Science and Technology of Polymers
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Lecture - 20
Rubber Products

Good morning, today we are discussing on rubber products; products made from rubbers. I have mentioned in the previous lectures, that the names of different polymers, showing elasto molecule characteristics, rubbery characteristics, viscoelastic characteristics. Rubbers are flexible, soft and it has got ample free volume, which can accommodate large number of additives including fillers. In which fillers quantity is the highest very high, means it can go up to 800 to 1000 parts in 100 part of rubber. You know what are the rubbers basic names of rubber molecules, say natural rubber, which is cis poly isoprene, synthetic rubbers styrene butadiene co- polymer, polybutadiene rubber, poly chlorophene rubber, Italian propylene rubber, Italian propylene dying rubber, butyl rubber, which is a co- polymer of isobutylene with a small quantity of isoprene monomer purpose fully introduced as co-monomer to develop a cross linking or magician site or curing site.

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Then other rubbers acrylic rubbers, policlinic rubbers, folio elastic rubber and other phropholin rubber like iconic rubber which is polis able rubber color solitude and ithalin. This way we can tell the names of any rubber polymers be soul's elastic rubbers numeric characteristics and these polymers are a blended with loss number of additives and the

total number of narratives can go is 13 numbers 30 directives. Normally incorporated and there are few products of the number may be less and these additives known as the functional additives. And these they have certain function these roles are to play during the fabrication processing of the rubber product as the during the service of rubber product we may use ok.

Now this slide shows the components. The major components present in a rubber product. Base polymers this base polymer may be natural rubber timing between rubber processing, rubber nutrias, rubber palliated, rubber Clorox. Rubbers are the names of all base polymers and the filler system. Means we have to incorporate feel us. We think the volume of product as well as they are certain types of fillers. Which imports' certain improvements in the properties to develop some broad of the properties in the rubber products.

Than processing aid system this is use introduces to incorporate and disperse the additives. We are going to include in our product that begins it increases the increases the fluidity and helps in incorporation and the discussion of these additives stabilize is the system. It stabilizes the polymer the rubber from the degradation of present in the environment. I mean the agencies like oxygen ozone heat electromagnetic radiation like ultra-violet radiation. These actually degrades the polymer because these polymers are hydro- carbon in nature and the browser become down maculate reduce in translating occurs and it affects from final of the product.

So come degrades stabilize are used who is actually stabilizing degradation. They do not allow of the polymer to be degraded and then curing system. A curry actually these rubber product majority of the rubber product exchange set thermo plastic elastic these are all balconies products or cross link products. That the measure final form of the product. Those are thermoses type to this in the final form. These products are insoluble are insolvents as well as infeasible by heat. So they are stay able so for that purpose as some curing agent are cross linking agent are the vulcanizing agent vulcanizing agent vulcanizing agent and these are used with the rubber product. And they help in cross linking. The rubber molecules they are converted into a thermo set structure from thermo plastic ok.

I will discuss the details of these systems. These than miscellaneous additives I mean say for development of anti-static property and over to what is that called development of static charge accumulation of static charge on the product. That causes the attraction of that is nothing. So this is not good for any product. So if there is some anti-statistics agent next with the product than that will not help, that will not actually allow the dust particles to attract to the products and not only.

That some agents fire retiring agents fire retarding agents flame retarding agents are needed to increase the flame register property. These property a product and sometimes a basic powders. In word to get some a very action an abrader will. That is used for abrading of some other surfaces for the purpose of sometimes say hard particles. Some hard materials say carborunna, carburranna powder. So these are incorporated in the product as miscellaneous additives. Along with these they are may be some testifying agents. There are may be some softeners so all these come in this miscellaneous category.

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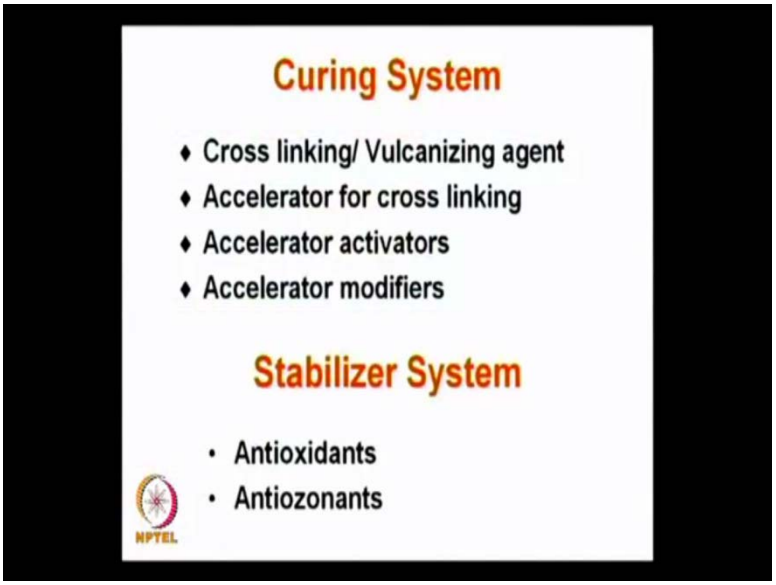

Than let us look into word. There is in the curing system. On this in the curing system cross linking are vulcanizing agents. They are mends for the rubbers. They are cross linking agents. Like sulphur selenium and delirium in the group of they belong to the same group sulphur selenium delirium. In they are mix to the rubber. In they react chemically with the rubber molecules to link to link. The 2 molecules side by side to show, that inter molecule link is developed through sulphur atoms that means the mono

supplied disulphide monosulphide linkages. It cross links or forms 3 dimensional lay to work structure. So that is the effect of cross linking isn't and in order to promote .The reaction in order to help the reaction between sulphur and rubber. Some accelerator is used. Which accelerates the reaction speed between the sulphur and polymer for that purpose accelerator is used accelerators are compounds of organic compounds these are mostly amindervetives, amindervetives so this accelerators are amindervetives so these accelerators for cross linking are used in rubber products, for decreasing the vulcanization time.

For example; in normal alpha only without using any accelerator. It takes about more than 8 hours time. This is not economically viable or industrially physical. Now by using this accelerators and accelerators activators all these things. These gradients it has been found that vulcanization time has been reduced from 8 hours to 5 minutes or even 2 minutes. You see the effect or influence or the role of accelerators. How it is important and how it is essential in rubber products. You can understand from this phenomena and then accelerators modifiers. You see this is again another category of this curing another member of the curing system accelerator modifier means in. We are incorporating the alpha cross linking agent in accelerators.

So these decompose at the vulcanization temperature or the temperature of the rubber compound increases. Then these compounds may decrease degrade decompose and form few radicals and those radicals are actually takes part in forming cross linking bonds. Now during processing and fabrication. The rubber compound as to pass through is machineries' at elivarated temperature saying may be sometime. It present goes as high as 80 to 90 degree ravin 100 degree Celsius temperature. There may be at the decomposition of a part of the you are crossing accent as well as the accelerators. And there during processing and they are fabrication before fabrication of final finishing are setting of the item. It may start organization of cross linking. If it starts what will happen it will not flow properly and it will not fill the cavity of the mould. So it will affect the shape and am mention of the properties. So that as a product. So this is not good for such products. So we have to control such type of adverse affects for controlling that. We have to use some modifiers these modifiers may be of 2 kinds one is retarder.

