Industrial Inorganic Chemistry
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Lecture – 38
Potassium and It's Compounds

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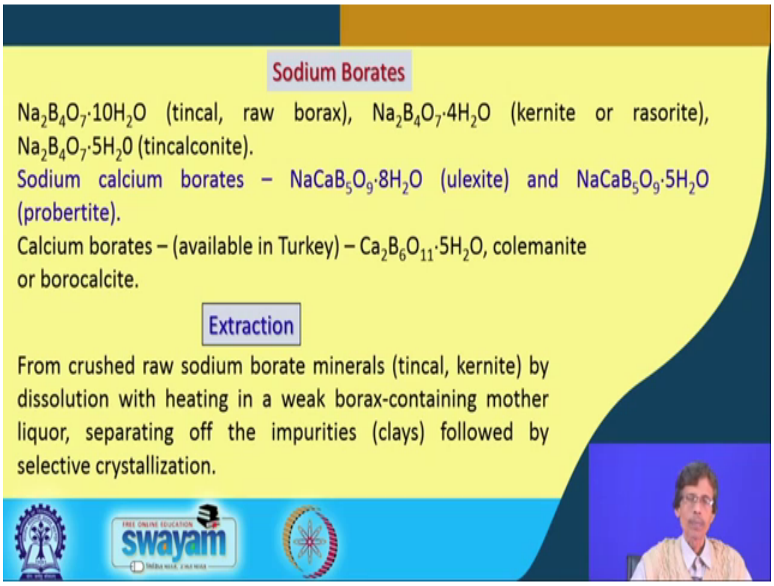

So, welcome back to the class once again where we are talking about the different sources of the boron based compounds and we have seen the borax we have, calcium borates we have and other types of calcium borates because that one name of the country is given because large amount of this particular calcium borate is available from Turkey.

So, the form basically either you can have sodium as it is corresponding cation or calcium as it's corresponding cations and the different number of oxygen's and boron's are present for all these compounds from your borax to boro calcite. So, these are our raw materials so different country will have the different procedures for your industrial production of boron fast and then making of your sodium borates.

So, how we can go for the typical process which will be known as your industrial extraction process. So, how we go for that particular extraction? We take that raw sodium borate minerals like the first two one that tincal and kernite if possible those are sodium borate mineral this is also a typical type of name because these are sodium containing naturally occurring borate minerals or borate material which will be allowed to dissolve by heating with a weak borax containing mother liquor.

So, we will take some mother liquor basically where we have small amount of borax already added to it and that small borax baring mother liquor is useful for dissolution of more and more amount of your tincal and kernite. So, the tincal and kernite will dissolve there and basically by doing so, only the part which is there as you are Na 2 B 4 O 7; that means, the borax part with different number of water molecules of crystallization.

So, they will be going to the solution separating of the impurities like clays so, the silicon dioxide we consider the clay material, silicon dioxide or any other thing other oxide impurities we can have. So, those will be there as the impurities so, how you remove those impurities? We physically remove those impurities by filtration.

So, typical filtration process you can have and that filtration process will be helpful for us to separate the corresponding borax material in the borax containing mother liquor already there so you have a saturated borax solution from which we can go for its corresponding crystallization by selective or the partial crystallization process.

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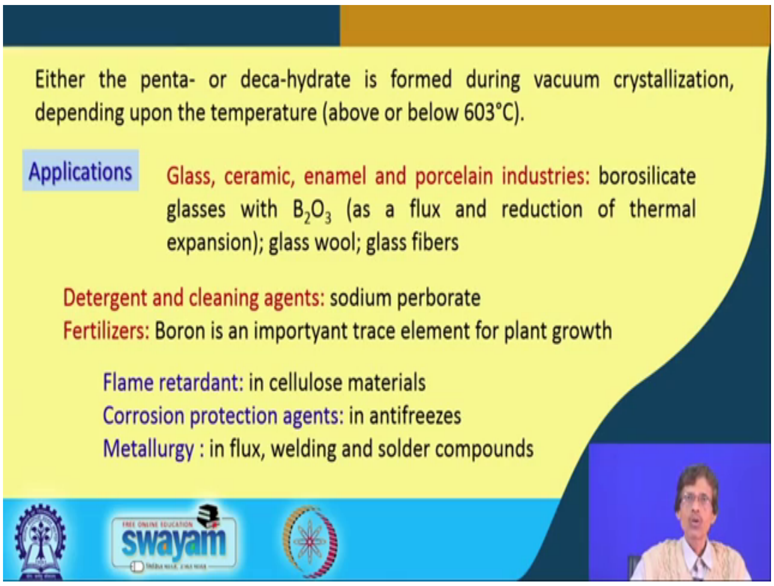

