Industrial Inorganic Chemistry
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Lecture - 22
Halogen and Halogen Compounds

Welcome back to this class again, where we are talking about the sulfide or bi-sulfides.

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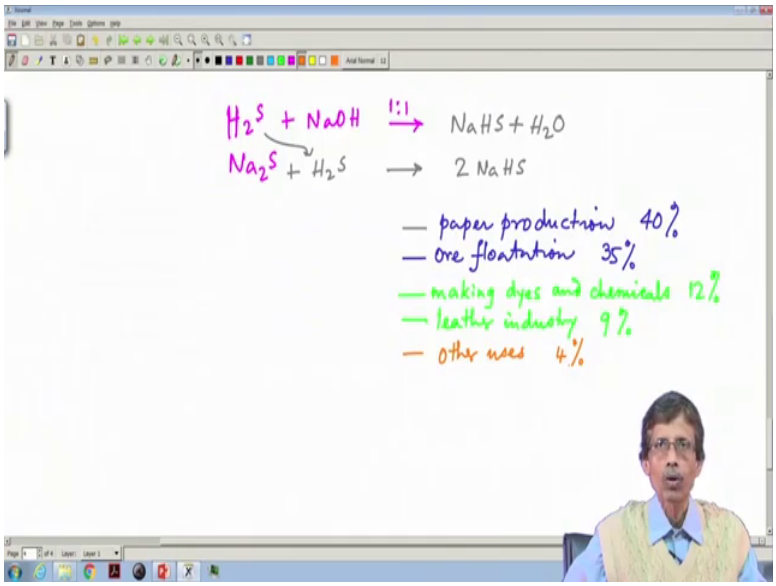

So, we can have, the good source of sulfide as your hydrogen sulfide gas H 2 S or the corresponding sodium salt; that means, the sodium sulfide. So, the reaction is very simple, when we react with these with sodium hydroxide, 1 is to 1. Remember this reaction is 1 is to 1. If you go for 1 is to 2 you will be producing sodium sulfide. So, the production of this for 1 is to 1, giving you N a H S plus H 2 O.

How you use this one? This is a very simple reaction. You bring H 2 S in it. Because not only you have to remove one sodium ion from it, you have to put in corporate 1 H plus. So, as more and more amount of sodium sulfide you will be able to produce from hydrogen sulfide, in between you can use this particular reaction. Where you can utilise a 50-50 mixture or 1 is to 1 mixture of the original hydrogen sulfide. Along with your sodium sulfide, giving you twice of N a H S.

It is a very simple reaction and very useful reaction for making your hydrogen sulfide. So, it is a huge application of these because, all these times what we are talking about how you produce it and what are those application basically. The reacted things and all the things are very trivial sometimes, is a not a special type of thing.

So, in the paper industry for paper product xion, again as a useful reducing agent; so, 40 percent of the material what industry produces as sodium bi-sulfite, is consumed for paper production. Then for other cases like; other cases, the ore floatation and this is nearly this range that 35 percent of is being the utilised then for making dyes and chemicals including the pharmaceuticals, the agrochemicals, in the food industry everywhere.

So, this is also a very good component; that means, about 12 percent, we are using is a global pictures. Globally we use it then, less amount for leather industry, which is about 9 percent, and other uses about 4 percent. So, we see now that the sulphur bearing all these compounds, giving us some good information about their production and their utilisation. But we will finish this particular class based on sulphur, if we take one typical example: while large amount of a liquid material or a solvent material is being produced, which is nothing but your carbon disulfide which is your CS 2.