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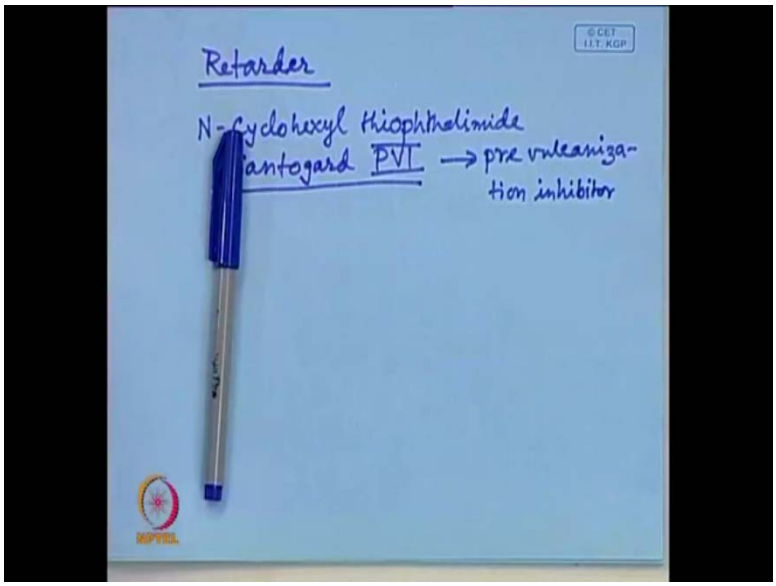

Mostly modifiers are retarder's retarder molecules that means that retards the vulcanization that retards the vulcanization or premature vulcanization or premature cross linking. Before final setting retarder molecules are used say cyclohexyl. In cyclohexyl thiophthalimide in cyclohexyl thiophthalimide this is a compound which is used for the retardation or retardation of vulcanization or retarding the vulcanization reaction or it is actually a trade name is santogard p 6 pvi p. You can say pvi or p 6 pvi in other way. Can say pre vulcanization inhibitor pvi. You can say pvi pre vulcanization inhibitor or you can say p 6. So this is a trade name of this compound in cyclohexyl thiophthalimide. I will probably there are some of the examples; in subsequent slides. I will show you this is about curing system.

Then in stabilizer system 1 is antioxidants and the other is antiozonants normally. Those these 2 classes of stabilizers are used in our products. Then let us look to the components of rubber products.

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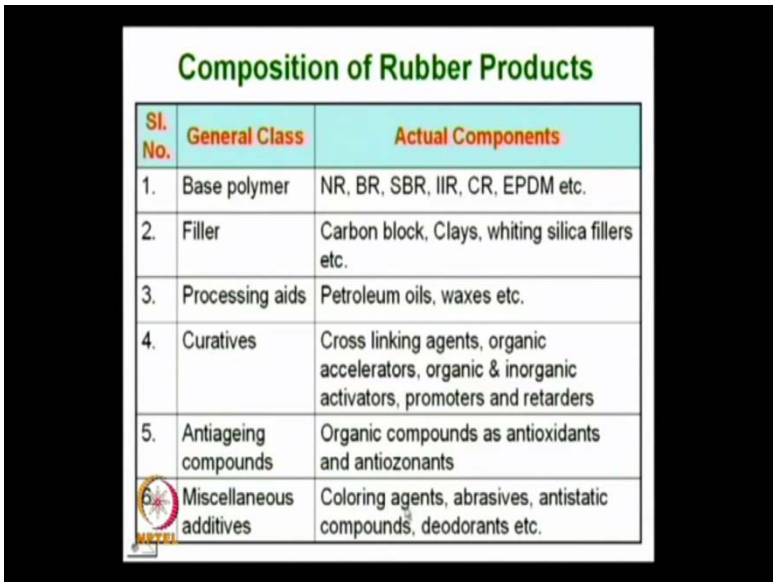

So, general class in these compositions are base polymer base polymer. I have already mentioned the names have few names are shown here in the slide. Then filler; filler was a carbon, clays, whiting, silica fillers, etcetera.

Then processing aid processing aid that increases the fluidity reduces the viscosity helps in processing, means incorporation and dispersion of the additives particulate additives in rubber product. So that helps you in processing say 1 kind of lubricating effect. It wills it lubricates. This particle so that, it can enter into that rubber molecules rubber matrix. Though it helps in dispersion then comes curatives curatives curatives are cross linking agents. I I have already described the organic accelerators organic and inorganic activators promoters and retarders. There are also again promoter's means which promotes again this vulcanization. That is further in your increasing of the vulcanization rate. Some time promoters are used along with the accelerators accelerators activators. Then an ageing compounds organic compounds as antioxidants and antiozonants miscellaneous additives coloring agents abrasives antistatic compounds deodorants this entire things ok.

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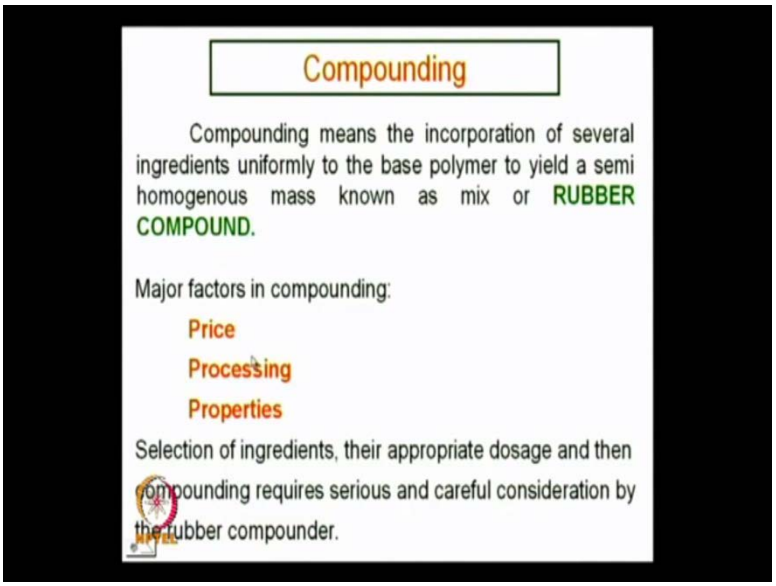

Then now, we have some idea, what are the components or ingredients general ingredients used in rubber product. Now we have to make a compound. You know you have some concept of compound means. Compound forms while linking of atoms of elements to form a new product. That is a compound chemical compound it is not exact. It is also a chemical compound but, mixture of chemical compound is a rubber compound. Rubber compound means you are compounding. You are compounding together additives with the polymer rubber so the process of incorporation and dispersion and forming a semi homogenous or near to homogenous bland of this rubbers with the additives is known has a compounding. And the compound and the process is known as compounding and major factors in compounding to be kept in mind. Before selection of ingredients.