Either the penta or the deca hydrate we take either the compound as the 5H 2 O or 10H 2 O. We can get this through this particular crystallization process during one particular specialized crystallization we call; that means, we put some vacuum there; that means, under reduced pressure, we allow the entire material for crystallization which can be known as not reduced pressures sometimes if your pressure is very less we can consider it as the vacuum crystallization.

We all know that the sodium chloride salt or some other thing we consider is as the corresponding vacuum evaporation. So, you put vacuum everything has been sublime or evaporated, then we condense all them together for some other in the particular purest form that also increases the purity of the material. So, the vacuum crystallization process in this case basically depending upon the temperature, so either you have a temperature set of 603 degrees centigrade, either below and above you get either the penta or the deca hydrate.

So, depending upon the temperature of the crystallizations you can have the 5H 2 O molecule or 10H 2O molecule. So, these molecules basically can go for typical is supply for its application in making again the glass industry the fulfilling the demand of the glass industry.

So, the corresponding borax material that the sodium borate as borax sodium borate as borax can be supplied to your glass, to ceramic to enamel and to porcelain industries because all of them require a complex mixture of all different types of oxides like sodium, potassium and the silicon oxides.

Along with that we require some amount of boron; boron as your boron oxide or B 2 O 3 which we all know that industrially very important and the trade name is also well known to us which are known as your borosil glasses, which are nothing, but your borosilicate glasses. So, is a boron containing silicate; it is nothing else. So you have the boron containing silicate as your glass material.

So, you have the borosilicate glass and you apply this so the borosilicate glasses will have the corresponding content of the B 2 O 3. So, if you go for the analysis of the borosilicate glass along with your sodium oxide, potassium oxide, silica other oxides like calcium oxide can have sometime then magnesium oxide can also. You also try to analyze its content of boron oxide; that means, corresponding B 2 O 3.

So, percentage of B 2 O 3 will tell will improves the quality of the glass so that particular concentration is very important because if you see that involvement of B 2 O 3 in the medium is basically the function of flux, that means it is reducing the temperature melting temperature of the whole material the process. Then it also reduces the thermal expansion because it will have a very low thermal expansion, so thermal expansion behavior will be less if you have the boron.

So, borosilicate glasses will have superior quality compared to your glass which are not having the corresponding boron in it. So, the boron oxygen bonds within this particular network will improve the quality of that particular glass material. Then this borosilicate glasses are also useful for making glass wools, we all know that what are these different glass wools, then glass fibers; glass fibers are very useful the optical glass fibers nowadays we all know for communication purposes for all these land wires and all these we have all the time we know that we use optical fibers.

So, those optical fibers the different types of optical fibers which allow a good quality of total reflections when your information is going through those fibers are improved. If you can go only improving, the quality of the glass molecule or the class material by putting or doping we can consider these as the corresponding doping of boron within the glass material.

Then it is useful for making detergent and different types of cleaning agent which is known as your sodium perborate is not sodium it is sodium perborate, so different form of another formula basically. So, sodium perborate will be useful as your typical detergent along with that of your sodium phosphate sodium that corresponding meta phosphate or sometimes sodium poly phosphates are there so different sorts of phosphates are there along with that you have the sodium perborate.

