Textile Finishing
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Lecture - 26
Mothproofing of Wool

Welcome to this class on textile finishing again. Let us see what did we do till last time.

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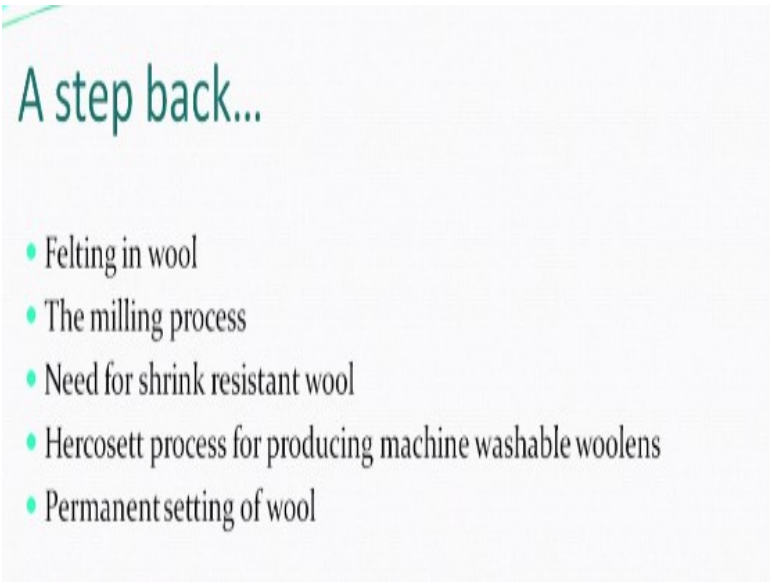

We did learn about felting. We had learned about milling process. We had also learnt about shrink-resistant wool, hercosett process and also permanent setting of wool, which can be done by using steam or creating new crosslinks between the molecules of wool or keratin alright, which we know is a protein okay. So any other special finish we may like to discuss today or do you have any idea would like to work on. Do you have any idea what kind of other special finishes could be given other than the flame retardancy and everything else in softening and stiffening, any guess one.

One of the more important thing, which is basically for wool is called mothproofing of wool, moth you see, so this is a term reserved for woolens only. We do not talk about mothproofing of cellulose, we do not talk about mothproofing of silk, different, so it is only for wool. Whatever proofing means you know you can understand this, resistant is the right word shall we say that, but this term continues, so mothproofing we call it because ultimately you do not want this to happen.

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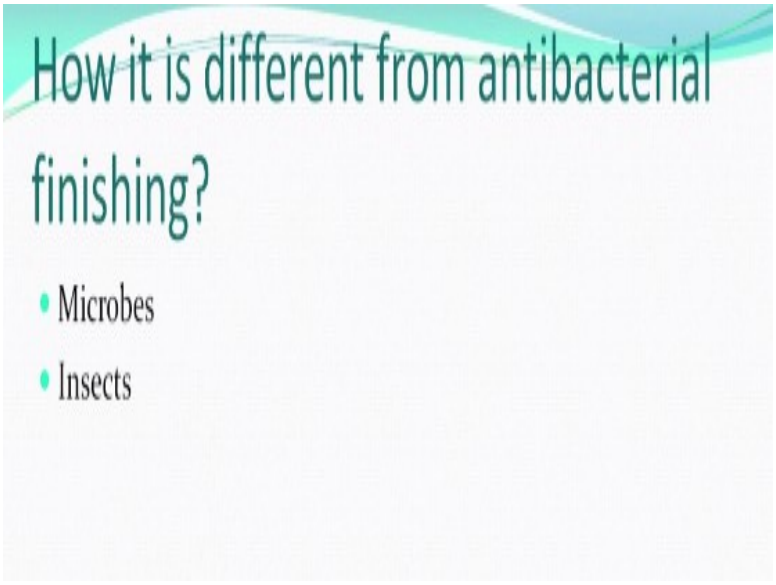

So how this mothproofing is different from let us say what we had discussed few classes before, which we call the antibacterial finishes. So those things were microbes, either fungus or bacteria. Moth is an insect, it moves, you can see it, it flies, it eats, alright like any other thing that you see walking, running, and eats, so it actually eats the wool.

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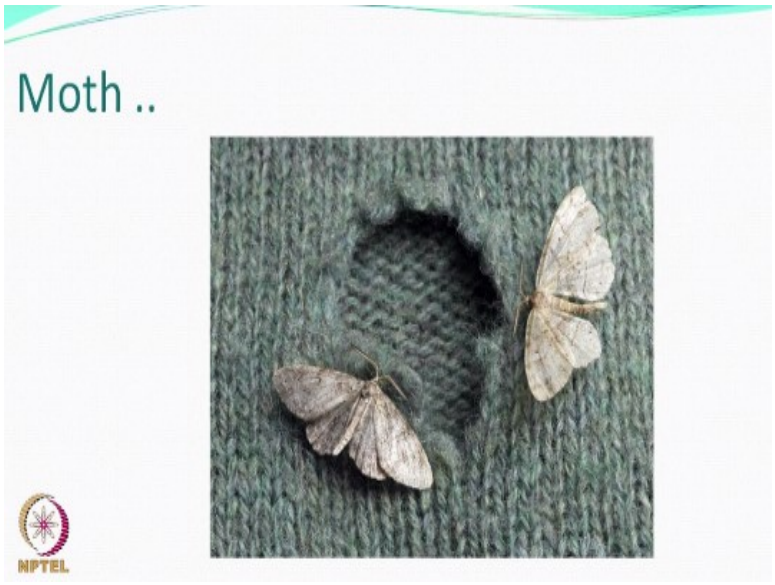

You can see holes of different kind, let us see just a picture. Oh God, see this, like butterflies, but they are not butterflies. They will eat it up. They actually can finish, they love wool, they love the protein, they can break it up into amino acids which they need for their growth, right. We need amino acids, we need proteins, we eat proteins, is not it. So, they also need protein, but they can digest this protein. People like us may not like to eat wool, right, but this moth which is an insect loves it and so we need to work on avoiding these kind of damages okay, these kind of damages on the woolen fabrics.

We know as such the woolens are costly items. If something like this happens to your jacket made from Marino wool, I am sure you will not be very happy. So what do people do? We take care, you know one care which we always took was we dry cleaned it, now of course, we say we can have machine washable material, which can have labels as machine washable or carefree labels, which may be put on the wool if you done the setting and shrink proofing, shrink-resist treatment.