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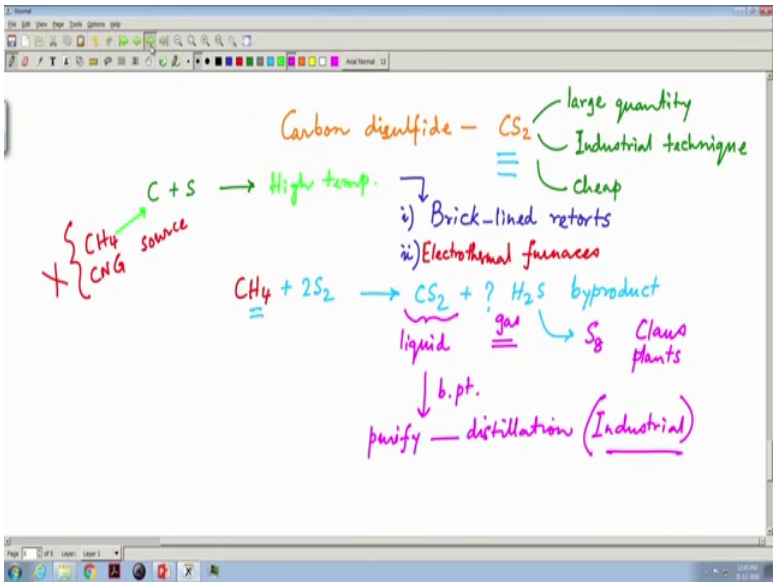

We use it, now we have use from our school days, but we do not know how we produce it in

a large quantity. That means; the, our goal is that you have produce it in large quantity. That is why we need a industrial technique. Why we require this technique? And which is also be cheap and we should apply this particular procedure on some easily available material.

So, if you have this carbon and sulphur in your hand. So, what we do we basically from the scratch, we should try to go for a reaction between these two; that means, a typical reaction between carbon and sulphur. Sulphur as we know that, it can be your S 2 or S 8 is the elemental sulphur in your hand. Then large amount of carbon source also you can have, the carbon as a different feedstock and we can have the typical source of your carbon from your methane. And you can have the corresponding carbon form your CNG also.

But, there are some countries which do not have much of this CNG source or the methane source. They can have a different types of mechanism for this particular reaction. So, you can use directly from carbon from, all these sources which are not based on your compressed natural gas, or the methane source. So, you can directly use all other carbon sources, you can have your charcoal black or the animal charcoal black and all these for the countries which do not have the typical methane source in it. And it basically gives you a reaction between these two at a high temperature.

So, this high temperature reaction in Brick-Lined retorts, in a Brick-Lined retorts, is the reaction chambers. So, you have the Brick-Lined because, you can have the high temperature with stand for these and this is the first thing what we use second thing, what we will be using there is your corresponding furnaces. So, you have to generate the high temperature and you should get the corresponding control of the temperature also.

So, is Electrothermal, electrically heated furnace; so, is electrothermal furnaces. So, electrothermal furnaces were you can have the corresponding regulation for the temperature. Because you have to produce a, you have to optimize the corresponding reaction condition, for this particular production.

So, if you do not have your CH 4 or CNG source for those countries, where we do not have your CH 4 or CNG we use other carbon sources and high temperature brick-lined thing we can use. But if you go for simple use of methane, that would be much easier to react, with that of your twice S 2 giving you again that CS 2; that means, carbon disulphide. So, you will

be producing CS 2 plus what? So, our goal is for the production of your CS 2 so we got that, that this carbon will be reacting with this sulphur as sulfide.

So, you have this; so, you have this carbon di-sulfide like, carbon dioxide as we burn its oxygen, we get carbon dioxide from the carbon sources. So, when we burn in sulphur (Refer Time: 08:40) or in presence of sulphur we get carbon di-sulfide. So, what you get basically over there is that this one. So, where this hydrogen will go? This hydrogen again presence of sulphur source. Because we know that the hydrogen burning in presence of sulphur will produce H 2 S. So, this is your byproduct; so, byproduct H 2 S is there in your hand.

And this can be utilised also, if you do not require the production of your H 2 S you can take it back for the production of elemental sulphur. Because we have seen earlier that H 2 S can be a very good source for the production of sulphur, which is a solid powder material you which you can store. But H 2 S is a gas, you cannot store it for a huge area. So, the preparation is difficult for H 2 S. So, better way to make it or quickly convert it into sulphur and store the sulphur which will be industrially useful.

