Industrial Inorganic Chemistry
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Lecture –13
Tetrapotassium Diphosphate Preparation

Hello, good morning everybody. So, we are still continuing with phosphorus where will be basically talking about that industrial part of phosphorus chemistry.

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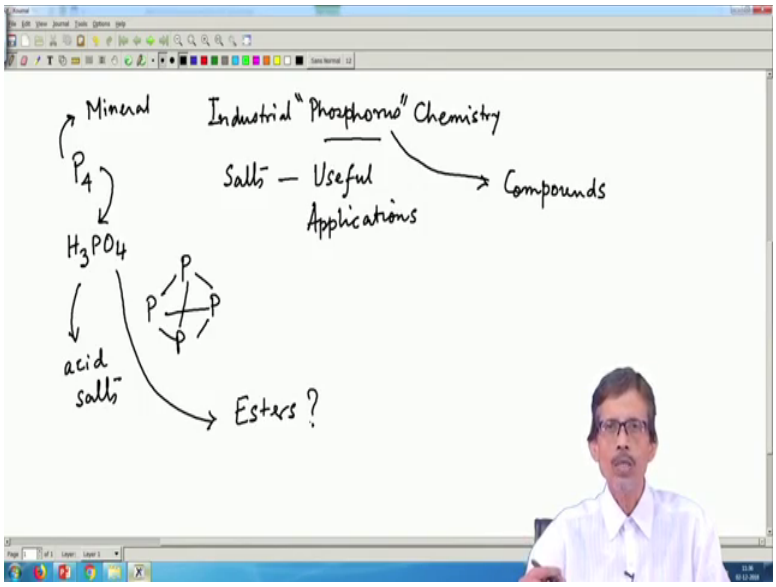

So, Industrial Phosphorus Chemistry; so we will be concentrating on that and already we have discussed about the gating of P 4 from the mineral source, and from there we have reached up to the industrial preparation of phosphoric acid and the different corresponding salts.

So, if we consider that we are concentrating our attention on the inorganic chemistry of phosphorus, and how we can apply that for making large amount of different types of compounds. So, making all these phosphorus these compounds tell us that we can have these different salts also and these salts are very much useful. So, we are categorically discussing about their applications, and in doing so whatever application it can have and whatever importance in the market. And the industry we should never forget about the corresponding basic chemistry what we can have, because these phosphorus as we all know that this P 4 molecule is very interesting one; and basically this particular one the

tetrahedral p 4 molecule what we can have and if we can get it from the mineral source like that of our apatite. We can get this P 4 and P 4 can be converted to some other forms what is useful as their corresponding phosphorous compound. So, mostly in all these cases after getting this phosphorus or the elemental source of phosphorus or nitrogen whatever it is, we basically focus our attention on the different compounds. So, these different compounds one such will be definitely the corresponding acid salts. So, once we get these acid salts and if this is the acid and whether we can get these as the corresponding esters or not, we will see this.

Because while knowing the corresponding organic chemistry such as that of our acetic acid or any other thing we know that how we get the corresponding organic acid esters in our hand. So, similarly if we can get that from the inorganic sources we can put some organic alcohol to get the corresponding acids as the esters of all these phosphoric acids.

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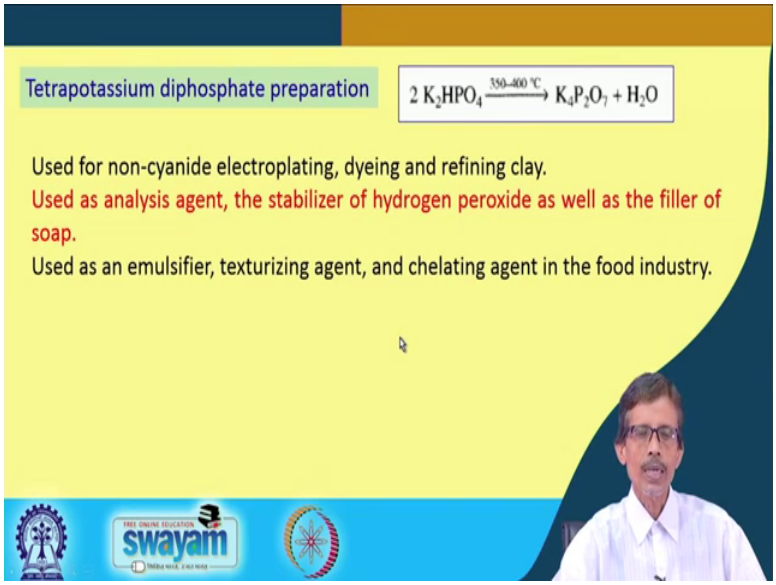

So, that will see here in terms of the corresponding compounds, what we can have that some of these compounds they are very much useful. So, in terms of their application if we see that these applications what we can get is therefore, that use of cyanide, non cyanide and electroplating in dyeing and refining of clay. What are those compounds which will be useful for this purpose? So, it is basically a tetra potassium diphosphate compound and how will prepare that?