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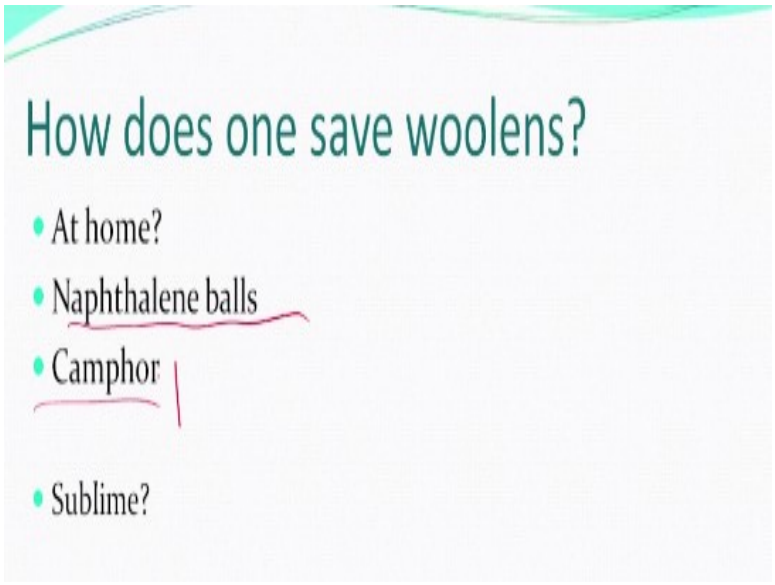

Now, this is another one which is very different, alright. Now here, we have to deal with this external element. I am sure you are aware at home when you store after winter is over your woolens, people use naphthalene balls, is it true or not, yeah, or sometime camphor. What are these type of compounds, no, when you leave naphthalene ball or a camphor tablet on open environment, after sometime you see, their size is decreasing, they are still solid, so unlike if you have a cube of ice put on the table, its dimensions will go down but you see liquid, which is the water.

In this case, you do not see anything, there is a sublime, right, direct solid to vapor. So these are some of the compounds which people use, you may have seen it, some of you, I am sure. So what is their role?

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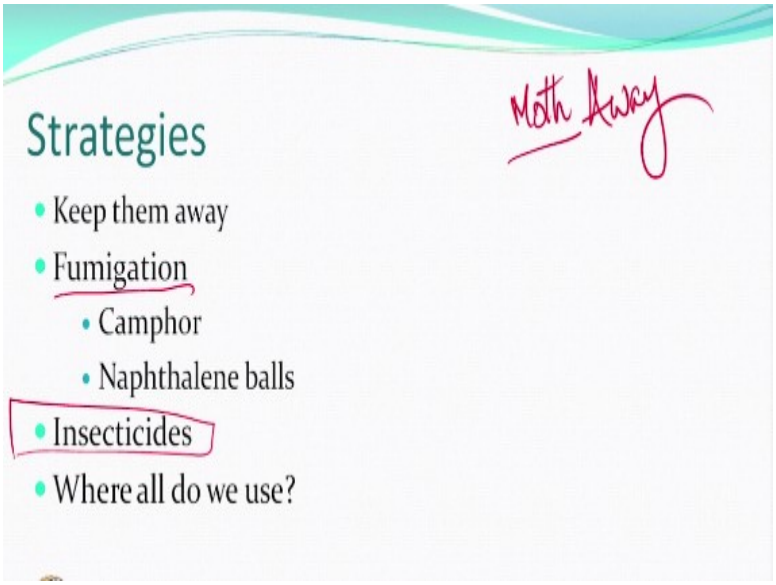

So the strategy to keep the moth away from your garments, woolen garments, one of them is fumigation and can actually take this into fumigation, you must have seen mosquito repellent or mosquito you know smog is done, the fumigation is done at different places, something similar can be done, you can have a fumigating machine, you can put some camper or naphthalene ball and you can you know create vapor by little bit of heating and then you create vapors and keep them.

Otherwise just at room temperature, they will keep subliming or you store them inside in a box that keeps subliming, there will be enough vapors, they will keep them away. Other is actually using insecticides. These are insects, moths are insects, so insecticide is obviously the one which is there to kill the moth alright. So, here you want to do this, use these kinds of compounds. You remember some of the insecticide, the mosquito repellant itself, repellent is repellent like you put in to screen, but the sprays that you have they kill.

So insect killing systems compounds are insecticides and some of those types could be used for moth as well, it is also an insect.

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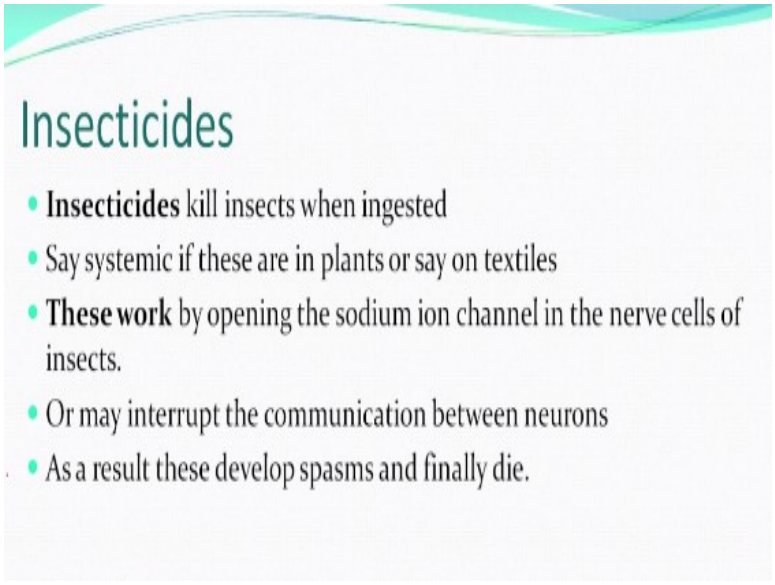

So let us look at some of these compounds which are used, which had been suggested time to time for various purposes and for wool mothproofing as well. So what do the insecticides do? They kill when the insect bites into it, cuts a portion of it, and this chemical gets ingested in the body, that is how they get killed. So, they actually go into their body, from where, they may be like pesticides being sprayed all over in the fields.

So they can be on the vegetable matter and therefore they eat it up and then they get killed or maybe on textiles like what we saw in a picture where you could actually carried out and then when you digest them, the amino acid that they want to use for their growth also has some chemical along with it which is the insecticide. How do they work? Some of these things work by what people call as the opening the sodium ion channel which actually is very much responsible for all those biochemical things that are happening everywhere, particularly reeling with the nerve cells, so everything in a body is controlled by the nervous system.

So if something goes wrong there, all the things that are supposed to happen stop functioning in any case, for us also, if something happens to the brain, then all the functions can finish including breathing, including beating of the heart, everything else. So they work at the nerve cells or within the brain system, the neurons have to communicate to pass on the messages, they make it attached, they bind to something and then some of the communication system by releasing of certain chemical which would go and trigger the information channel may not happen.

So if it does not happen for too long, they do not know what happened, so anything else can happen, that is how they would work. So they are very serious, they believe these kind of things are basically dependent on the fact that they would interact and the bodily systems work at the nervous system and break down and then they will develop all kinds of spasm, uneasiness, and then finally they will die

So, we are actually killing, it may not be the best thing to do, but if you want to save your fabrics or sometimes save yourself let us say from mosquito, what do you do, then you kill the mosquito or you get your killed yourself. So, I think we would better kill the moth, okay.

