Chemical Technology
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Module 08
Polymer
Lecture 03
Polyvinylchloride, polycarbonate,
Thermoses Resin: Phenolformaldehyde,
Uriaformaldehyde and Melamineformaldehyde

Today, we will be discussing about the polyvinylchloride and polycarbonate that is also the one of the important thermo plastics. Other one of the important class of the poly motor thermoset strategy, in that we will be discussing about the phenol formaldehyde urea formaldehyde, melamine formaldehyde and also a proxy range.

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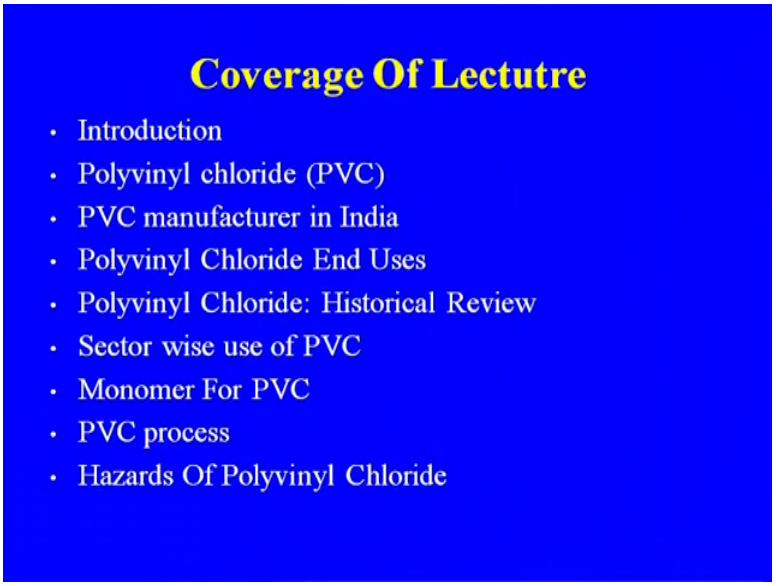

The coverage of the lecture that will be introduction that will be discussed in detail about the polyvinyl chloride. So, the polyvinylchloride PVC manufacturer in India, polyvinylchloride end uses, polyvinylchloride historical review, sector wise use of polyvinylchloride what are the monomer for polyvinylchloride PVC process and hazards of the polyvinylchloride.

This is one of the important issues in the case of the manufacture of the PVC and at the same time polyvinyl hazard also it is requiring huge amount of oil. So, the transportation of the chlorine and the other products hydrogen and sodium hydrate say that also to get

some issues regarding the probability of the PVC plant and hazards. So, as far the hazards is concerned, we are handling chlorine we are handling the explosion that is to be exported and the vinyl chloride reactor. Also, these are from the environmental point of view also and PVC there is some of the major resources.

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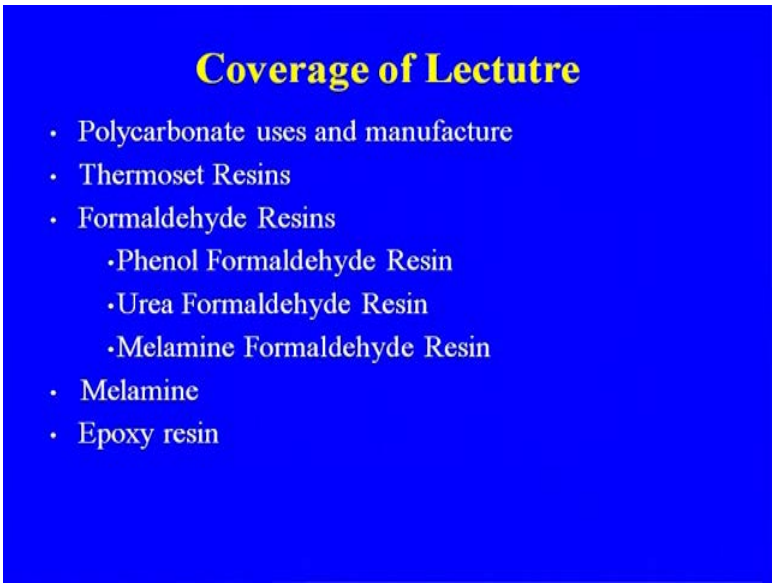

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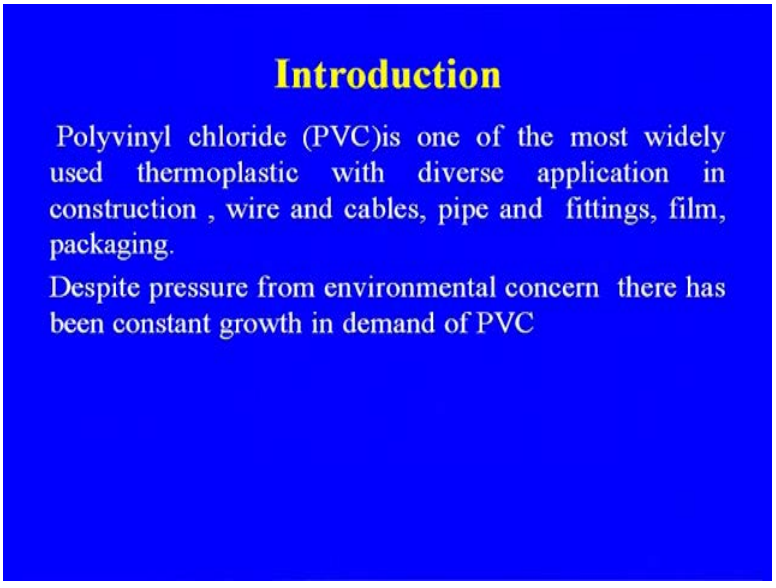

We will be discussing about the polycarbonate, its usage and manufacture, thermo set resins and in this class the formaldehyde is very important thing formaldehyde. We will

be discussing about the phenol formaldehyde, urea formaldehyde, melamine formaldehyde and then melamine, epoxy resins.

Polyvinyl chloride is one of the most widely used thermoplastic with diverse application in construction, wire and cables, pipe and fittings, film packaging. Despite pressure from environmental concern which I told you, there has been constant growth in demand of PVC and the demand is increasing.

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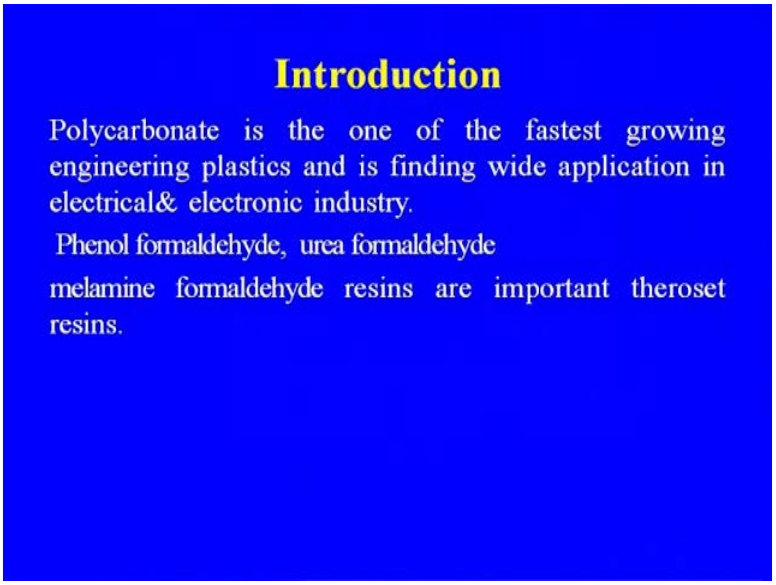

Polycarbonate is another important plastic is one of the fastest plastics and is finding wide application in electrical and electronic industry. The optical create of the following classes that you are making from this phenol formaldehyde, urea formaldehyde melamine formaldehyde resins are the important resins, phenol formaldehyde. We know the name it stated the death light and the commercial back light and earlier all the electrical which is another materials owned, they were all owned from of the phenol formaldehyde and the resins and other resins also the varies. Let us now discuss about the Polyvinyl chloride and then we discuss about the thermoset resins.

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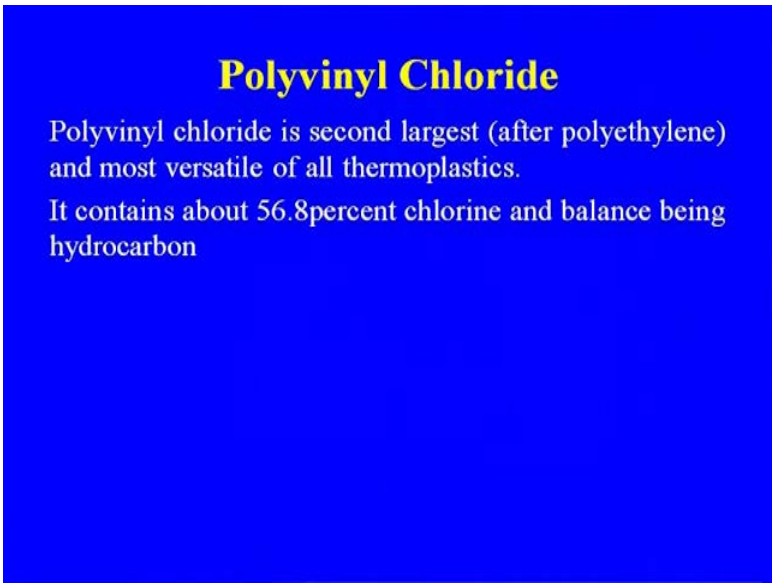

Polyvinyl chloride is the second largest after polyethylene and most versatile of all thermoplastics. It contains about 56 percent chlorine and balance being hydrocarbon. So, the chlorine that is one of the important raw materials for the PVC and if you see what happens in this case, there this start PVC is manufacture started.

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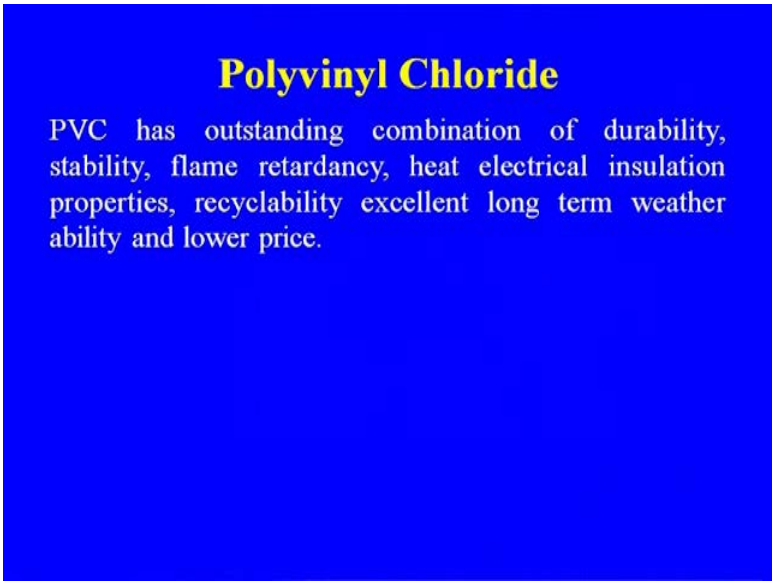

They started the plastic resourcing plant there was the less use of the hydrogen and the chlorine. So, this is the reason why they call the floor clastic and not the clothing industry. So, that is one of the case of the Polyvinyl chloride because the manufacturing

point will be at one place and the user will be at another place. The user will be some of the petro chemical substance like reliance; they are having their own clothing plant at Gandhar.

So, PVC has outstanding combination of durability stability flame ret ardency, heat electrical insulation properties, recyclability, excellent long term, weather ability and lower price because of the usage. You see in one of the major revisal in the PVC production data has been the availability of the clean from the cracker because earlier was the ethically from the molasses group or it was from the calcium carbonate rule. Then, to your vinyl chloride, so this is what we actually one of the major factor is the Polyvinyl chloride.

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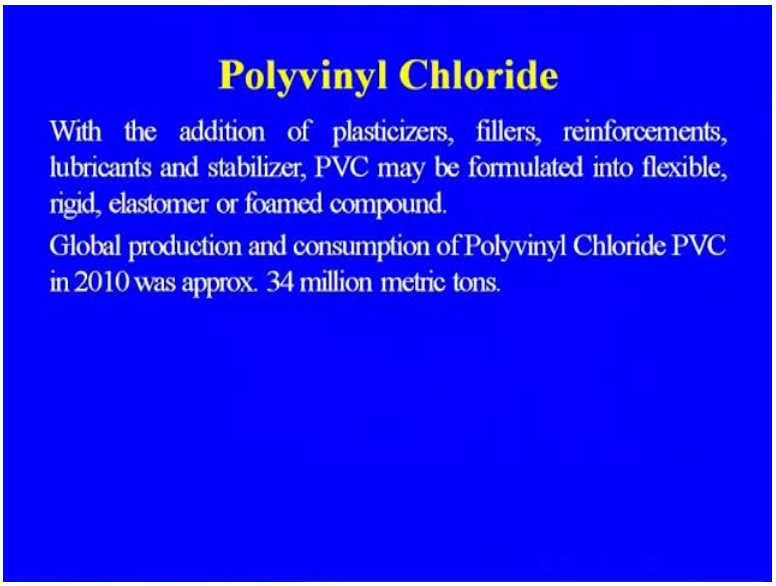

With the addition of plasticizers, fillers, reinforcements, lubricants and stabilizer PVC may be formulated flexible rigid elastomer or foamed compound global production and consumption of Polyvinyl chloride in 2010 was approx 34 million metric tons. So, what the vinyl industry in India is concerned vinyl industry in India is valuated about 20,000 crores. India is about imports are slated to increase to 19 percent by 2016, construction sector is the research consumer of the PVC because you see the piping's pipe fittings and the insulating material per wire is also the PVC flooring. So, one of the major source of the consumer is the consumer sector.