Then in fertilizer already we have seen that how we have the different elemental compositions are present in different types of fertilizers like that of your nitrogen, you have potassium and you have the corresponding phosphorus we call them as the NPK based fertilizers. So, along with that a very small amount of boron is also useful for the plant growth because it is the micro nutrient.

So, is a important trace element not trace element sometimes it can consider as a very low level micronutrient because the concentration present should be very less for the plant growth. Then it will also be useful as a material for reduction of the flame or fire. So, it is a flame retardant in cellulose material so if you have the cellulose material which we all know that very quickly it can catch fire, but if it is soaked with this particular borax or the B 2 O 3 molecule we have less particular affinity for catching the fire.

So, it can reduce the corresponding behavior of catching the fire to that particular material so it is functioning as a useful flame retardant. Then it is also useful for corrosion production agents in as an anti freezing agent also, then in metallurgical industry it is a very useful flux and it is also very useful in welding and solder compounds. So, when we go for a welding process or when we go for a soldering process, we go for some fusion and some salt is added such that you can have a fusion mixture and that fusion mixture is typically used for reducing the temperature of that particular fusion for your welding and soldering process.

So, if you have boron oxides B 2 O 3 is present, that gives you the improvement of the corresponding material which is getting deposited after welding which is getting deposited after soldering also unlike the other soldering material, the pure soldering material what do we use. So, it is one of the ingredient like it is improving the quality of the glass so from improving the quality of the glass it can also improve the quality of the welding material quality of the soldering material also.

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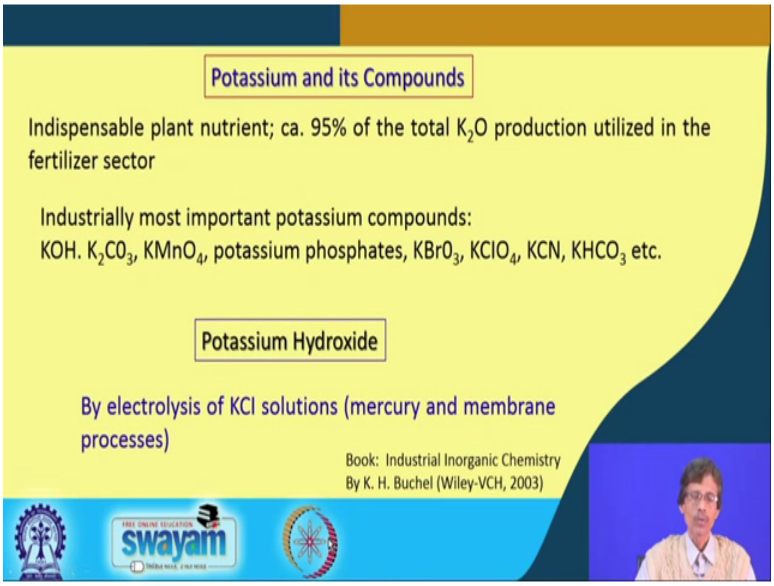

Then we will see how we can use the thing for the other one after sodium, after boron as we are talking together boron in terms of your sodium salt; that means, we are still talking about sodium, but sodium corresponding borax and the sodium borates basically, now will move to potassium.

So, this potassium as well as this potassium compounds how we get that is very useful plant nutrient as we all know, while we are talking about the production of the fertilizers. So, 95 percent of the total production or potassium oxide is utilized mainly in the fertilizer sector. So, we should know like your Na 2 O formation is the material for glass also K 2 O is also a component for your glass formation, but 95 percent will consume for your fertilizer production.

So, there are a large number of industrially important potassium compounds we can have. So, if we can get potassium in the elemental form we can convert them for making our potassium hydroxide, making our potassium carbonate making a potassium permanganate potassium different types of potassium phosphates the mono potassium, the di potassium all these then potassium bromide, potassium chloride, potassium cyanide and potassium bicarbonate.

Then first thing if we take the example at how we get potassium hydroxide industrially, what are the useful process we can follow? Again will take the example of the production of corresponding metallic sodium. Now the direct production of potassium hydroxide can be achieved by electrolysis of potassium chloride solutions.