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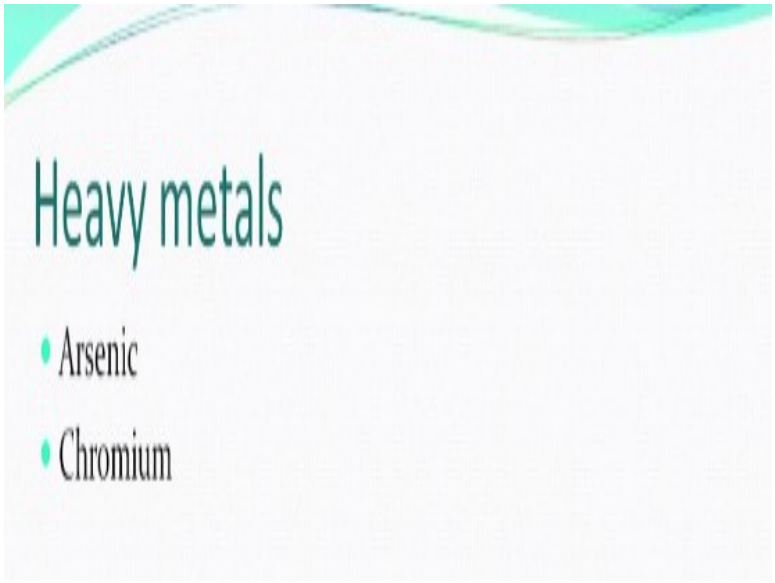

So, I am sure about arsenic for example is a poison right, people have been talking about it. So metals could be used, but they are poison to us, so we did not like to use these things. Similarly, chromiums and coppers and heavy metals, they could also be dangerous to these insects and the moths okay. So we can use them, they can work and they can work as nicely, but then they can harm also, you may not like to have too many of these things metals on your jackets and cardigans that you use, obviously you know, so you better have something different.

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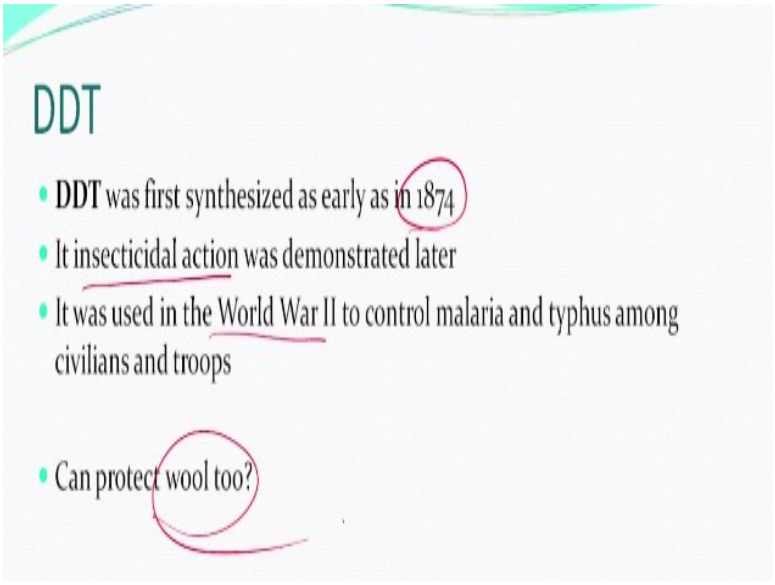

So there are organic compounds which were developed as insecticides and tested in everything, you know, whichever is called insect. So at least the biological knowledge generally said that we as mammals grow differently than insects and so some of the compounds could be more detrimental to insects than us and so we use them, obviously those quantities have to be limited, you cannot think that something which harms only an insect and if you digest or ingest too much, nothing would happen to you, but within the limited arena, within the limited concentrations.

Insects probably would be hurt more than the humans and that is how some of these things were designed and developed. I do not know how many people have heard, how many of you have heard a compound like DDT? People like us who are old enough, we always talked about a compound like this which was a white compound that would be thrown everywhere on the roads and there and then and it would dissolve and you can put it solution spray, DDT, people would do DDT spray in their houses to avoid insects.

So this was one compound, which was designed and developed much early, very early, but this actual action that this is how it does and that it can be used for a purpose like this was demonstrated at a later stage. Interestingly, it was used quite a lot in the second half of the World War to control malaria and typhus among the troops and civilians as well. Can it protect wool? Yeah, of course, if you put it up on woolen garment, it can protect wool as well.

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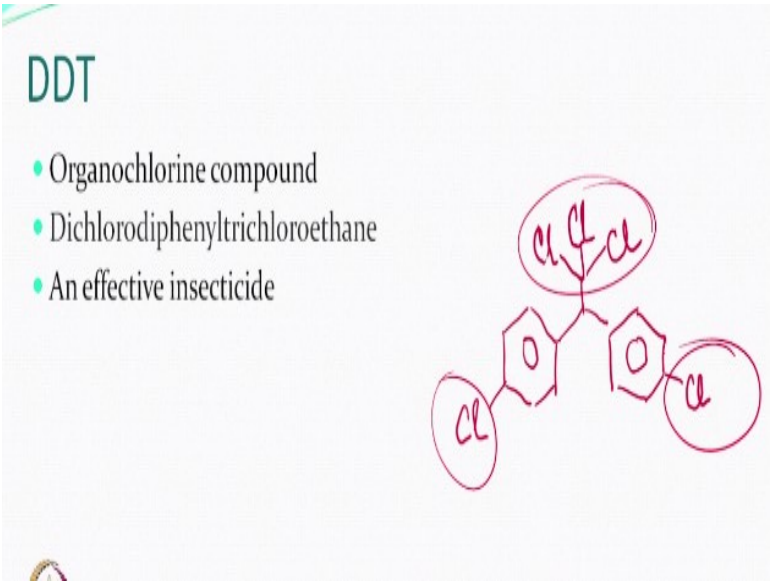

So, you have one insecticide, DDT, interesting compound, you can see a lot of chlorine there. So it is an organochlorine compound, alright. So organochlorine compound, so you can look at it, it is a diphenyltrichloroethane based compound, effective. When it was designed, it was pretty effective insecticide, but then many things happened. Like we are growing and becoming smarter, the insects also become smarter, their bodily systems also adapt to something which they see every day.

That is why people say do not use too much of chemical, do not use too much of antibiotics, otherwise things start getting resistant to these chemicals also. With DDT, this also happened, it was pretty good for this thing, but later on it became not so much effective, of course other issues also came up. So as such, this compound is colorless, tasteless, and more or less odorless compound. So, it is a good compound in that sense, you can use it, and it will work when the insect digests it, in our case it is moth, but what happens, over the period of time, the resistance to these, this DDT developed.

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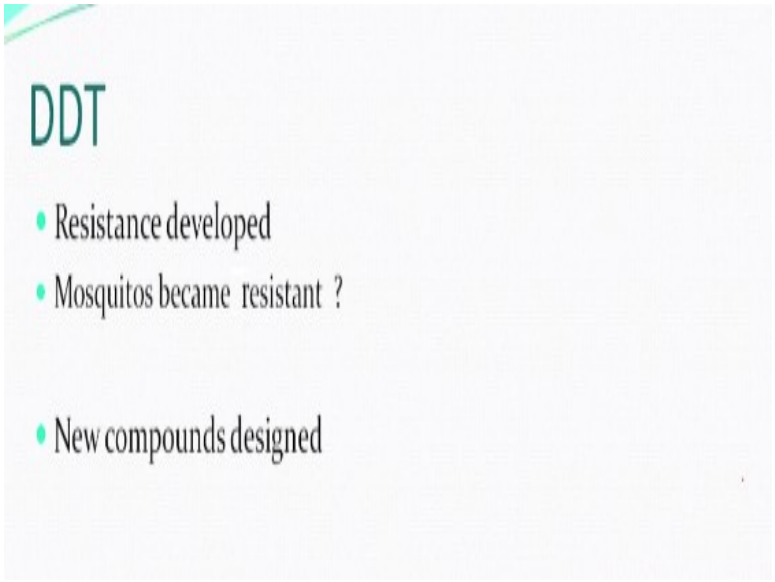

This was used for you know mosquito eradication quite some time, the mosquitoes also became with time resistant to these chemicals and therefore newer insecticides had to be developed which is the process of growth, right, one thing stops, the other one has to start, but whenever we are dealing with the biological systems, this must be kept in mind that nothing can be forever, though such development will be forever because the living species are going to keep on adapting themselves to various types of thing that you make.