So, what we can have by knowing the name of that particular compound we should be able to tell that it is not a simple phosphate salt is the diphosphate salt. So, 2 phosphate units because these phosphate units are always very interesting, today we will just simply cover from all these 2 up to some very deadly or lethal not gases also. So, phosphorus based compounds in all the different types will just try to understand or try to see how they are prepared. So, if we get the diphosphate preparation.

So, diphosphate preparation is dependent on some reaction where we can get is as the completely all these things as the tetra potassium salt. So, tetra potassium diphosphate preparation be useful in terms of their uses. So, the second category of uses are they can be used as analytical reagent or analysis agents. So, they can be useful for some kinetic reagent, such that if it can give you the corresponding diphosphate for the metal ions.

Because as you see from the tetra potassium diphosphate thing that you have this potassium ions already. So, if we can go for substitution of those potassium ions by some other metal ions like calcium, magnesium even laid and all other thing. So, we can get the corresponding salts as the diphosphate salts of those metal ions. So, it can function as a analytical reagent for that purpose. And it is also a stabilizer, the potassium salt which is highly soluble in water last time we have seen that that this can have the 4 negative charges when you have the 4 k plus ions in it. So, it will have (Refer Time: 05:41) it is highly water soluble. So, it can be a stabilizer for hydrogen peroxide and as well as sometimes it can be used as in soap as the filler material. Why we can get these things? Because we will see at some point because one of the most important compound in our industrial sector is that of your nod diphosphate is the sodium diphosphate.

So, that sodium diphosphate can function initially when it was discovered long back about 70 years back during 1947, people tried this for as the substitute of the soap material. Soap we all know they are basically another kind of subtract and molecules the anionic surfactant molecules. So, these are very long chain fatty acid sodium salts of long chain fatty acids. So, these can be substituted by these phosphate based materials which can be considered as the detergent material.

So, the whole industry of detergent as flourished after that during the discovery of that thing. So, it can therefore, be filler. So, the pure form of these solve the try sodium that is diphosphate salt is your detergent material, but this diphosphate salt can be utilized for

filler material for the soap. Then in the third category it can be used as emulsifier, it can be used for texturizing agent.

That means it can improve the textures of the textiles or the cloth material or the paper or any other thing where we can try to improve the texture even the metallic surface also if we improve the texture of that metallic surface we can use it as a texturizing material or texturizing agent. And then the chelating agent for the food industry, why we go for the chelating agent? Because we know that a very useful chelating agent that you can use for our analytical sake or analytical purpose is the ethylene diamine tetra acetic acid which can bind very nicely the available metal ions like calcium and magnesium in hard water. So, if all these metal ions or some other metal ions are also present in the food material. So, if we want to trap that for all these thing to improve the quality of this food material we use these as the chelating agent or chelating agent to trap those metal ions in the food industry or the food material.

So, what we can do is for these preparations so diphosphate preparation as a tetra potassium salt we will use dipotassium hydrogen phosphate in our previous class we have discussed in an elaborate fashion, that how we can get the different types. That means, at least 3 types: the mono sodium, the di sodium and the tri sodium salts of phosphoric acid. Similarly the di potassium salt of phosphoric acid gives us the corresponding K 2 HPO 4 as a salt. So, we can get it from directly from this acid medium giving potassium hydroxide or potassium carbonate or potassium bicarbonate. So, to get this one; that means, is basically a condensation reaction between 2 phosphate units which can be achieved at a temperature of 350 to 400 degree centigrade.

