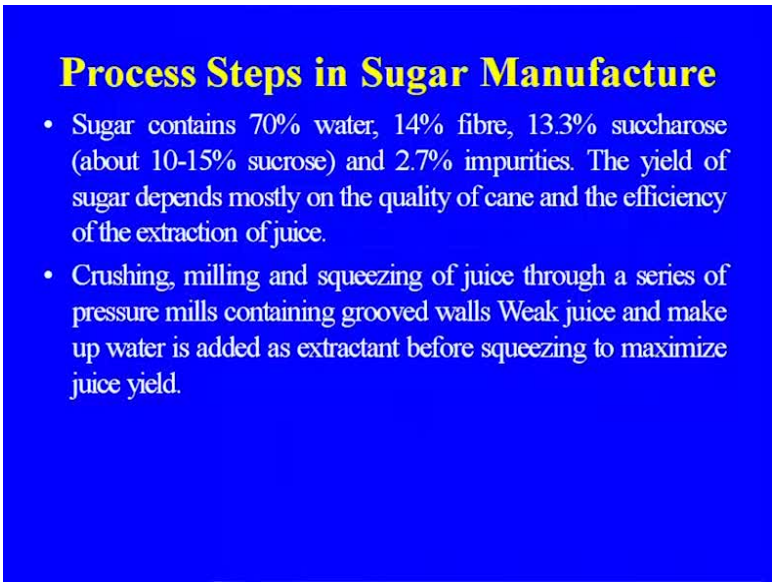

As sugar contains 70 percent that is not sugar, sugarcane contains 70 percent of the water, 14 percent of the fiber, and 13.3 percent of the sucrose about 10 to 15 percent sucrose and this is the region why normally, the recovery part which is there it is around 12 to 13 in most of the mills. So, if it is 12 to 13 it is sometimes it may be, but not more than and 2.7 percent impurity, the yield of the sugar depend mostly on the quality of the cane and the efficiency of the extraction of the juice. That is why I told you the milling process and extraction of the juice, and the installation of the faberizer that was the reason for going to increase the extraction of the juice.

Next step which I told you in this, when I summarize the that was the in this the abstract which I give you the about the various steps involved, that is the crushing milling and squeezing of the juice though a series of the pressure. Mill rolls containing grooved walls weak juice and makeup water is added as an extractant before squeezing just for the, to have more and more extraction that we are increasing, we are using the weak juice there.

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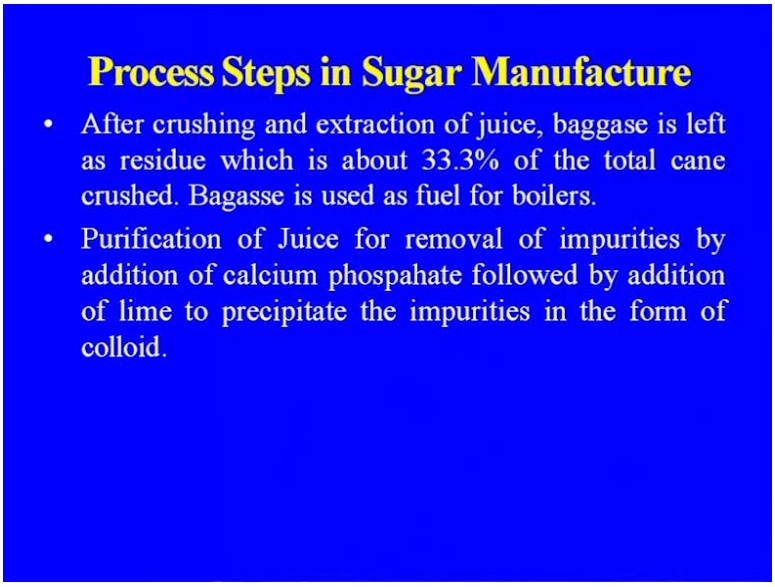

After crushing and extraction of the juice, bagasse is left as a residue, which is about 33 percent of the total cane crushed bagasse is used as a fuel for the boilers and the still. Whatever the bagasse, we are producing around 10 to 15 percent of the bagasse is surplus and that is being used by some of the paper mills, and number of paper mills based on the bagasse has come due to the increase in the production of the sugar cane. Purification of the juice of the removal of the impurities by addition of the calcium phosphate followed by addition of the lime to precipitate, the impurities in the form of the colloid because the purification parts also is that is very important, to get the good quality of the sugar crystal.

Then the evaporation and crystallization, the clarified juice is concentrated in the multiple effect evaporator to about 40 percent. And concentration, the concentrated syrup is again bleached by passing S O 2 through it. Concentrated sugar solution is then sent to the vacuum pan, where thickened syrup is boiled 3 to 4 times and then sent to the crystallizer, where separation of the sugar crystal takes place.

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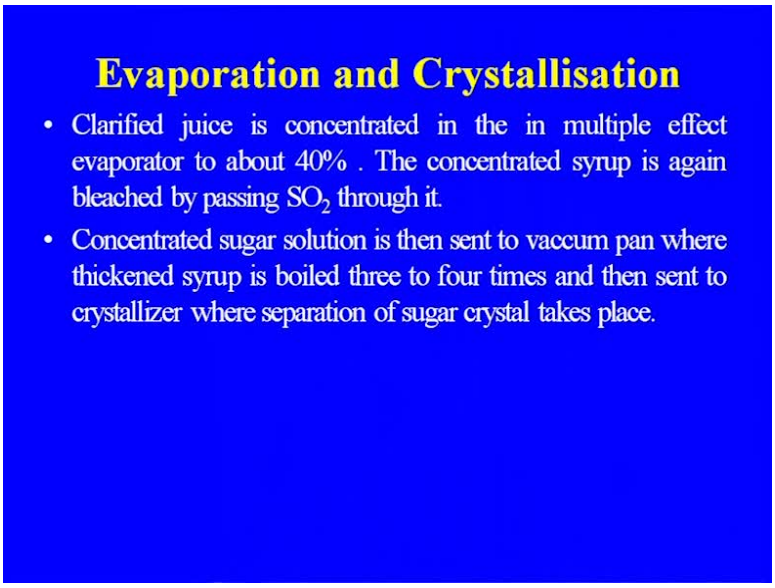

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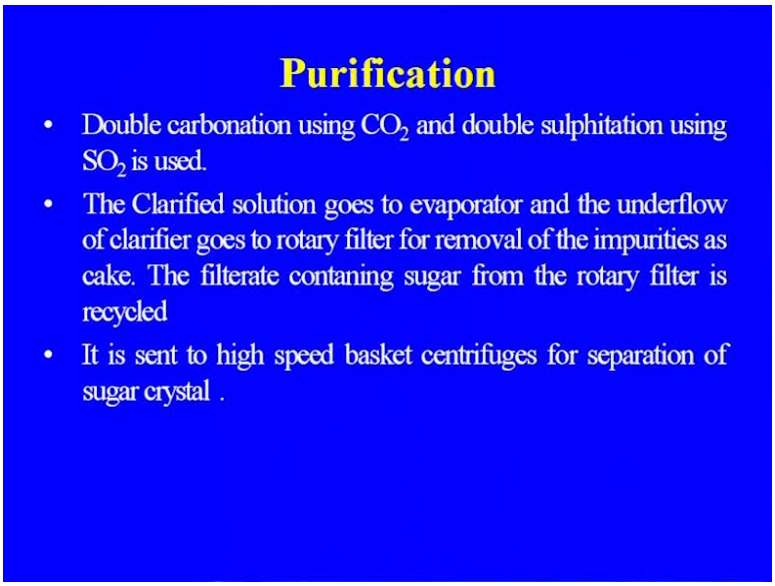

Then comes the purification for arriving the double carbonation using C O 2 and double sulphonation using S O 2. The clarified solution goes to evaporator and the under flow of the clarifier goes to the rotary filter, for removal of the impurities as cake which I told you the rotary filters, we are using the filtrate containing sugar from the rotary filter is recycled that is the filterate, we are using during the extraction stage. Then it is sent to the high speed basket centrifuge, the concentrated of the purification for this separation of the sugar crystal.

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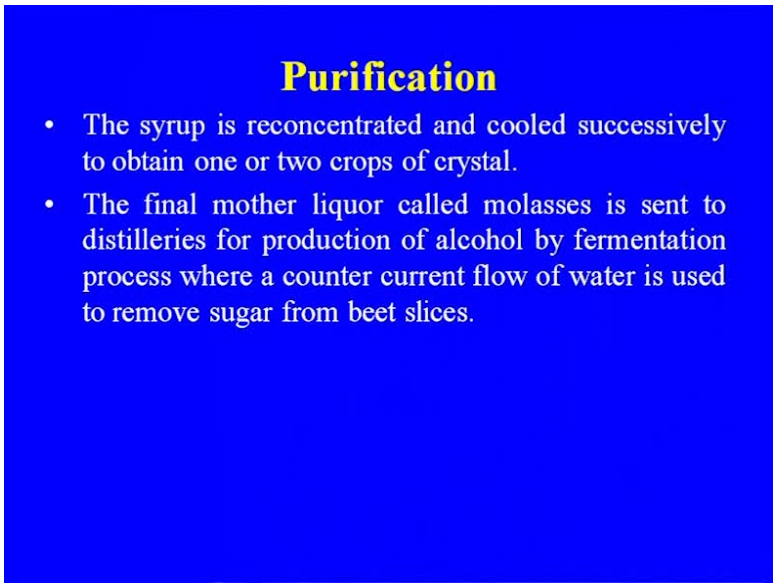

The syrup is concentrated and cooled successively to obtain one or two crops of the crystal. The final mother liquor called the molasses is sent to the distillery for the production of the alcohol by fermentation process, where a counter current flow of water is used to remove the sugar from the beet slices, if you are using the beet.

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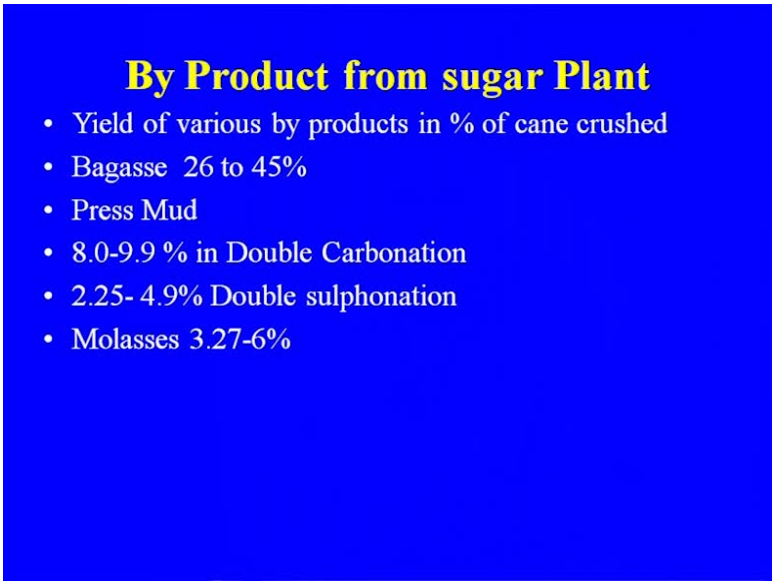

These are the some of the figures yield of the various product from the cane crushed bagasse press mud, and again the press mud that will depend up on the type of the

purification you are having whether, you are having the double carbonation or the double sulphonation and then the molasses.