To formulate a rubber product or price of the ingredients processing characteristics of the rubber compound. And the properties of the final rubber compound and the vulcanized product keeping in mind. These entire things one can go for selection of ingredients their appropriate. Dose and compounding requires serious and careful consideration by the rubber compounder. The person who actually deals with these things, who makes a formulation, who prepares the rubber compound for making a rubber product is known as compounder. Rubber compounder there are in rubber industries as a rubber compounder ok. They work in the the instruments the machinery.

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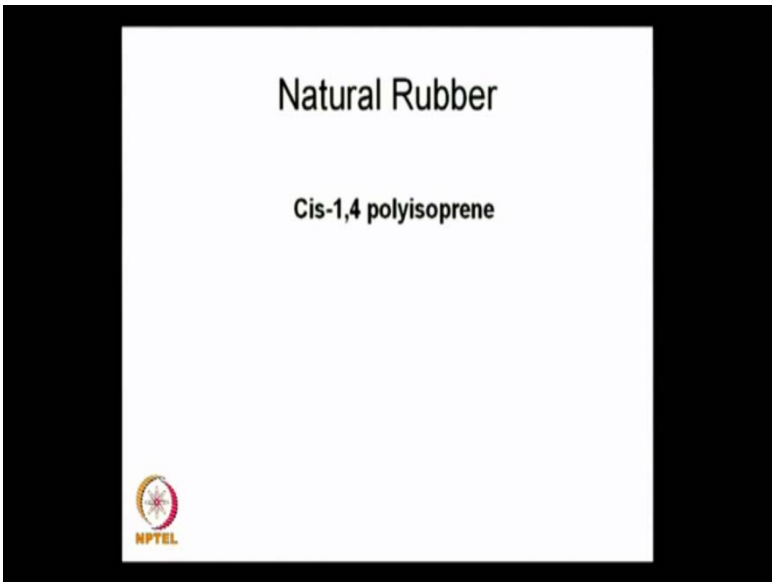

Then let us look into rubber this natural rubber. You will see some properties of natural rubber. You will see some properties of synthetic rubbers little bit for your understanding. So cis 14 polyisoprene you know its structure. Properties of natural rubber, its molecular weight. It is given here two different kinds of molecular weight. Molecular weight numbers of molecular weight. So this number of molecular weight. It is wrong here, it will be less than 22 bar 6. It is wrong its value is wrong. It will be 22 bar 5 or less than 22 bar 5 22 bar 4 to 22 bar 10 and molecular distribution is broad and high tack and green strength is required. I have already described before you. What is the meaning of tack tackiness and stickiness. And what is the meaning of green strength of the product that means green strength means after making a rubber compound give a green Sep prior to curing prior to curing is safest item is known as the strength of the item. Priority curing is known as green strength.

That is under green condition. It is not fully formed or fully cured. Than high tack and green strength and gum strength good processing characteristics is available with natural rubber. And it is a crystallizing rubber means, if you stretch it first if, we stretch it it develops crystallization. That means crystallites are formed so it increases the induced strength that is called trays induced crystallization or you can say strain induced crystallization strays induced crystallization or strain induced crystallization the polymers which provides such type of performance or behavior is known as crystallizing polymer ok.

Than vulcanization properties of natural rubber tensile strength. You see this some properties range is given 17 to 24 degree varies from compound to compound varies from rubber to rubber. It is not fixed. It may be 15 to 28 30 even varieties shown as 17 to 24. This is not rigid it is valuable depending on the nature of the polymer. Depending on the nature and number of additives and the quantity of additives used in there. Tensile strength of green rubber filled organized is around 24 to 32 than abrasion and wear. So you think of a rubber tire. When it roles roles on the road surface surface is rough so the outside surface of the wheel which is called trade trade portion gets worn out due to wear and tear due to fiction with the road surface. So that wear resistance must be there and there must be grip road gripping otherwise. There will be skidding of the wheel after sudden pressing of the break, it should be stop immediately.

In advanced car you find that even a car. That is running at the speed of ham 140 to 150 kilometers per hour. That can be stopped with in a very short distance. Today that type of advanced car is has been developed in the world. And I have the opportunity to see. That kind of car and to travel with that car also it is so nice. Now that kind of properties actually is available from this rubber. It has a beautiful grip with the road. So that it does not skid. It should not occur an accident these things and, it gives very good grip in the road grip and skid resistance and wear resistance of these properties and for improved skid resistance. Sometimes oil extended natural rubber is used is used to this thing and actually. There is a science underline this thing. We have to explain that things needs more time. If you really want to know, that science you can discuss with me outside the class. I will help you.

Dynamic properties that means you think of again rubber tire. It is under dynamic stress. That is wheel or the wheel is rotating. It is the contact between the road and the wheel. It is under always dynamic stress stressed stress load applied load. Than application it is released. So continuously this application application this kind of cyclic load is there. So this is called dynamic stressing and, that is actually evaluated in the laboratory in the simulated condition by flexing machine or ferric fail to failure machine. That means is there in our department. That machine is there, if you are interested. You can see their, how it fails means it fails after incision of a crack followed by crack propagations ok.

Now, these rubbers are having properties like. Some rubbers are having resistance to tack insulation but, once crack is insulated crack propagate faster. There are some polymers

were, it it does not resist crack insulation crack may be insulated but, crack propagation. That is slower so these properties are available with say for example; Natural rubber they are having just opposite properties. These two so this way the the duty of the compounder to select suitable rubber in his formulation while he is making a tire that means he is to keep in mind which area of the world, which part of the road. This wheel is too performed by them. So keeping so keeping that aspect in the mind you will select suitable rubber.

Compressions set and creep. You know what creep is, it is an, it is a flow properties with time under constant load. Creep is a property of deformation with strain at constant stress. Creep is a property of deformation with time elongation with time at constant stress and at a fix temperature again. The temperature is increased the creep property will decrease. That means it will deform more in less time and reeducation. It is again a time depended phnemaon, it is a decrease of stress with time at a constant strain at constant strain. Due to loosening of the molecules due to reeducation of the molecules again here is science due to science if you want to know you can correlate knowing that science you can correlate the the this creep properties. properties aging poor but, improved antioxidants and antiozonants can prefect. Such ageing characteristics synthetic rubber there is various polymers available as synthetic rubbers.

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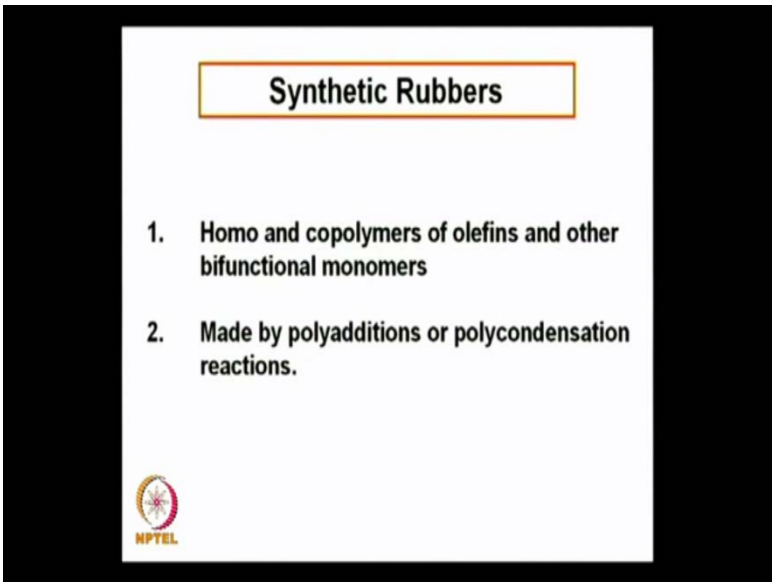

There are homo polymer is a homo polymer strain than rubber is a co- polymer ethylene propel. Rubber is a co- polymer. There are homo polymer and co- polymer which is used

as a rubber and, they are made by polyadditions of or polycondensation reaction of different chemical compounds are making a synthetic rubber.

