Electrochemical Technology in Pollution Control

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Lecture - 30
Electroplating 3

Greetings students, once again we meet to continue our discussion on Electroplating. And, I was discussing about the plating on aluminium and said that aluminium plating is slightly different from conventional electroplating because of the unique nature in reactivity of aluminium.

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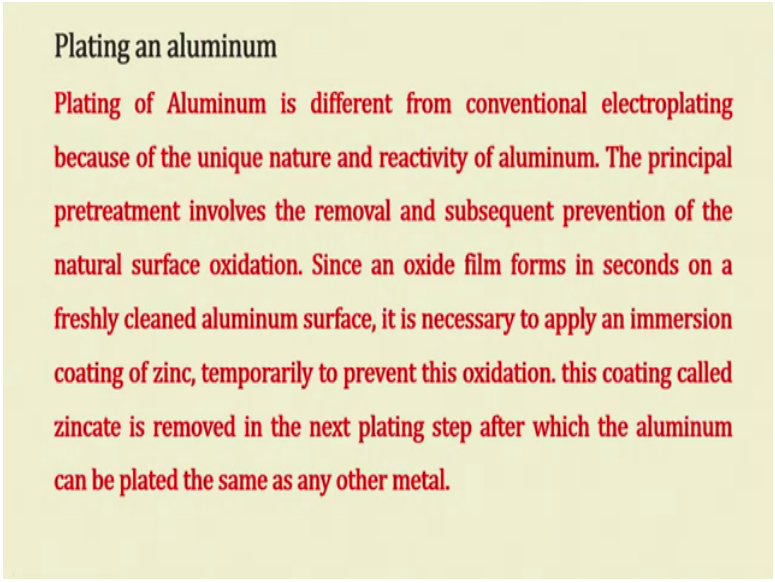

Normally, we try to prevent the natural surface oxidation. So, it is necessary to apply an immerse coating of zinc, temporarily to prevent the oxidation. This coating is removed for the

actual electroplating. The zinc electroplating is only a sort of precaution for aluminium plating. I had shown you this slide also that is preparation of the basic material.

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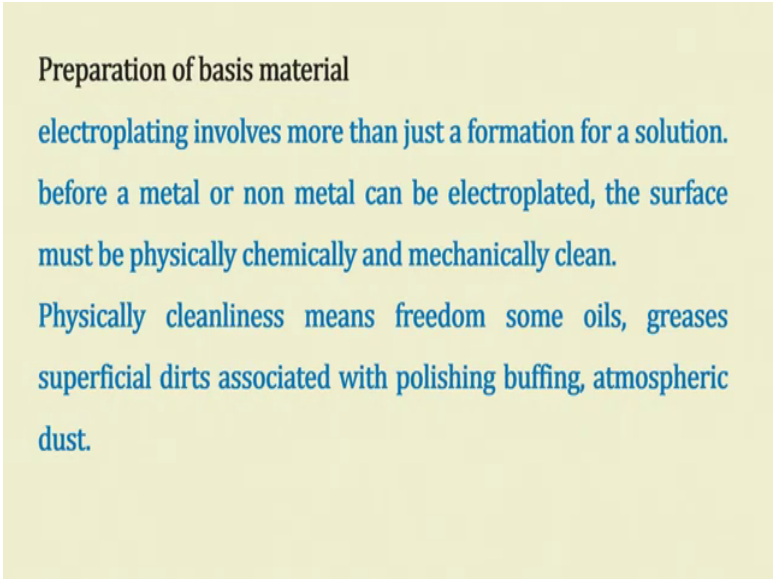

And what we write here? We write that electroplating involves more than just a formation of for a solution. So, before a metal or non metal can be electroplated; the surface must be physically and chemically clean; this we have to ensure. Physical cleanliness means; freedom from oils, mud, greases, superficial dirts, associated with packing material, plastics and so many other things that are involved in that. And, atmospheric dust also quite often is associated with the metals which are stored for long time in the open that is also to be removed before we go for electroplating.