So, we have seen that how we can get from seawater or the brine sample the corresponding sodium chloride, similarly we also have some certain percentages of potassium chloride so that particular thing is your material for your electrolysis. Then we go for two different types of processes one is based on mercury and another is the typical membrane process for your electrolysis.

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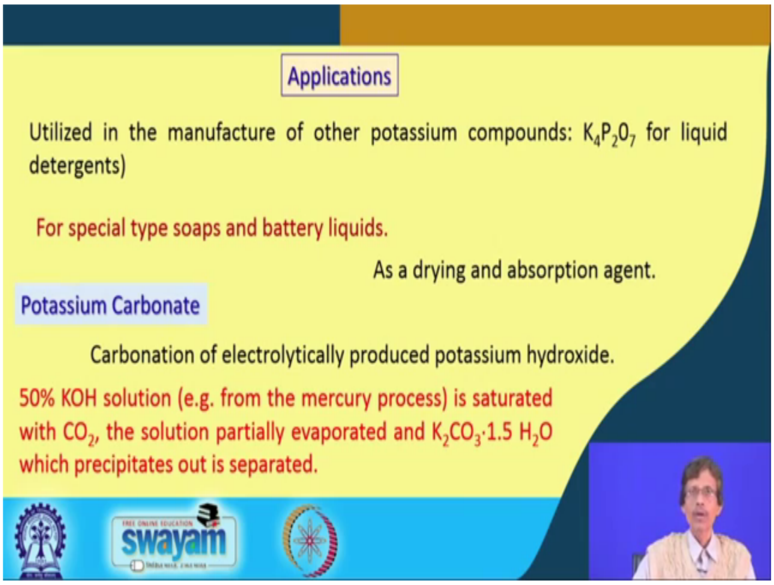

So, mercury and membrane processes will be useful for your production or potassium hydroxide through electrolysis. Then we can go for its corresponding application so, utilized in the manufacture of other potassium compound. So, production of KOH potassium hydroxide industry will be largely having the other sectors also the production of other the potassium phosphates, the biphosphates also di phosphates K 4 P 2 O 7 and other liquid detergent because these are the types of phosphates.

So, this particular type of phosphate that mean potassium di phosphate is useful component for your detergent and sometimes the liquid detergents nowadays we are very popular in the market, we have a huge amount of liquid detergents we are consuming still unlike your soaps only solid soaps. So, one of the useful component of it is your K 4 P 2 O 7. Then the different types of soaps and battery liquids.

So, special types of soaps are will be of only potassium salt unlike sodium, salt as we all know that the sodium permitted, sodium stearate these are all sodium salts. So they are not have special type of source or only typical salts the commonly available salt, but if we have something where we try to avoid sodium ions from the salts of your soap formation, we can go for the replacement of that sodium bi potassium. So, it get you the typical types of soaps then sometimes the corresponding potassium salts in its liquid form or the solution form give you the corresponding battery liquids.

It is also useful drying and absorbs an agent because KOH can absorb because certain towers made up of either the corresponding pellets of KOH small pellets, that are available industrial in the laboratory sector also. So, the pellets the powder or the granules can absorb some time, such as that we know that gas absorption the carbon dioxide absorption. So, the different gases different other compounds it can absorb for the drying purpose only.

So, first thing it can absorb moisture, second thing that it can also absorb carbon dioxide or any other gas molecules where it can react it basically. So, you can have huge column either a gas trapping tower or a huge tower type of thing through that the entire gas molecules can pass and those gas molecules will be trapped inside the tower functioning these KOH as your drying and absorption agent.

Then from KOH if we go to K 2 CO 3 potassium carbonate like your sodium carbonate we have talked more about sodium carbonate. So, will quickly go through this, these are all of the same type, but of different variety; that means, it is of potassium salt. So, the process is basically now the carbonation of electrically produce electrolytically produce potassium hydroxide.