So, again the Claus plants or the reactors can be utilized for the production of elemental sulphur from the H 2 S which is your byproduct during the production of carbon di-sulfide. So, this liquid you get now, and you have to purify. So, you have to purify it for some unwanted material, you should know the corresponding boiling point. You always you should know when you have the liquid sample, when you have the solid sample or when you have the gaseous sample; how you purify those?

So, this particular one is purified by distillation. So, it is a very simple technique, but it is a huge scale. So, is a industrial distillation process will be utilised for the production of pure quality of your carbon disulfide. So, this particular one; so, is very easy to make.

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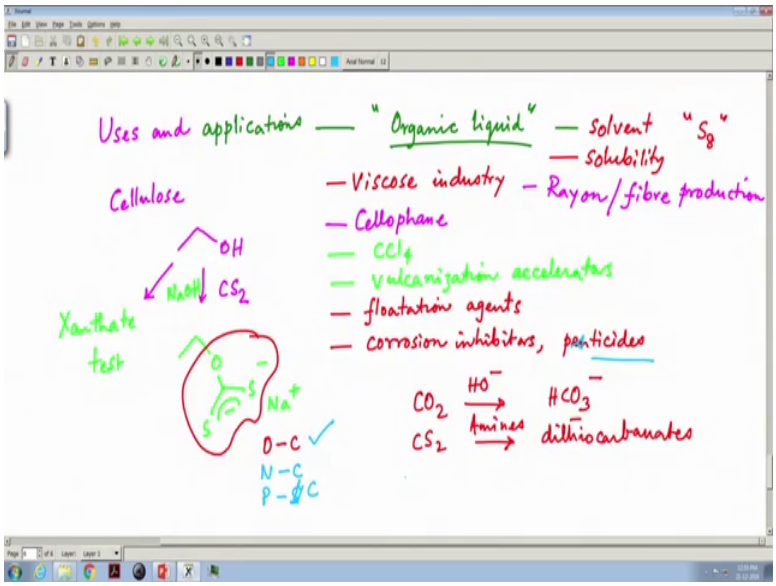

Now, we will see its uses and applications. So, always you should try to guess, whenever you are handling some chemical or produce some chemical industrially. You should have a chemical sense, because the whole area of this particular study is independent of your chemical sense or is dependent on the economics also.

People study the chemical economics. How the economics of a particular country is dependent on the amount of resource. The mineral resource or the ore resource or the natural resources what we call, is effectively utilized for the production of different types of value added compounds. But in country we do not have that particular activity, we just simply use all this in some specific applications. And for some speciality material or the speciality chemicals we are always dependent on some other countries. But there are some very simple very trivial compounds available like this, like yours carbon di-sulfhide.

So, they use an application is that, is a typically what you can consider it as because we have introduced carbon to your inorganic sulphur. So, you can consider it as a organic compound. But we never considered your carbon dioxide is a organic compound or organic gas, but we can consider at as, because it is a liquid and it has a very pungent smell. So, you can consider it as a organic liquid.

So, what you are handling basically you see, what you are producing is a compound starting

from the inorganic sulphur, and carbon is also inorganic component when it is in the carbon form. So, you get these particular compounds. So, you have this organic liquids, so organic liquid you can use it in a very simple way that, the first application what you can write quickly is a very good solvent therefore. You know the boiling point, you know the flux point all other data sheet for this particular solvent you can know.

And its solubility for other compounds, weather some other compounds are soluble in this particular. Particularly if we considered that weather S 8 or elemental sulphur is soluble in carbon disulphide or not. So, that is very interesting area of understanding and we have given that example also right now that when we go for this sulphide compound, with some sulphur you get some polysulfide or the tetra sulfide.

So, definitely your sulphur (Refer Time: 14:01) sulphur that S as S 2 or S 8 can be solubilise this in this carbon disulphate and go for this reaction. So, what we get that you had, you get this for in different viscous industry. We know that viscous is a name applicable to the Rayon industry the rayon making, for the preparation of this rayon or fibre production. Then we can go for handling or making cellophane, we every day we use cellophane papers. And this cellophane paper basically we get from cellulose.

