Introductory Organic Chemistry
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Lecture - 36
Reaction of Alkynes Part-2

Now, we are also going to look at one more reaction which is very important synthetically. And once we go ahead and look at retro synthesis, you will see the use of this particular reaction. So, now what we are going to see is how to prepare an alkyne from an alkene, okay.

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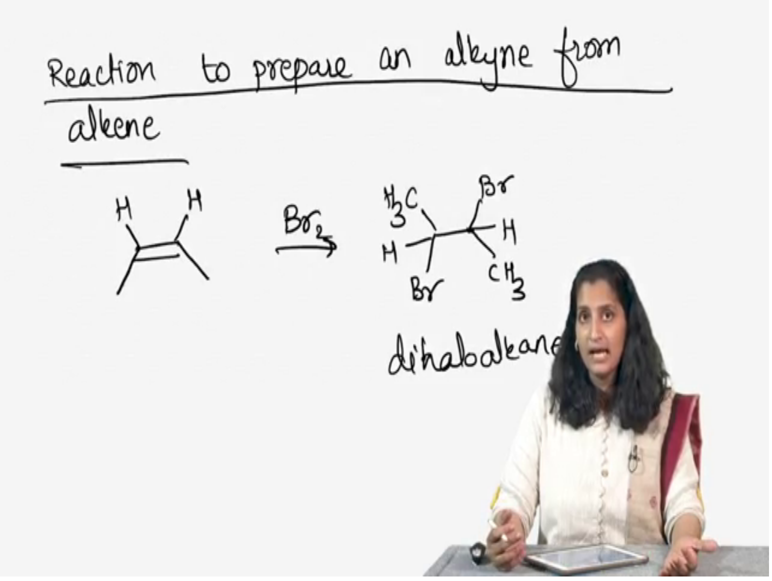

So, in order to do that what we are going to do is we are going to take the alkene first, and then react it with either bromine or chlorine to give us the dihaloalkane, right. So, let’s take an alkene and I am going to add the bromine across this particular molecule, okay. So, what we have formed is a dihaloalkane, okay. One thing to remember is that this is not a geminal dihalide, it is a vicinal dihalide, okay.

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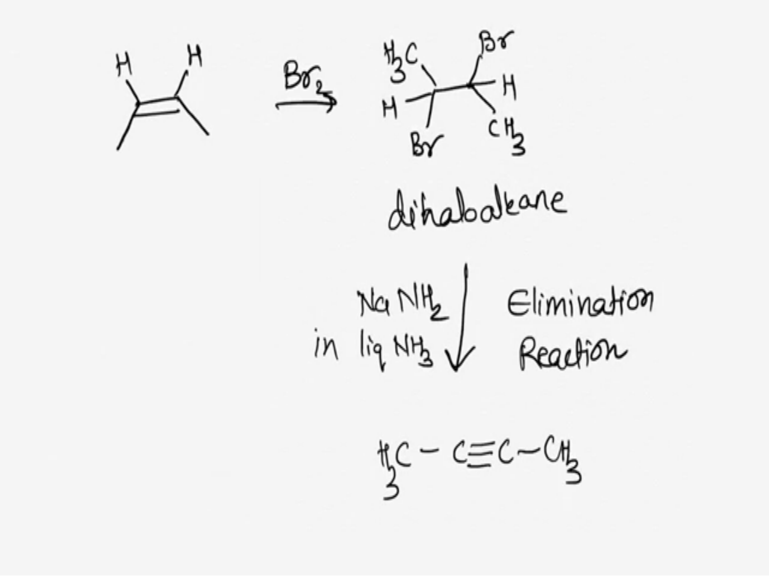

And, what this particular vicinal dihalide can do is it can undergo a reaction called as elimination reaction, okay. For now, I just want you to remember that this particular dihaloalkane can undergo a successive dehydrohalogenation reaction or rather two successive dehydrohalogenation reactions such that in presence of a really strong base like $NaNH_2$ in the presence of liquid ammonia, it can form the corresponding alkyne.

So, this is an elimination reaction. And we will look at the mechanism later, but for now I want you to know this reaction how to go from an alkene to an alkyne via reacting it first with Br_2 or Cl_2 to give you that dihaloalkane, and later on reacting it with a really strong base to give you that alkyne, okay.