So, we also use quite often chemical cleanliness. In the chemical cleanliness means; freedom from oxides or other surface formed compounds may quite often it is the oxides, sometimes it

is if it is copper metal then copper sulphate, copper sulphide, silver sulphide, many other compounds associated with the atmospheric components that react with the metal.

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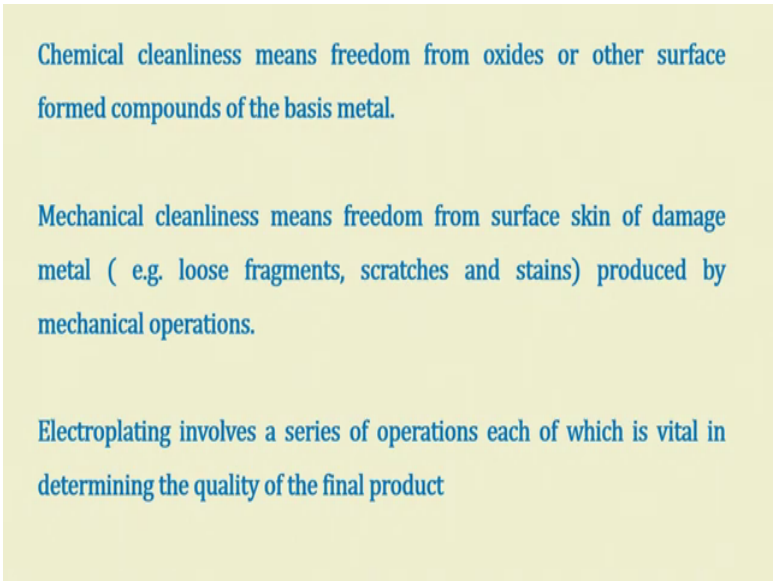

Usually, it is sulphur and oxygen. Mechanical cleanliness again it means; freedom from the surface skin of the damaged metal. So, sometimes loose fragments are there and when you there will be scratches, there will be stains etcetera.

These are produced by mechanical operations while removing one metal from another one from their from the bottom you want to take out one metal from another metal. So, there will be automatically some scratches and other things happening on the metal this thing. So, electroplating basically involves a series of operations. Each of which is vital in its own way for determining the quality of the final product.

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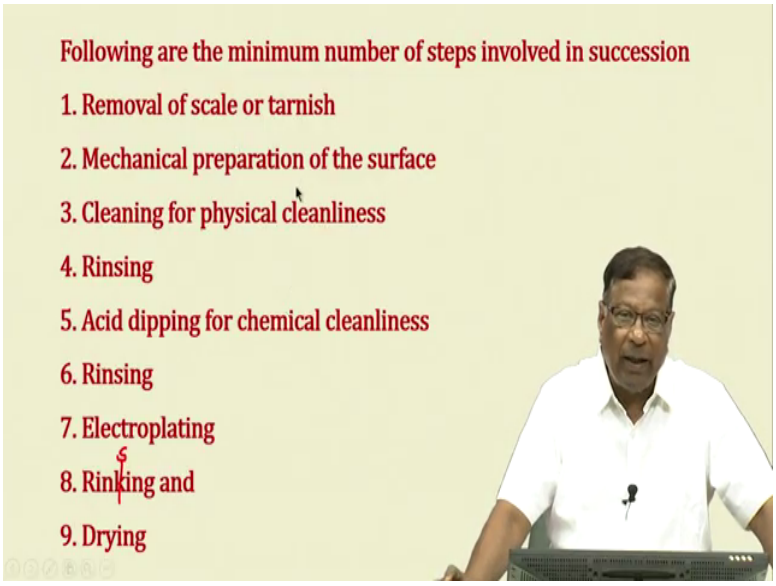

So, what are the basic steps that are involved in electroplating? First of all we have to remove the scales and these scales are of oxides if it is stainless steel, otherwise many oxides and sulphides as I had already explained to you. Sometimes the face of the metal gets tarnished. The metal does not have the shine that a metal should have. I think you have all experienced such kind of tarnish; normally, what when you go to buy a metal vessel or something in the shop, we expect the metal to be shiny and nice looking etcetera.