Why synthetic rubber, why do you go for synthetic rubber, now the main reason is there is a of natural rubber. If it is not available in a country in own country. Then they can synthesize rubbers. They can use synthetic rubbers. If they do not have, they do not have to depend on natural rubber. But if you have plenty of natural rubber. You then you may not have depend on natural synthetic rubbers. You can use natural rubber to meet the demands for some special properties. Where natural rubber fails, you see to meet the demands for some special properties. Other than availability if, you have a special demand. When natural rubber fails then you can use synthetic rubbers are such special propose. For example; process ability oil and solvent resistance low temperature flexibility heat resistance properties better dynamic properties abrasion resistance environment stability.

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For example; say for a petroleum force in the petrol filling stations in the fuel filling stations. Where the fuel diesel or petrol is pump from the reserve to the car in the pipe is used pipe is made of rubber. There natural rubber is not suitable, because natural rubber is swelled is cross link. It will swell in contact with diesel or petrol but, if you take some say synthetic rubber special rubber like cynitren rubber or chloro phine rubber. So that is very strength to swelling in that oil.

So, these are the properties, and, there are some applications of high temperature selling. So environment is high temperature as well as in contact with some petroleum oil. There you have to use special purpose like silicon rubber or flour is suitable there ok.

So, this way we go for special purpose rubbers depending on the properties .We need than general purpose and non-oil resistant rubbers are, these are the examples styrene-butadiene rubber polyisoprene rubber ire polybutadiene rubber by isobutylene-isoprene butyl rubber ethylene propylene rubbers edam thermoplastic rubbers. These are non-oil resistant rubbers that mean, you cannot make any product which as to perform to contact with oil. I mean petroleum oil petroleum base oil not vegetable oil.

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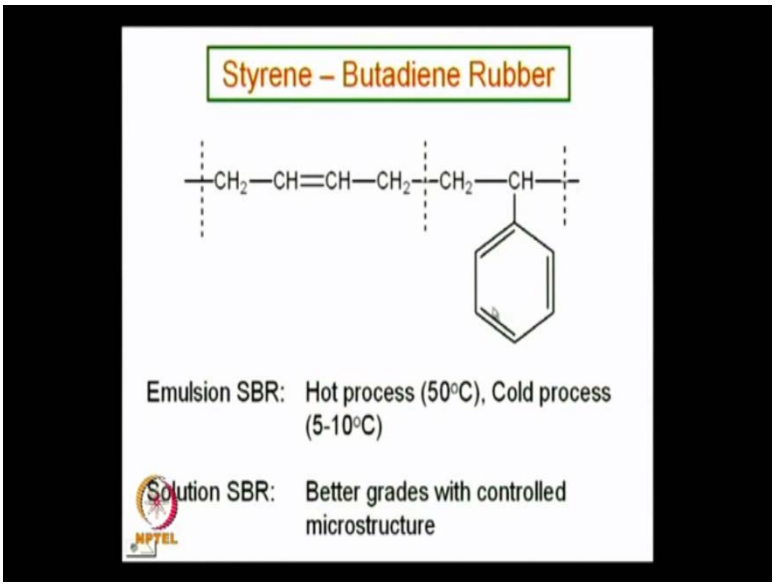

This is the formula of the chemical formula of the styrene butadiene rubber. And this is sythentized by emulsion polymersion or solution of polymersion by emulsion polymersion. There are mostly 2 process followed. Today hot process can at 50degree of Celsius. Cold process can at around 55 to 10 degree Celsius. And this process actually came different micro structures of the polymers. Have a due to difference in the micro structure. They are processing characteristics. They are final vulcanized properties are dependent on the process they are synthesized and because of those things. There are large numbers of grades commercially available in the market. of there. So, here we have to select suitable grade for your rubber product you are going to make.

Solution, rubber means produced by solution polymesion technique. It gives better grades with controlled microstructure. Or you can have a better controlled microstructure. Whatever you want you can have a control you can get that the microstructure of the polymers.

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Special purpose rubbers chloroprene rubber chlorosulfhonated polyethylene. I have mentioned the name acrylonitrile butadiene rubber, nitride rubber polyacrylic rubbers fluorocarbon, rubbers silicone rubbers polyurethane rubbers, ethylene-acrylic rubber ethylene-vinyl acetate rubber polysulfide rubber. So these are special purpose rubbers other. These examples; there are may be many other polymers. Because you know there is a versatility and tolerability characteristics of the polymers. So in can make a design new designer polymer. You can synthesize, you can virtually develop and develop a suitable technology these special purpose rubbers.

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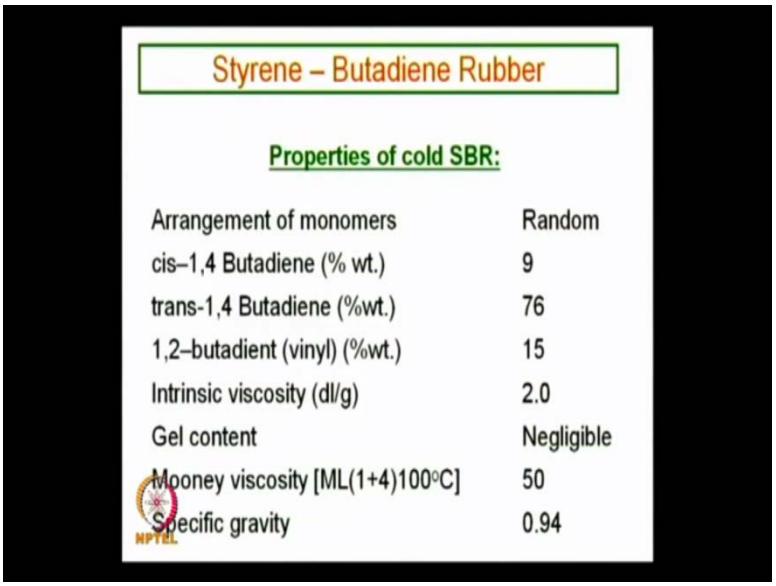

Properties of cold sbr, you see some properties are mentioned over here mixture of content butadiene. You can means butadiene unit the butadiene unit in the sbr will have certain percentage cis form certain percentage transform certain percentage 1 to 2 butadiene. This is wrong butadiene e into sub t. It will be e on to butadiene on to structure of super structure both is same.