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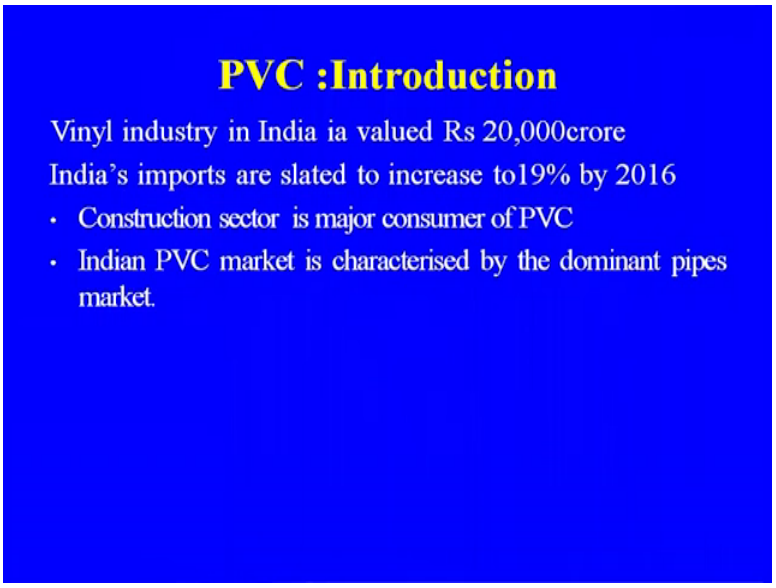

Indian PVC is characterized by the dominant pipes in the market which I told you the pipe and pipe fittings.

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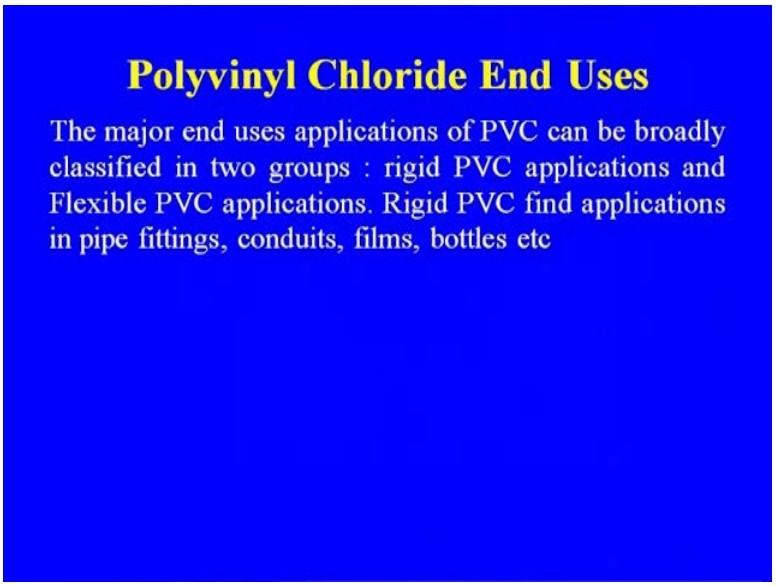

The major end users application of PVC can be broadly classified in two groups' rigid PVC application and flexible PVC application, rigid PVC find applications in pipe fittings, conduits, films bottles etc.

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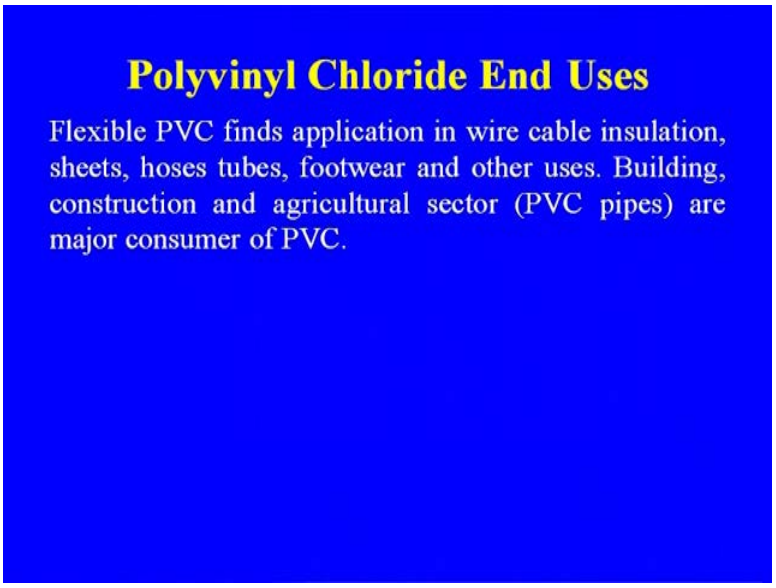

Flexible PVC finds application in wire cable insulation, sheets, hose, tubes, footwear and other uses building construction and agricultural sector as I said are the major consumer of the poly vinyl chloride.

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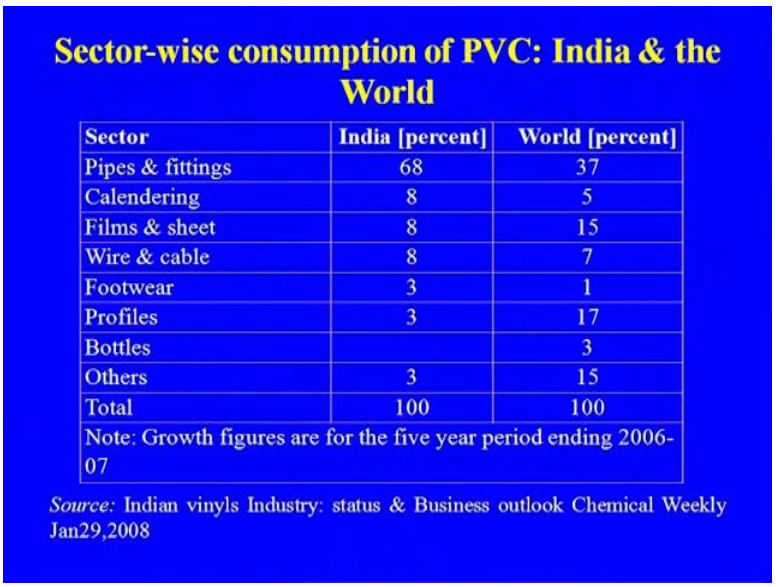

This is the sector wise consumption of the consumer is the pipes and calendaring, films and sheets footwear profiles. Then, others and the total all world wide the percentage and that is pipes and fittings in India, only it is 68 percent and the other part of the world is 37 percent.

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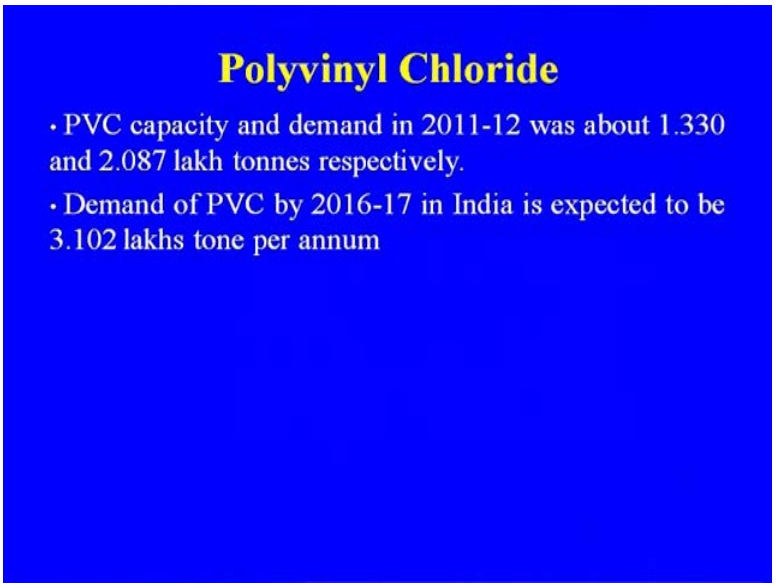

PVC capacity and demand in 2011 and 12 were about 1.330 and 2.087 lakh tones. Respectively, demand of PVC by 2016-17 in India is expressed to be 3.102 lakhs ton per annum. So, you can just imagine the requirement of the PVC the figure which you are having it in 11 and 12 and in the figure expected which is in 2016 is more PVC plant.

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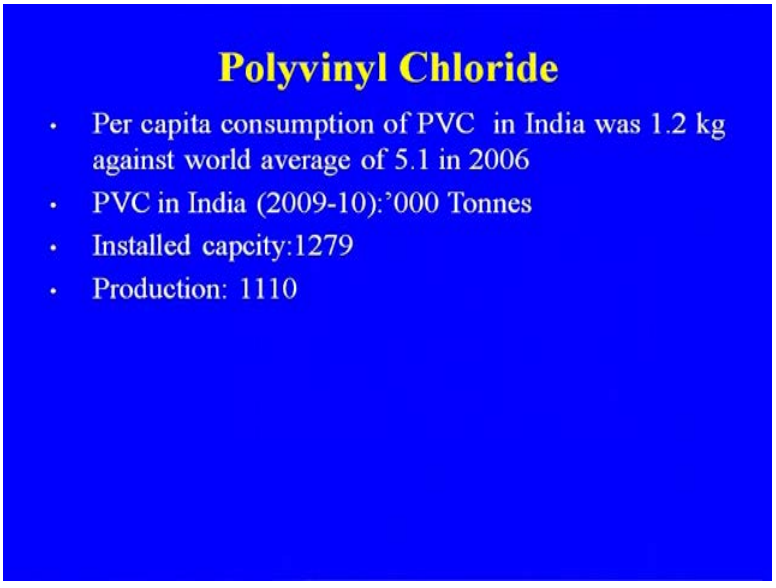

Per capita consumption of PVC in India was 1.2 kg per that was in 2006 in which the world average was five point one the PVC in India was in India. This is the installed capacity and the production that is 2,000, that is installed capacity is 10 PVC

productions. Now, let us some historical review or poly vinyl manufacturing theory in India because the early stage before coming of the better complexes of the structure PVC was manufactured.

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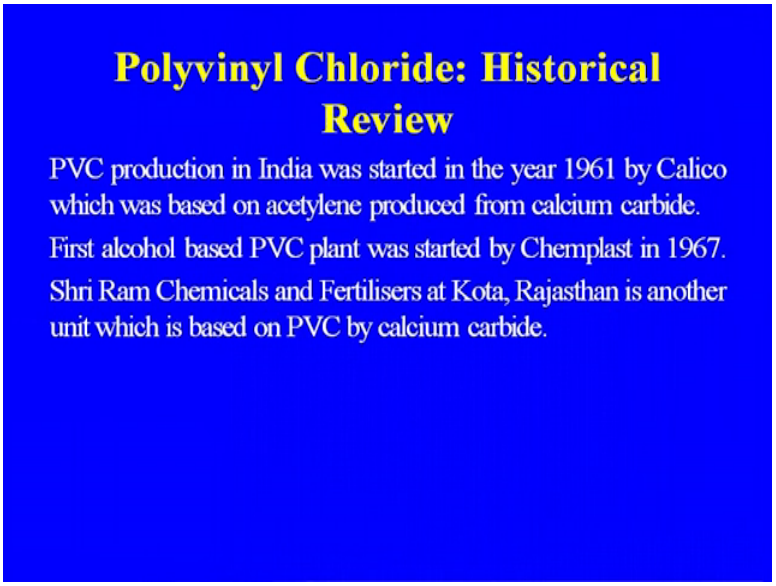

So, the PVC pipes was manufactured was started in the year 1961 by Calico and you see after that the came in a carbon plant say or those are they were all during the 65-66 and 70. PVC production in calico that was based on the on acetylene produced from carbon carbide, so see the route is still then the Shri Ram chemicals and the fertilizers, they are making by this role.

First alcohol based PVC plant was started by Chemplast in 1967, it was the first alcohol based plant because from alcohol to ethylene to vinyl chloride etc and etc to vinyl chloride towards the process. Even at that time 1966, ethylene was not available from the petro chemical complex Shri Ram chemicals. The Fertilizers at Kota, Rajasthan is another unit which is based on PVC by calcium carbide because in making the calcium carbide and calcium carbonite to acetylene to vinyl chloride.

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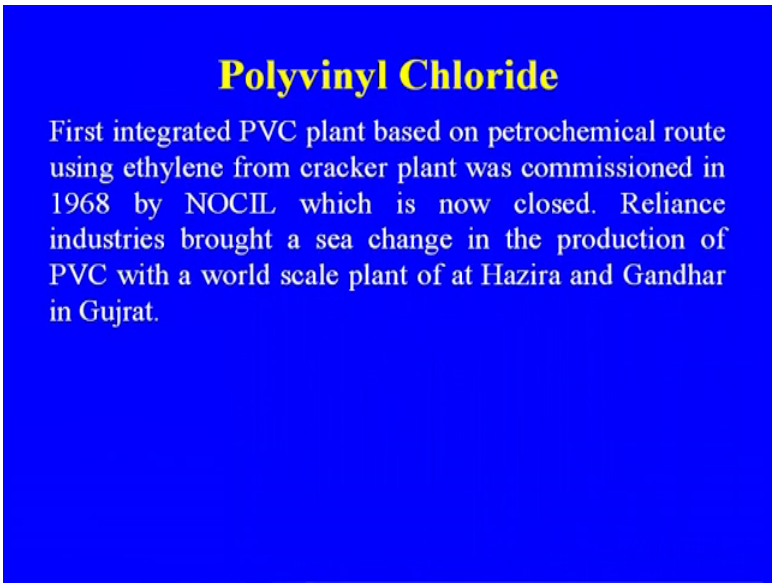

First integrated PVC plant based on petrochemical route using ethylene from cracker plant as now commissioned in 1968 by NOCIL because it is closed. It has now been taken over by reliance it is now the carbon sulphate of this place, reliance industries brought a sea change in the production of Poly vinyl chloride with a world scale plant of at Hazira and Gandhar in Gujarat. These are the two major complexes which are making huge amount of polycarbonate and the other unit of the reliance which was earlier by the caustic they are also having the plant. So, the requirement of the chlorine that is from their own generation own production of the chlorine.