So, you take potassium hydroxide and you have to supply the corresponding CO 2 as the bicarbonate or the carbonate form, such that whole thing will be converted to your potassium carbonate. So, what we take? We take 50 percent of the KOH solution what already we prepared, already the industry that part of the industry is manufacturing for us. So, from mercury process the process is also you can utilize as the mercury process for KOH solution which is saturated with KOH CO 2.

So, KOH solution is saturated with CO 2 by parching or pushing CO 2 inside the material and that solution is then partially evaporated; that means, more and more amount of water molecules will go out through evaporation living behind the corresponding crystallized form of k 2 CO 3. So, directly from KOH through CO 2 parching will be able to make K 2 CO 3 with 1.5 water of crystallizations which precipitates from the reaction medium from the industrial scale huge reactor and is now separated in that next step.

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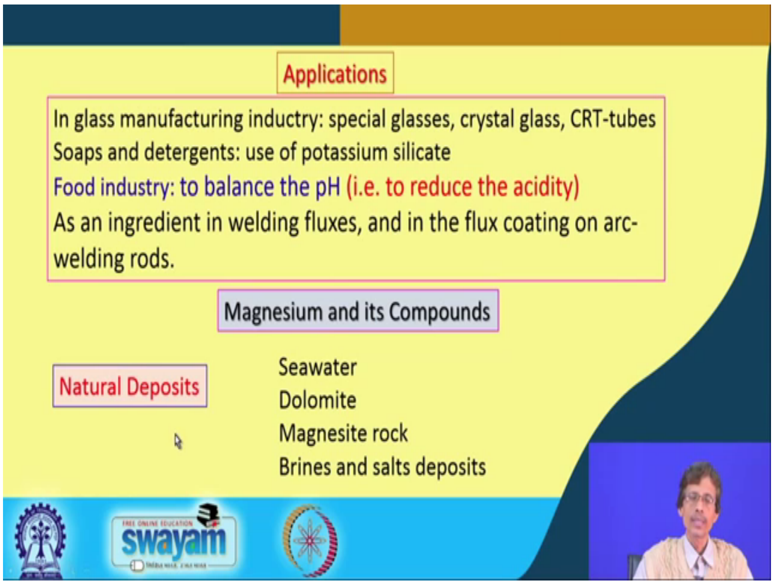

So, this particular material; that means, your potassium carbonate now like your potassium hydroxide is again utilized in glass manufacturing industry. So, is the glass making industry it is utilized in special type of glasses, will have a different amount of potassium oxide K 2 O.

Because we are using now potassium carbonate because the carbonate immediately the carbon dioxide will go out. Then crystal glass we know that the different materials; that means, the different utensils glass utensils we have the kitchen wires and all these sometimes very beautiful flower process are made of crystal glasses. So, these crystal glasses are made of with that particular type of glass which consume huge amount of your potassium carbonate.

Then cathode tubes with the CRT tubes we call, so the cathode ray tubes basically we use this particular material for its production. Soaps and detergents are also getting benefited through the use of different types of potassium silicate instead of your sodium silicate. So, sometimes that potassium silicate is used in making of these soaps and detergents also the soap and detergent industry making a potassium silicate is also there.

Then food industry because we are not using sodium bicarbonate of sodium carbonate, but it we are using potassium carbonate. So, it is used as balancing the pH to reduce the acidity. As an ingredient in welding fluxes so we use these for the different welding fluxes and those welding fluxes are useful and in flux coating on arc welding rods.

So, that coating is also achieved through this particular process, that where we get these ingredients; that means, the inorganic salt is getting deposited and is getting coated on arc welding rods because not that the bare rods are utilized, but you need some coating. So, that particular welding flux basically is getting coated. So, after sodium and potassium will definitely go for your one of the example will go for other one also.

The next level of this metallic thing; that means, the industrially important metallic elements is your magnesium along with that will just proceed afterwards for calcium because magnesium is a very useful compound not only industrially for different types of magnesium compounds we have, but also medicinal is very useful and is all know these also a biologically important metal ion we know that magnesium is present also in the chlorophyll.