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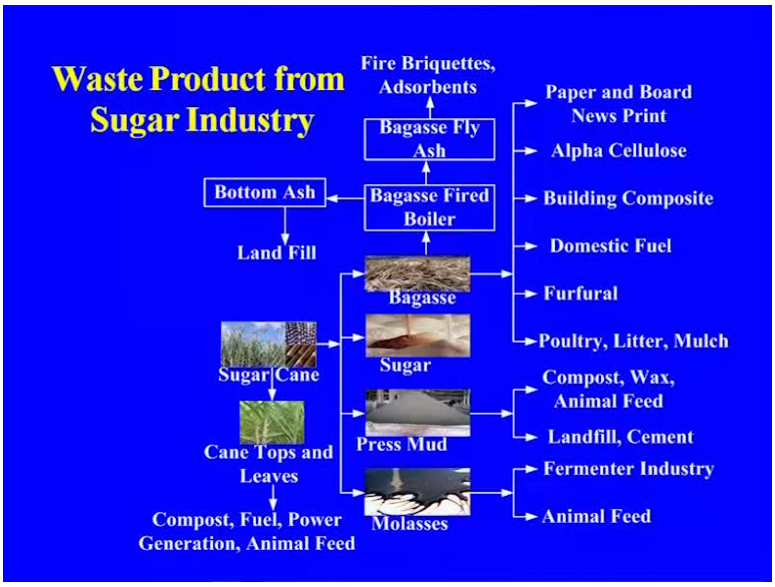

These are the some of the waste product that we are getting from the, this is we start from the sugar cane, cane tops and the leaves that is the waste. And that can be used for making the compost, fuel, power generation, animal feed that is normally it is being used as a animal feed, but the dry part that can go that can be used for gasification also. Then the bagasse, which we are getting after the removal of the juice; then that is going to the bagasse fire boiler, bagasse fliers that can be used for the and bottom ash from the boiler that will go to the land fill and the bagasse, which is there that is having good amount of the carbon also, that can be used as a adsorbent or for making of the fire briquette.

Similarly, the other use of the bagasse that may be the as I told you the now the number of paper mills that has been they are using the bagasse as a raw material, and paper and board, news print also. Alpha cellulose, building composites along with the bagasse and some of the polymeric compound that you can make the building composites, domestic fuel furfural from the bagasse that is possible, poultry litter and the mulch composed wax animal feed, land fill and the fermentation industry, animal feed.

So, this is for the molasses that is an press mud that can because that can be some organic part is there that can be used as a fuel also, and that can be composed also because as I told you now, the because all the solid waste has to be utilized and. So,

along with the reject from the membrane separation process, they are making the compost also.

Now, let us discuss about the ethanol manufacture because you see the ethanol, that is one of the very important product of the. And many of the sugar mills they are integrating they are having the sugar production, as well as production of the ethanol. So, that is link, but many of the mills they are having the only the sugar making part and so, the molasses, which ever they are producing that is supplying and this is under control.

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India is amongst the two largest sugar producing countries in the world, and convert the molasses from sugar plant to alcohol. India is the fourth largest producer of ethanol in the world and second largest in Asia. India produces about 2.75 billion alcohol annually liters that is the alcohol. The demand for portable alcohol has been ever increasing and the number of the your plants, which are making ethanol. They are also making the alcohol portable grade alcohol, apart from the industrial grade alcohol, which we are using.

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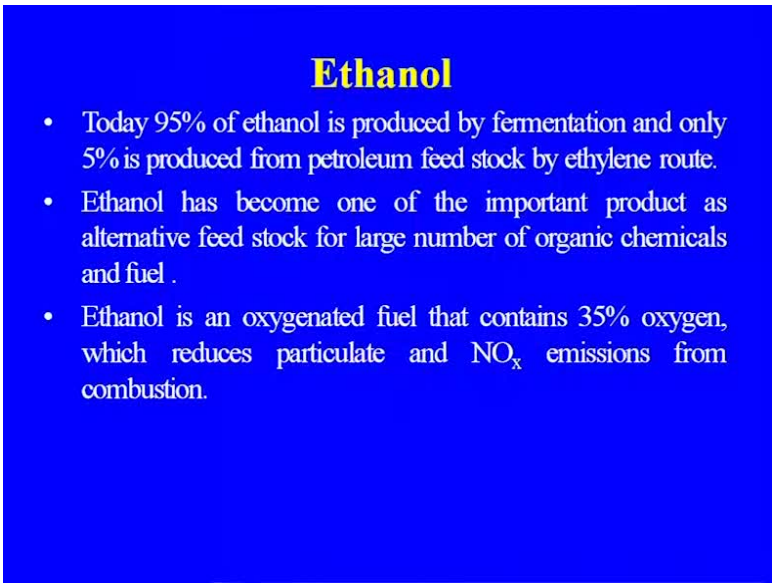

Today 95 percent of the ethanol is produced by fermentation, and only 5 percent is produced from the petroleum feed stock by ethylene route, because there are number of routes for ethanol is there, but the major production of the ethanol in India. And in some other part of the world, where the lot of the sugar is produced like Brazil and the other part of the world where the sugar cane production is more, it is the fermentation of the molasses that you are making the alcohol.

Ethanol has become one of the important product as alternative feed stock for large number of the organic chemicals, and fuel that will be discussed in lecture 2, while discussing the ethanol as the bio fuel and as the chemical feed stock. Ethanol is an oxygenated fuel that contains 35 percent oxygenation, which reduces the particulate and the N O X emission from the combustion and that is the reason why, that has been recommended blend of the alcohol along with the gasoline. Now, let us come to the historical review of the alcohol production.

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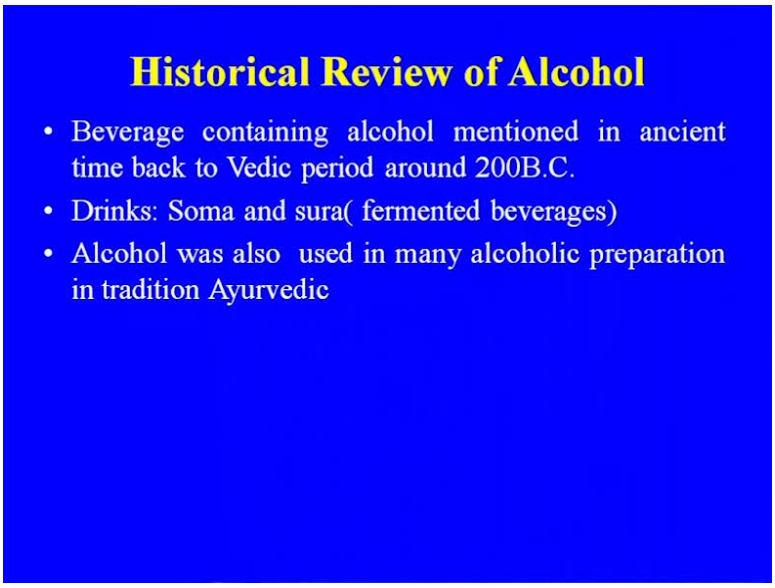

So, for the alcohol as a beverage is concerned that is mentioned in the ancient time, back to the Vedic period around 200 B C. Drinks soma and sura that was the fermented beverage and that has been mentioned in our religious books also. Alcohols are also used in the many alcoholic preparation, and the tradition Ayurvedic medicine also because that has been the part of the medicine also, the alcohol and now you will find the many of the syrup, cough syrups and all those they are containing some alcohol also.

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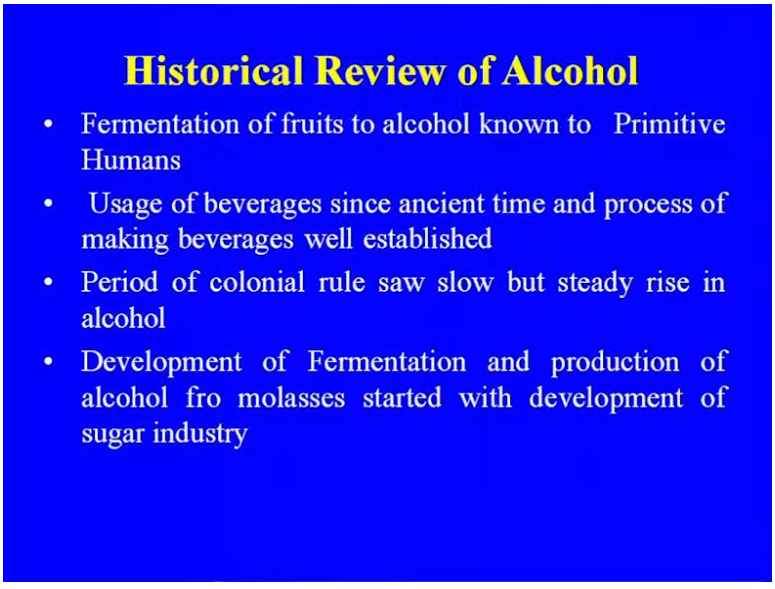

Fermentation of the fruits to alcohol known to the primitive humans. Usage of the beverage since, the ancient time and process of beverage is well established that the smaller scale operation that was there earlier. Period of the colonial rule saw slow, but steady raise in the alcohol production. Development of the fermentation and production of the alcohol from molasses started with the development of the sugar industry, number of the sugar mills that increase and the production of the molasses was there, and the molasses was made available to the fermentation industry, for making the alcohol that we call will the distillery.

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This is the various types of the drinks that we are having. So, for the portable gate of the alcohol is concerned a wide variety of the not only from the molasses route, but other routes are also there beet, sugar. All those thing they are also from the beet also we are making some of the grape of the fermentation of the some of the fruits also, we are doing and making good quality of the drinks.