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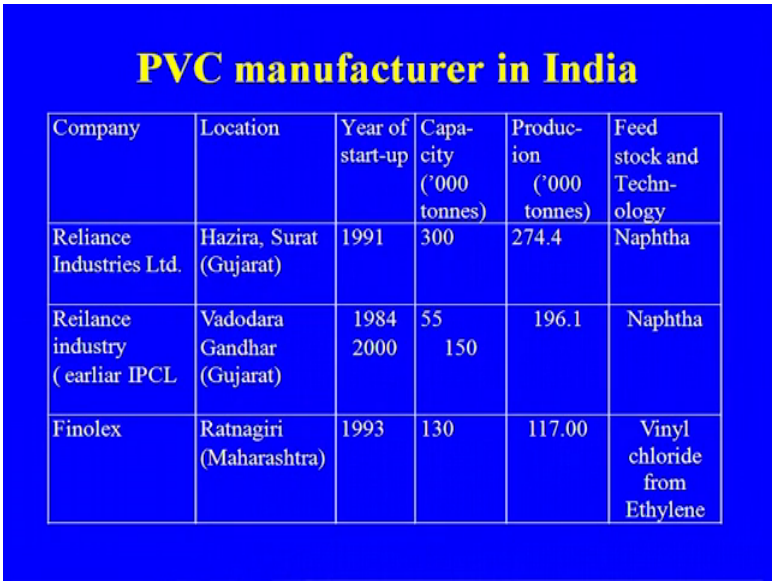

These are the various series reliance, reliance, IPCL, Finolex, Hazira this is the location of the plant start up of the various plants in India. So, here you can see your sources of the stock naphtha cracker, Finolex, vinyl chloride from ethylene.

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PVC manufacturer in India

Company	Location	Year of start-tup	Capac-ity ('000 tonnes)	Produc-tion ('000 tonnes)	Feedstock and Techno-logy
Chemiplast	Mettur (Tamilnadu)	1967	60	58.0	Ethylene from Alcohol
DCW	Tuticoran (Tamil Nadu)	1972	60	45.0	Acetylene from calcium carbide
DCM Shriram	Kota (Rajasthan)	1964	33	24.7	Acetylene from calcium carbide

Then, Chemiplast, ethylene from alcohol Mettur in Tamil Nadu this has been started in the year 1967 DCW Tuticorin, Tamil Nadu acetylene from calcium carbide DCM Shri Ram Kota, Rajasthan acetylene from calcium carbide chloride vinyl chloride.

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These are some of the all application you can see the fittings pipe fittings because. You can see that along with poly pre line PVC they are also using the appreciable amount using the hospital m material. That is for the back age in the hospital that is the syringes and other material, so these are some of pipe fittings these are some of other material that we are making.

Then, the vinyl flooring that you know that this is the water tank mate of PVC and this is how the PVC that is playing the important role in playing many of the items. We shall find them using the trials because the issue of the PVC trials which was supplied in African country that was having some liquidity and that was it rate, so that is one of them importantly regarding the or in trios also we are using that PVC.

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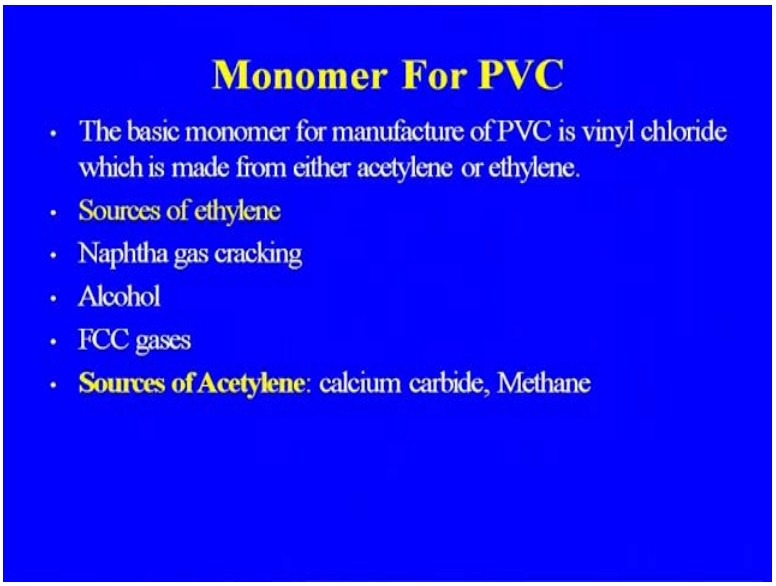

The basic monomer for manufacture of PVC is vinyl chloride which is made from either from real also while discussing the raw material from the chemical industry and time to time in the petro chemical various sources phenol chloride. Earlier, it was the acetylene followed by the ethanol and then after coming of the plant of noisily or the IPCL Vadodara and lecture by IPCL it is Gandhar, Hazira. They started in making the vinyl chloride through the naphtha, so this is the vinyl chloride naphtha alcohol.

This is from some interest of the FCC gasoline there while discussing the FCC gasoline the 4 g 5, I told that the FCC guys also contain the TLS scheme the low percent of ethylene n. So, it becomes now the refineries they are looking for the recovery of the

ethylene from the FCC gases sources of the ethylene route is the calcium carbide. We do not need any idea carbon that is dependent upon the petroleum industry and another route in the data entry methane this is also one of the factors discussed. And these two are the methods how we have esteemed the how the reactions are involved.

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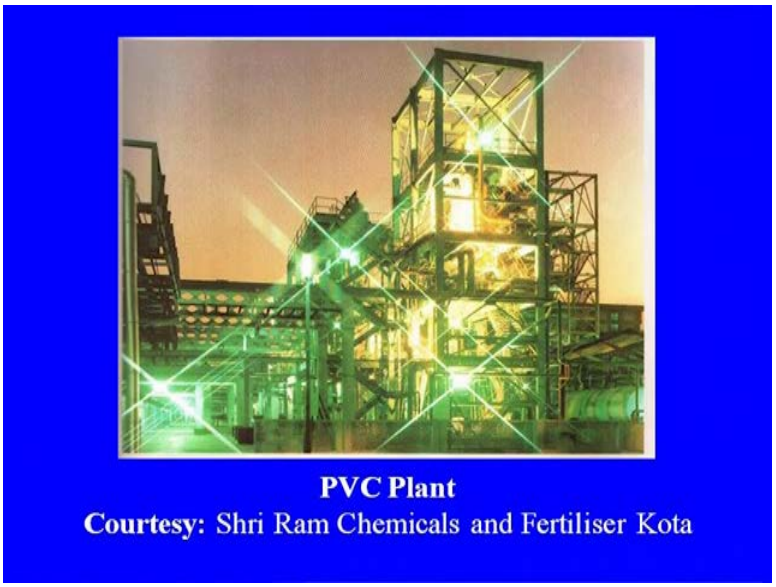

This is the PVC plant of Shri Ram chemicals and fertilizers Kota and this is the courtesy Shri Ram chemicals and fertilizers Kota. This figure is the PVC plant they are having that is based on acetylene from the calcium carbide.

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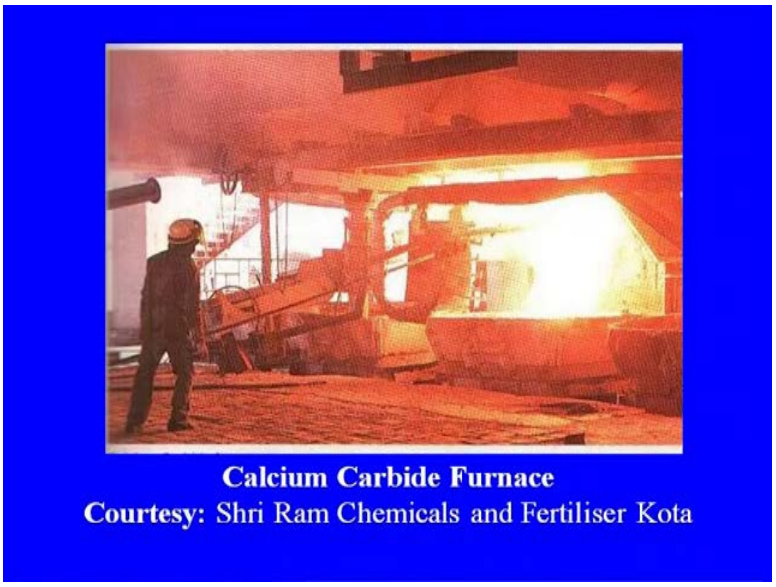

This is the calcium carbide plant; you can see that the environmental condition of plant this is the route, and how we are making the calcium carbide.

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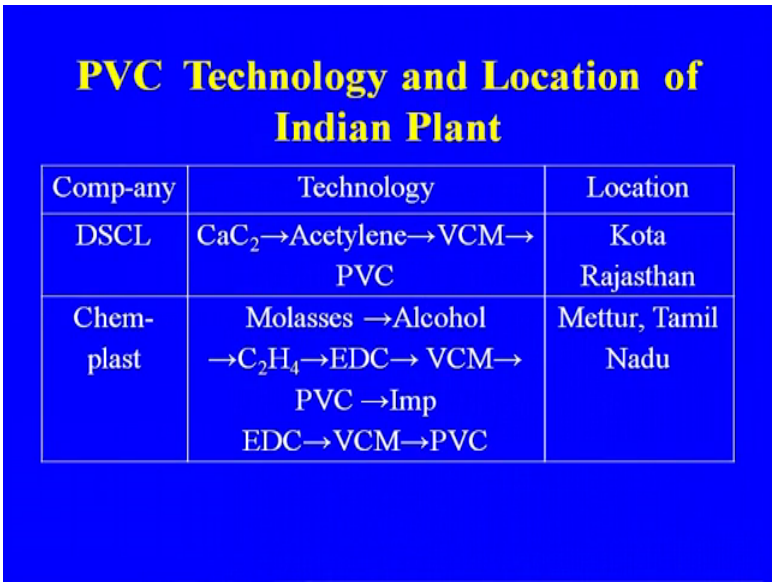

These are the some of the location already we have discussed about the location, but what is the route. They are making for the acetylene that is DSCL calcium carbide acetylene to the vinyl chloride monomer Chemplast molasses to help alcohol to acetylene, and the acetylene chloride after cracking vinyl chloride monomer and the PVC that we are getting and DCW VCM to PVC.

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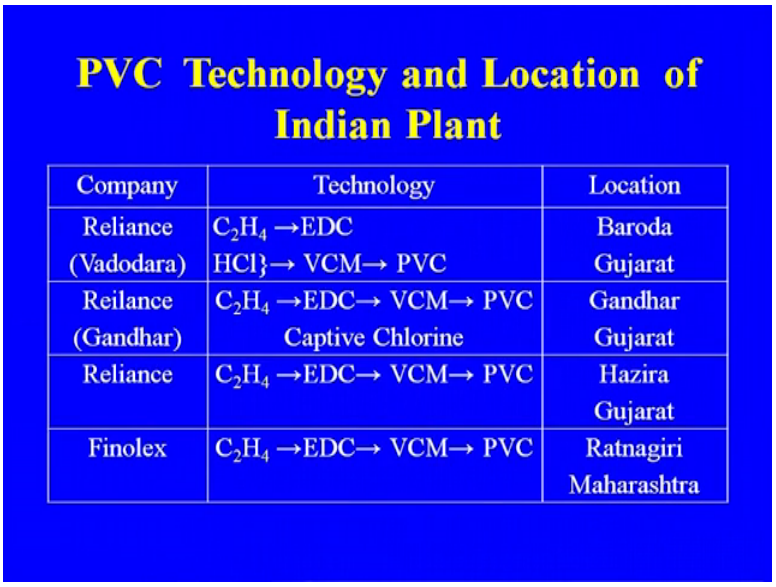

Reliance Vadodara, reliance Gandhar, reliance Hazira, these are all the ethylene cracking from the plant and the Finolex Ratnagiri are also for ethylene from making of the vinyl chloride. What are the process technology that is available to suspense and process suspense and polymerization is very common.