So, we will just search, we just look, we just go for first the where we can have the natural deposits of magnesium and if we find those natural deposits we should know that what are the compounds we get from there and what are the formula of those compounds which are readily available as your magnesium salts. So, sea water is your source dolomite now we all know that the dolomite material which is nothing, but your calcium magnesium carbonate, then magnesite rocks are available.

So, magnesite rocks are nothing, but magnesium baring rocks the name will tell you that it has magnesium, then along with your sodium chloride potassium chloride we can have magnesium chloride also because this is the readymade source of your magnesium in brines and salt deposits and this particular thing magnesium what we get in from that talc the hydrated magnesium silicate that is a different type of thing, that has some application as the material only because we use we all know that the talcum powder the talcum powder is nothing, but your hydrated magnesium silicate.

But from there the isolation of magnesium is not permissible you cannot take magnesium from the talc material, like the way we cannot get aluminum in a reasonable way from the fly ash after burning the coal material we have the fly ash then fly ash material also have some elements silicate type of thing like your magnesium silicate type of thing, but from there we cannot get aluminium extraction or aluminium isolation from that material.

So, these are not your mineral or ore material so always you try to apply your aptitude, your brain, your knowledge in terms of your inorganic compounds or inorganic material that were from we get magnesium or the element itself. So, those are your natural deposits were from we can take out magnesium in a quite easiest way.

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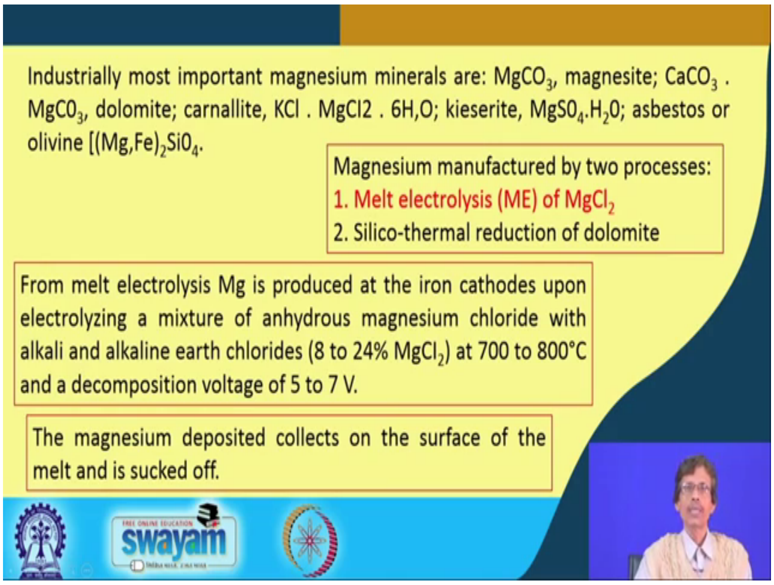

So, most important magnesium minerals therefore, would be your carbonate one. So, magnesium carbonate the MgCO 3 which is also known as your magnesite. So, available magnesite we should try to have look at it the corresponding deposit of magnesite, then the mixture of both calcium carbonate and magnesium carbonate which is known as the dolomite because the dolomite we know that the hilltops the entire hill is made up dolomites sometimes we find

Then you have the corresponding carnalite; carnalite is the double salt of potassium chloride and magnesium chloride. So, it’s a mixture of potassium chloride and magnesium chloride and sorry this is 6H O, potassium chloride, magnesium chloride with six water of hydration is another salt, but you give it is a double salt, but you have the magnesium chloride such that you can isolate magnesium as magnesium chloride from that material.

Then kieserite; kieserite is your magnesium sulfate then finally, the asbestos or olivine. So, asbestos and olivine is also a not a very good material for isolation of your magnesium, but it is a material where you can use it for some other purposes like that of your talc just now I told you. So, this is not a typical magnesium silicate like your talc, it is magnesium iron silicate. So, you have magnesium as well as iron in this asbestos so asbestos and olivine are some form which can be derived from your talc. Two process we basically utilize or handle for getting magnesium one is your melt electrolysis or ME process of magnesium chloride.