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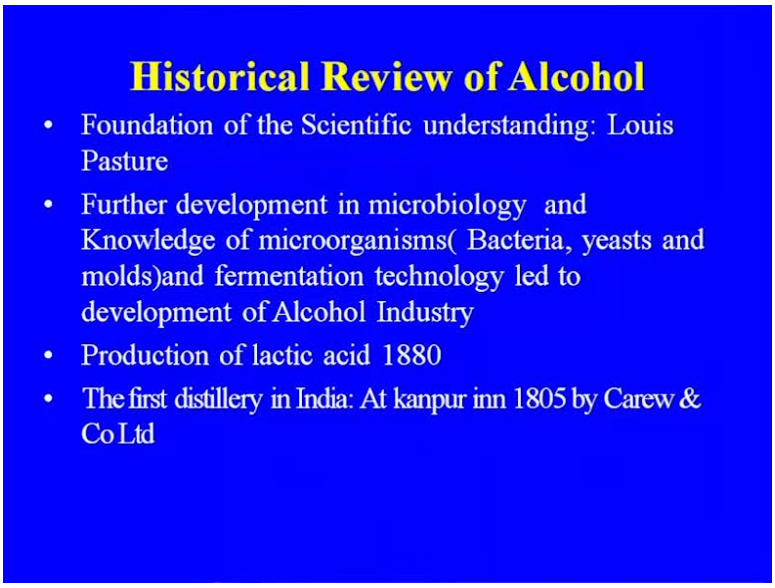

Foundation of the scientific understanding that was only after the Louis Pasture, who developed the micro biology further, the development is micro biology and knowledge of the microorganism because we are using yeast here in the fermentation, and the fermentation technology led to the development of the alcohol industry. Production of the lactic acid that was in 1884 that is the. So, for the fermentation is concerned the first distillery in India was at the Kanpur in 1805 by Carew and the company that was in Kanpur.

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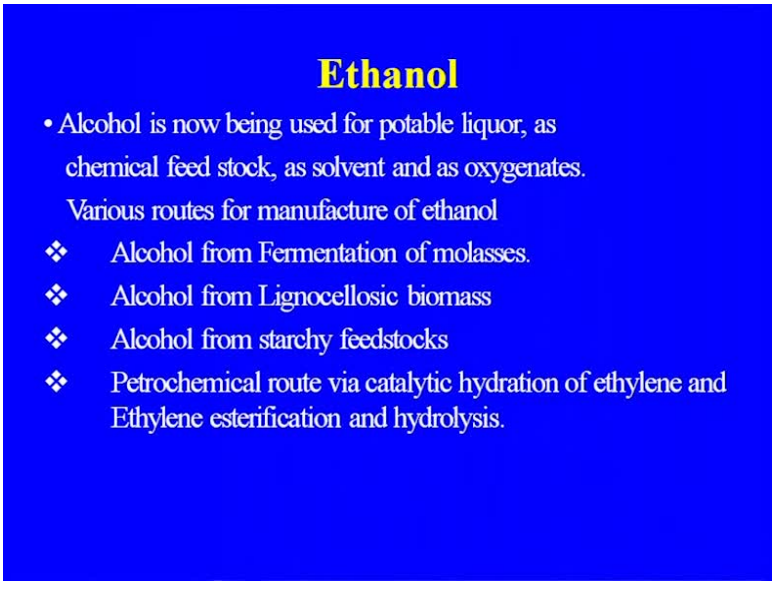

Alcohol is now being used for the portable liquor, as chemical feed stock, as solvent and as oxidant various routes for manufacture of the alcohol because molasses is one route, molasses from the fermentation of the alcohol from the fermentation of the molasses. Alcohol from lignocellosic biomass because now, the lot of the work is going on also, this process from the biomass that was well developed earlier also, but there has been some problem in the pre treatment of the biomass.

And so, with the development of the pre treatment processes and the removal of the lignin, now it is considered as biomass that can be also a promising source, future source of the alcohol. Alcohol from the starchy feed stock petrochemical route were we are using the ethylene, and from the ethylene esterification and hydrolyzing various products that we can make.

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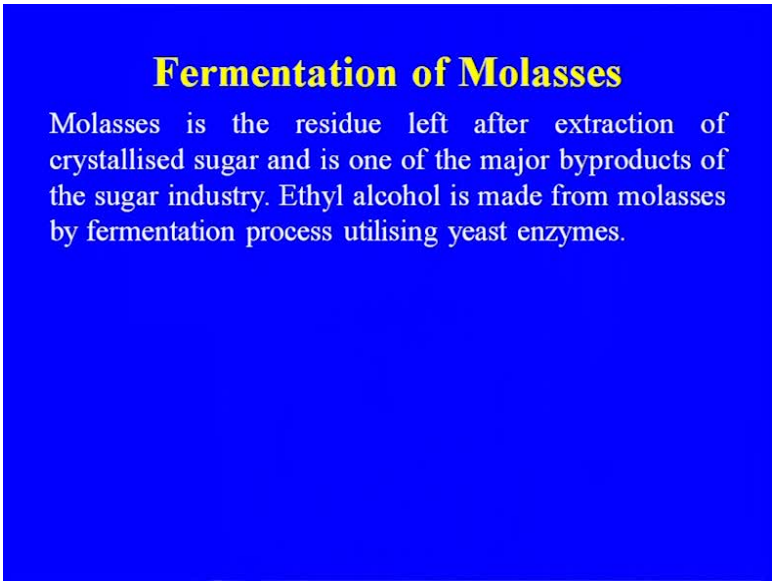

The molasses is the residue left after the extraction of the crystallized sugar, and is one of the major byproducts of the sugar industry. Ethyl alcohol is made from the molasses by fermentation process using the yeast enzyme. The various steps involved in case of the alcohol production that is the molasses handling, the molasses you are getting, because in many of the mills they are not having the fermentation plant, and there were alcohol production is not there. So, that is being some plight through the tanker to the different mills which are having your fermentation plant.

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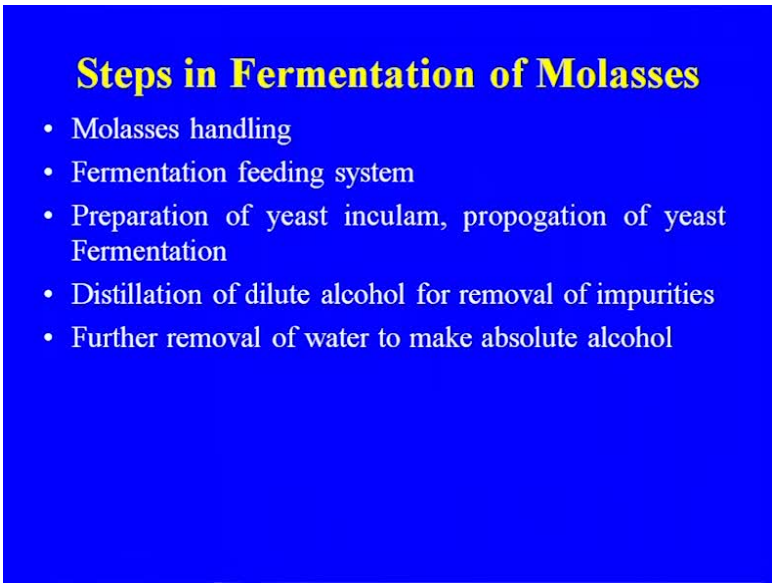

So, the molasses handling fermentation feeding system, preparation of the yeast inculam, propagation of the yeast from for fermentation distillation of the dilute alcohol for removal of the impurities because normally, in the fermentation. During the fermentation process, we are producing dilute alcohol and that alcohol that has to be concentrated, if you are interested for absolute alcohol, further removal of water to make the absolute alcohol or even anhydrous alcohol.

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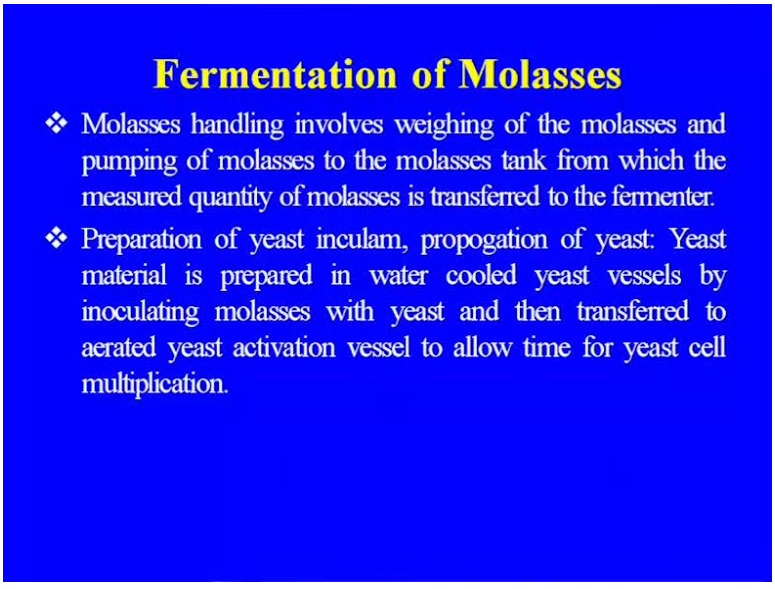

Now, let us discuss the various steps in more detail the molasses handling involves weighing of the molasses and pumping of the molasses to the molasses tank, from which the major quantity of the molasses is transferred to the fermenter because that is a continuous process. Preparation of the yeast inculam, propagation of the yeast, yeast material is prepared in water cooled, yeast vessels by inoculating molasses with the yeast and then transferred to the aerated, yeast activation vessel to allow time for yeast cell multiplication and after that it is being added.