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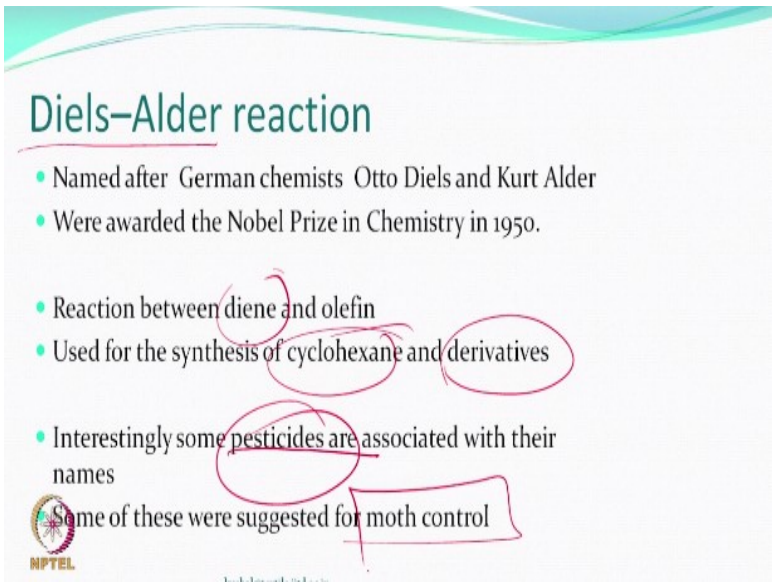

So, DDT is theoretically not available so much these days because it was not found so useful, so the new compounds had to be designed and developed. One of the interesting reactions, you know just, not so much required as the textile finishing is concerned, but interesting to know that these 2 scientists actually created a new way of synthesizing chemicals. So these 2

German scientists, Otto Diels and Kurt Alder, were the ones who devised a new way to react and synthesize organic compounds.

So that reaction is actually called the Diels-Alder reaction, okay. In fact, this was so nice method or mechanism of understanding how 2 compounds can react and make certain type of chemicals, they were awarded Nobel, so this was very interesting. So they found that reaction with dienes and olefin can synthesize cyclohexane and derivatives of cyclohexane. So a large number of chemicals could be designed based on this reaction, this became a very important reaction you can understand you get Nobel prize for this, right.

So it is not so easy, in some sense it is revolutionary, therefore I thought share with you. So other than their name which is carried with the reaction, some pesticides were also designed and developed which approximately carry their names right. In textile or polymer systems, you remember any other pair of scientists whose name is associated with the process. Can you remember some scientists whose names are associated with a process, you remember Ziegler and Natta, so these two also designed one catalyst okay.

So the whole polypropylene chemistry and later others also where tacticity had to be controlled, the Ziegler and Natta catalysts became important and so their name was carried along with the catalyst itself, the catalyst of course are organometallic compounds, but here this reaction is known as Diels-Alder reaction, which can explain how the diene and olefin can react to make cyclohexane and based on what kind of diene and what kind of olefin you can make different kinds of derivatives, right, so they became important.

So why I talked about it, because some pesticides also are almost carrying their name, and of course, they were suggested for control of moth as well, our interest.

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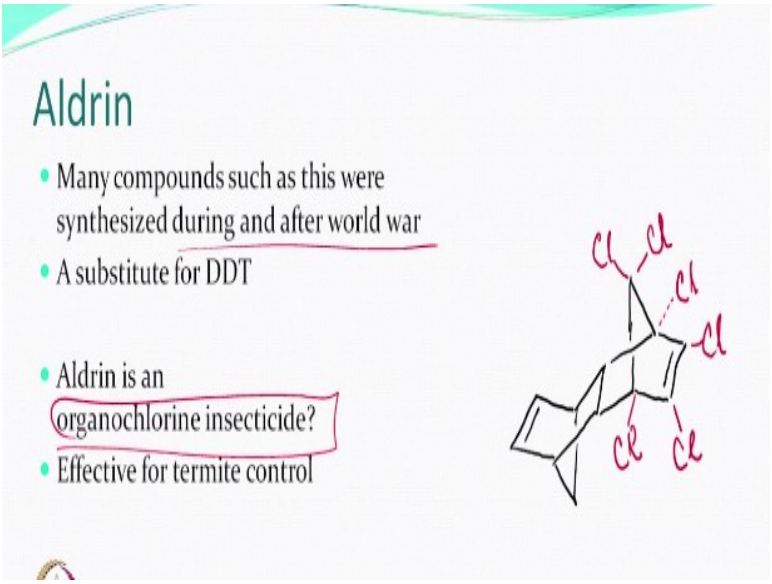

So aldrin is this compound, see how many chlorines right. So it is again also an organochlorine compounds, but if you look at the structure, I mean it is a 3-dimensional structure, very different kind of a structure okay. It is a very different kind of structure. So you will find that some of these insecticides are complex structures because some of these chemicals are available or similar-looking chemicals are available for the growth of the body also and therefore like they are called the metabolites.

So if you create a different kind of a compound, they can become anti-metabolites, but important thing is they are all complex, they are not simple compounds, so quite complex compounds can be there. This is one of the compounds. So interestingly during and after World War, imagine World War happening, because there is a need, so you start creating compounds, that was a bigger need at the time, but later on of course, these chemicals become important for us.

It was considered a substitute for DDT, you know which could work around. So, it is an organochlorine insecticide okay, which is clear from this table there are 6 chlorine atoms attached. It was used effectively for termite control as well, that means any insect with a termite, mosquito, any other thing which is there, a bug, they can be sort of killed.

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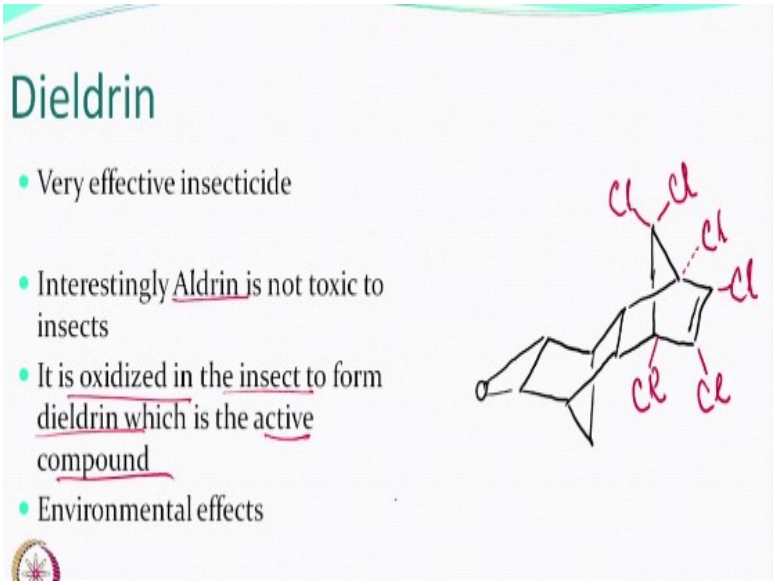

Another compound again those Diels and Aldrin, their name is getting associated with this compound, this is slightly different, it is an oxide of the previous compound, why, it was also very effective insecticides. An important thing is the Aldrin, the previous compound by itself was not toxic to insects, so many chlorines, but not still toxic to insects, but when it goes into the body, it gets oxidized in the insect itself to form dieldrin which is active compound, so the oxide is active.