That means if you grind the pour it and make it a powder and if we put that powder in a oven and that particular oven is maintained at a temperature of 350 to 400 degree centigrade. Then as the basic reaction at that particular temperature the condensation of two phosphate units do take place for that particular case to give you the corresponding K 4 P 2 O 4 species and the elimination of one water molecule. So, that is the thing that we basically remove this. That is basically some kind of dehydration reaction high temperature dehydration reaction at a temperature of this range. So, we basically get the corresponding di phosphate as a tetra potassium salt and this will be very much useful for the different purposes.

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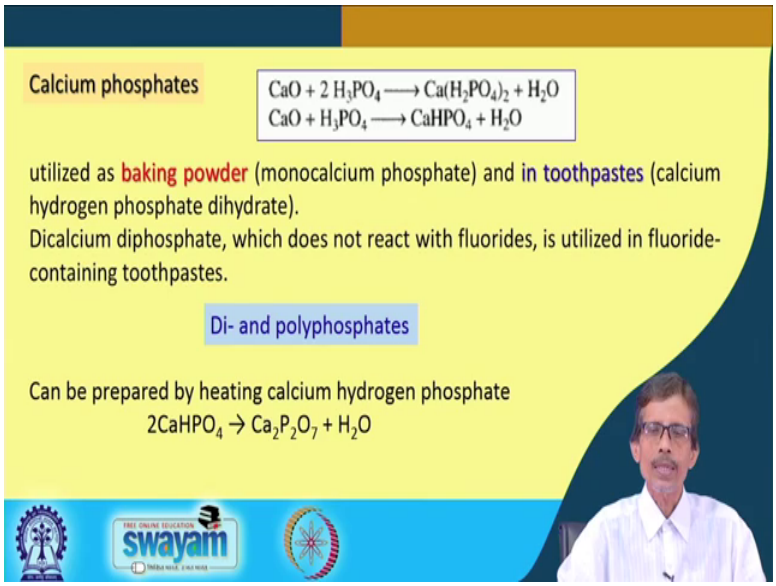

So, we can get also the other salt like that calcium phosphates: how we get these calcium phosphate that is also very interesting to know, that getting calcium phosphate is also in a similar fashion directly from the phosphoric acid material.

So, if we use instead of calcium hydroxide or any other calcium salt you can use simply the calcium oxide which we get from limestone. So, the source is also known to us and is cheaply available. So, that calcium oxide when it is directly utilized for its reaction with phosphoric acid we can get the calcium salt as a typical one for is Ca H 2 PO 4 whole 2 or one is to one reaction will give you a calcium hydrogen phosphate in our hand.

So, this particular calcium phosphate like that of ha tetra potassium diphosphate salt is useful for getting it in the form of a baking powder, because one of the constituent of the baking powder is your mono calcium phosphate or the Ca HPO 4 and also in toothpaste. So, tooth paste also we use the calcium hydrogen phosphate dihydrate. So, calcium hydrogen phosphate and its di hydrogen like that of our gypsum, gypsum is calcium sulfate with 2 water molecules of crystallization.

Similarly, here the corresponding salt as the dihydrate salt if we get that can be useful for our making toothpaste. So, along with all other constituents: one of the constituent easier corresponding calcium hydrogen phosphate dihydrate as a toothpaste material. Similarly we can have the di calcium phosphate which does not react with fluoride it utilized in the fluoride containing toothpastes also. So, other phosphate salts can also be utilized in case

of making other types of toothpastes. So, like that of our di potassium or disodium salt, if we can have the di or polyphosphates and it can be a typical calcium's salt. Why we are considering this calcium salt?

Because as just now I told you that calcium and magnesium which are the basic constituent for your hard water and the entrapment of that particular material; that means, the entrapment of this calcium as EDTA, for the corresponding complex of calcium EDTA to remove it from the hard water which basically removing the hardness of that particular water sample. In a similar fashion if we can use directly that particular diphosphate for trapping calcium. So, we can get the corresponding salt like that of your tetra potassium salt, we will also see that tetra sodium salt which is also very much useful.

So, this particular one; that means, the Ca 2 P 2 O 7 can be prepared also in a similar fashion like that of our calcium hydrogen phosphate. So, it is basically your diphosphate and diphosphate can also be utilized from your calcium hydrogen phosphate, which we have prepared already from your calcium oxide our corresponding compounds as it is also.