So, melt as we have seen already nowadays you are familiar with this particular electrolysis process and what is your melt electrolysis process? Because the material what you have in molten condition you have the desired or the chosen anode or the cathode and that chosen anode and cathode will be utilized for the electrolysis.

The thing is that you should know the corresponding reduction potential we are not bothering about this particular one, but the process immediately will tell you the material will immediately tell you we are taking care of that particular reduction potential the e 0 value for the magnesium 2 plus 2 magnesium 0. The way we have checked it for the reduction of potassium from potassium plus or for sodium from sodium plus because the e 0 values the reduction potential values are different.

So, the depending upon the different types of anode and the cathode material we can go for the typical electrolysis and the second process is your silico thermal reduction process, but the material for that particular process is different unlike your electrolysis is the dolomite. So, most of these melt electrolysis processes, ME processes whether you go for sodium, whether you use it for the potassium production, all of them are basically utilizing or handling your corresponding chloride salt.

Because sodium chloride is readily available, potassium chloride is readily available and magnesium chloride is also if it is not readily available you have to make it from other sources to get that particular one as your magnesium chloride. So, what do you do in the ME process? That magnesium is produced at iron cathodes now, not your corresponding carbon cathode or anything. So, it is iron cathode and upon electrolyzing a mixture of anhydrous magnesium chloride.

So, you have the hydrated magnesium chloride like that of your carnalite, which is the double salt also if you allow it if you dissolve it and pers if you crystallize it for magnesium chloride really that can allow you the crystallization of magnesium chloride only, but that can be your hydrated form and that hydrated form can be converted to your anhydrous form through heating only simply.

If you heat the material; the material can leave all the water molecules to give you the anhydrous magnesium quite because that anhydrous magnesium chloride will be useful for your ME process otherwise you will end up with the electrolysis of water. So, alkali and alkaline earth chloride is mixed with basically again to modify the corresponding temperature the way we have done earlier for sodium chloride mixing with calcium chloride and barium chloride.

Now, the reverse thing will do now other alkali or alkaline earth chlorides to mix it with 8 to 24 percent of magnesium chloride. So, 8 to 24 percent of magnesium chloride at, around again close to 700 degrees centigrade. So, 700 to 800 degrees centigrade temperature basically, will be available for your decomposition and the decomposition voltage can be said not very much is only 5 to 7 volt.

So, the 5 to 7 volt electrolysis process not very high electrolysis process. So, 5 to 7 volt of that particular electricity consumption will be required for your production of magnesium from magnesium chloride. Then what do we get? We get the deposition of pure magnesium so magnesium is deposited as your magnesium elemental form and it collects on the surface of the melt.

So, you have the melt and above that you have the corresponding solid deposition of your magnesium and that melt we basically from the top of that particular melt is sucked off. So, sucking procedure is useful for taking away that particular form magnesium through electrolysis.

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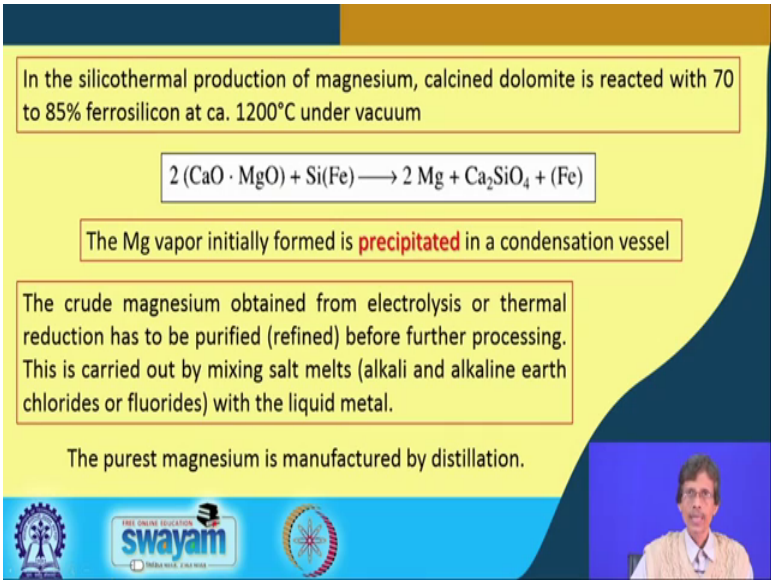