Intrinsic viscosity gel content Mooney viscosity. Mooney viscosity says, what is Mooney viscosity. Mooney viscosity is a viscosity of a rubber compound. Before compounding you can measure the Mooney viscosity of the rod of the polymer. After compounding prior to vulcanization. You can measure the viscosity because these viscosity can tell you can tell you at what temperature how at, what machine speak means rpn revolutions per minute. You have to run the machines for getting the rubber compound in a reasonable length of time ok.

Then viscosity actually it is related to the torque developed during processing. So it is measured through a torque measurement. How it is done? You take a small compound of small amount of rubber. Now, there is a rooter in a cavity. The rooter is connected to a motor. This is connected to transmitter to measure the top. That rooter can be rotated with the help of motor and within that cavity you place the rubber than close it and, that cavity as arrangement of heating. So supply heat so the temperature is maintained at 100 degree

Celsius or some other temperature of standard specification. So at that temperature while that equal to equilibrate. After achieving equilibrium temperature of 100 degree Celsius.

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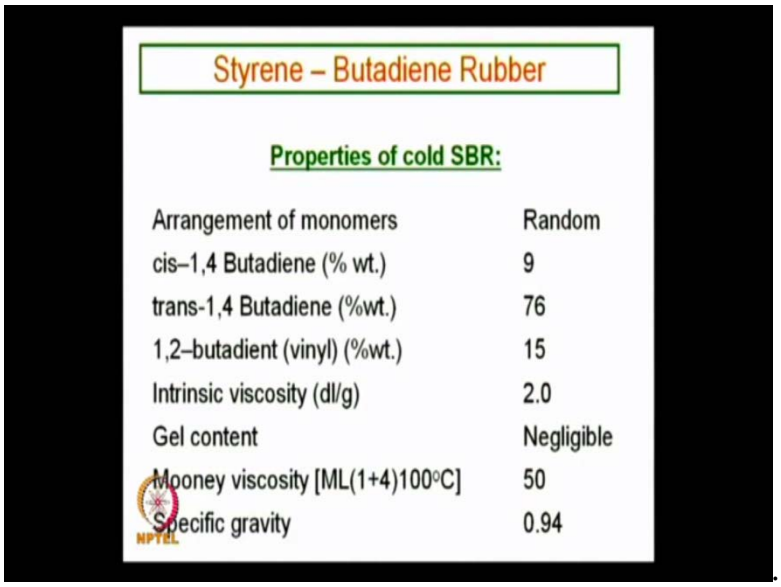

Then you start the motor. So it will run for 1 minute first. Then after 1 minute you are running then, it will again achieve after 4 minute residence are there. You see how much the top is. If it is 50, then money viscosity number is 50 money viscosity is called 50. If it is money viscosity is 60, so, at 1 pulse 400 degree Celsius. It is reported like this 50, 40, 30, 35, 45, 52 like this, had the number had the viscosity lower the number lower the viscosity, for gum rubber. Sometimes Mooney viscosity might be same 40 to 50 for compounded rubber. Where the fillers and the other additives been incorporated but, it is not vulcanized UN vulcanized rubber compound continuing the fillers. That the Mooney viscosity may be as, I have 60 64 70 like that. So that tells you how much tark is necessary, how much share force as to be provided as to be given during fabrication of the product. Say during execution during execution. How what will be the rooter speed of the rooter. So that will be dictated by this Mooney viscosity number. So very high means high viscosity low means low viscosity then specific gravity. These are the properties have been elevated for synthetic rubber. That is the same properties are also elevated provide to vulcanization provide to compounding at all this things.

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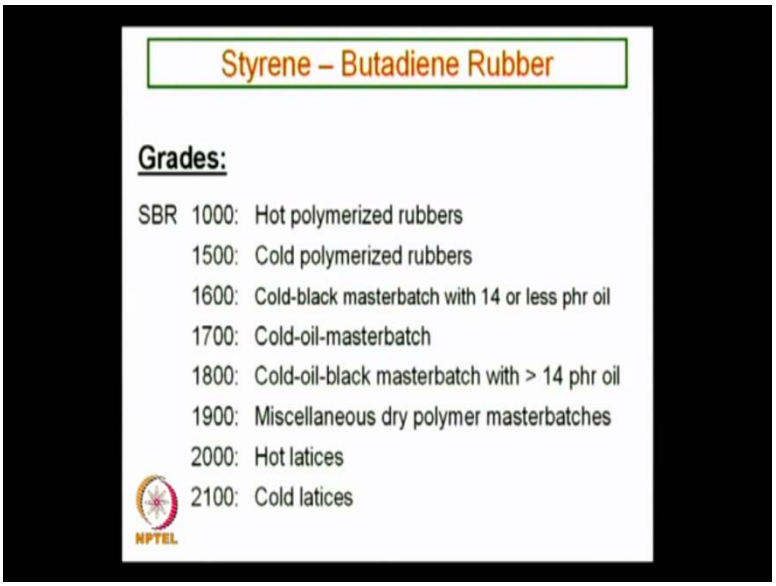

Also these properties elevated for natural rubber. Also these are the varies grades. As I mentioned various. These are available in large number of that is only few are mentioned over here. You have to maintain the clarity or for your componention all these things. So I have only included few grades. We have many other grades. So we did not say 1 5 0 0 category, say may be 1 5 0 2 1 5 0 5 1 5 0 3 1 5 0 7 like this the again different grades having different minor. Minor not major but, minor difference in properties they are internal grades.

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Styrene butadiene rubber applications tires footwear mechanical goods sponge and foamed items, water proofing items, hose belting, adhesives carpet back coatings. Sometimes see lands, sometimes rubber coated fabrics and, so many that means large number of products can be fabricated from synthetic rubbers. As well as from natural rubber.

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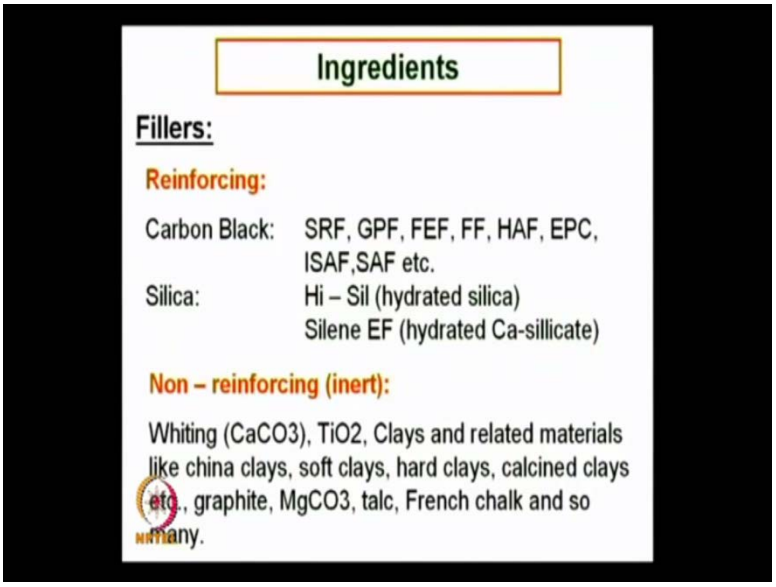

Now come to the details of the ingredients look at the fillers. There are two categories of fillers Reinforcing fillers and non-reinforcing fillers in reinforcing fillers. That increases the improves the strength properties of the rubber compound by the presents. That means they enter in to a direct interaction between the polymer and the filler. There will be if there will interaction polymer and the filler then we call it is a reinforcing filler.