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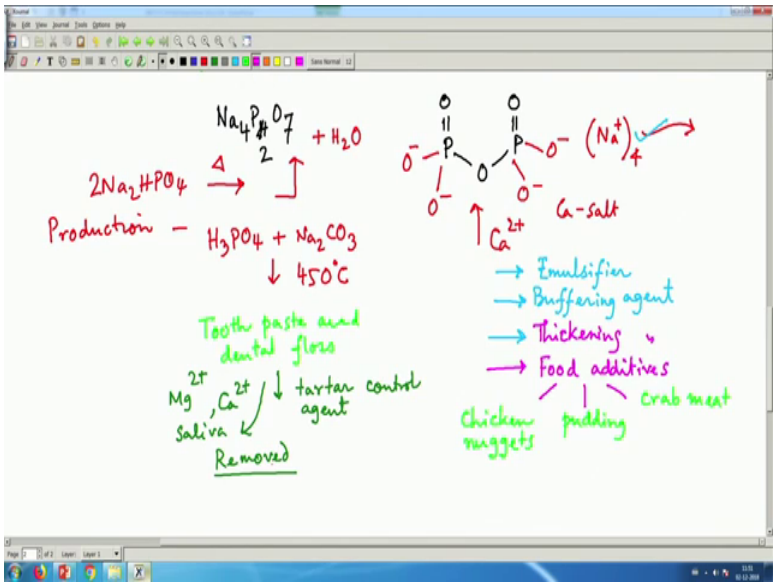

Next example what we will take is Na 4 P 4 O 7; that means, you can have this not enough P 4 is P 2 Na 4 P 2 or 7; that means, your diphosphate. So, diphosphate is basically we can have the P O P linkage and that pop linkage will have the double

bonded oxygen also over there, and we can have these other groups also. That means, you have this O as O minus here also O as O minus O as O minus. So, these basically when you have these sodium ions. So, Na plus so 4 such sodium ions will be present over there.

And it is highly soluble in water, because it is fully dissociated because the sodium ions will go and it will be available and this corresponding hydrated form of sodium, but if we use calcium is basically can get in with this particular structure. So, it can binds quickly interact with this particular 2 oxygens to give you the corresponding calcium salt. So, this particular one in a similar fashion like that di sodium hydrogen phosphate we take again simple heating of this thing will give you. So, 2 molecules of this will give, give you this plus water. So, heating of this particular one will give you this particular species, similarly we can have also the large scale production, what we can get the large scale production basically we can get it directly from phosphoric acid from the reaction with sodium carbonate.

So, sodium carbonate will take care of these high protons over there and here the temperature is in the range of 450 degree centigrade will be useful for this particular preparation. So, this corresponding one; that means, the sodium salt how is full this particular sodium salt is therefore, that it can be utilized as emulsifier like that of our corresponding potassium salt what we have seen. That it can be used as emulsifier, it can be used as a buffering agent it can be utilized for thickening agent for food industry, thickening agent.

And therefore, it can also be a very good food additives, because additives are added basically in the food material to improve the corresponding self life or to stop the corresponding decaying of that particular food material. So, where we use these food additives basically we use them in making chicken nuggets, in making pudding and in storing the crab net.

So, these are very useful application of this material for our study and where we see it also like that of our potassium salt it can be used in toothpaste also and making the dental floss. So, medical application also it has. So, dental floss because it can be useful in controlling the tartar on our teeth. So, it is a tartar control agent, because why we get tartar because we had the corresponding deposition like that of in boiler material. We can

have the calcium deposition also because our food material our other contents what we take even in water we can have sufficient amount of calcium as well as magnesium.

So, we can have both calcium as well as magnesium which is also present in our saliva. So, that particular one can be removed.

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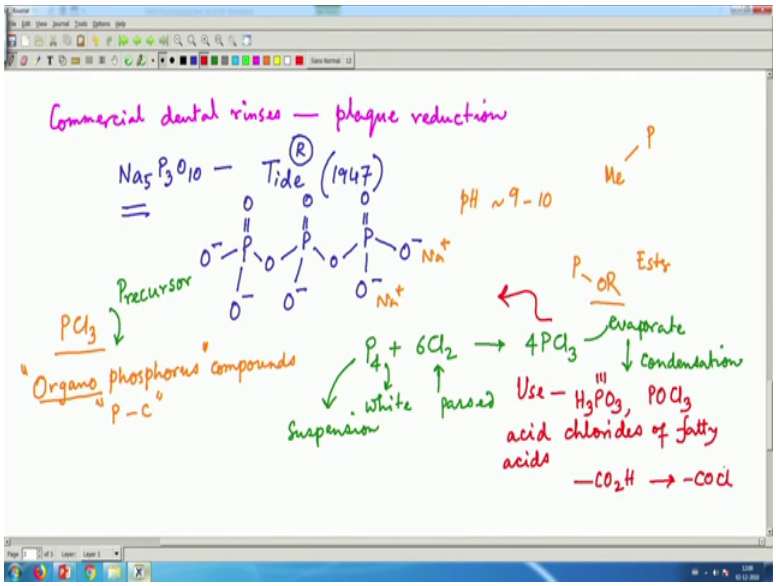