And if your cellulose has some free alcohol form since that will be utilised to react with your CS 2 carbon disulfide and as you all known that, a typical test the detection. How you taste a sample inside a test tube or beaker or a round bottom flask, that whether you have some liquid, as a water is present as a water or alcohol.

So, the best way of doing this is the corresponding detection of this particular alcohol is we all know that is know as your xanthate test. So, in this making cellophane or this viscous liquid formation, this O is also; this O will be there, then this will also form in presence of a base since sodium hydroxide. So, this is minus Na plus. So, this xanthate type of these all functionality can be developed giving you the viscous formation or the cellophane formation and then you can go back with acidification for the treatment of this material.

So, very simple reaction, like that of your xanthate test, we can utilise it. Then CS 2 can be converted to another useful organic solvent which is carbon tetrachloride. That means, if we can go simply by chlorination; that means, incorporation of your chlorine. That reaction of

your chlorine with elemental carbon or the carbon powder as the corresponding charcoal may not be useful, but you can go very simpler way on carbon disulfide. Then since sulphur is present in this liquid; that means, in carbon disufhide it can go for vulcanization.

So in vulcanization, it can use as accelerator; it is used in vulcanization accelerators. Then as ore floatating agent every time you see that all the sulphur bearing compounds for the different purposes, they are very good ore floatation agent. So, they are ore floatation agents and lastly there are very good corrosion inhibitors or can be used in making pesticides.

So, as this as say is formation of this particular; that means, on a alcohol end you make it as a corresponding xanthate type of functionality, or if you can have the amine functionality because, this particular CS 2 is very reactive like your carbon dioxide. Because as we you all know that a carbon dioxide in presence of base what it gives? You basically give you the bi-carbonate. Similarly your CS 2 is also reactive in bases in elemental sulphur in all other cases. It is reacting with alcohol, it is reactive with amines. So, when it is reacting with amines, it is giving dithio.

So, what you are doing? You are making here this particular case oxygen carbon bond you are forming. When you have this particular one also, dithiocarbonate you are using amine; that means, you have the nitrogen carbon bond. Then you can able to make phosphorus baring compound, with carbon disulfide this phosphorous sulphur bond also you can form. And you can have this particular one, as this one as the simple, not a very huge one from your cellulose. But you can have from methanol, ethanol or anything. So, small molecule can also be activated for your formation of your O C bond to it. So, making this particular in pesticides, pesticides.

So, making this pesticides what we can have, that pesticides if they are either xanthate based or dithiocarbonate based or the phosphorus based (Refer Time: 19:58). That means they are, not phosphorous sulphur, phosphorus carbon bond because you have the phosphorus and then elaboration from the C S 2 N. So, you get this as a very useful organic molecule, and we can utilise this particular reactivity for carbon disulfide for making a different types of this pesticides ok.

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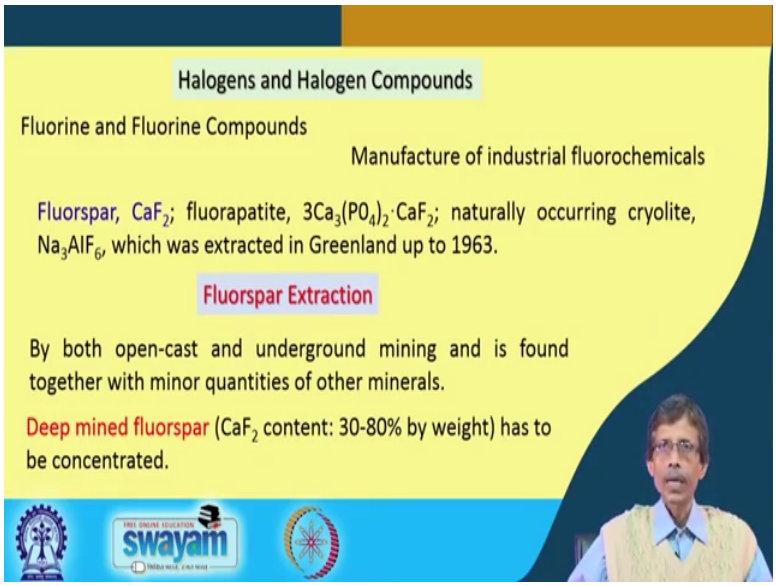