So whether you can make dieldrin outside and just get it ingested or applied to chemical or a textile or a plant and this would happen. So if this gets ingested, it will automatically do the thing. If aldrin gets ingested, it gets converted to this within the body and then this system would kill in the same manner as we discussed before. Now, see how much is difference between aldrin and dieldrin, very small, so one of the compounds by itself may not be an insecticide, but you change little bit, it becomes.

The human systems are very complex, the living systems are very complex and slight changes here and there can make things different for them. Of course whenever we talk about it, people say well what will happen to these compounds when they go into the waterways and so on and so forth, so organochlorine compounds are always suspect, but they are effective. So now the question is what is more important, the environment or the mothproofing, whichever way you want to go, but environment will finally be important because they are involved.

What happens is that immediate effects will be seen on the insects, they will die, you happy. Long-term effects of even very small concentrations of these chemicals will be seen later, but we as wise people and society would obviously be concerned about that as well, unless and until these compounds are dissociated, broken down with time, with processes that are known.

The situation that happens is that they are in some sense can you say poisonous to the insects and they would always, whenever something like this would be required, they would first kill that before that fellow can break it. So something else has to be done, and if you do incineration and so on and so forth, the chlorine may not be the best thing to be coming out, right. So, there are environmental issues, we cannot ignore them.

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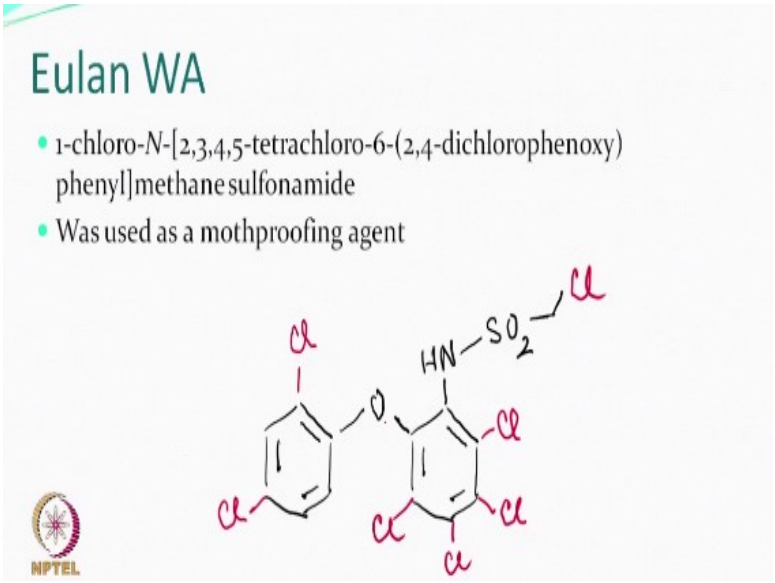

Another compound which is an interesting compound, which we call the Eulan. In the whole of the Europe, this was being used at one time and particularly developed for wool only, this was developed. So there are many compounds similar to Eulan WA, so there are many such series was developed with some change here and there. So if you want to look into it, you can always go back and look into it, what kind of Eulan series were there.

All of them were very effective compounds, with time people found that they can have some harmful effect to the human as well and so the data sheets were prepared and you had to know how much dangerous it is, at what ppm levels and so on and so forth, one had to work around. Complex compounds, so the structure can be written down also in a long thing, but basically this is the compound that you have very large number of chlorine per molecule. So

somewhere it is clear now, the chlorine compounds as a disinfectant, has antimicrobial also, and now as insecticides are very effective compounds.

It is being suggested and used for mothproofing, not just WA, but many other such compounds were tried, tested, and how to apply, these are the question that were there which obviously optimization processes were used.

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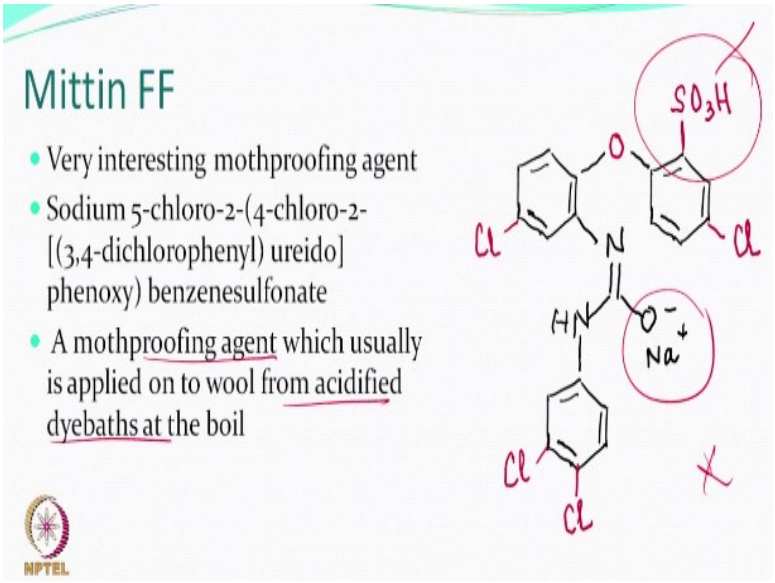

This is another one of the very interesting compounds which is an insecticide, at least for wool, for mothproofing, this has been suggested and has been found to be less objectionable to the environment, let us put it this way. So it became quite interesting compound, Mittin FF, The chemistry is this, but the commercial name was Mittin FF and if you type it out, you will get lot of data about Mittin FF, and the more important thing is look at this. So it was first a sodium salt, so ionic salt dissolves very easily in water, that was one interesting.

The previous compound if you see, they had to be dissolved in some organic solvent okay and then you can apply and after that solvent can evaporate and they can stay back, but this had water based thing and then this SO_3H or sodium salt of SO_3H, it could be a SO_3Na also. So this becomes interesting compound in what sense? This could be applied to wool from acidified dyebaths at the boil. So you are doing the dying, add this compound, you have negative charger in acidic medium.

Wool would have positive charge, and so like the acid dyes, direct dyes also our anionic, they can also go, but acid dyes are anionic anyway, so this also anionic, a larger compound, but it

also can be adsorbed and diffused into the wool along with the dyeing process. Therefore, it became very interesting compound, also gave a way how some of these compounds therefore can be made water soluble and applied if possible along with the dyeing itself, okay. So, dying and mothproofing processes can be combined.