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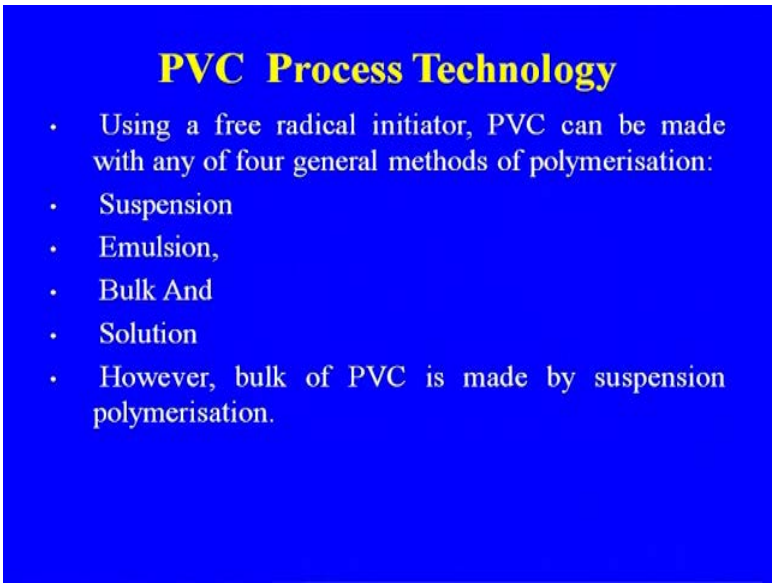

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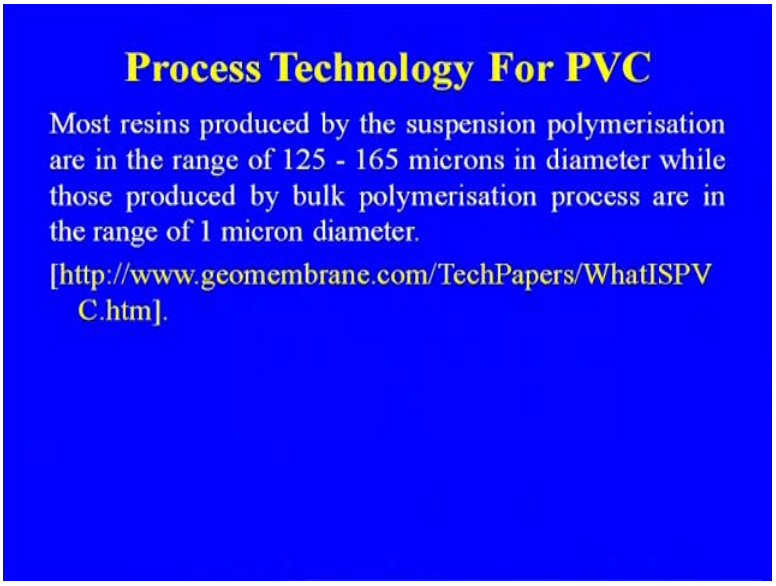

Using a free radical initiator PVC can be made with any four general methods of polymerization suspension, emulsion, bulk and the solution polymerization. However,

bulk of the PVC is made by suspension of the polymerization, but all the four methods that can be used, but most of the times are made by the suspension polymerization.

Most of the resins produced by the suspension polymerization are in the range of 125 to 165 microns in diameter while those produced by bulk polymerization process are in the range of 1 micro diameter. So, this one of the comparison of the bulk polymerization for the process technology of PVC. Now, let us discuss about the process technology for poly Vinyl Chloride.

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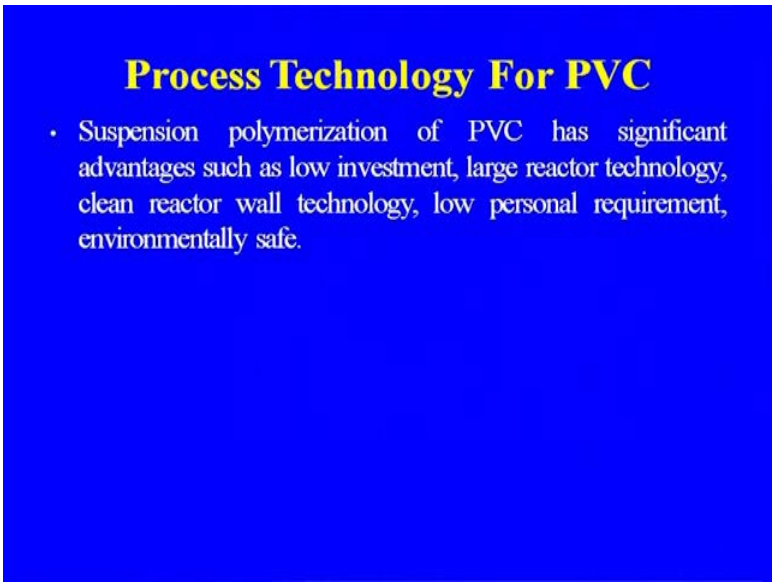

Suspension polymerization of PVC has significant advantages such as low investment large reactor technology clean reactor wall technology low personal requirement environmentally safe. So, these are some of the advantages of the suspension polymerization system with the vinyl chloride because that has been given in case of synthetic fiber also vinyl chloride that has also added to the fiber.

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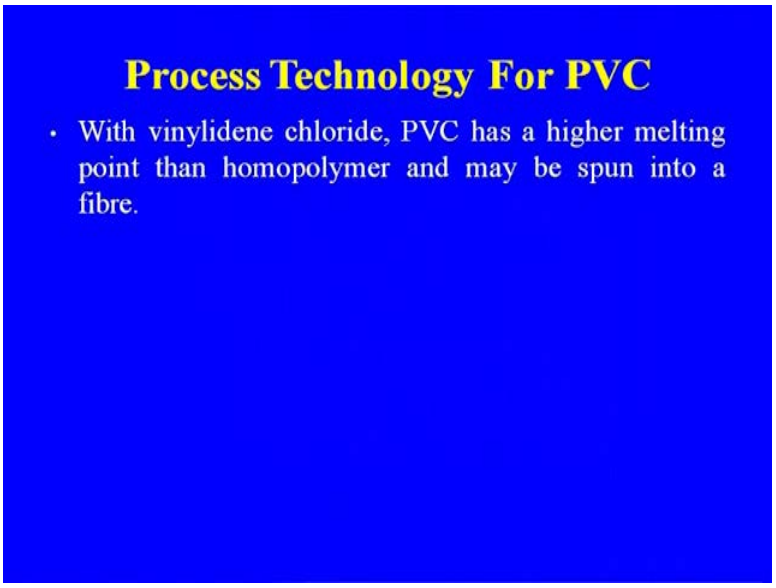

So, PVC has higher melting power, then the homo polymer and may be spun into a fiber also.

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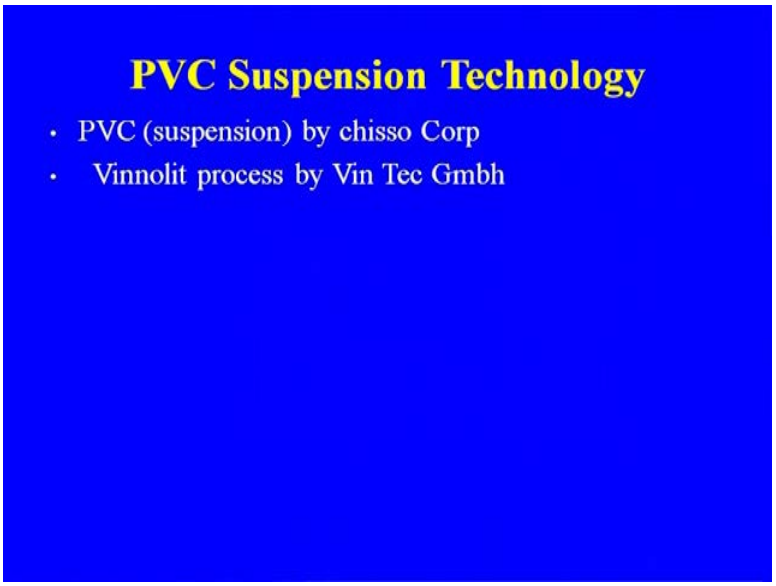

So, this is the suspension PVC by Chisso Corporation that the process licensor vinnolit process by Vin Tee Gmbh both the process is also placed by suspension polymerization. Let, us now discuss the many description of the suspension polymerization process of the polybenayl, polymerization process.

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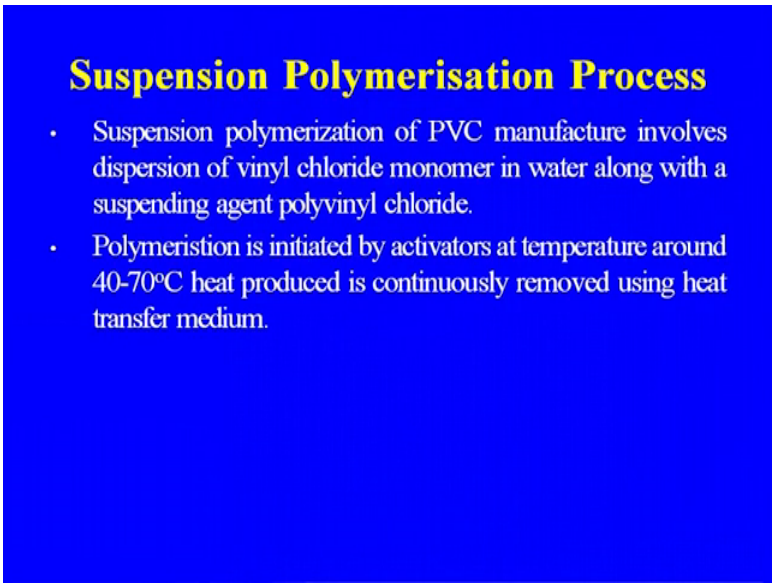

Suspension polymerization of PVC manufacturer involves dispersion of vinyl chloride monomer in water along with a as name itself says that the suspension monomer are in the suspension form. So, the vinyl chloride monomer is in the vinyl chloride monomer is in water along with suspending agent is there. So, polymerization is initiated by activities activators at temperature around 40 degree to 70 degree centigrade heat produced is continuously removed using heat transfer medium.

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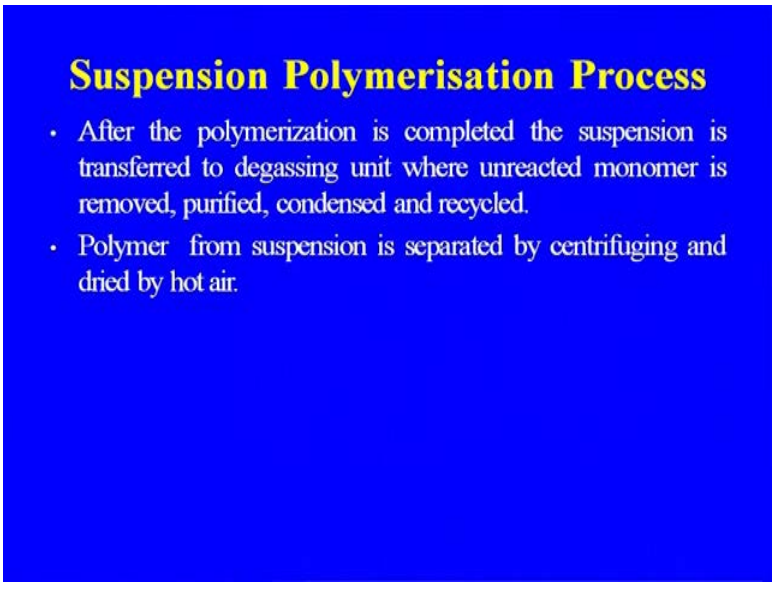

After the polymerization is completed the suspension is transferred to degassing unit where unreacted monomer is removed purified condensed and recycled polymer from suspension is separated by certifying and dried by the hot air.

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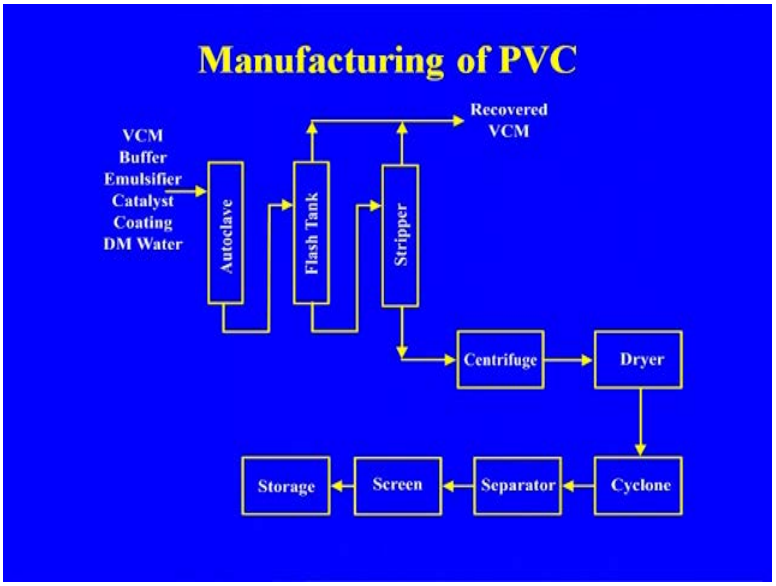

This is the process for the manufacturing of polymerized here, you this material vinyl monomer along with the catalyst and then the water it is going to the autoclave auto clave with the flash tank where we are recovering the monomer. It is again recycled and found this stripper also from flash tank and from this stripper to the phenol chloride monomer. That will be to the autoclave and to the bottom of this column that is deviation that is for the centrifugation and the centrifugation separation of the PVC to the dryer and dryer to cyclone, cyclone to the separator. It is to screen and it is finally to storage, so this is brief about the PVC manufacturing technology.

As I told you earlier because there are always hazards associated with poly vinyl chloride and one of the reasons, we are using as I told the large amount of chlorine is there in the poly vinyl chloride and the handling of the chlorine. Then, the plant they are not at the sight of the unit, so transportation that is small part that is regarding the economic part in case hazards is concerned is because the of your chlorine.