Our next chapter basically where we will move to the different types of your Halogens fluorine, chlorine, bromine, iodine so, we can have also we know that it is a natural source. You can have a good source of sodium chloride, that from the ocean water also we can get the sodium bromide or sodium chloride. So, these are all from the natural sources, always think of the natural sources the ores what you can have, for getting this halogen and the halogen compounds. First thing what we will be talking about is your fluorine and fluorine based compound because these are all very useful compounds now a days.

Weather you have a organic molecules, where you try to introduce a fluorine on the carbon centre. That means, instead of your carbon hydrogen bond you try to introduce a carbon fluorine in it. Or the typical fluorine based compounds starting from your fluorine gas F 2 molecule. So, F 2 molecule or the hydrofluoric acid or sodium fluoride.

As all the time we are focusing our attention on the thing that what raw material you have; the naturally available raw material in your hand, because the countries should have a good source of those raw material. Otherwise you cannot compete industrially to those companies, what are they are producing a very low cost; at a very low cost. So, manufacture of industrial fluorochemicals so, the general terminology we can use for industrially useful or industrially important chemicals where you have the fluorine as the constituent in it. So, it is a fluorochemical.

So, we have the natural sources as we all know, because the geologist can help you, from the geochemical point of view, you know that one of the most important material what is available on the earth crust is the fluorspar. So, the fluorspar, fluorspar is nothing but your calcium fluoride. CaF 2 is bivalent calcium attach two fluoride groups. So, it should be a very good source of your fluoride ions. Weather you try to make hydro fluoric acid or whether you try to make sodium fluoride your fluorspar is the very useful one.

And it also varies from quality, from one particular path to the other from one country to the other. So, the quality of fluorspar will tell you that which particular material you can handle or which can produce. In another, very important material is your flourapetite. Flourapetite is nothing, but your fluorine baring appetite. When it is chlor appetite we call it as a chlorine based appetite because it is a calcium phosphate material, large number of areas you can have the corresponding calcium phosphate mineral, attached to calcium fluoride. And the ratio the stoichiometric ratio is 3 is to 1.

3 molecular formula of 3 molecules of this particular calcium phosphate along with 1 calcium fluoride basically is a double salt type of thing and you can get it as this particular form and also other one, the third one is your Na 3 AIF 6 which is the cryolite; so, naturally occurring cryolite. So, naturally occurring cryolite, when it is available in a amount which is huge one, for a particular country. They basically use it not only for making some other thing because cryolite is well known for the production of aluminium.

So, if you have something in your hand, like Na 3 AIF 6, what do you think? That this particular material you will be using, for the production of sodium, or for the production of aluminium or for the production of fluorine. So, you must have a very useful technique or a very easy to handle technique or industrial accessible technique such that the production of one particular material such as your fluorine, from your cryolite will be there. So, country like Greenland, basically they have huge source of this cryolite, they have utilise this basically this till 1963 for the production of your fluorine only that means, typical halogen. Now if we take this particular one that how you utilise the calcium fluoride or fluorspar.

Fluorspar, how use for making some useful fluorine compounds. So, you go for the geological thing. That means how you go for mining. So, from geological knowledge to a mining, mining industry knowledge. You can go for both open cast and underground mining

basically, to extract fluorspar. So, first thing that you have to identify whether you have fluorspar or fluorspar reserve is there in a particular area of our country and is found together with minor quantities of other mineral.

So, when you take out fluorspar, we get other minerals along with that fluorspar. So, if we can separate out in the solid state or in solution. We can take the other minerals if they are very costly minerals, which is coming out with this fluorspar to we should take out or you can concentrate it for its production. And apart from your open cast mining, also we can go for deep mining. So, deep fluorspar, so the origin basically where from we are getting, because the corrector nature and the quality of those fluorspars are different.