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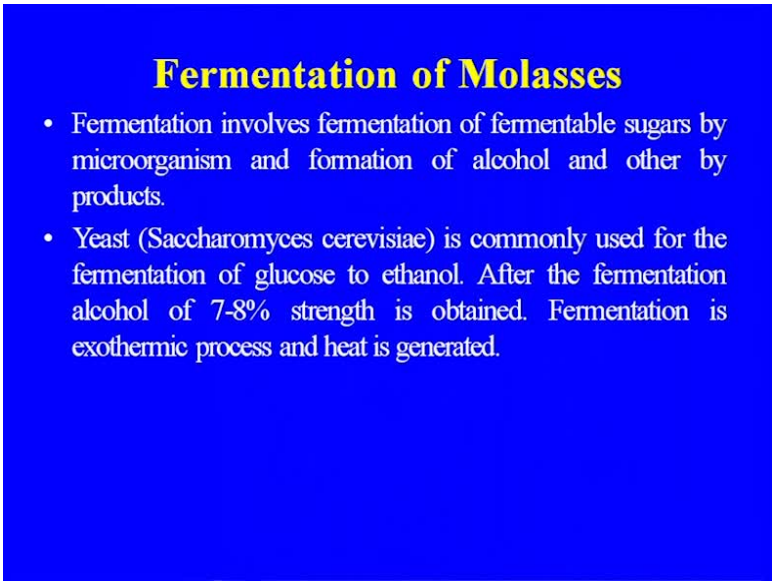

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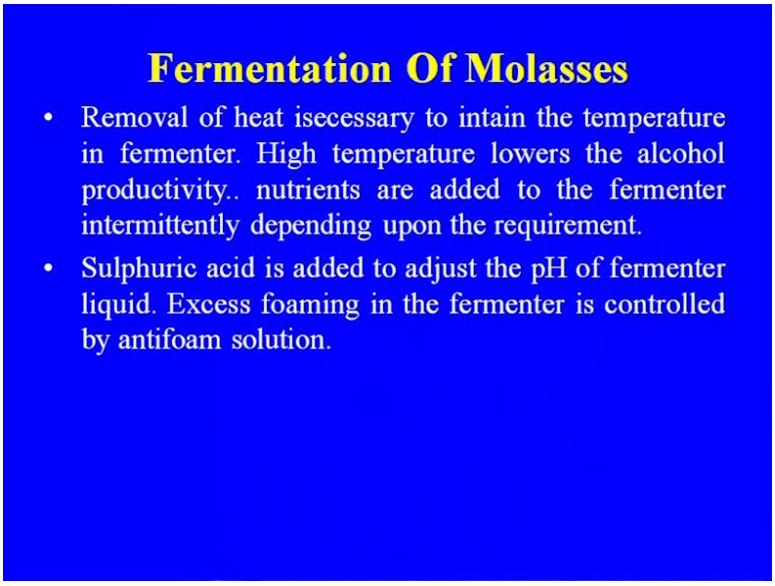

Fermentation involve the fermentation of the fermentable sugar by microorganism and formation of the alcohol, and other byproduct yeast is the commonly used for fermentation of the glucose to ethanol after the fermentation alcohol 7 to 8 percent strength is obtained, as I told you this is the we are getting the dilute alcohol. The fermentation is the exothermic process and heat is generated and so, continuous cooling has to be there during the process after C O 2 is removed.

And as I told you the removal of the heat is necessary to maintain the temperature in the fermenter. High temperature, lower the alcohol productivity nutrients are added to the fermenter intermittently, depending up on the requirement because all the micro process, if indeed the nutrient sulfuric acid is added to adjust the pH of the fermenter liquid. Excess foaming in the fermenter is controlled by antifoam solutions.

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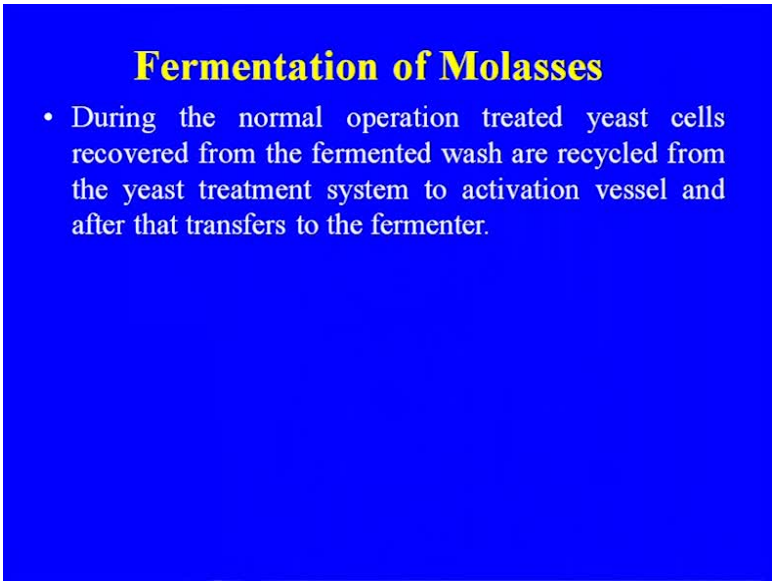

During the normal operation treated yeast cells recovered from the fermentation process are washed, recycled from the yeast treatment system to the activations vessel. After they transfer to again to the fermenter because one the growth of this yeast that has taken place then continuous, the process that is going on what about the yeast that is we are generating in the process that is again recycled.

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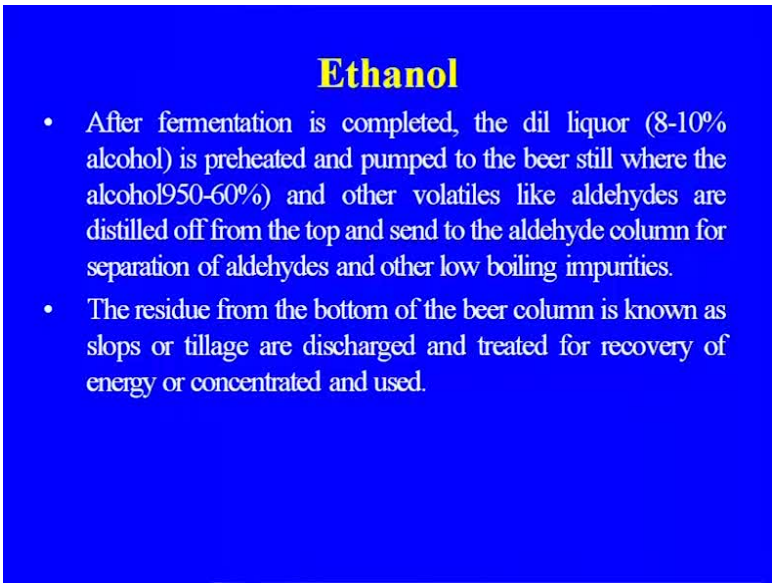

After the fermentation is complete the dilute liquor that may be, as I told you 7 to 8 percent or that will vary 8 to 10 percent alcohol is preheated, and pumped to the beer still where the alcohol of 95 and were the 50 to 60 percent. And other volatiles like aldehydes are distilled or from the top and send to the aldehyde column, for separation of the aldehyde this is the impurity that is the present, in the process and other low boiling impurities. The residue from the bottom of the column is known as slops, and tillage are discharged and treated for recovery of the energy or concentrated and used.

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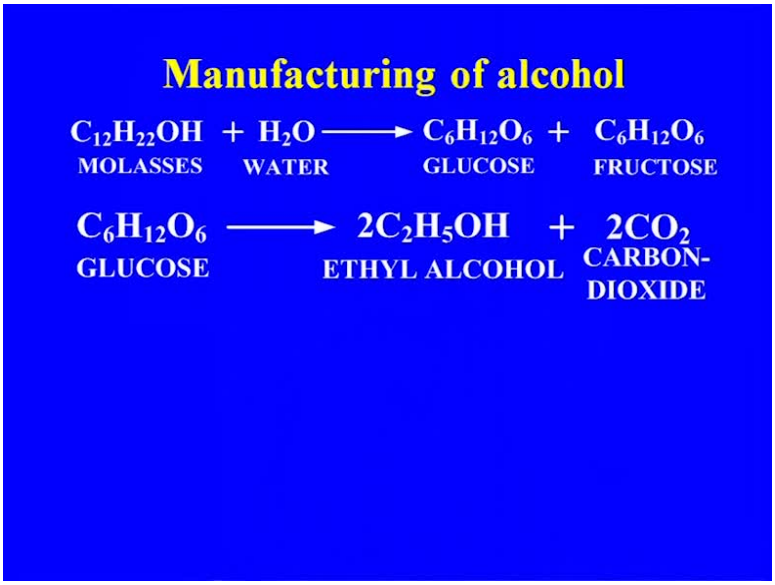

This is the reaction that is and during the process of alcohol manufacturing, lot of the C O 2 that is formed and that C O 2 some of the mills, they are also marketing, this C O 2 they are collecting, this C O 2 and that has been used for the various purposes, because it may be also used for making of the some of the useful chemicals.

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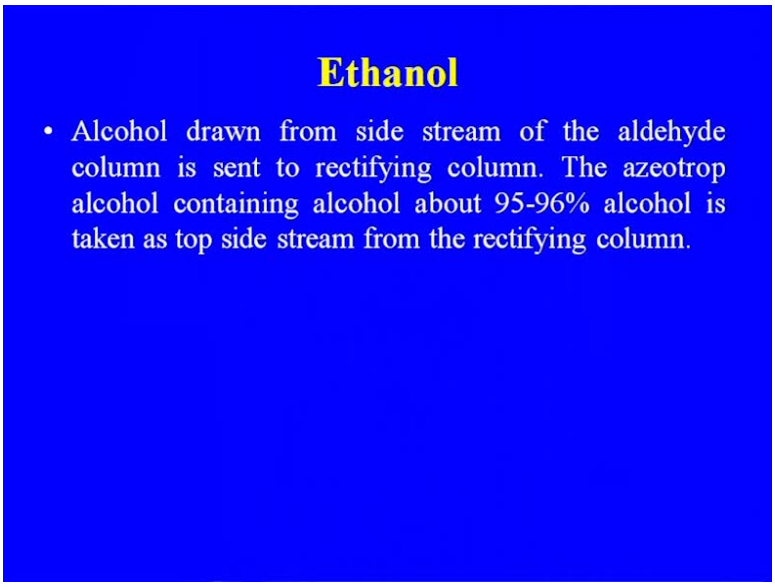

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The alcohol drawn from the aldehyde column is sent to the rectifying column. The azeotrop because here the alcohol, and water that is the famous azeotrop that you are making, it is containing alcohol about 95 to 96. See it is taken as top side stream from the

rectifying column. So, that is the azeotropic mixture is there and azetropic distillation is taking place to have the higher concentration.

This is the process you see the molasses, molasses it is going to fermentation process, it is going to distillery and then, the final products ethanol that you are getting.