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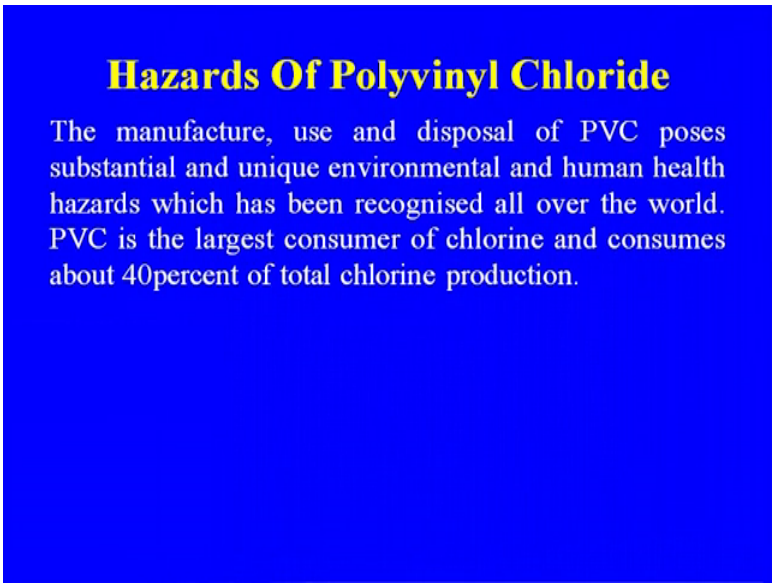

The manufacture use and dispose of PVC poses substantial and unique environmental even the disposal of the PVC because even if you are going for destruction description chlorine vapour chart will come. So, the PVC poses of the substantial and unique environmental human health and a hazard which has been recognizes all over the world PVC is the largest consumer of chlorine and consumes about forty percent of total chlorine production. So, this you can just see the amount of chlorine that has given, but see here the major changes that has manufacture of the caustic dine.

That was considered which is the hazards because of the use of the mercury self causes, but after the coming of the memorincial process for the production drastically. So, that is the production hazards essentially the caustic inbounds that has been minimized, but still that chlorine which is in PVC. That will create problem another problem is the reactor vinyl chloride reactor also me of the explosion that has been reported the vinyl chloride reactor also.

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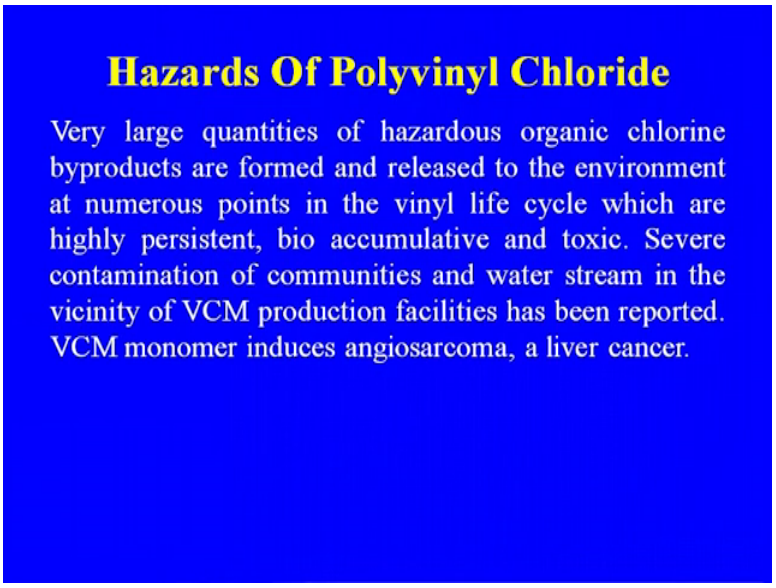

Very large quantities of hazardous organic chlorine by products are formed and realized to the environment at numerous points in the vinyl life cycle which are highly persistent bio accumulative and toxic severe contamination of communities. Water stream in the vicinity of VCM production facilities monomer production has been reported, this is why I was telling like vinyl chloride, it will not access the PVC. It is the vinyl monomer plant from which is one of the major sources of the pollution VCM monomer induces angiosarcoma a liver cancer.

So, the vinyl chloride because that si present in this because we are doing the polymerization in the VCM. So, that is one of the problem in the utilization of the PVC and that problem was said I told already that was the twice hazards of the twice when the children are using it so that has been there that has been reported in the literature. Now, let us discuss the other important part of the thermo plastic that si the polycarbonates.

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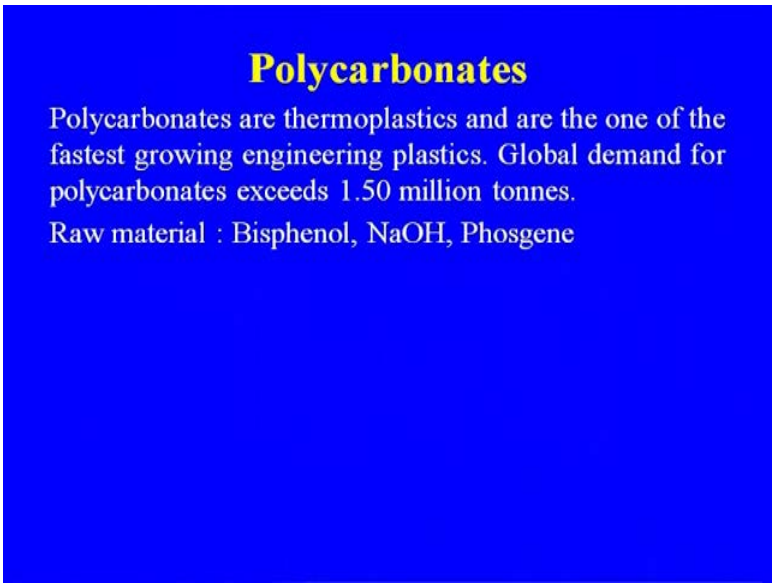

Polycarbonates are thermoplastics and are one of the fastest growing engineering plastics global demand for polycarbonates exceeds 1.5 million tons. Here, again problem some problem you know regarding the manufacture because the manufacture best phenol which the poly carbonate this phenol, we need the phenol in case of the polycarbonates we need the best vinyl for sea. So, it has this nature in case of the fall sea deficiency, so that is one of the sources in case of the manufacturing polycarbonates.

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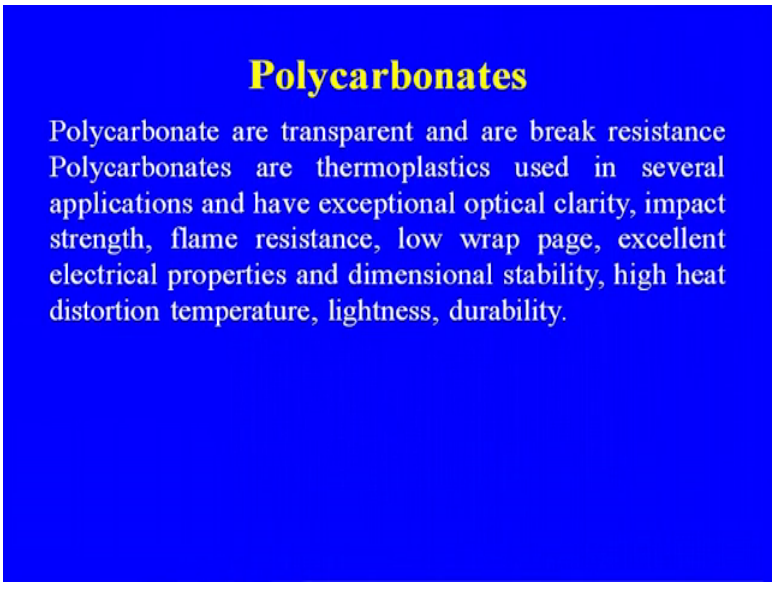

So, the polycarbonatism why the polycarbonates has so much in part in because you see it was the polycarbonates which was not well developed regarding this phenol manufacture and the for sea manufacture. At the same point some of the excellent parties of polycarbonates are there, which are the measures of the acting force of the development of the polycarbonates industry.

So, the polycarbonates are transparent and are break resistance polycarbonates are thermoplastics used in several applications and have exceptional optical clarity. This is the reason why we are using the optical glasses impact strength flame resistance low wrap page excellent electrical properties and dimensional stability high heat distortion temperature lightness durability. So, these are the some of the important properties of the poly carbonates which has led to the more and more use of the polygonal.

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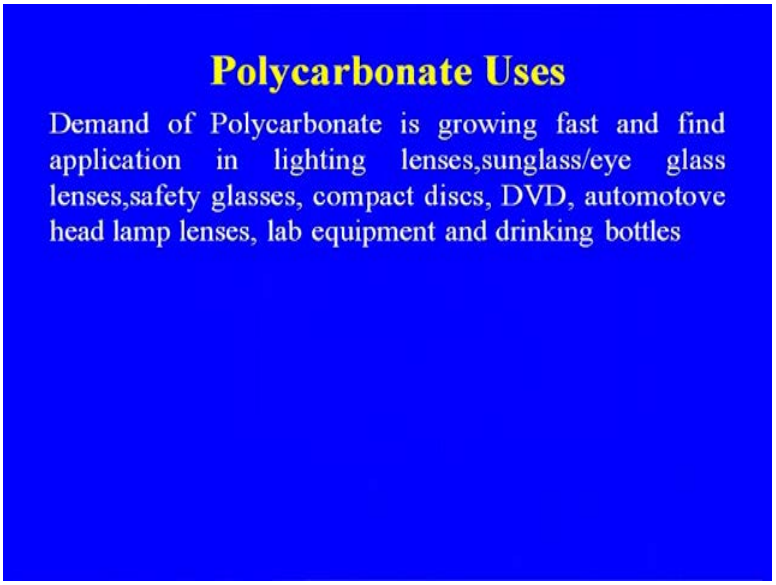

Demand of polycarbonates is growing fast and find application in one of the area, which are lighting lenses sun glasses or eye glass lenses safety glass. CD's is one of the major revolution in one of the CD and DVD which is the raw material using the polycarbonates formula automotive head lamp lenses lab equipment. Drinking bottles even in case of the this having very high strength in the sue also some of the force material also we are using the polycarbonates.

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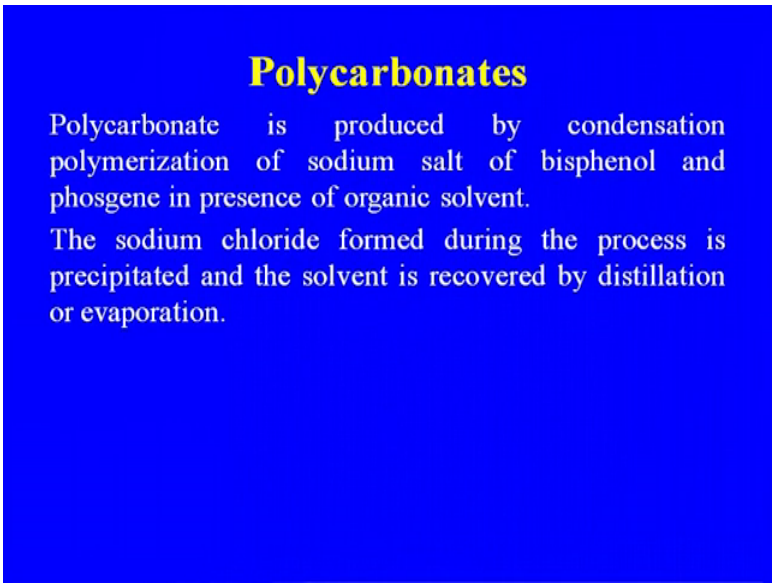

So, for the process technology is concerned polycarbonates is produced by condensation polycarbonates of sodium salt of bisphenol and phosgene in the presence of organic solvent. The sodium chloride formed during the process precipitated and the solvent is recovered by distillation or evaporation.

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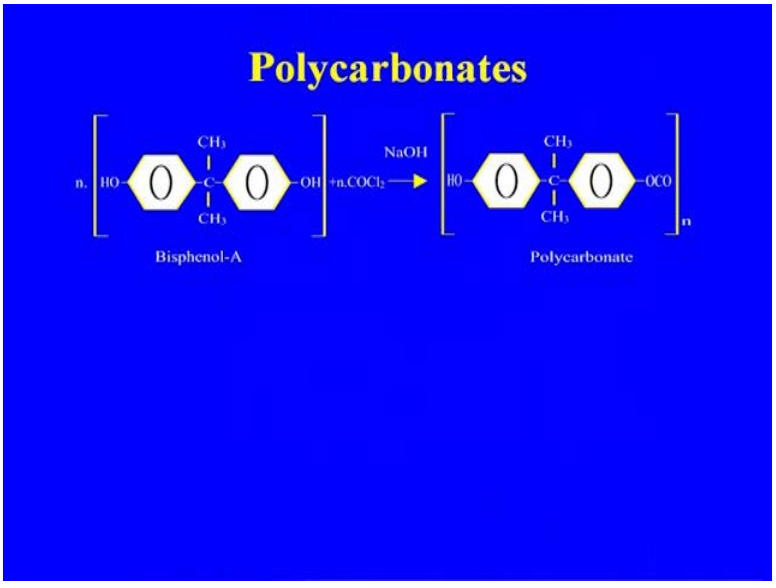

This is the reaction that is taking place and as I have told you that there are two important speedy stocks the bisphenol phosgene, again in case of the raw material of the phenol and sodium chloride all. Then, the phosgene and the polymerization we are

getting the polycarbonates. So, this is the process of manufacture and reaction that is taking place in the manufacture.