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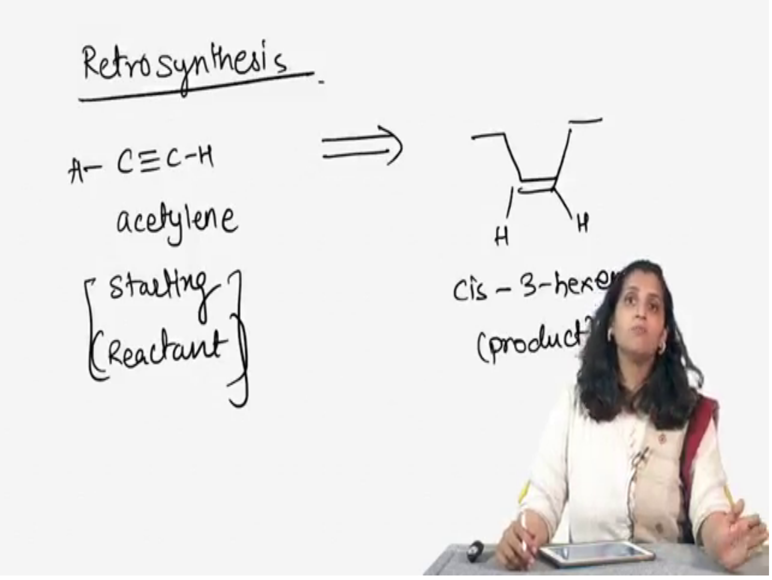

So, now we are going to start talking about Retrosynthesis. Remember the goal of chemist to do all these various kinds of chemical reactions is to build new molecules that are useful to mankind, right. So, we build molecules that can be used in pharmaceutical industries, we build molecules that can be used in color industries, in food industry and so on and so forth. But, what you will see is that most of the molecules that are used in these industries are quite complex, they are big molecules; they have number of carbon atoms with various functional groups attached to it.

What we want to do is we want to start building these molecules such that we start from very small building blocks, okay. The building blocks here are going to be compounds that contain 2 to 3 carbons or maybe a few more. But, the end product is going to be more complex and it's going to result into the formation of a bigger molecule.

Now, one of the ways to think about is, is to think it backwards. In the sense that if you have a big molecule what are the ways to form that big molecule starting from very small building blocks, okay. So, what we are going to do is, we are going to start thinking backwards, okay. And this particular way of thinking is called as Retrosynthesis, so 'retro' meaning backward, 'synthesis' is building, right.

So, we are backward building the molecule of interest. Of course, we are not going to start with very complex molecules to begin with, we are going to start with very easy example, so that we build this way of thinking or the strategy of retrosynthesis can be mastered before we go to really begin difficult molecules to synthesize.

Now, there are a couple of strategies that help us in this retrosynthesis, the first one is that first count the number of carbons in the starting molecule and the end product. So, that you know how many carbons you need to add to the starting material to really form the end product, right.

Also look at the functional groups in the end product as well as the starting material, because in the end product you are going to result with some functional group. And you can think what are the reactions I know to form this particular functional group from starting material, you can think what are the reactions I know of this starting functional group to really end up towards this end product. And, if we develop this way of thinking you will realize that it is much easier to think backwards, one step back at a time to really form the product in hand.

So, what I am going to do is, I am going to solve one very quick example here, and maybe we can solve a few more in the tutorial, which emphasizes this retro-synthetic thinking, okay. So, I am going to start my example with acetylene. And I want to do this reaction such that I end up forming cis-3-hexene, okay. So, this is my product, and this is a reactant or starting reactant, okay.

One thing to know is that even though we have shown that arrow, it does not mean that it directly goes from acetylene to cis-3-hexene. It in fact, means that there are multiple reactions in between and together at the end of the last reaction you will end up forming that final product.

So, now, the way to think about it would be what are the ways you know to form cis-3-hexene, right. Remember it's a very typical double bond that has been given here which is a cis double bond. And we just looked at a reaction which upon the reduction of a carbon-carbon triple bond in the presence of Lindlar's catalyst and hydrogen gas results into the formation of cis-3-hexene.