For example; carbon black the structure of carbon black structure means physical structure more follows the carbon black. You say if, you consider a spherical particle of carbon black. The spherical particle of carbon black can be considered as a graphitic layers plains of carbons and, there is spacing between 2 layers and, it is very light and floppy. That means is there is ample free volume in a carbon black particle even, if it is very small in diameter, say 10 nanometer or 30 nanometer or 50 nanometer or 100 nanometer or 300 nanometer like that.

So they are in carbon particles and, they are and graphitic plains. Now each such type of sphere can be considered as a nodular. Nodular now again there are interlobular fusions in

a carbon black particle. That means 1 carbon black particle is not isolated, spherical carbon black particle no. There are nodular fusion structure fusions as follows few fused on with the other.

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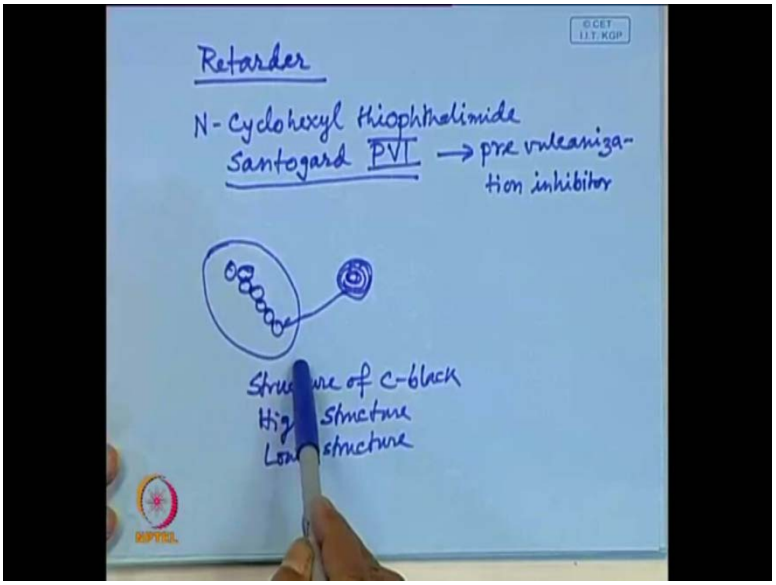

So, 1 nodular can consider like this. They are such they are inside the layers are there. 5 layers are there. So this is these are fused together. So here is the fusion here is the fusion here is the fusion here is the fusion. This entire fusion fused nodular structure is known as structure of carbon black. There are high structure carbon black and low structure of carbon black. High structure means high extent of nodular fusion low structure means lower structure lower structure extent of nodular fusion.

Now again they dictate the processing characteristics of a rubber compound while carbon black is used as filler for incorporation, and this version now it is known it has been found. It has been verified experimental proved that, high structure carbon black is difficult to incorporating rubber compound but, it is easy to disperse.

Please note it down high structure carbon black is difficult to incorporate in rubber compound. But, it is easy to disperse once, it is incorporated with difficulty then the letter part of dispersion becomes easy. High structure means this this structure is high or longer then by virtue of the bigger forming is difficult to incorporate in our party. That is easy to disperse because the complex as a property of agglomeration by virtue of the surface process surface energy even, if you are incorporate in rubber should will try to form agree

grades or a agglomerates. Now a better dispersion. That means you have to separate all these things. So that is well dispersed in the rubber matrix and, that means each and every small particles should be coved by rubber. Otherwise there will be if, there is a magnicate that aggregate is made of carbon. There is no polymer then that is the weak side in rubber product, and the stills will be concentrated in that weak side and the tire of all rubber product will be failed and dynamic stressing dynamic loading in ok.

So, this is the problem so inward to avoid the problem overcomes those problems all we need we have to propel the disperse the particle within the rubber so here the problem comes high structure carbon blacks carbon blacks are carbon black particles are difficult to incorporate. But, easy to disperse, because they do not they are not proof to form agree grades. Because they are all bigger particle size bigger particle size noting a structure. So they are difficult to incorporate. But, to easy to disperse.

On the contrary if, you take fine structure low structure carbon black low structure carbon black. They are easy to disperse, they those rubbers you are carbon black particles. Low structure carbon black particles can be easily accommodated. But, once it is accommodated agree grades and then the baking of those agree grades is rather difficult. While once they agree grade by virtue of the surface process surface energy. Than if you want to break those agree grades. You have to go for extend extended milling extended milling in the milk that means you have to apply prolonged in the rubber compounding machine.

So that will again decrease the molecular product. The rubber molecules molecular size of the molecules size of the molecules. If the size of the molecules are shorted. That way than a final mechanical property of the ultimate mechanical properties of the final product vulcanized product will be inferior. So these are problem. So it is so you have to take care of the all those things to use, some processing aids because during such application of share. It will force continuously go on increasing the temperature mechanical energy will be converted to thermal energy. So that will increase the temperature of the rubber compound, and that will cause adverse effect on rubber product. So, that is while compound or product. So that is why one has to have some control and compromise.

So this is carbon black and by virtue of that flofy fracture by virtue of those these ends of the rubber molecule and the segment of the rubber molecules get occluded within the

porastracture. Here is some volume now part of the rubber molecular chain has some segment can be occluded over that can be not only ends of polymer chain be ancoured over there. So this kind of encourage through occlusion of part of this segment or ends of the polymer chain will occurred in carbon partica land here is the mechanisms of impoundment. This is in brief the mechanism how the impoundment is occurs because, if you have seen that some valid foods in the thordne surface. You have seen in the childhood days probably, you have played with those things just you are fring on the over here there of your front it sticks on the head on the hair.

So, that a surface if, you put a carbon block in polymer what happens in rubber chain, it accrued over with both the side and it gets encored after that, what is encored. It define with figure to separate from there ok .So this is a phenomena acclution encourage and this give physical encourage. So physical entrapment of rubber molecules with the polymer of carbon partial and, this way that is called reinforcement. Other than this say chemical interaction in between carbon block and rubber chain ok that also at reinforcement characteristics. So reinforcement occurs in two ways physical encourage and chemical interaction.

So engineer say physic chemical interaction between carbon block. And rubber molecular these known as reinforcement. This is a brief idea of reinforcing by philo tactical ah rubber. There are plenty of literatures available of this thing ok. That needs few hours' carbon all these things by reinforcement. I know all these things but, you do not have a scope in discuss in the class. These non in forcing feel us the present in the rubber compound. As simple feeler just increase the volume. There is reducing by the cost of the product and sacrificing. Some mechanical product that is available in the market.

Soft clays hard clays calcined clays graphite magnesium carboit talc .French chalk and so, these are used as inner filos and it is good for the despertion. If they are actually modified with some organic material. Then it become easy to for and despertion in a rubber compound.