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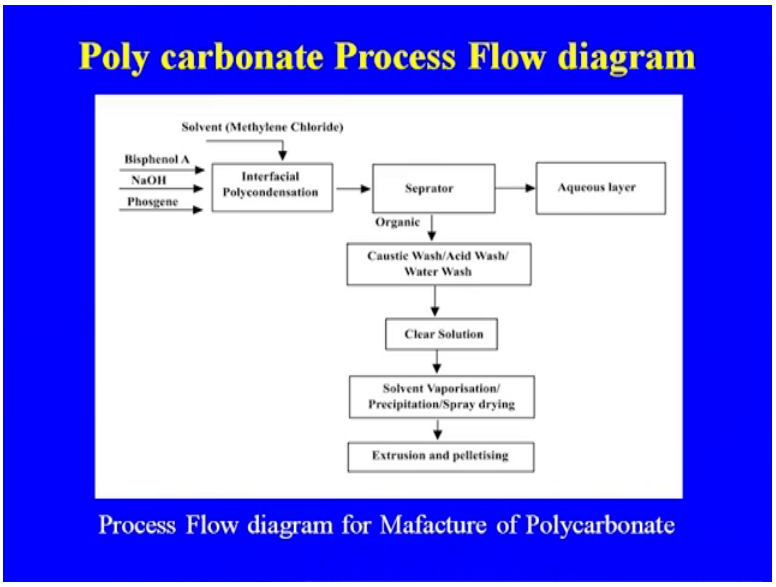

This is the block diagram of the polycarbonates system, that is bisphenol NaOH and phosgene that is going to the poly reactive in arising the solvent methyl chloride methyl chloride and is going to separator across layer. That is separated and organically where the caustic was and the water was in a clear solution solvent vaporization. Then, the precipitation is payable and extraction and pelletizing and will give you final polycarbonates what we are waiting. So, now let us discuss some of the important thermoset this was the poly carbonate and the PVC. What the thermo important does with thermo, does with thermo sets resins are the we are having the three major group of the thermo plastic which we are finding application that si.

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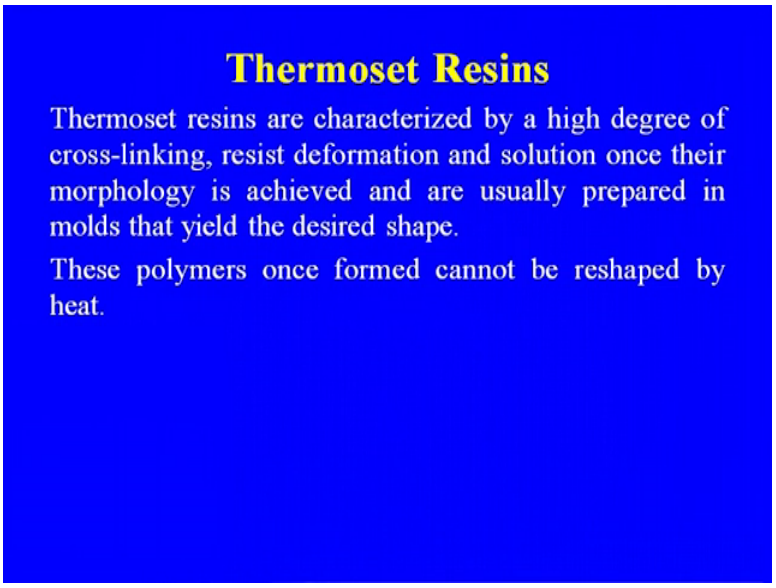

Thermoset resins are characterized by a high degree, of course linking resist deformation and solution once the morphology is achieved and are usually prepared in molds. That yield the desired shape these polymers once formed cannot be reshaped by heat, this is in case of the thermo plastic this is the basic difference between the thermo plastic and thermoset resins.

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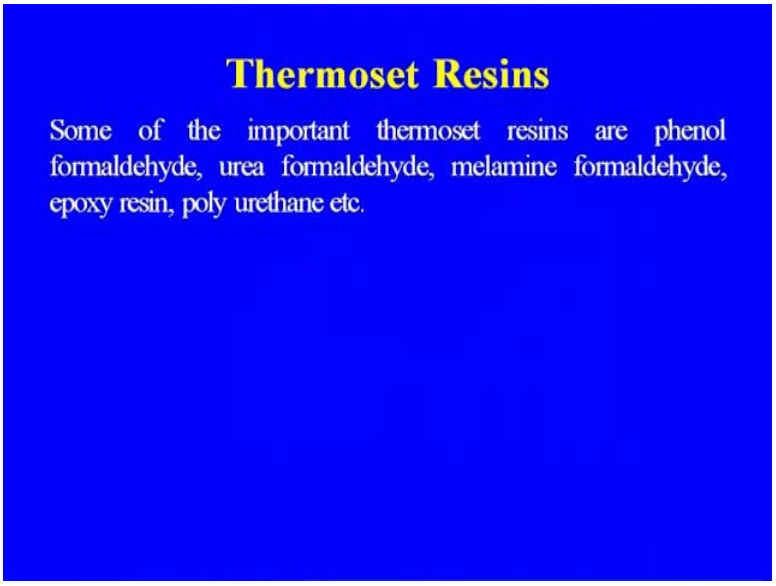

Some of the important thermoset resins are phenol formaldehyde urea formaldehyde melamine formaldehyde epoxy resin poly urethane etc, they are also coming under the units of thermoset resins.

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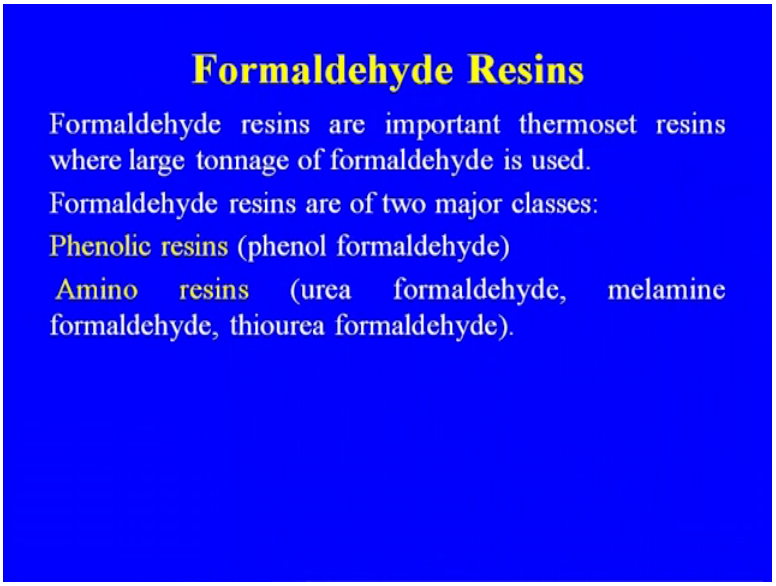

Formaldehyde resins because we discussed about the three important resins which are phenol formaldehyde urea formaldehyde melamine formaldehyde. So, formaldehyde is important thermoset resins where a large tonnage of formaldehyde is used. This is one of this we discussed to identify, this discuss of formal formaldehyde because methanol reasons for the importance of the methanol in petro chemical point of view for intermediate apart from the few. Few these are the organic few methanol technology, one of the major consumer is the formaldehyde picture and this formaldehyde that is you are using in manufacture of the resin.

So, the formaldehyde are of the two phenolic resins where we have the phenol formaldehyde amino resins mean the urea formaldehyde melamine formaldehyde and thiourea formaldehyde is also there, so this is coming from the amino reins group.

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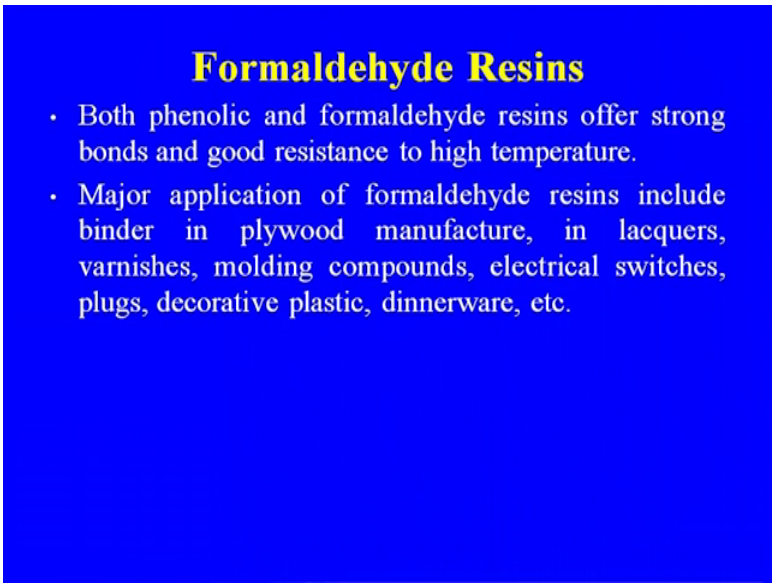

Both phenolic and formaldehyde resins offer a strong bonds and good resistance to high temperature; this is the one of the advantage. Major application of the formaldehyde resins include binder in plywood you see the phenolic in resin that you see the must have, even sometime if you go to the any plywood industry, you will find the smell of the phenolic resins. So, that is one of the major consumer in you binder which you are using in case of manufacturing the plywood manufacture in lacquers varnishes molding compound electrical switches. As I told you this was in the name of the backlight was there, so the earlier you must be remembering.

Now, there are changes in the switch configuration, but earlier we told it was all the backlight that was into the electrical even the color almost it was the black. That was more fancy in insulation in electrical appears, so the change in the huge pattern is also there decorative plastics dinnerware that are there in case of the melamine formaldehyde.

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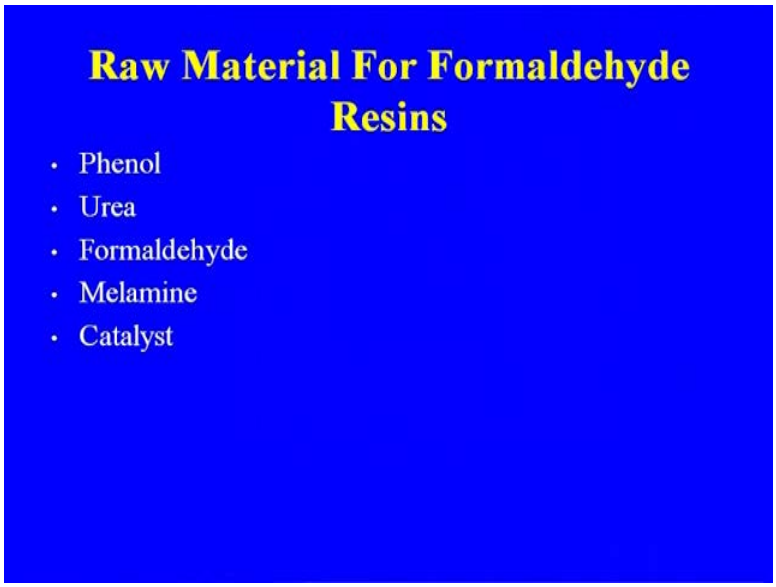

So, these are the raw material for the formaldehyde resins phenol urea and this is the importance, why the first generation chemical any petro chemical. You see it will be first hydrogen ammonia and the urea because the ammonia and urea are not only important from the petro chemical point of from the fertilizer point of view, but also in petro chemical point of view. Even in the case of melamine which is the gain for we are using for melamine formaldehyde that is also product for the fertilizer plant and one of the plant which are making the melamine that is the your Gujarat state fertilizers complex.

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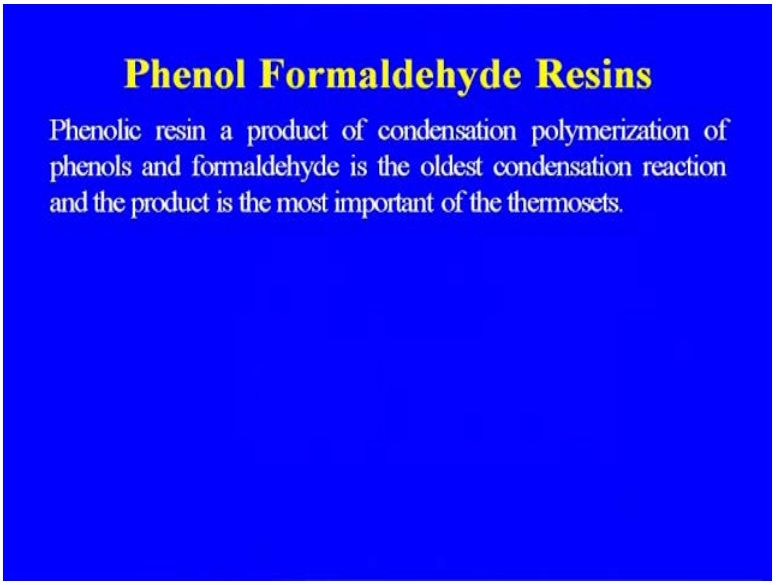

So, these some of major raw material, which I told you phenol urea formaldehyde and the melamine from the urea that you are making in the fertilizers plant normally. So, now let us discuss about the phenol formaldehyde resins phenol formaldehyde resins is the product of condensation polymerization of phenols and formaldehyde. It is the oldest condensation reactions and the product is the most important of the thermosets resins.