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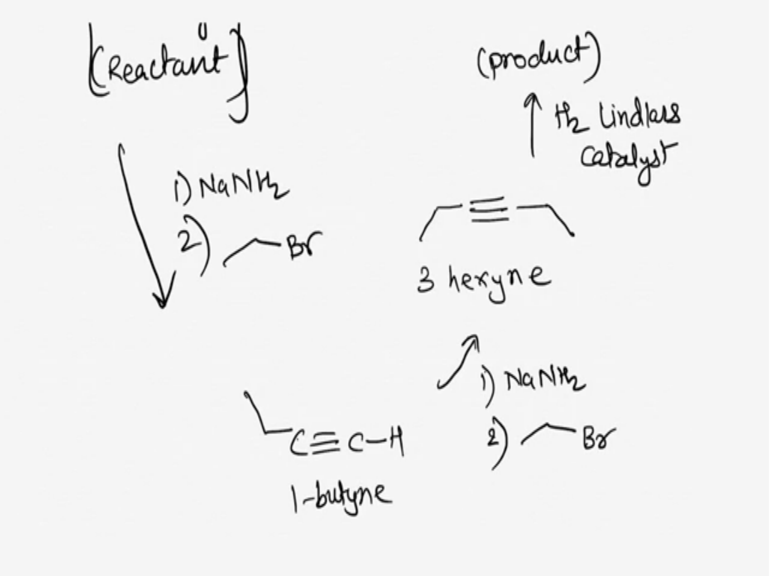

Now, we want to treat it with hydrogen and Lindlar's. So, you want to think what is that alkyne that will result into the formation of cis-3-hexene. Now, the answer would be 3-hexyne okay, and this 3-hexyne when I treated with hydrogen and Lindlar's catalyst is going to give you that cis-3-hexene, right; but wait we have not yet converted our acetylene to the 3-hexyne, right.

So, now I want to do a reaction such that it converts acetylene to 3-hexyne. Remember in acetylene, I have 2 carbon atoms and in 3-hexyne, I have 6 carbon atoms. So, we have also added carbon atoms as the reaction goes, we know a reaction called as an alkylation reaction which adds carbon to an existing carbon-carbon triple bond.

So, let's say that I can form this 3-hexyne from 1-butyne, right; if I treat this 1-butyne in the first step with $NaNH_2$ and in the second step with this corresponding alkyl bromide, since I have to add two more carbons, I will take ethyl bromide, right; it can form 3-hexyne and in fact, acetylene if I treat it with $NaNH_2$ followed by ethyl bromide can form 1-butyne, right. So, acetylene in presence of $NaNH_2$, and ethyl bromide can form 1-butyne which again when reacted with $NaNH_2$ and ethyl bromide it's going to form 3-hexyne. So, just now we have created a way to go from acetylene all the way to the product which is 3-hexene through multiple small steps, right.

And one of the analogies that is often given for a multi-step synthesis is that let's say that I am going to go to Delhi, I know my end destination, I know my starting destination which is Pune right now, right. What are the ways I can reach Delhi; now one of the ways to reach Delhi is via air. So, in order to reach the destination in Delhi, I need to first go from Delhi airport to that destination. But how will I reach the Delhi airport I will have to start from Pune airport and take the flight to Delhi. How will I reach Pune airport is probably I will have to drive from here to Pune airport, right. So, this is one way to get to the destination in mind which is in Delhi, right.

I can come up with another way to get there. So, I can probably take a train. So, I can go from IISER Pune to the Pune railway station, and I can then take a train to Delhi, right. And the train station in Delhi, I will have to take further next taxi to go to my final destination. What I am trying to get to is that in order to go from the product in hand from the starting material, there could be multiple synthetic pathways possible.

Now, the best synthetic pathway is going to be the one that is the most economical that is the one that results into the maximum yield. It also could be the pathway that is very-very effective such that it does not create more hazardous waste, it could be a green pathway. But depending on your criteria, you are going to see that one or the other pathway will be more acceptable to you as a synthetic chemist.

I want to point out that there are multiple ways of answering the same question of the retrosynthesis, because what you can see is that in order to reach the destination, you can take multiple routes or multiple ways to get to the final destination. So, we have seen one example of retrosynthesis. Let us now look at some more examples in tutorial. But with this I want to stop with the chapter of reaction of alkynes and really start with substitution and elimination reactions in the coming week.

Thank you.