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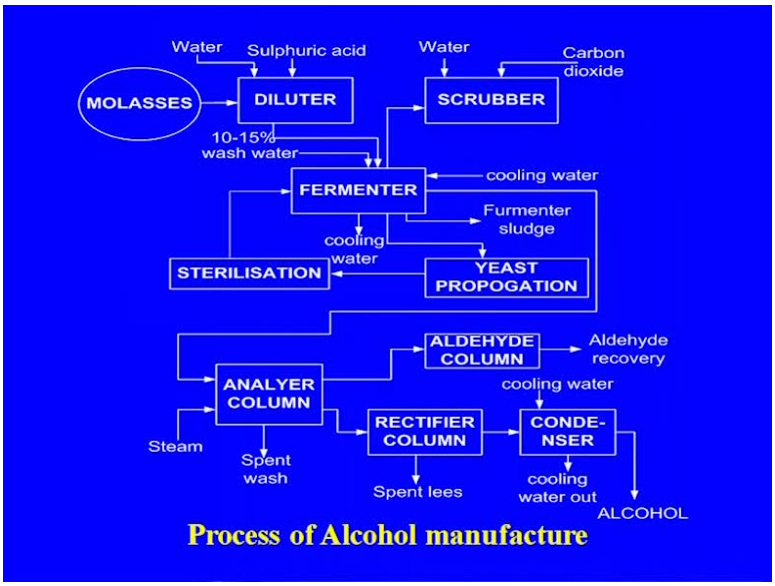

This is the in detail about the process, which I discussed. Molasses it is going to be the diluter were we are adding the sulfuric acid and after the sulfuric acid, it is going to the fermenter, fermenter this is was I was telling this C O 2, C O 2 that is going to the scrubber after there is a carbon dioxide, this is going outside from this cover. The fermenter after the fermentation, we are getting the here the because the from the fermenter, fermenter slice will be also there and your alcohol, dilute alcohol that is going to the further concentration yeast.

Again as I told you the yeast, which is produced during the process that is also multiplication of these it is there. And so the yeast of distraction again it is going to fermenter after that what is do the analyzer column, were we are concentrating further concentrating the alcohol. So, a spent wash is used, what is that spent wash? That is a very useful byproduct in case of the alcohol, and this is being used and this is having very high C U D 1 lakh.

So, that is the sometime problem also if you are not using the properly this spent wash. And so, they are generating the anaerobic treatment of the spent wash that are generating. And so, this is what we are doing in case of the sugar industries were they are having the sugar and alcohol both. So, the treatment process first it is the utilization of the spent wash in the anaerobic treatment process to produce the a methane gas, which is being used as the whatever, the gases there are that is being used for the power generation that is being using the industry.

And then the what about the spent wash after the even anaerobic treatment that is containing, you can say around 500 to 10,000 C U D still highly colored material that you are getting, after the anaerobic treatment. So, lot of the challenges the distilleries are facing, how to further treat this spent wash, which you are getting after the anaerobic treatment because that is highly colored, and the C U D load is very high. Some of the places they have because normally in some of the country, what they are doing the treatment of this spent wash.

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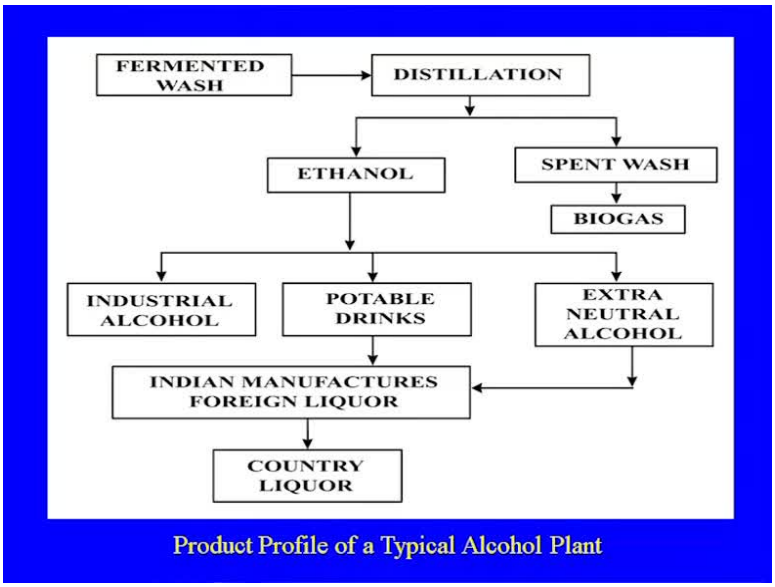

Before going it is going to anaerobic treatment, they are doing the pre treatment and in our country what we are doing, we are using this spent wash for the power generation and then it is going for the further treatment. Finally, we are getting the alcohol. You see as I told you, this I will be discussing in detail while in the lecture 2 that the, what are the different byproduct that you are getting the molasses? How to utilize the molasses and

they are converting? This alcohol molasses to alcohol and alcohol to ethanol and that ethanol that is being used for manufacture of large number of the product, this is the actually the flow diagram of the various product that is one of the molasses based chemical plant.

This is the product profile of the ethanol that is the fermented wash, distillation. So, we are getting the ethanol, spent wash that is going for the biogas generation, which I am telling after the biogas generation, whatever the effluent that you are generated that is going to the further treatment. Now, the centre portion control board they are very much concerned about the distillery because that is one of the highly polluting industry. So, the different type of alcohol, which we are getting that may be industrial alcohol, portable alcohol and so, that may be the extra neutral alcohol, country liquor although thing that is the various type of the product that you are getting.

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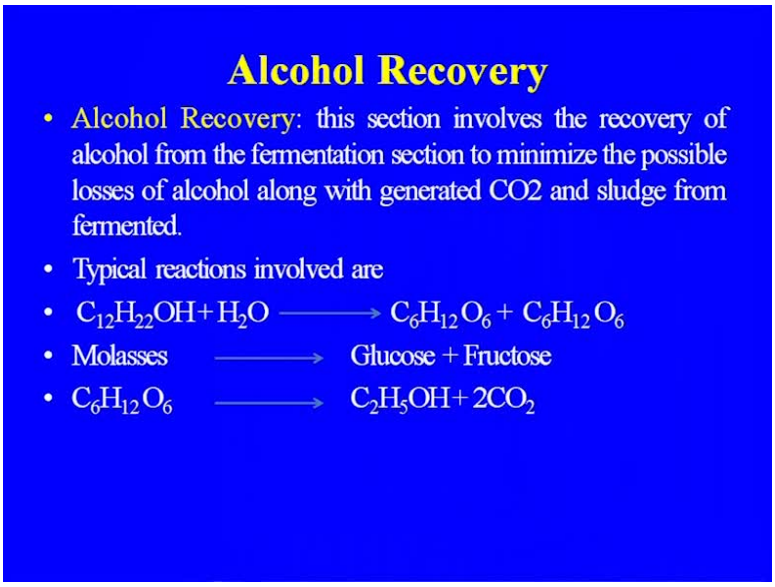

Alcohol recovery that is very important in case of the your alcohol plant. So, this section involves the recovery the alcohol from the fermentation section to minimize, the possible loss of the alcohol along with the generated C O 2, and sludge from the fermenter. Another thing that let us discuss because that was one source and now, the lot of the work that is going on for the production of the alcohol, ethanol forming biomass because the biomass gasification. We discussed earlier while discussing the coal and biomass

gasification, but another thing that we are interested in utilization of the biomass just for the production of the alcohol.

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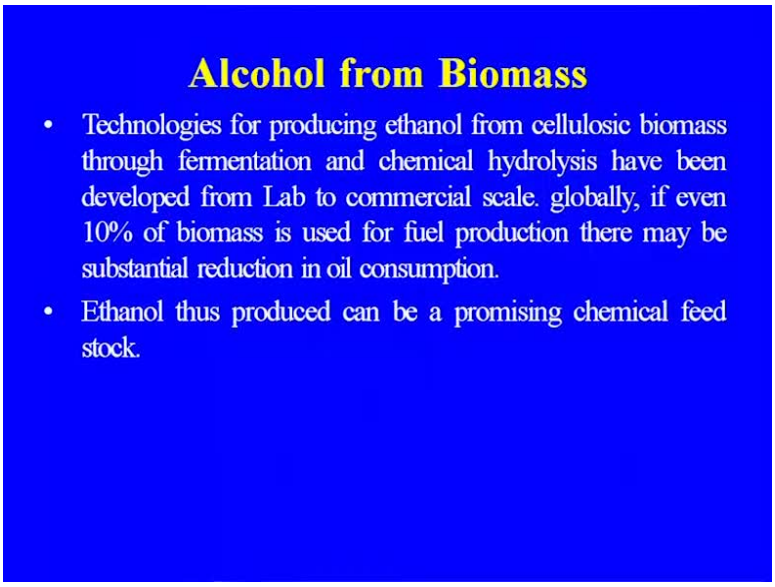

So, technology for producing ethanol from the cellulosic biomass through fermentation and chemical hydrolysis, have been developed from lab to commercial scale. Globally even if 10 percent of the biomass is used for the fuel protection, there may be substantial reduction in the oil consumption. So, it is being considered the future raw material for the chemical plant as well as, as a source of the fuel.

Ethanol thus because the gasification route that is one route, that can be the gasified gas that can be used for the making the that can be synthesis gas that can be as fuel, or making of the by these chemicals also another route that is the what, we are having the alcohol from the biomass. So, there may be substantial reduction because that will provide alternative source of the fuel ethanol. Thus produce can be a promising chemical feed stock also.

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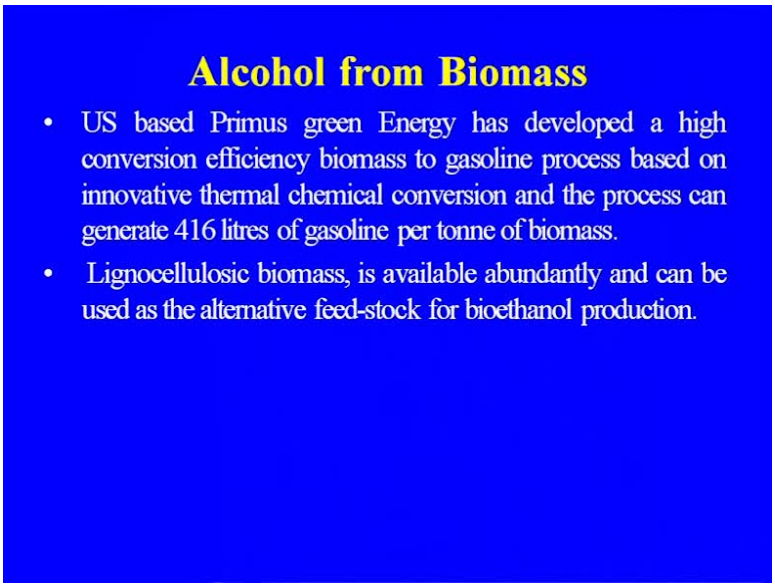

U S based primus green energy has developed a high conversion efficiency biomass to gasoline process based on the innovative, thermal, chemical conversion and the process can generate 416 liters of the gasoline per ton of the biomass. Lingocellulosic biomass, is available abundantly and can be used as the alternative feed stock for ethanol production. Alcohol from the biomass, what are the process that is involved in case of the when we are using the biomass because from you see the during the 30, 40 also the lot of the work that was done for the making of the lingo, but the micro biology that was not well developed.