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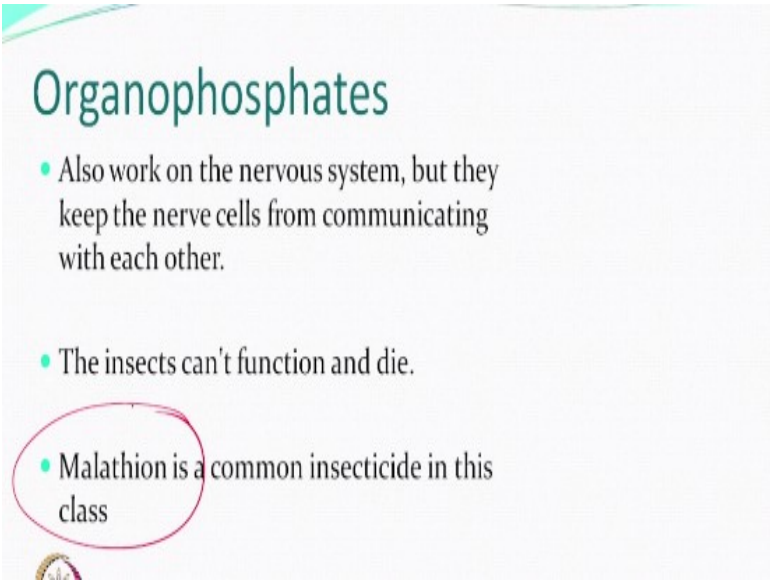

So instead of organochlorine, people thought about organophosphates also, if chlorine is more harmful, so phosphate may be less harmful to the environment. So these compounds were also developed. They also work in the nervous system, but they tried to bind with systems so that the communication between the neurons does not happen as much as it should have been happening and so they can stop this process, and if they do stop this process, their functions are stopped and so finally the insects would die.

One of the compounds which maybe some of you have heard is malathion. So, malathion is a common insecticide of this category, which is organophosphates, so you had organochlorine, chloro-organics or organochlorine compounds and now have organophosphates.

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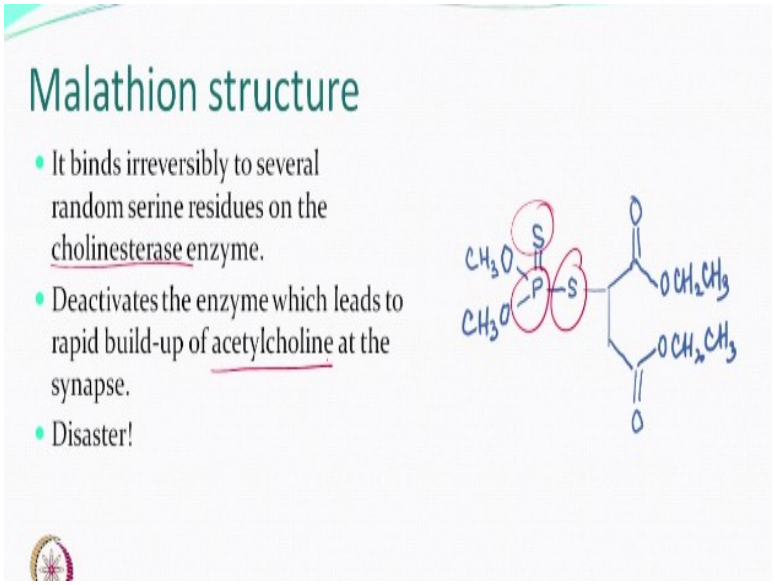

So one of the compound is this, malathion, complex but it has got phosphorus here, got some sulfur, and of course this is a compound, not a cyclic compound but a branched compound. So, this compound which is the malathion binds irreversibly to various residues, serine, you know serine is also one of the amino acid you remember, on the enzyme. An enzyme is cholinesterase. So, these enzymes do some functions. If it binds, then this function is negated.

So the enzyme gets deactivated and the compound which is acetylcholine keeps on forming, which is not good, that is why this enzyme was required to keep on breaking this, this enzyme becomes deactivated and so disaster, okay, insect goes off, interesting, not for the insects.

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So if environmental issues become very important, obviously they are, so can we look into other type of things, it will be always a question. Now if you have very nice compound, which are very nice to everyone, then they may not be so harmful to the insects, this balance how do you maintain, that question always remains. So people try to work around chemicals, which probably are already available in nature and you modify them in some way or the other, and then we now let us say subject the insect to these treatments.

Then there is a confusion which happens, but because the structures may be quite similar to what material already is in the nature, therefore the damage to the environment obviously expected less because they can biodegrade then, right.

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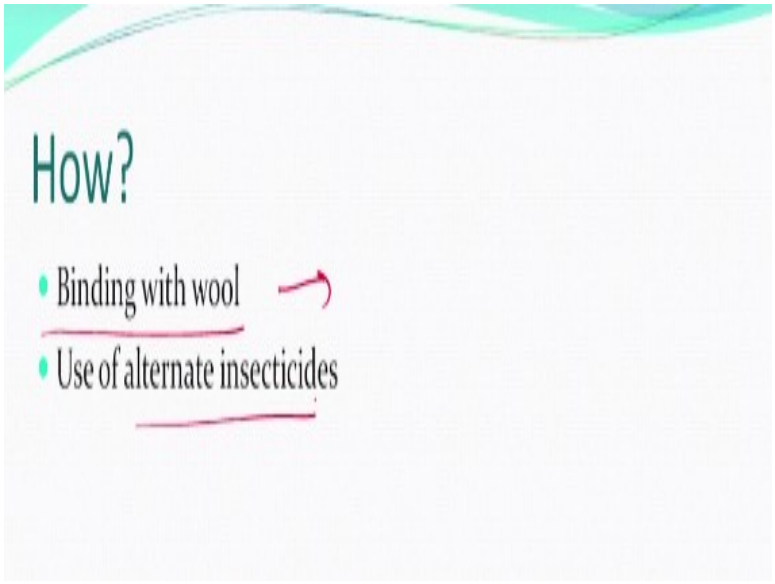

So for the environment question, one could be that when I bind it to the wool, it will not be easily available and it would not easily get leached out to the waterways during washing and so on and so forth if at all it is permanent, that could be one process that you can think of covalently bonding them with the wool, so when the insect bites it, then there is a problem to the insect, otherwise it will not be released on your skin, it will not be in the waterways.

So that could be one approach when you have these nice beautiful chemicals, but that is one important thing or use of alternate compounds. So these could be two approaches if you want to address some of the issues of the environment.

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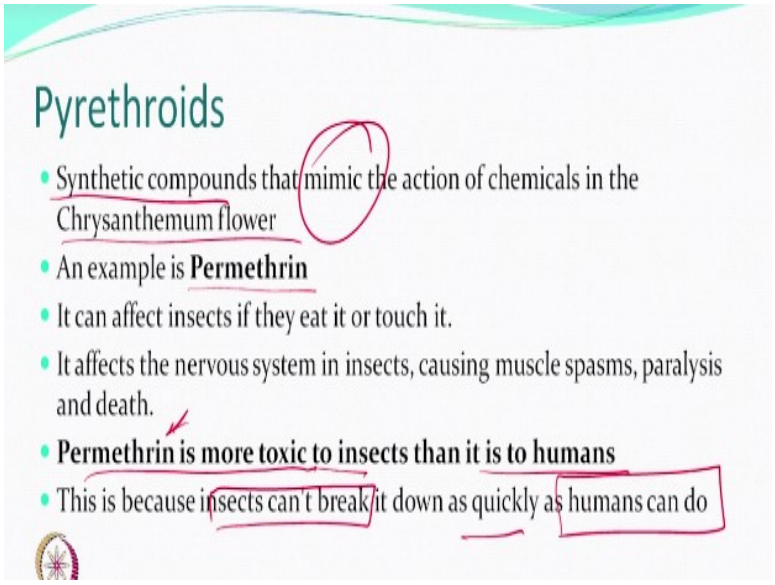

This very interesting compound which are called the pyrethroids, related with things which can be extracted even from plants. So, there is a flower, chrysanthemum flower, so it has got these compounds which are called the pyrethroids, the class of chemicals, which can harm an insect, but because they are in the plant therefore they are biodegradable, and so therefore could be more environment friendly, but there are many class of compounds which are synthesized which mimic the action of the chemicals found in these flower for that matter.