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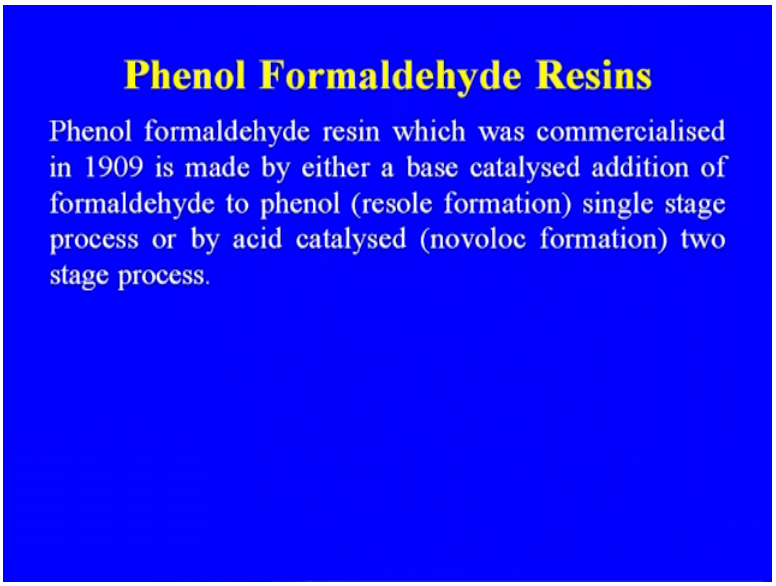

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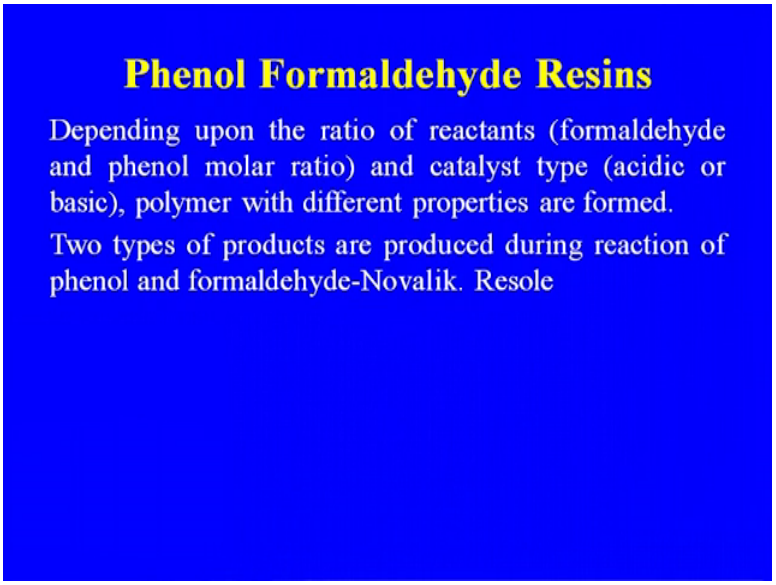

Phenol formaldehyde resins depending upon the ratio of reactants formaldehyde and the phenol molar ratio and the catalyst type acidic or basic polymer with different properties

are formed. So, these are the some of the important parameters, which can be adjusted to properties of the phenol formaldehyde two types of the products are produced during reaction of phenol and I told you the formaldehyde novalic the resole.

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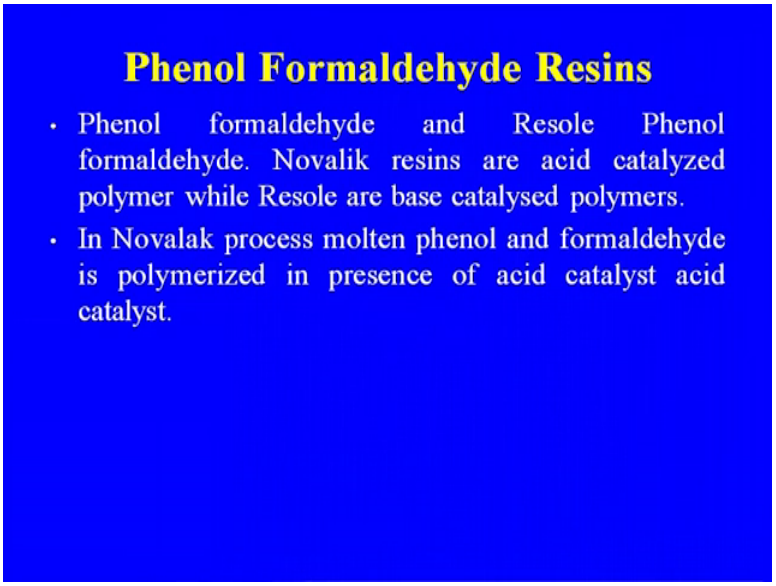

Phenol formaldehyde and resole phenol formaldehyde Novalik resins are acid catalyzed polymer, while resole are base catalyzed polymer in Novalak process molten phenol. And formaldehyde is polymerized in presence of acid catalyst.

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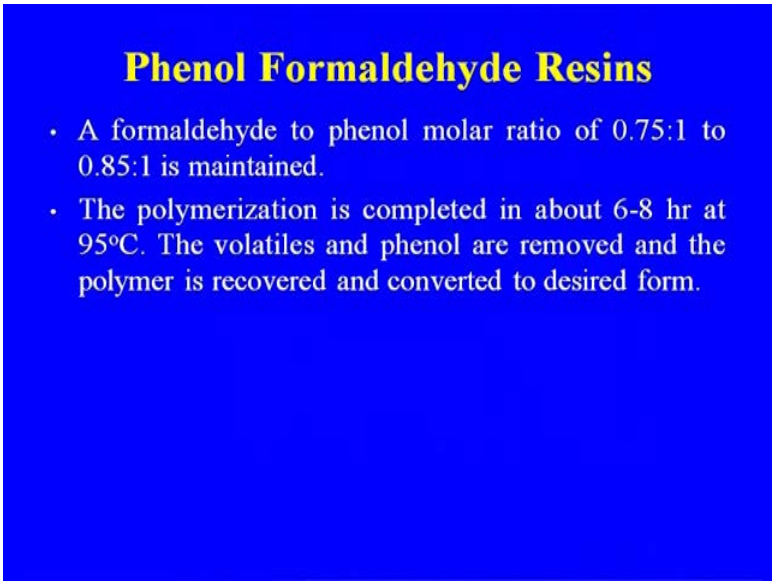

A formaldehyde to phenol molar ratio of 0.75 to 0.85 is maintained the polymerized polymerization is completed in about 6 to 8 hours at 95 degree centigrade the volatiles and phenol are removed and the polymer is recovered and converted to desired. Now, let us discuss about the Urea and melamine formaldehyde.

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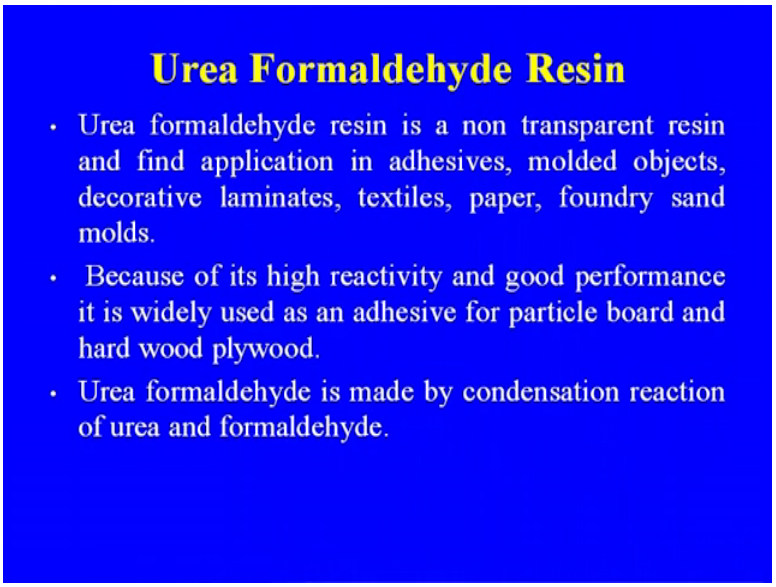

So, Urea formaldehyde resin is a non transparent resin and find application in adhesives molded objects decorative laminates textiles paper foundry and molds because of its high reactivity and good performance. It is widely used as an adhesive for particle board and hard wood plywood urea formaldehyde is made by condensation reaction of Urea and formaldehyde.

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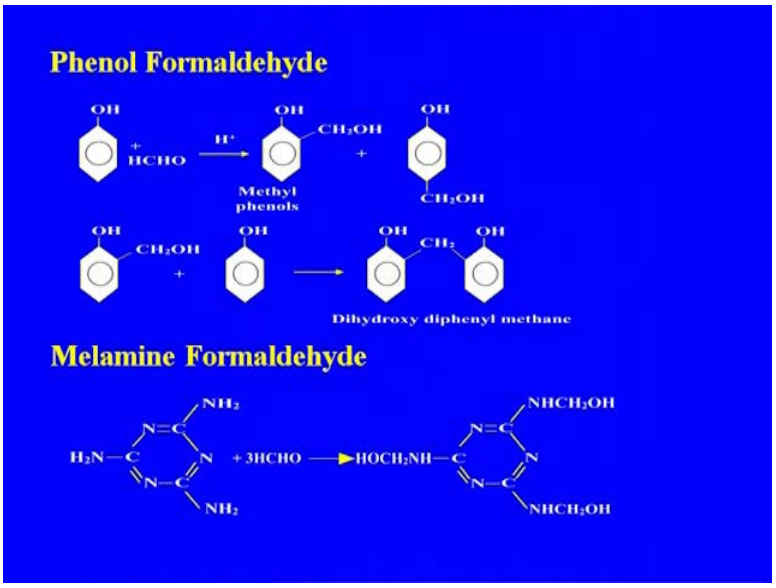

This is the reaction, that is taking place of the phenol formaldehyde and this is from the urea formaldehyde and not the melamine, but Urea formaldehyde.

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This is the I was telling the earlier the having the different energy, but this was the original phone that you see that is the meet of backlight means the phenol formaldehyde resins. Now, let us come to the melamine formaldehyde because that is now the important resin and that came into the market and replaced most of the still and still we normally use to have in work station. That was because of the cheaper cost for less and at

the same time light weight and it derivability that was not the problem because so why it is not breakable, as in case of the your glasses and the kitchen ware material that you use.

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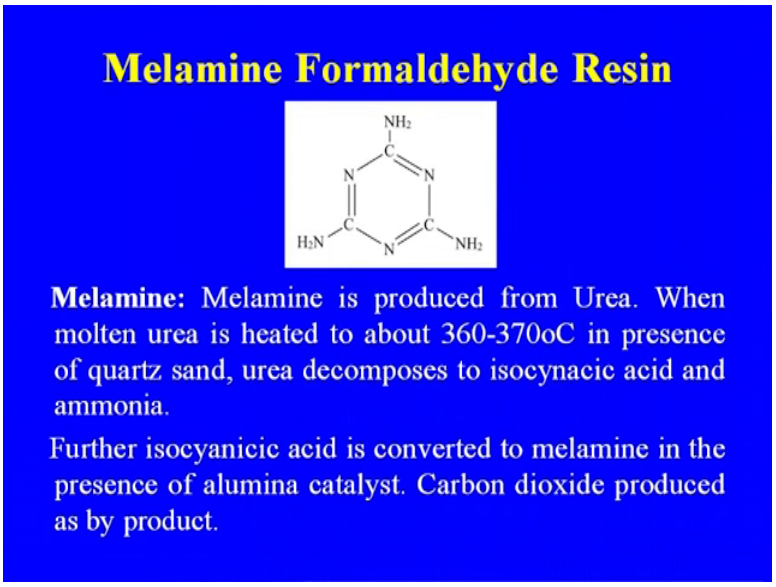

Melamine is produced from urea as I told you the molten urea is heated to about 360 to 370 degree centigrade in presence of quartz and urea decomposes to isocynacic acid and ammonia. Further, asocyanicic acid is converted to melamine in the presence of alumina catalyst carbon dioxide is produced as by product, so this is actually the melamine structure.

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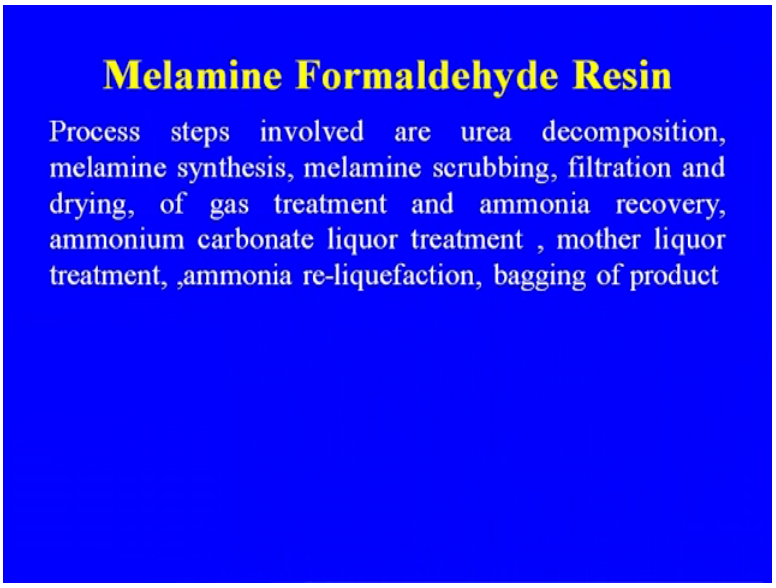

Process involved in case of the melamine formaldehyde resins first thing is the melamine synthesis which is the urea decomposition melamine scrubbing filtration and drying of gas treatment. Ammonia recovery ammonium carbonate liquor treatment mother liquor treatment ammonia re liquidification and bagging this is the about executing the formaldehyde resin in case of the melamine manufacture this is the method that we are using. So, the importance why the melamine formaldehyde I told earlier also with the coming of the melamine formaldehyde that replace almost 16 in the kitchen ware and other your kitchen ware material.