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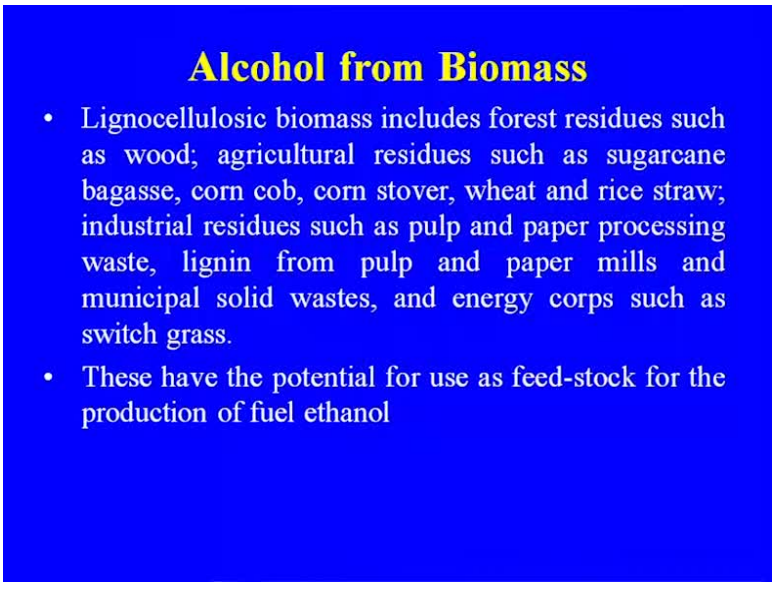

The pre treatment process were not well developed and so, the real actually the work that was started for making of the alcohol from the biomass, with the development of the pre treatment technology, and the processes for the removal of the lingo. So, lingo cellulosic biomass includes forest residue such as wood, agriculture residues such as sugar cane bagasse, corn cob, corn stovers, wheat and rice straw industrial residues, such as pulp and paper processing, waste lignin from the pulp and paper mills and municipal solid waste and energy crops such as the grasses.

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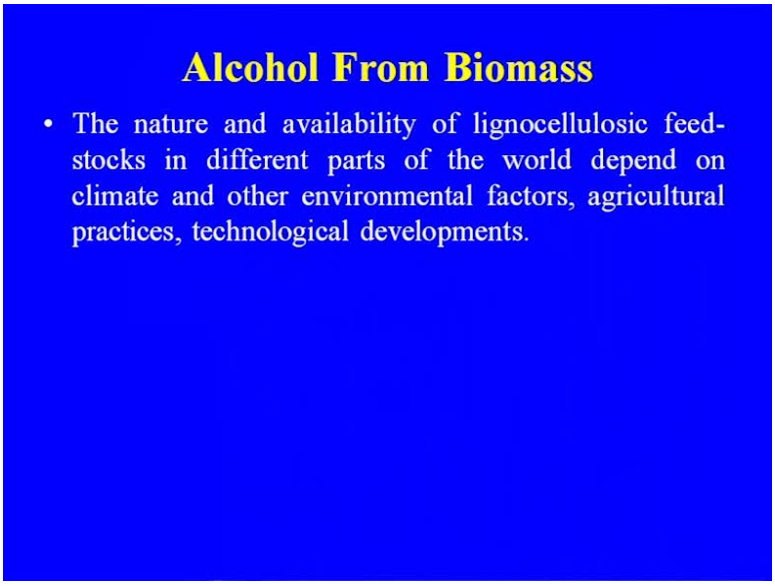

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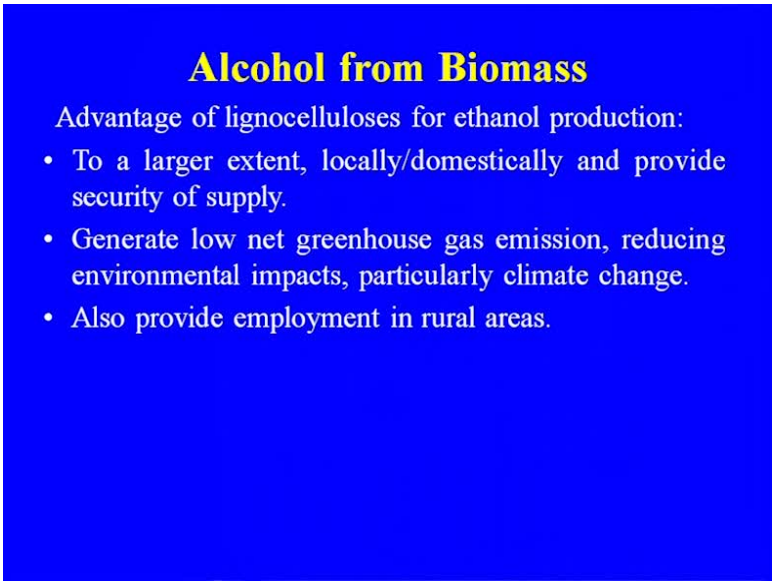

So, this is the actually the some of the biomass general term we are using for biomass for these waste material, these have the potential for the use as a feed stock for the production of the fuel and ethanol. The nature and availability of the lingo cellulosic feed stock in the different parts of the world depend on the climatic condition another environmental factor, agriculture practices, technological development.

Advantage of the lingo cellulosing material to a larger extent locally, domestically and provide security for the supply. Generate low net greenhouse gas emission, reducing the environmental impact, particularly the climatic change that we are having because of the deforestation because of using of the natural resources. Also, the providing employment in the rural area.

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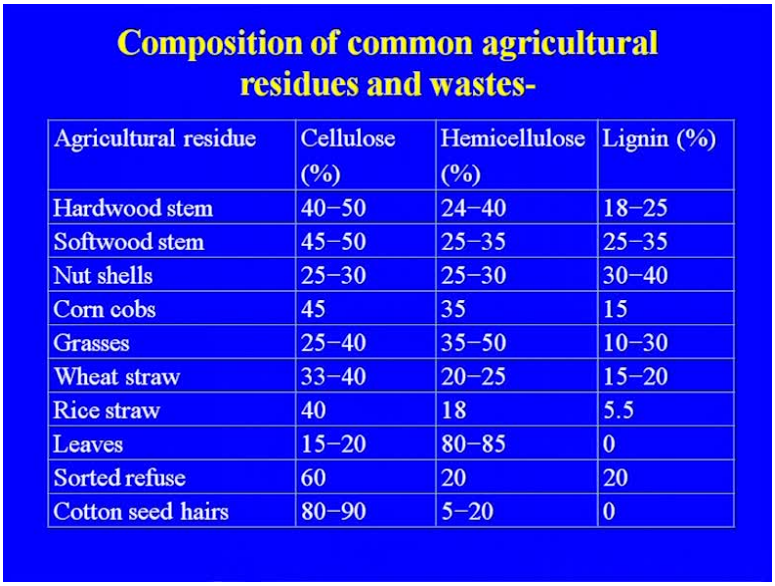

This is the cellulosic content of the various raw material hardwood, softwood, nutshells corn cobs, grasses, wheat straw, rice straw, cellulose contain hemicelluloses. This lignin that is creating problem in utilization of the biomass for the alcohol purpose. Otherwise, if so for the bio gasification, you concern no problem and at the same time use of the these biomass for the production of the paper, again that will depend up on the cellulosic content of the your biomass.

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Agricultural residue	Cellulose (%)	Hemi cellulose (%)	Lignin (%)
Coastal Bermuda grass	25	35.7	6.4
Switch grass	30–50	10–40	5–20
Solid cattle manure	1.6–4.7	1.4–3.3	2.7–5.7
Swine waste	6.0	28	
Primary waste water solids	8–15	NA	24–29
Paper	85–99	0	0–15
Newspaper	40–55	25–40	18–30
Waste paper from chemical pulp	60–70	10–20	5–10

Source; Bhoopathy,1998, Cheung. and Anderson 1997.

This is again some of the agricultural residue that you are getting.

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Bio-ethanol from Biomass

TECHNOLOGIES:

- Concentrated acid hydrolysis
- Dilute acid Hydrolysis
- Enzymatic Hydrolysis
- Biomass gasification and fermentation
- Source: Biofuel 2003

Technology bio-ethanol from the bio-mass, what are the technology available? The concentrated acid hydrolysis, dilute acid hydrolysis enzymatic because of coming of the enzyme bio-technology, lot of the improvement in the hydrolysis process that has taken place biomass gasification in the fermentation. Biomass gasification, already we have discussed this is the fermentation process, from where you can get the alcohol there, it will be the bio gasification to your synthetic gas, synthetic gas to methanol and that

methanol again that can be used for the making of the bio-fuel, this is the ethanol production per ton of the product, di-product from the various sources.

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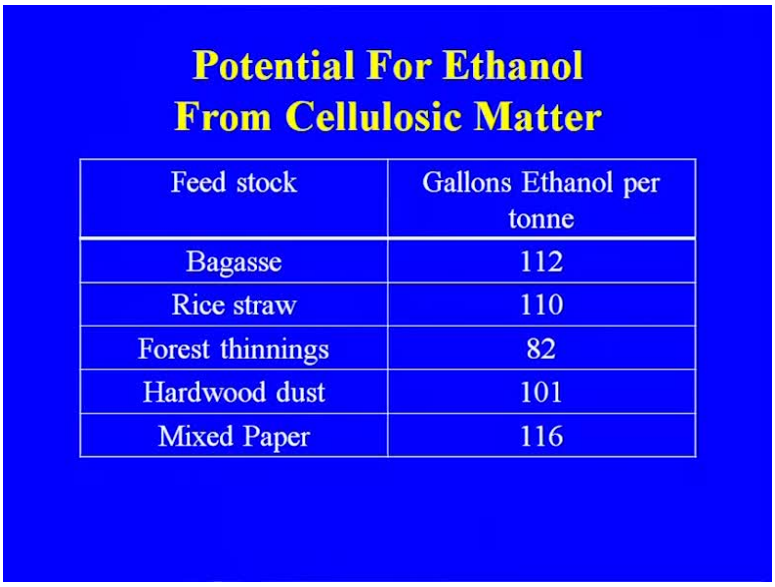

Bagasse, rice straw, forest thinning, hardwood dust and the mixed paper.