But, if the metal in the same shop if the vessel is kept for long time there will be dust and there will be when you see that you will say that oh this is old this is tarnished, it is not it does not have a shine, I will not buy it then. So, quite often what happens is the metal should if it is very pure, it must have that special shine of a metal. And, if it is not there, we will have to clean it and mechanical preparation of the surface is one of the way to do that.

So, you have to take a cotton cloth and buff it, wipe it nicely number of times etcetera. Shopkeepers normally do that; almost all metal articles they want to sell everyday morning they come and clean it with their mechanical clean it mechanically with a cloth. So, that the tarnish is retained. So, cleaning for physical cleanliness is a must. Then after cleaning; we want the metal to be the dirt and other things should be washed away that is known as rinsing. What we do is, we take the metal dip it in water and take it out. So, that water will pick up the dirt dust and fibres this that etcetera and then we go for acid dipping for chemical cleanliness.

After you take out from the water bath, we just pull it out and then take it to another bath which contains acid. So, metal should be dipped in acid which metal, it is the object which is to be electroplated. So, after that, there will be certain amount of acid remaining on the metal. So, that acid residue will start acting on the metal. So, again that has to be removed. So, again I have a water bath in which I will dip the material, acid also will go down along with water and then I have one another one or two rinsing operations where the last remnants of the acids are removed before it is ready for electroplating.

And after electroplating; again I have to go for rinsing and then drying. There is a error here, it is rinsing only, this is not there it is rinsing. So, they after electroplating again I want to get rid of the chemicals that are adhering to the metal which is not electroplated. So, those things again need to be removed and what is the best way to remove such chemicals is again take it for a rinsing and then one more rinse and then see that everything gets diluted and the electroplated material comes out soft, shiny, beautiful etcetera.

After that there is a requirement for drying because, water even if it is left on the metal can leave a small trace of stain. So, immediately it should be dried and then removed, it will be checked for quality and then only there will be other operations going on. So basically, this is the operation for all electroplating units; the chemicals may be different mechanical preparation of the surface may be different and acid dipping may be there may not be there sometimes, we clean it with alkali also. And that is also there, but again in general this is the sequence for base metals, that is involving iron cobalt nickel etcetera.

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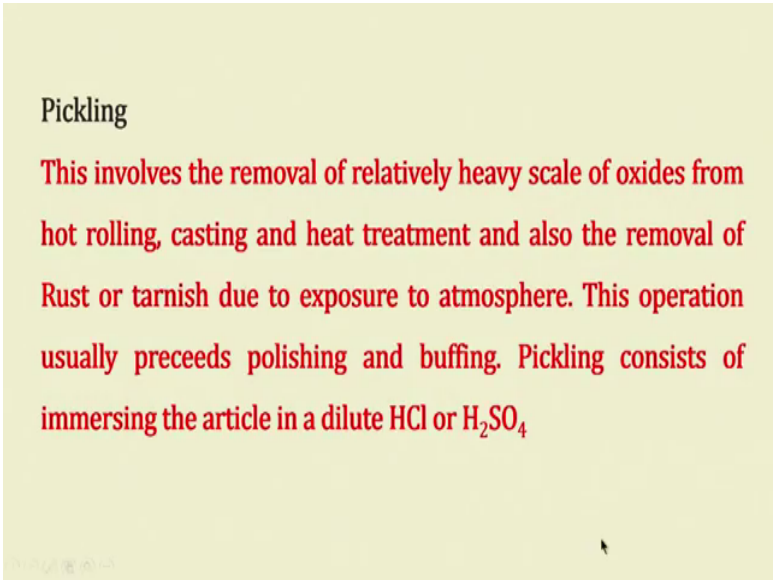

So, sometimes there will be heavy scale of oxides from hot rolling casting and heat treatment and also the removal of the rust and tarnish due to exposure to atmosphere. Here I have to explain to you that the metal which we normally take for electroplating if it is kept for long time. It will pick up this exposure there will be rust and tarnish will be there and that is only due to atmosphere. But, quite often the metal sheet or metal object that is to be electroplated itself needs to undergo several operations before it is ready for electroplating.