But for the second process which we have seen that it is the silicothermal process and that silicothermal process the production of magnesium is a different one what we take that material for that production already we have seen is dolomite now and dolomite is also readily available and the cost of the dolomite is also very less and that dolomite is reacted with 70 to 85 percent of the ferrosilicon.

So, is a typical type of material of iron silicon so the ferrosilicon is mixed up with ferrosilicon and because we can use at a very high temperature reaction of 1200 degrees centigrade under vacuum. So, the process is little bit different compared to your electrolytic process, but your source is cheaper; that means, you are utilizing the dolomite. So, what is that particular reaction basically?

So, dolomites are nothing, but your calcium and magnesium carbonates. So, when you heat it at a high temperature they are converted to the corresponding oxides. So, if you consider that your dolomite is your a 50 percent mixture of magnesium carbonate and another 50 percent is your calcium carbonate.

So, two together will give you another a 50 50 mixture or 1 is to 1 mixture of calcium and magnesium oxides, which will be reacting with your ferrosilicon; ferrosilicon is nothing, but your silicon along with some iron with some allowing type of thing because that particular iron is then freed away and silicon from their own lives not available from a the other silicon wafer or any other thing, it is from that ferrosilicon the silicon can be taken out with the reaction of the oxides of calcium and magnesium to form your silicates.

So, calcium silicates will be separated out from the reaction with the formation of elemental magnesium and some other form of the pure iron as the iron material which can function as a typical material separating out from your ferrosilicon. Then what do we get? We get the magnesium vapor and that magnesium vapor is coming out which can be condensed and form in the precipitated in a condensation vessel.

So, if you allow the cooling process because the temperature is very high is it 1200 degrees centigrade. So, only cooling can help you your condensation process. So, after cooling you get the corresponding magnesium as a precipitated form because that higher temperature it is in the liquid form. So, you are have the condensation pipeline or condensation chamber also and in that condensation chamber your magnesium is getting precipitated drop by drop or its form in a precipitated form.

And the solid magnesium block because magnesium we all know that magnesium rebounds from our school days, every time I give the example of your school days what we have seen basically because magnesium rebound we have seen where we bound magnesium rebound to form your magnesium oxide. So, through this particular process the crude magnesium what is obtained from electrolysis or thermal reduction.

So, we have considered two process; one is there electrolysis process another is your thermal reduction process. So, these two processes are giving us Mg as the magnesium elemental form of the magnesium now has to be purified. So, you have must have a typical purification process following this. So, is refined for that after processing. So, the refinery process; that means, the magnesium refinery process to remove the impurities will be the next thing what we can follow and what we can do and it is again carried out by mixing salt melts alkali and alkaline earth chlorides and fluorides are there with the liquid metal.

So, if you have the liquid metal in your hand with the addition of that alkali and alkaline earth chlorides and is further purified through that particular process and the purest magnesium is finally, we are getting through distillation. Because we need basically, will see when we talk in the next class is your application where we use the magnesium. So, the quality of the magnesium is important whether you require a 90 percent pure magnesium or a 99 percent pure magnesium.

That depends on this particular process whether the process would be expensive one through this sort of distillation. So, when we try to achieve the purest form of your magnesium which will be 99 above or 99.5 percent purity we should go for the material where we talked these as the purest magnesium. So, you must have the good idea about what is your purest magnesium. So, that can be obtained finally, through your distillation.

So, magnesium metallic magnesium is getting distilled now and that distilled process will increase your purity to 99.5 or more thank you very much then we will consider next class your application of your magnesium.