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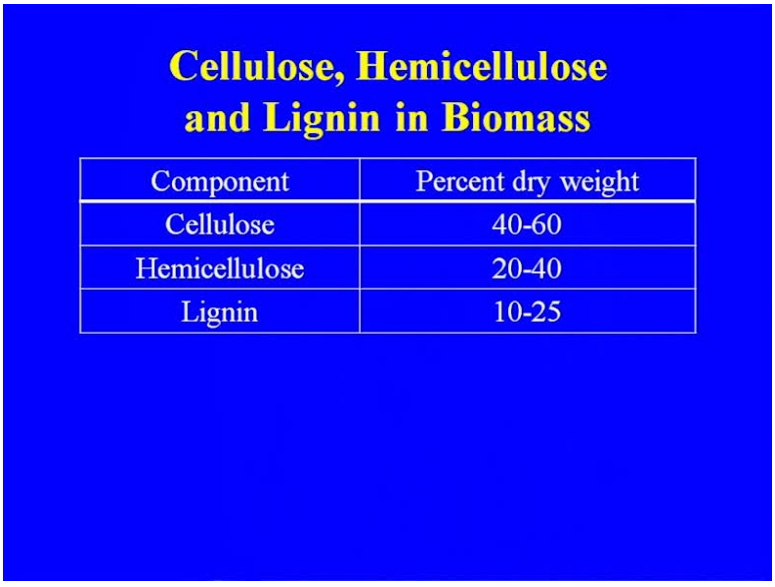

This is the cellulose, hemi cellulose and lignin in the biomass and that is the 40 to 60 percent, 20 to 40 percent hemi cellulose and lignin 10 to 15, 25 percent. Disadvantage of ethanol because there has been lot of discussion for ethanol as a bio-fuel, again that will be discussed by discussing the importance of the ethanol as a bio-fuel, but these are the

some of the disadvantages, which has created problem in utilization of the ethanol as a bio-fuel.

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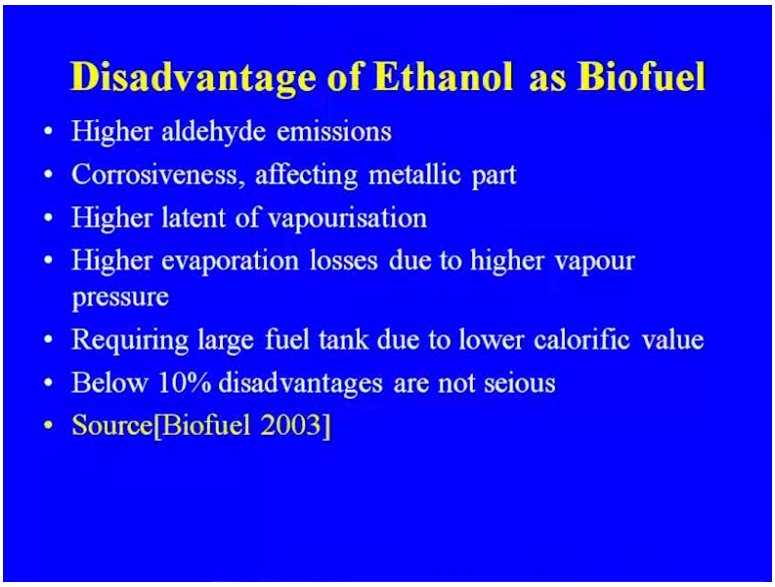

Higher aldehyde emission, corrosiveness, higher latent of vaporization, higher evaporation loss, requiring large fuel tank to lower the calorific value below 10 percent due to a disadvantage are not serious because normally, it tells the reason. Why 5 to 10 percent blending of the ethanol that has been recommended?

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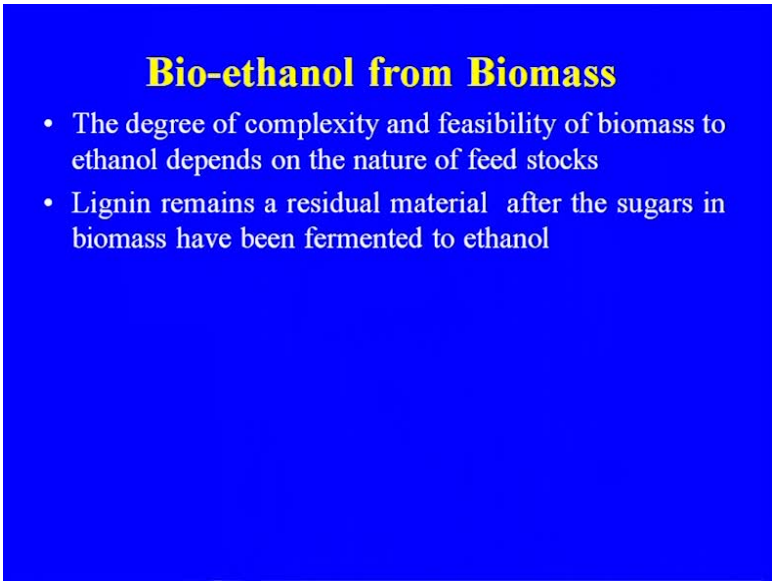

The degree of the when you are going for the bio-ethanol from the biomass, the degree of complexity and feasibility of the biomass to ethanol depends on the nature of the feed stock. As I told the contents of the, because the variation in the composition of the biomass is there, lignin remains a residual material, after the sugar in biomass have been fermented to ethanol. That lignin evens the separation of the lignin that is creating problem in case of the utilization of biomass. Already we have discussed these are the some of the technology that is available.

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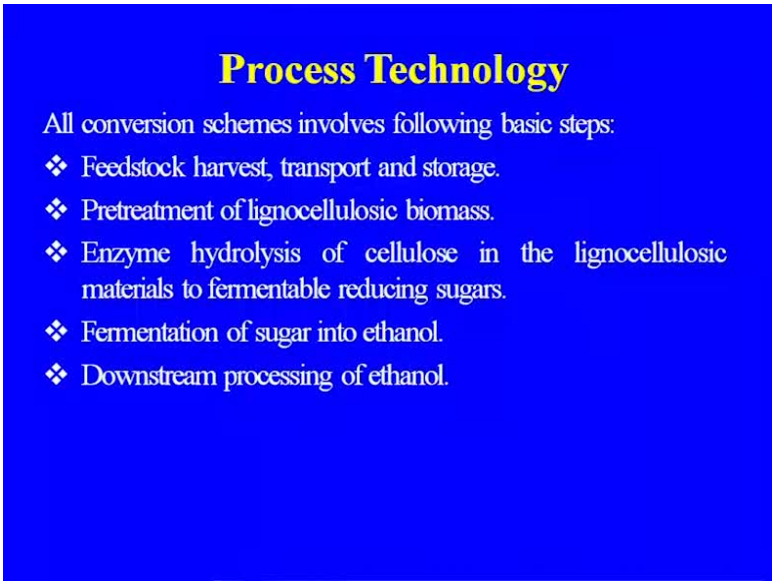

All the conversion processes in case of the biomass to ethanol that contains the feed stock harvesting, transport and storage pretreatment of the lingo cellulosic biomass, enzyme hydrolysis of the cellulose in the lingo cellulose material to fermentable reducing, sugar fermentation of the sugar into ethanol downstream processing of the ethanol. So, these are the some of the steps involved in case of the when you are going for manufacture of the ethanol from biomass. So, as I told you the pretreatment that is one of the problem in case of the, but that is pre requisite without that you cannot go for the further other process, which involve in case of ethanol process.

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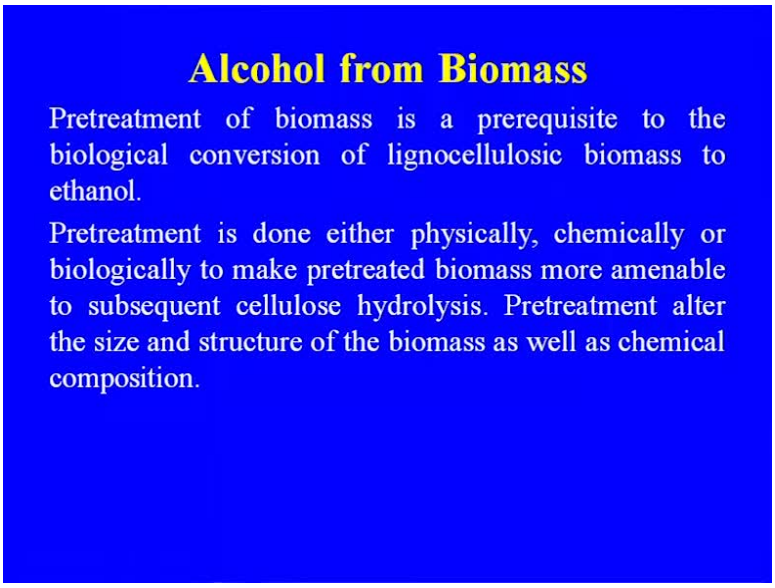

So, the pretreatment the biomass is a prerequisite to the biological conversion of the lingo cellulosic biomass to ethanol. Pretreatment is done either physically, chemically or biologically to make the pretreated biomass more amenable to subsequent cellulose hydrolysis. Pretreatment after the size and structure of the biomass as well as chemical composition because these are the some of the factor that will decide, the that will the pretreatment impact of the that will be that will alter the size. The structure of the biomass, as well as the chemical composition because some of the impurity that will be removed, during the pre treatment process. This already I have discussed in the, I have summarized.

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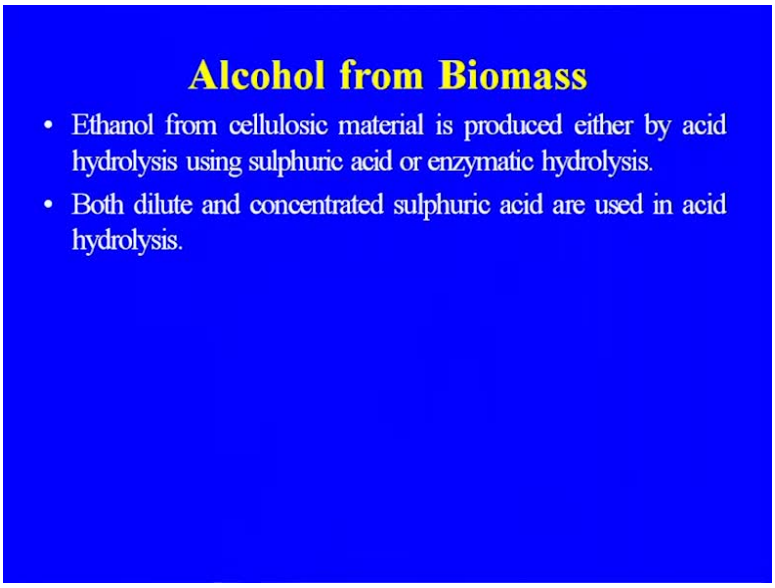

The various steps involved in case of the alcohol that is the cellulosic material, which produce either by acid hydrolysis using sulphuric acid or enzymatic hydrolysis. Both the process that is available, both the dilute and concentrated sulphuric acid are used in the acid hydrolysis.