So, these metal ions can be removed from there. And therefore, in commercial dental rings as basically where we get the commercially available commercial dental what we call as the corresponding mouth washes also. So, sometimes it is recommended that for this commercial dental rinses is before processing we use this, we recommend to use these to reduce the plaque. So, it will be useful for plaque reduction. So, in all these cases what we see that our easier thing is that how we track the metal ions like calcium, and magnesium by some other material which is closely similar to that particular type of material which is already present in our toothpaste.

So, if the toothpaste can have that particular material it can also attack or it can also fight against the plaque formation or the controlling in the tartar in our mouth. So, it is and be useful for our mouth wash as well as for our dental rinses. So, the next one what you can see is that tri 1. That means, Na 5 p 3 O 10 which is the corresponding triphosphate and is commercially it was prepared from industry levels. So, it is basically the company what we know the tide which is making the huge amount of detergent. So, the tide is the registered trademark for that so tied R.

So, tied is making and is they were working on it from say 1947 where it can be very much useful for this getting this particular one as your triphosphate. So, how you get like polyphosphates, and all the thing is that you should know only that how many phosphorous atoms are present over there. So, if we have the 3 then we get the double bonded all these will have the double bonded oxygen over it.

And then we complete the tetrahedral site above this. So, why we get this Na 5? So, you get O minus 1, O minus second, O minus third, O minus fourth and O minus. So, this basically so you can have the huge amount of charge and all these things like our different biomolecules, what we all know that the very interesting biomolecules what we can have in our DNA, and all other cases the deoxyribonucleic acid. So, they can be giving us here ATP molecules and these ATP molecules are the diephosphates.

So, they can go for releasing one phosphate groups giving you adenosine diephosphates. So, getting all these conversions even in our body also we do all the time the conversion of the phosphate to di phosphate to triphosphate. And again back to diphosphate or the mono phosphate. So, all these reactions; that means, the phosphate formation and its condensation reactions are very much useful for this commercial application as well.

So, this particular one can also very good for controlling the pH of the medium. So, for a pH it can control in the range of say 9 to 10 which is very much useful. So, is the alkaline medium so it is not acid it basically. So, alkaline medium of pH d is there. So, another interesting compounds what we will be seeing now that going from these esters and all these things will come back again if we just n consider this thing. Before that if we just simply see how we get a one more compound which is also very much commercially useful and it is prepared in an huge scale on a large scale. So, it can also be a precursor for different types of organo phosphorus compounds; so, organo phosphorus compounds. So, if we want to make this because these are very useful compounds organo phosphorus compounds the name tells us that you can have some organic part to eat.

And that organic part basically therefore, we can have a palladium carbon bond sorry phosphorus carbon bond. So, this phosphorus carbon bond will give you this particular cases; that means, all kind of phosphorous compound, but in some cases we will see that when we talk about the esters instead of these. That means, you can have at 1 end instead of t O minus Na plus this is your O minus Na plus because these are all your Na plus N a

plus for your charge balancing thing. So, if these are from some organic part. That means, the alcohol part is giving you the ester sometimes in a loose fashion we also consider these as organophosphorus compound.

Since the organic part is attached to this phosphorus through oxygen not a direct phosphorus carbon bond you have. So, truly speaking the organophosphorus compounds should be like your different organometallic compounds and all other cases that you can have direct carbon to metal bond; here you can have the carbon to phosphorous bond. So, if we are able to substitute this; that means, the around this phosphorus. So, if we can have these; that means, if we are able to make say p ami or some phosphorus carbon bond it then we can consider this as a typical organo phosphorus compound. So, it can be the typical pickers are for every precursor. So, therefore, this PCl 3 is the precursor for the different types of organo phosphorus compounds and we get it very quickly or very easily by reacting elemental phosphorus which we write most of the cases as P 4 or sometimes we can write it also as P 2; so P 4 plus 6 Cl 2.