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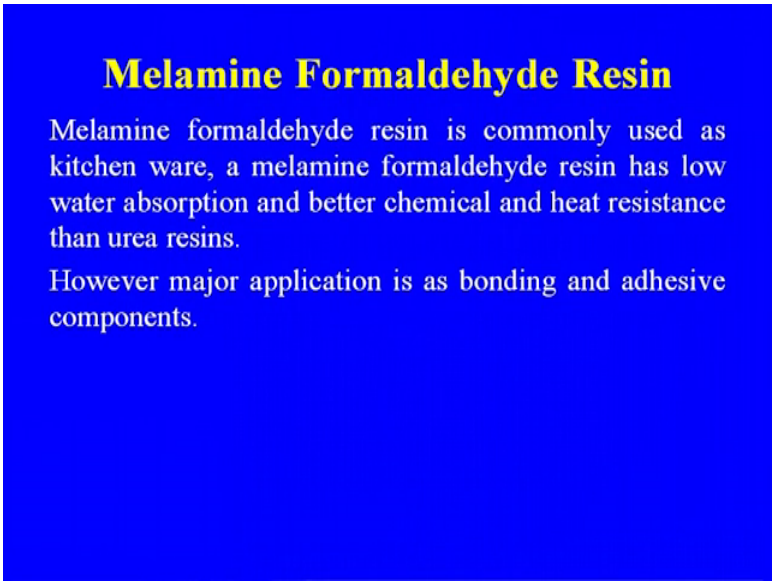

So, the melamine formaldehyde is commonly used as the kitchen ware a melamine formaldehyde resin has low water absorption and better chemical and heat resistance than urea resins, however major application is as bonding and adhesive components.

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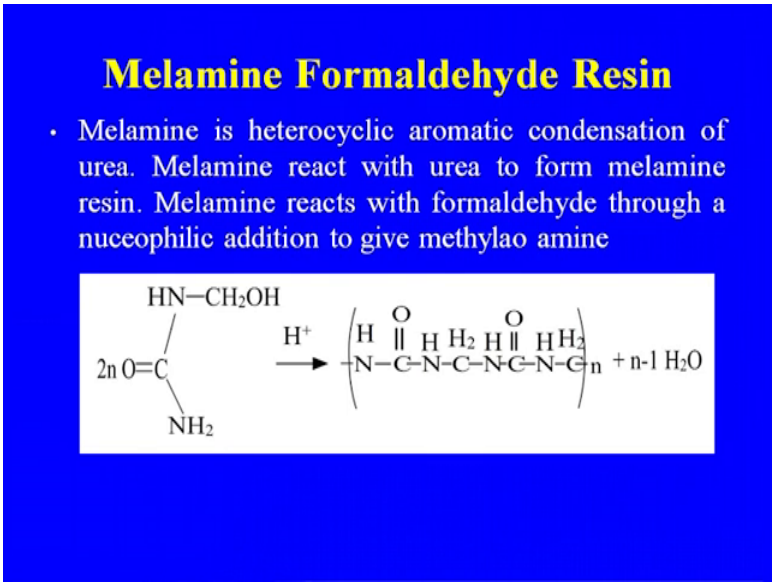

This is the reaction that is taking place and the condensation of the urea melamine react with the urea to form melamine resin melamine reacts with formaldehyde, where this is for the making of melamine urea for melamine. Note for the melamine differs and then melamine reacts with formaldehyde that you are getting the resin.

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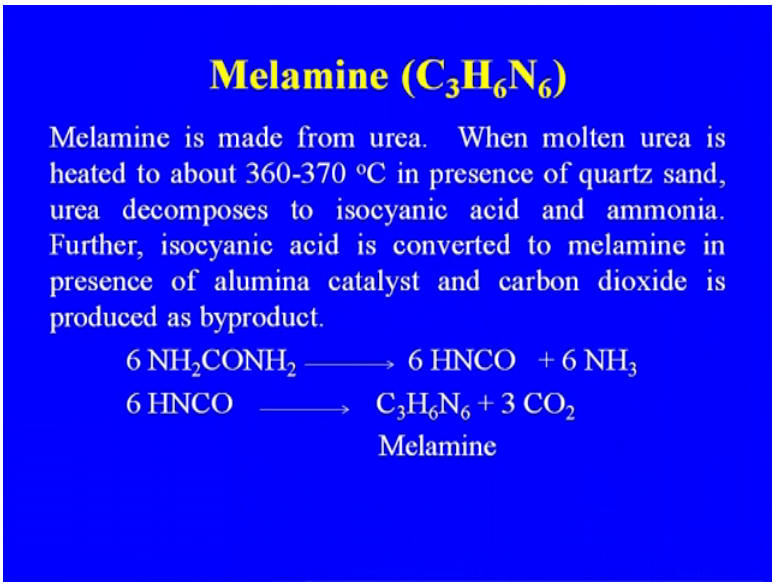

This is about the how I told you the melamine is made melamine is made from the urea this is the reaction that is taking place while making of the melamine. Now, let us discuss about the one of another important thermoset resins epoxy resins.

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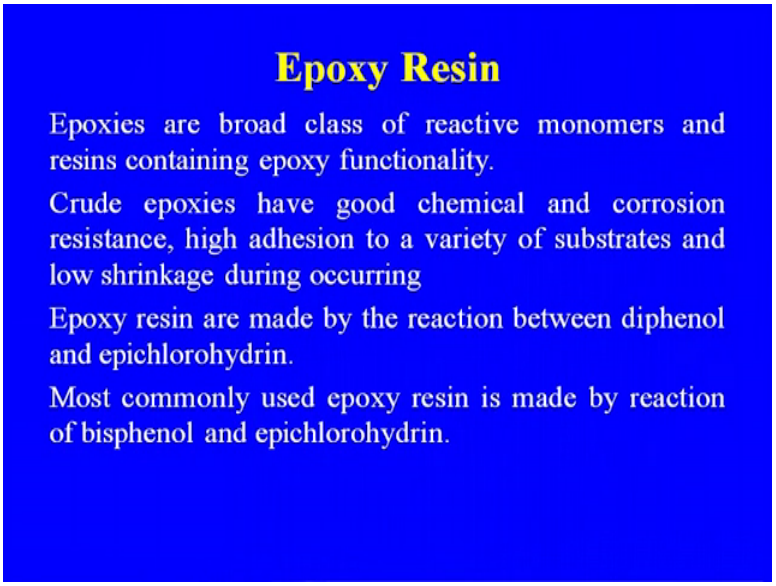

Epoxies are broad class of reactive monomers and resins containing epoxy functionality crude epoxies have good chemical and corrosion resistance high. Now, you see in the case of the epoxy resins in paint industry huge amount of epoxy resins are to the high adhesion to the variety of substrates and low shrinkages. Here, epoxy resins are made by the reaction between diphenol and epichlorohydrin here also the involvement of the chlorine while making the epichlorohydrin. So, the most commonly used epoxy resin is made by reaction by bisphenol and epichlorohydrin. So, here again the same problem handling of the bisphenol manufactures where we handle the phenols and the resins, so for that is why they are so important for the epoxy resins.

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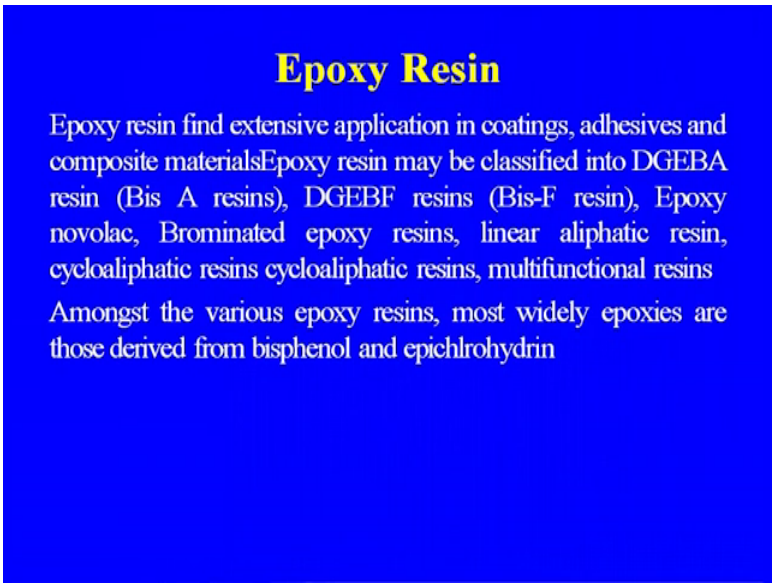

Epoxy resins find extensive application in coating adhesive and composing materials epoxy resin can be classified into various resins. That is given DGEBA resins DGEBF resins Bis-F resins epoxy in all the brominated epoxy resins linear eliphatic resin cycloaliphatic resin cycloaliphatic the multifunctional resins amongst the various epoxy resins. Most widely epoxies are those derived from bisphenol and epichlrohydrim, let us discuss in brief about the process technology because as we know we need the two important feed stock that is the bisphenol in the epichlrohydrim.

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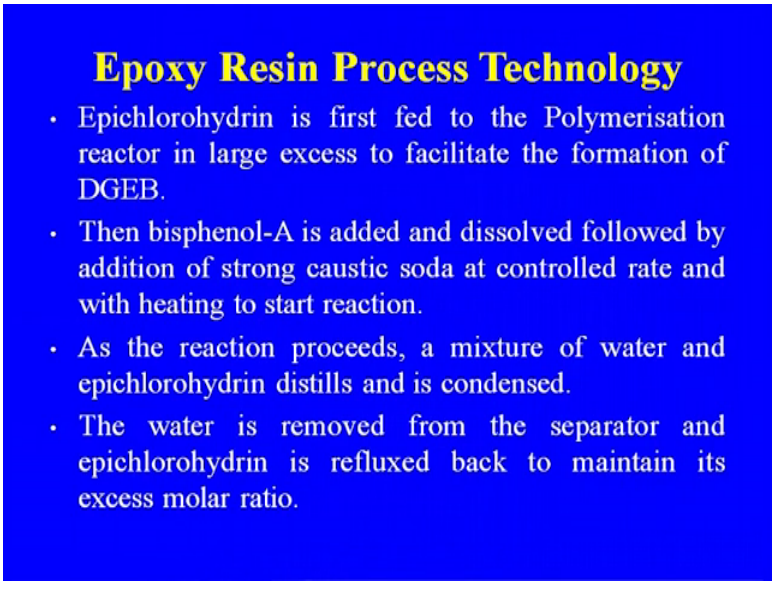

So, here in the polymerization of form making of the epichlrohydrim is first led to the polymerization reactor in large excess to facilitate the formation of DGEB. Then, bisphenol A is added and dissolved followed by addition of strong caustic soda at controlled rate. With heating to start, reaction as the reaction proceeds a mixture of water and epichlrohydrim distills and is condensed the water is removed from the separator and epichlrohydrim is refluxed back to maintain its excess molar ratio in the polymerization.

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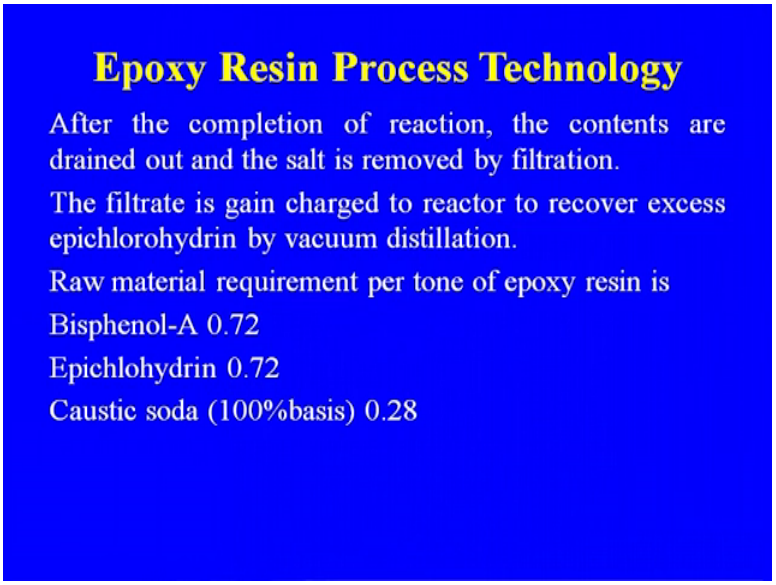

After the completion of the reaction the contents are drained out the salt is removed by filtration, the filtration is again charged to the reactor to recover excess epichlrohydrim by vacuum distillation. Then, raw material requirement per ton of epoxy resin is the bisphenol epichlrohydrim and the caustic soda. So, this was about the some of the important the rosetgene and also the PVC resin that the polyvinylchloride. There is something important that is polyvinylchloride and the method technology process for the PVC, we discussed in the next lecture. We will be discussing about it because these two lectures was based on the polymer, the next lecture will be on the elastomer because the ellastomer are also playing very important role.

We are using in our daily life various material from the elastomer, so the next lecture of this module will be based on will be on the elastomer. There will be discussing about the natural covered entity covered historical development, which has taken place. Some of the major synthetic role of which is being manufactured in India and other parts of the

world because you see the synthetic revo industry, which again having the force for the development of synthetic revolt.

That has been the coming of the cracker plant, but at the same time here also revoked petroleum refining, but at the same time you see the historical background, which will be discussed in while. Discussing the SVR that was through the non petrochemical means ethylene formed the almost places.