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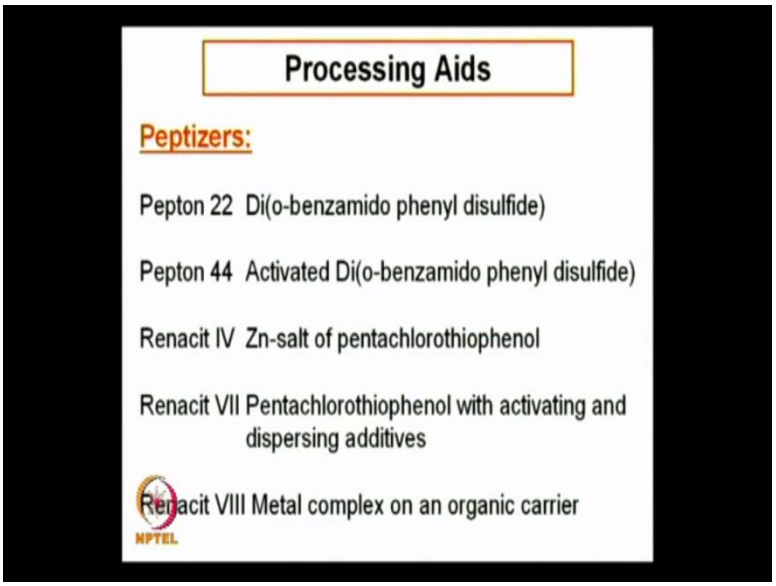

Processing Aids peptizes. You know peptizes you see while going to incorporate this particular you need to decrease the phiscosity of the raw polymer. Say for example; if the mooneyviscocity of the raw polymer is 50 ml 1plus 400 degree selcious is 50. Then you cannot incorporate any of the particular dilative. You have to bring down this mooneyviscocity form 50 to 45 or 40 for doing, so you have to apply some mechanical force from mechanical force. It will decrease the molecular by braking breakdown of the molecules. That is known as mastication.

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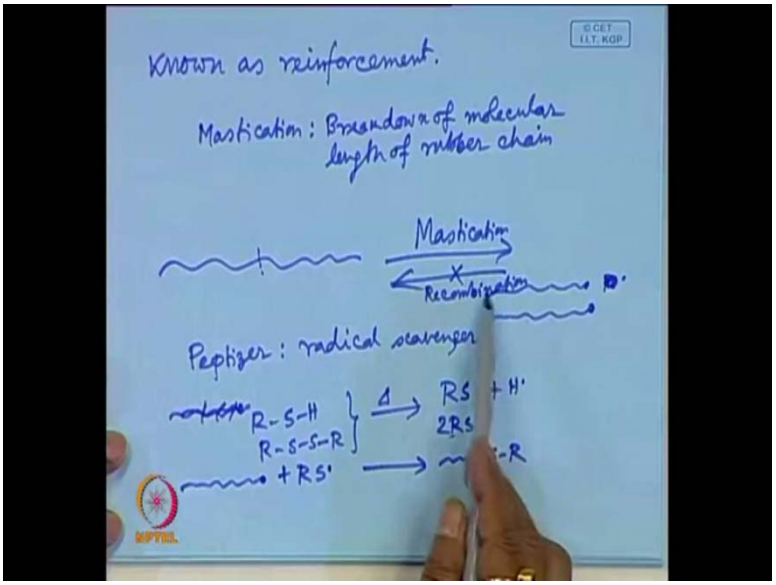

Mastication process breakdown of molecular length of rubber chain. Say suppose this is the length of rubber chain mastication. So it will form two part in breakdown by theory. A simple theory by therefore, than it 2 fractals generate. This is a reverse will passes .They can be recombine again mastication recombination. They can become again, when it is recombine our perpus is not solve. That is a mastigationay affected .So it needs of more time of willing more time of willing time as, you go for more willing time. Then you are losing power that means you are costing more. You are increasing the price of the product. So that is not a pricable show. What will need, you are prevent the type of recombine. You have to avoid this process reverse will process, so you use to peptizer. Peptizes are radicals radical scavenger. What it does say, if there is a preradical scavenger. So peptizer some was r s h. These are type or risalfy type. So what did they do actually, they thermally breakdown thermally breakdown for the for being rs radical plus h radical are, it can form 2 rs radical means this kind of radical. Because either rs radical no this is these are from the peptizer radical than, what happens this furatical rubber which has reproduce an it comes breakdown rs radical scavenger.

So, by this way it an apriveant there in combination reaction. Its devise process is privies devise process. So peptizer Akashi. So when actually in in real compounding phenomena. What happens internal big shares. If, we used peptizer this castigation step can be complete within 3 minute harries. If we do not we used peptizer. It may linger of to 5 to 6 minutes in 1 batch. So 3 to 3 to say Addition 3minutes or 4 minutes times, and running of size of a huge a machine in the huge motor. You can understand. What is the amount of power ricvaire for running for that privier that length of time. So a rubber mail may be as vide as this room the bigger than of this room.

And height may be teagarden then the height of this room, in your bound sealing for rotating and routers and very big. There for rotating as routers is in highthiscocitis polymer of there and you can understand. How much in the power consumption. So saving that power are consumption for 3 to 4 minutes in 1 batch is in is a very big thing saving lot of price. So for that former these prices for that used are see chemical compounds. Dye o-benzamido phenyl dye sulfide activated dye o-benzamido phenyl dye sulfide is zing.

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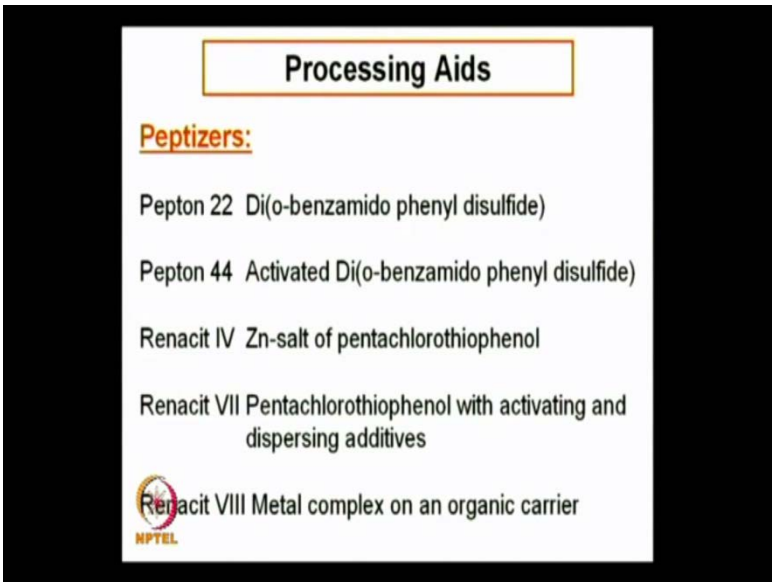

Salt of pentachlorothiophenol pentachlorothiophenol is activating and dispersing additives. Metal complex on an organic carrier. These are actually used as peptizer molecules is are commercially available in the market. Then processing aids respectively made etc. Plasticizers and petroleum jelly paraffin wax glycols fatty acids and salts factice pine tar bitumen etc. All this thinks and tailed extra plasticizer. And dactyls tailed dibutyl tailed dye eyeso octal tailed d .i o p all these things see in case of plastic products.