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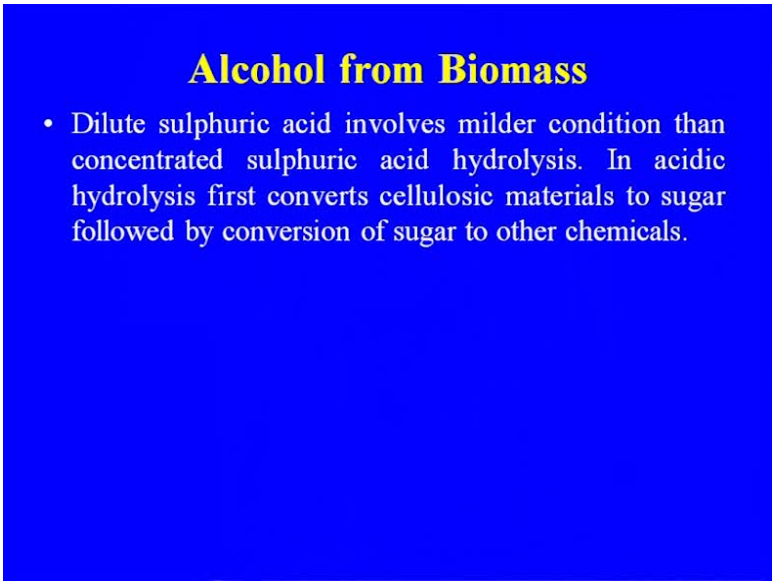

Dilute sulfuric acid involved milder condition than the concentrated sulfuric acid hydrolysis. In acidic in acidic hydrolysis, first convert cellulosic material to sugar followed by the conversion of sugar to other chemicals.

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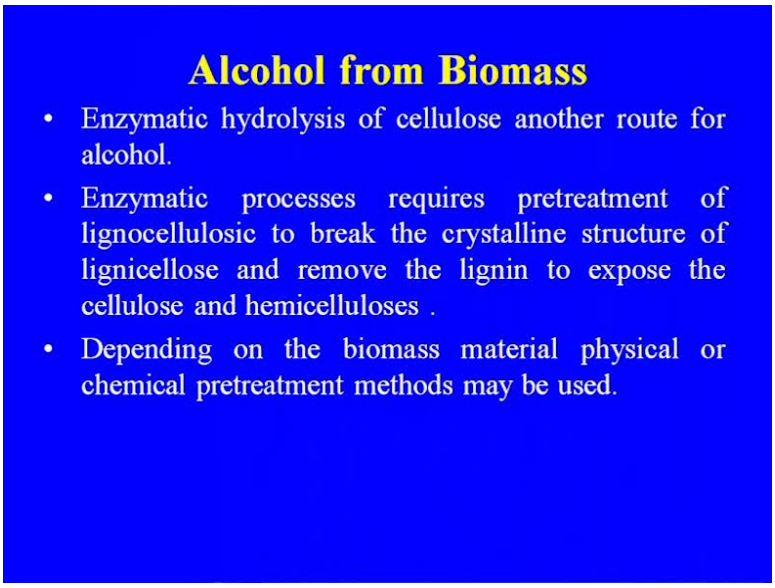

Enzymatic hydrolysis of the cellulose another route for alcohol, enzymatic process requires pretreatment of lignin cellulose to break the crystalline structure of the lignicellose, and remove the lignin to expose the cellulose and hemicelluloses, because this is the reason. Why the lignin removal? That has been very important. Depending on the biomass material physical or chemical pretreatment methods may be used.

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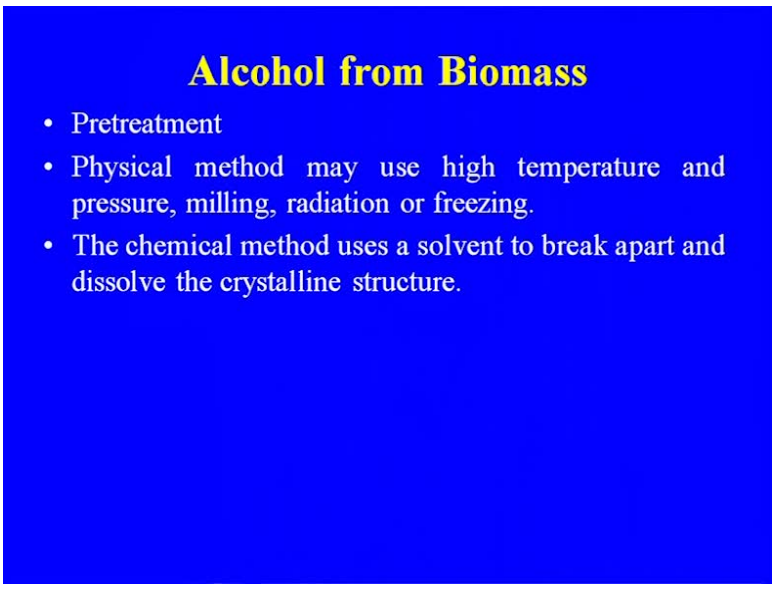

So, as I told you the physical treatment method may use high temperature and pressure, milling, radiation or the freezing. Chemical methods use a solvent to break apart and dissolve the crystalline structure.

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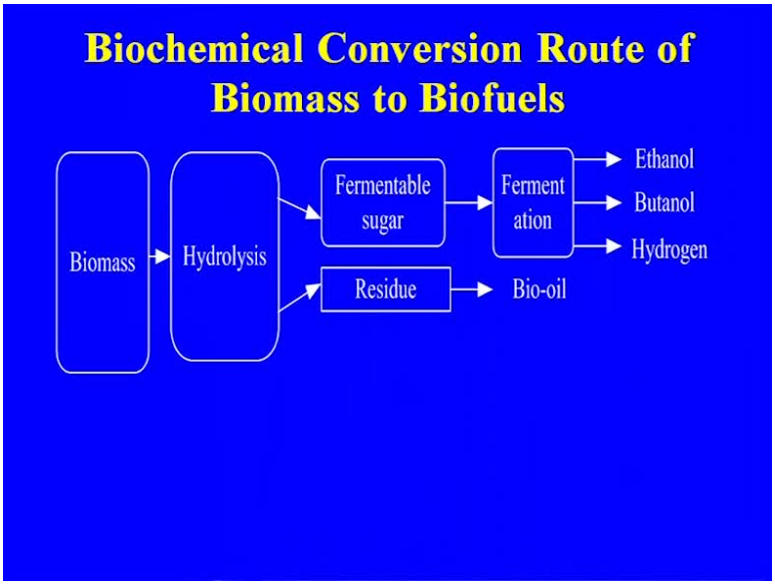

This is the actually the steps involved biomass, it will go to the hydrolysis fermentable sugar and then the residue and then the fermentation process, ethanol, butanol or the hydrogen whatever the product that what have.

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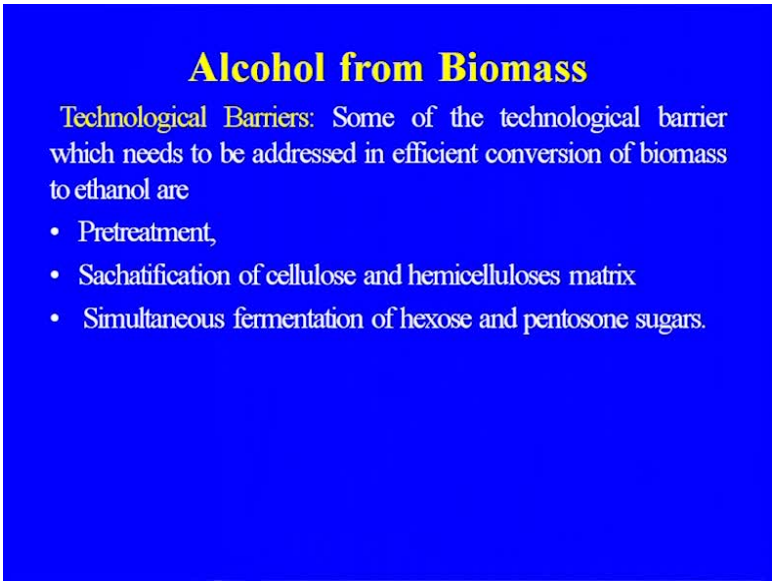

Technological barriers. Some of the technology barriers, which need to be addressed in the efficient conversion of the biomass to ethanol or the pretreatment sachatification of the cellulose and the hemi cellulose matrix. Simultaneous fermentation of the hexose and pentosone sugar. These are the some of the technological barriers.

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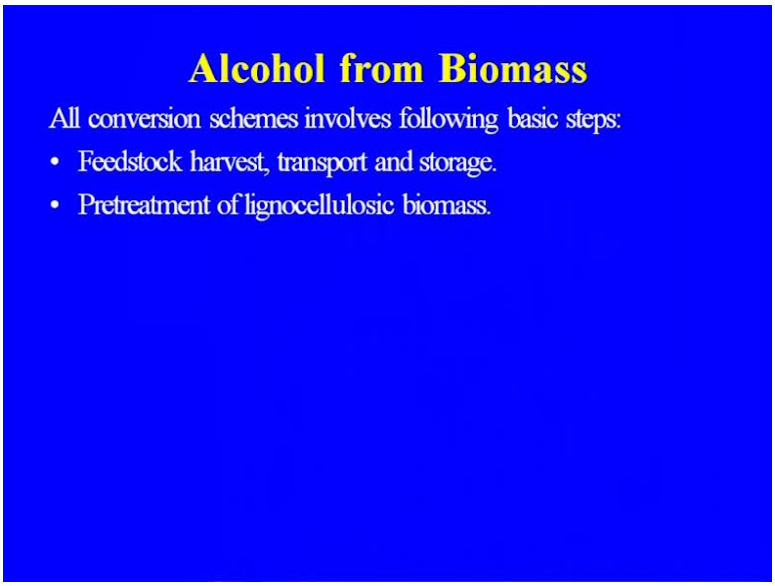

All conversion schemes involves following basic step already I discussed the feed stock, harvesting pretreatment and then the finally, the hydrolysis. So, this was the how we can alternative source of the ethanol from the biomass is there. In the next lecture, lecture 2 we will be discussing about the ethanol in more detail about, how the ethanol that can be used for the production of the various useful chemical. And that is being used in many of the plants, some are integrated and in some of the cases they start from the fermentation and then the ethanol that is being used for the manufacture large number of the chemicals.

And one of the because even the starting of the some of the chemical that was through the ethanol route not it was the petroleum route. But it was the ethanol route as some of the example are the Indian glycol, vam organic which is now synthetic chemicals barely and some of the other plants, sumaya chemicals all are they are they were using the alcohol for producing the large number of the chemicals, which are now being made from the petro chemical route.