So, if we pause the chlorine gas over it is basically converting it to your 4 PCl 3. So, is basically going for the evaporation we evaporate it and from that evaporation if we go for condensation we get back this particular PCl 3. So, this particular one as this is is applicable on say typical source of this phosphorous is your white phosphorus and we take it as a suspension. So, suspension of white phosphorus we have and we pass the chlorine gas. So, when chlorine gas is passed over the suspension of white phosphorus we get this PCl 3 in our hand and this PCl 3 making this PCl 3 can have. So, many uses and those uses are making H 3 PO 3 we have not considered in detail of this particular acid, we have considered the phosphoric acid.

But these the phosphoric acid where the phosphorus oxidation state is in plus 3, then we can have the corresponding making of POCl 3 which is another very useful reagent for the laboratory purpose for industrial purpose also. Also for making phosphoric acid and the acid chlorides of fatty acids also; acid chlorides of fatty acid even for the different organic chemicals making the different organic chemicals also the acid chlorides of fatty acids. That means, this is the very good chlorinating agent, it can provide the chlorine to the organic molecule converting this to particular molecule as your corresponding acid chloride. So, when you have thing as your CO 2 H we get it as COCl which is your acid chloride.

So, in this fashion so is the phosphorus trichloride. So, from phosphorus trichloride we get it as the corresponding one as the next compound which is your PCl 5.

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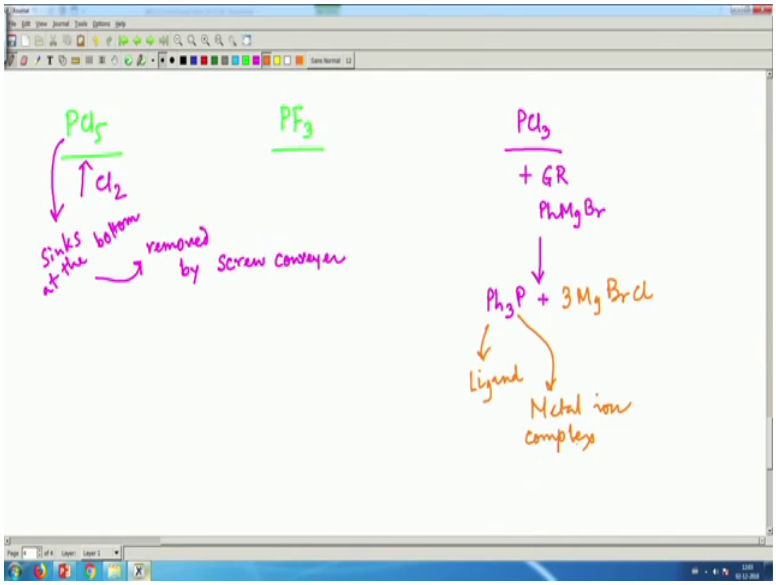

So, this PCl is again we can have, and we can have also the PF 3. So, all these things will be considering in our next class.

But before going over here so we just get this as how you get this PCl 5. So, is nothing, but addition of one of the Cl 2 on the PCl 5. So, when we get that this basically as a product as things at the bottom of the reaction chamber and which should be removed from there. So, they are removed by a screw conveyor. So, when you have the spiral screw type of content not the flat type of thing. So, screw conveyor; screw conveyor will be useful to take out that particular one from there and they this also can be useful.

So, application for this particular PCl 3; so one such example is that if we use for with some Grignard reagent if we allow it to react with the Grignard reagent that phenol magnesium bromide what should be the product? So, if you can ask our self that what should be the product for this reaction; that means, if you have the phosphorus trichloride and reacting with this is basically giving us a very useful molecule which is very useful ligand. So, this is considered as a ligand. So, this is our ligand and this basically giving for the corresponding one for making this triphenylphosphine. So, is basically the 3 M g Br Cl.

So, that 3 Mg Br Cl formation will give us along with that of your triphenylphosphine which is your ligand. So, will consider in our next class that how this particular triphenyl phosphene can be useful for making the different types of compound because these when this is your ligand we can get the corresponding metal ion complex from there. So, all these things along with will come back again for making this PCl and PF 3 will just consider them which one will be useful ligand, because we are in the intention of making some useful catalyst based on these phosphorus base ligands.

Thank you very much.