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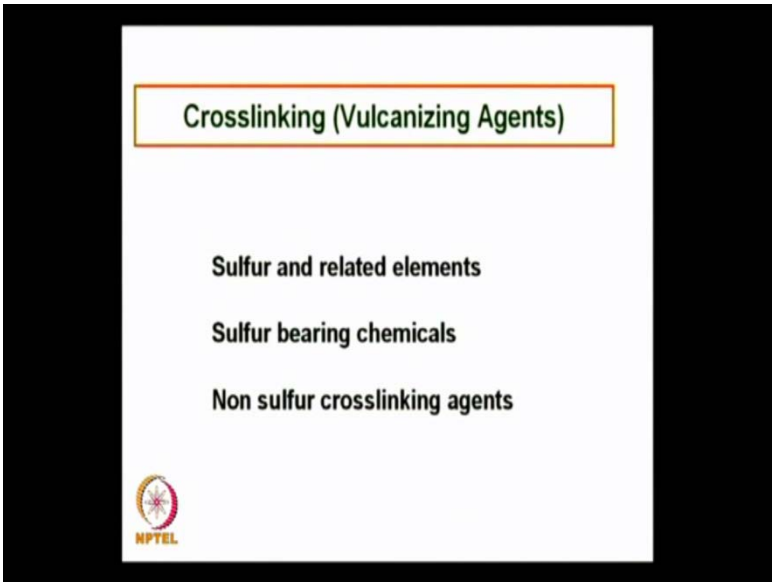

These are not new cross linking vulcanizing agents assignments and sulfur and related elements. Sulfur bearing chemicals non sulfur cross linking agents these are vulcanizing agents used for making a rubber products.

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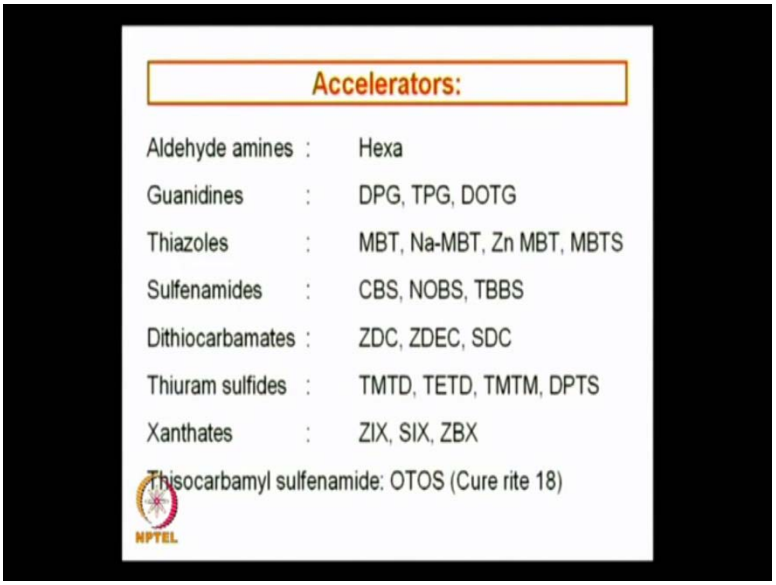

Then accelerators now there are various accelerators available in the market. Which are really used in common ser practice. Say mostly, the sulfonamides categories Thiazoles categories sulfonamides categories dithiocar bamates. That means starting here thiazoles sulfonamides dithiocarbamates theorem sulfides xanthates thisocarbamyl. These are mostly used in making rubber products.

Now actually as you passed from top to bottom. This speed of they are acceleration are reactions increases from top to bottom. That means these are all faster reacting of this, i e 5. So you some formulas as you say.

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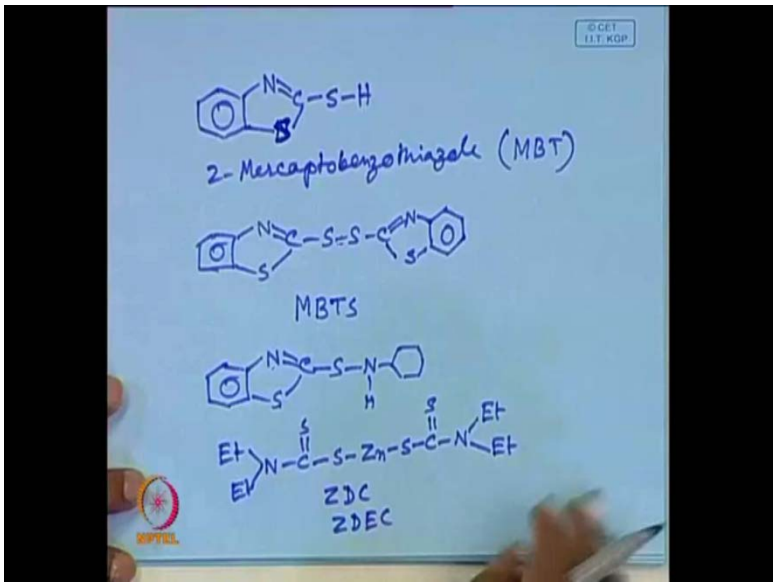

Say m b t, what is m b t this is a m b t I am sorry Rheometer sulfur sulfur his sulfur s h. t. This is to mercaptobenzo thiazoles on as m b t. Similarly, its diazole produce is available to market to benzo thiazoles dye sulfide m b t s similarly; it is Zink Soult curve available. Zink will commend between in this 2 sulfur Zink, Zink Soult sulphynamaites. Salphynamaites say c b s. This is n saiclow exile to market to benzole thiazoles bainzole thiazoles bainzole thiazoles, thiazoles sulfonamides, and have diothacorbonet. I am just say you say z e c z e c Zink dutiable dithiocarbamates say.

I am writing this structure formula, e t nitrogen e t ethaile groups .This is z d c are z d c Then next category is t m t d theorem, dye sulfur theorem sulfur say tetraiythaile. I am dye sulfide. Then another is tetraiythaile just simply soft ethaile group. If you Write ethaile. It will be t e t d. Then xanthates xanthates xanthates are actually again. Some time for formula but, they are xanthates acceletors xanthates acceletors xanthates xanthates. This 1 xanthates actually, this is wrong it should be thaio not this.

So s should be dropped various. This is wrong a thiocarbamyl sulfonamides. If have a dought. You can discuss in after this class. Thiocarbamyl sulfonamides what is these thiocarbamyl sulfonamides. This look at this is thiocarbamyl sulfonamides. This is actually thiocarbamyl bound sulfonamides thiocarbamyl thiocarbamyl solta thiocarbamyl If we do not know the chemistry, this difficult for to understand. I am not going to that of depth.

So, this is thiocarbamoyl sulfonamides. And I can have other thiocarbamoyl sulfonamides like C H 3 or say, say you can take Morpholine , sorry C S is S S N, again Morpholine this a actually OTOS, here I have 18 OTOS oxy diethylene; the oxy diethylene thiocarbamoyl n single bound C, double bound S, single bound S N again diethylene thiocarbamoyl sulfonamides. It is actually called oxy the name is Monsanto chemical product, in the thread name cure-rite 18.

Thank you very much.