So this is interesting. So you go for what nature is doing and then you get back, look at those compounds and make something similar if not exactly the same, making exactly same is always much more tough, but can be done. So one of the compounds which is known as a good insecticide belonging to this category is called the Permethrin. It can affect the insects as they eat or touch maybe ingest somehow.

Again works in the nervous system, causing muscle spasms and paralysis and death, that you are interested, but this is more important, more toxic to insects than to humans, because for whatever reason we are made differently, our systems are more stronger in that sense and so this what happens. Because the insects cannot break this compound as easily and quickly as the humans or other mammals can do, so if you use these type of things, so a pest control for mothproofing, they could be you know the future directions, nice directions.

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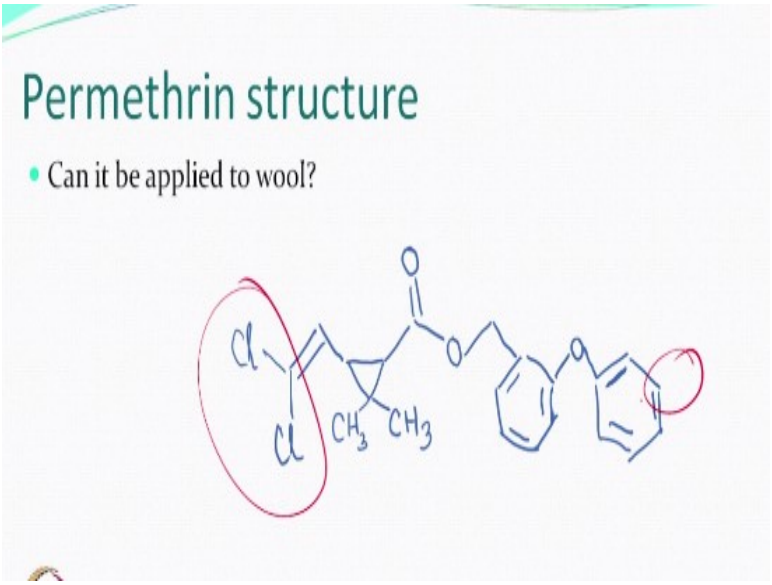

Very complex compound again, it has some chlorine, but synthesized right, but this compound can be applied to wood, yeah if you use it like this, then of course you can have these chlorine actually getting reacted as such. You can dissolve and apply or if you can think of modifying the structure, making sure that some other groups like sulfonic acid groups could be created somewhere here, and if you can do that, then it can be water soluble and you can apply through water solvents, the things along with the dyeing and so on and so forth, they can be applied of course through solvents without any problem.

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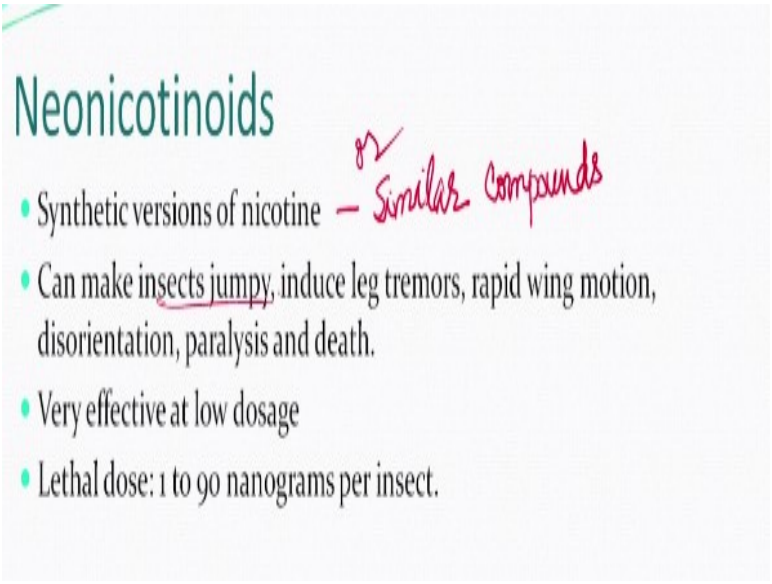

Then neonicotinoids, you know nicotine you have heard, nicotine, cigarettes and bidis and all such things contain nicotine. It does somehow does not kill the human, but we say well some harm it does create, lot of advertisements you must have seen. Best compounds based on

similar structure like a nicotine can be used which becomes much more effective on the insects, again so synthetic version of nicotine or nicotine or similar compounds okay.

So, the same thing they can do, they can start jumping, tremors, they are insects like moth, the fluttering of the wings could be very high, and then disorientation they would not know where to go, nervous system paralysis, death, very effective at very low dosage. One get surprised that they can be very effective at very low dosage and what low dosage you are talking about. We are talking about something 1 to 90 nanogram per insect, nanogram you understand, very small, it works, and at this dose nothing is likely to happen to the humans at all.

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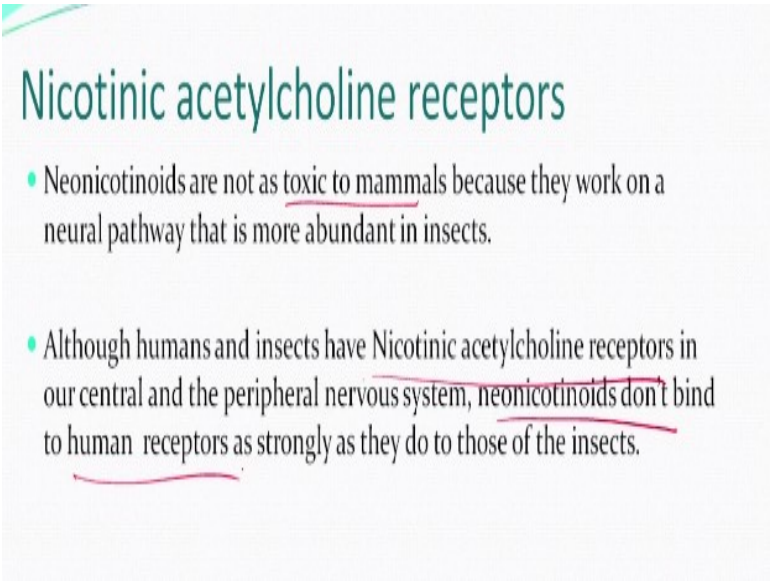

So their mechanism is that there are receptors which are nicotinic acetylcholine receptors in the body. These neonicotinoids are not toxic to mammals because they work on different pathways than the insects. So theoretically speaking, the humans, the mammals and insects, they do have these receptors in our nervous system okay, but these things do not bind on human receptors as strongly as they do to those of insects. So even if they come, they will be released sooner, our systems are designed differently, that is how we work.