So, you get that so deep mine fluorspar has to be concentrated. Because you are calcium fluoride content is less compared to open crust or little bit a lower level underground mining. So, here only sometime it can be very less like 30 percent of calcium fluoride and sometime it can go up to 80 percent. So, you should go for mineral enrichment or ore and (Refer Time: 26:51) enrichment.

So that means, you have to be concentrated whether you go for concentrated in a powder form; that means, grinding and all the things. Because we have a density difference is a solid powder from also or you can go from solution leaching and then you can concentrate it.

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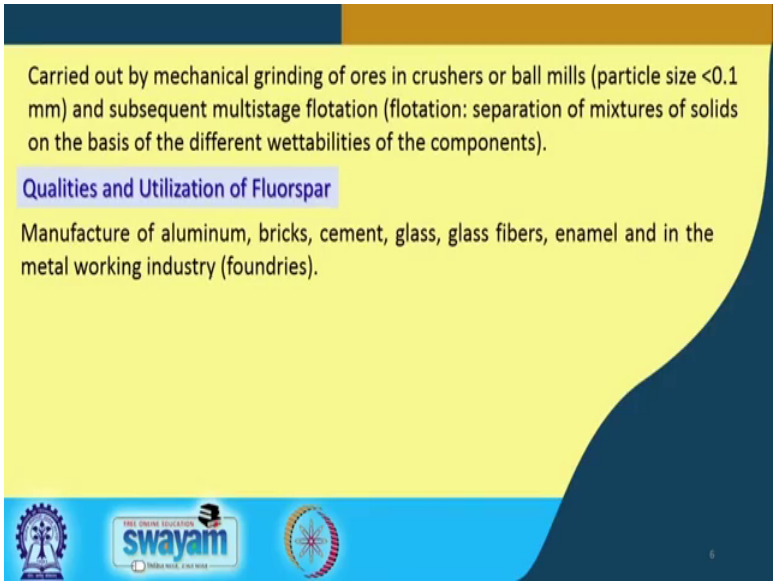

So, is basically carried out, how you do this particular separation or the concentration; is carried out by mechanical grinding. So, mechanically you crush it. So, mechanical grinding of the ores in crusher or ball mills, we know all the what is ball mill and the particle size less than 0.1 millimetre should be achieved and subsequent multistage flotation.

That is why the ore flotation just now we are talking about, separation of mixtures of solids on the basis of a different wettabilities of the components. So, it is a very typical terminology for mineral, separation; the different wettabilities. So, the material as a liquid, what you are talking like a carbon disulphide or a saturated solution of sodium sulphide. Have different wettabilities for your fluorspar for the individual component.

So, you can separate it out by flotation technique; the ore flotation technique. Then you can consider the different qualities and their utilisation of these fluorspar. So, where we use? So, already we know there is a calcium fluoride. So, it will be utilised for the manufacture of aluminium. It is utilized that mean you use calcium fluoride for the production of amount of your cryolite.

Then for making bricks, one of the component calcium fluoride can be one of the component in making bricks or some high quality bricks also. The high heat resistance resistant bricks also. Then we can make it for the cement one of the component because some amount of calcium definitely is there. So, calcium fluoride can give you the corresponding source of calcium for the cement production. So, cement industries also dependent on the fluorspar then for making glass fibres.

So, calcium based glass fibre sometimes it can have also the fluorine. Then making a enamel and in metal working industry. So, the people the metallurgical engineering basically, the metallurgical engineering they have the foundries. They are the huge workshop. They are we call as the foundries. So, in those foundries if they are doing some work basically on making some alloys or some other material which is metal dependent ore metal based material. They basically utilize this fluorspar for handling all these thing, because it can use a different type of temperature the fusion temperature all this things when they go for melting processes and all this things. So, it is a very useful additive or ingredient in all these foundries for the metallurgical engineering.

So, is a very useful material that we will see how this can be utilise for all are the purposes; that means, how you utilize this for the different purposes or you can take it for the production of fluorine, over there.

Thank you very much, the next day we will continue from here for the remaining part.