So more toxic to the insect and less toxic to mammals, and because they are quite similar to the natural compound, therefore their biodegradability is not so much of a question and their environmental impact is likely to be less.

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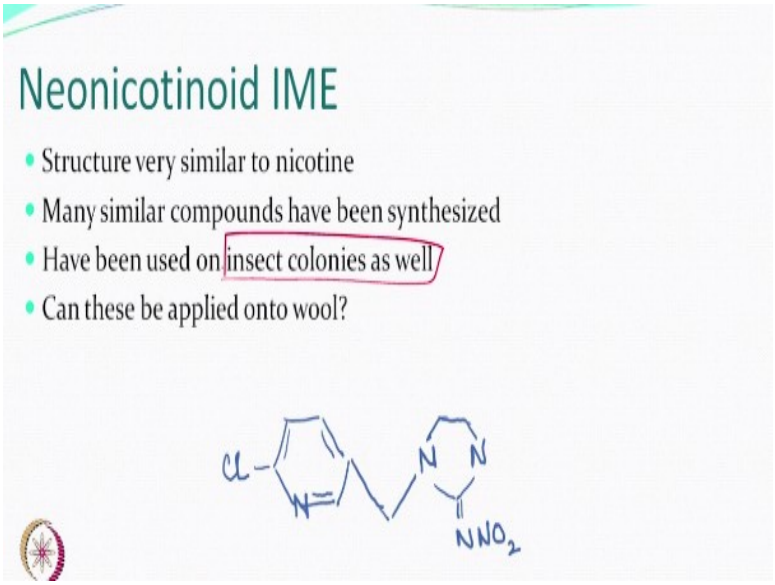

So one of these compound is the neonicotinoids IME, so this is one compound, interesting compound which has got very less chlorine, lot of nitrogen here. So they can be broken down easily, the structure is similar to nicotine, but this is not nicotine, right. Many similar compounds have been synthesized which may have different names and their effectiveness will be obviously different based on their own structures and so organic chemists will keep making new compound, will keep testing them, and that is what is happening, but better part obviously is some environmental concerns.

Also the biodegradability is concerned, whether their effectiveness is so much that if you know where the colonies of the insects are there growing, if you put them there, the whole colony could finish. Can be applied to wool, yes, they can be applied to wool. You can have possibility of through solution, you can spray. If you can create sulfonic acid groups, then it can work. If you can use some of the double-bonded structure to create a covalent link, it is possible to make bonds also.

So they can theoretically be bonded also, otherwise they are very effective compounds. Now one important thing which people have seen is they can do this harm in the colonies itself, though somewhere in some countries they have been banned also. They do not harm so much as for the humans are concerned, but there are very useful insects as well, like the honeybees. If they are there, honey bees would just finish, but they are interesting insects. So, there is again going to be a balance.

Environment, I do not think there is going to be a problem because they are almost similar to natural compound, they can break down easily and very less amount of chlorine we can see that, effective on the insects, so that is also good, but you can always have some questions.

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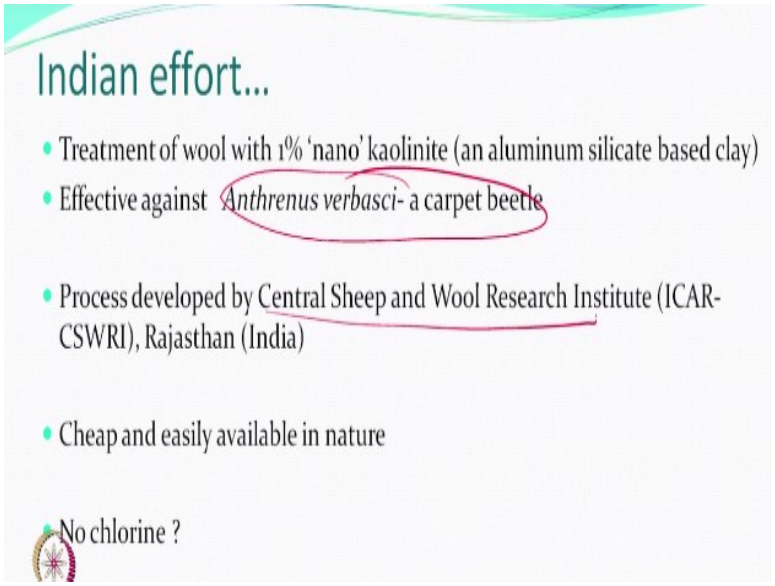

Some Indian efforts also have been done using a clay, a nano kaolinite clay okay. They have been found to be very effective for a carpet beetle, you know, carpet beetle. So you see lot of things moving, so they are beetles, they become moth at elder state, carpet beetles. Our own Central Sheep and Wool Research Institute has used these clays and applied them on carpets and found good results. Cheap and easily available in nature, therefore they are natural products, so they are relatively more safer. No chlorine, good idea.

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Okay, so we come to the end. So what do I do? So, learn something about using clay for finishing a wool, not why wool, other textiles also. Some people are using clay, various kinds of clays are available for finishing textiles. So, why do not you learn something about them yourself. There are called Bt insecticides, you know, biotechnology, you have some heard about Bt cotton right, Bt brinjal, so you can have Bt insecticides that is being generated by the genes themselves, from one to the other, one can be harmful to the other. Those types of things also being done, so you may like to learn more about them, do learn.

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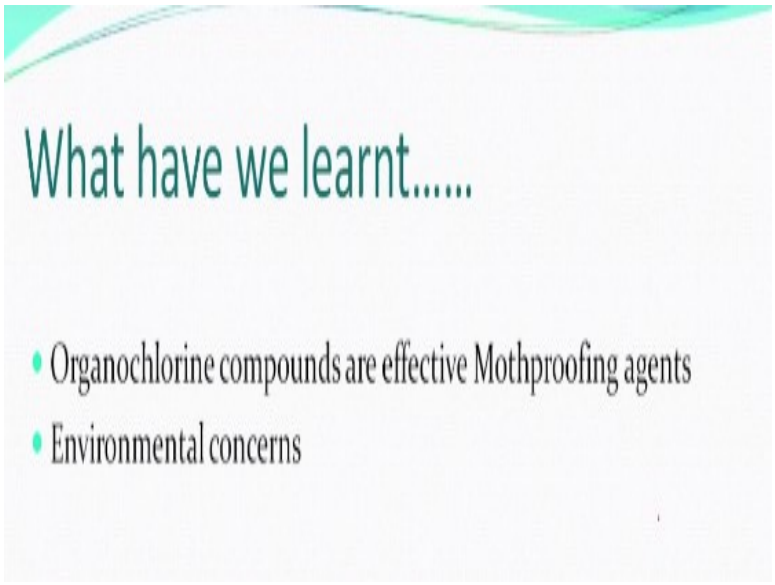

So today, we have learnt about the organochlorine compounds, which are effective mothproofing agents. Because of some environmental concerns, we have to look for compound other than chlorine as also get inspired from chemicals that are available naturally. You mimic them, the properties, the structure approximate, and then see how things change okay. So, there we are. We stop there, and in the next class, we will see if some enzymes could be used also for finishing of textiles. Till then have fun. See you in the next class.