Sometimes, we hot roll it hot it is called hot rolling, sometimes we cast it; so, while casting it comes into contact with several chemicals and then again those things need to be removed. Sometimes, we give heat treatment because heat treatment is one of the requirement for making the metal surface very tough. So, heat treatment is normally done in cyanide baths ah. So, there will be a coating of the nitrite element and that makes the metal harder, it would not

break. It is like a tool, a tip of the tool that is usually heat treated. And there will be the of course, removal of rust and etcetera.

So, apart from the normal tarnish, there will be exposure to there will be exposure to several hot rolling cold rolling casting heat treatment and there are many other operations a metal before a metal is used for electroplating. So, this operation usually proceeds a polishing and buffing. It should be precedes again here let me correct it right now. Otherwise I will make the correction here itself its precedes. So, the mechanical operation, usually after removing the scales etcetera, we need it for we need to do polishing and then buffing and pickling consists of immersing the article in a dilute HCl or sulphuric acid ok.

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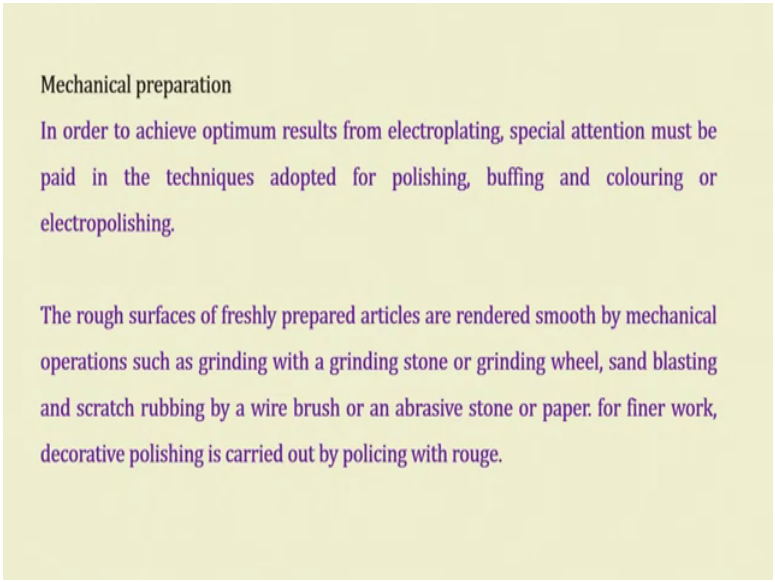

So, mechanical preparation involves the polishing only. Polishing, buffing and colouring sometimes or it is known as electro polishing. The rough surface of freshly prepared articles

are rendered smooth by mechanical operation. What do we achieve sometimes quite often there is always a question why should we clean it so much with mechanically also. Because, when the metal is cast the surface will be usually rough it depends upon how you cast.

If it is investment casting using molten wax or something surface will be smooth. But if it is cast in a normal operation where tons and tons of millions of tons are being produced every day, you cannot have smooth finish for that the to improve their appearance and strength there are other operations like cold rolling hot rolling etcetera and those things are all there.

After that; again still there will be some sort of rough edges on the metal surface. So, that is removed by a grinding operations and then buffing, grinding stone, grinding wheel, milling wheel and scratch rubbing by a wire brush or abrasive stone or paper. Finally, and for finer work decorative polishing is carried out by polishing with the rough.

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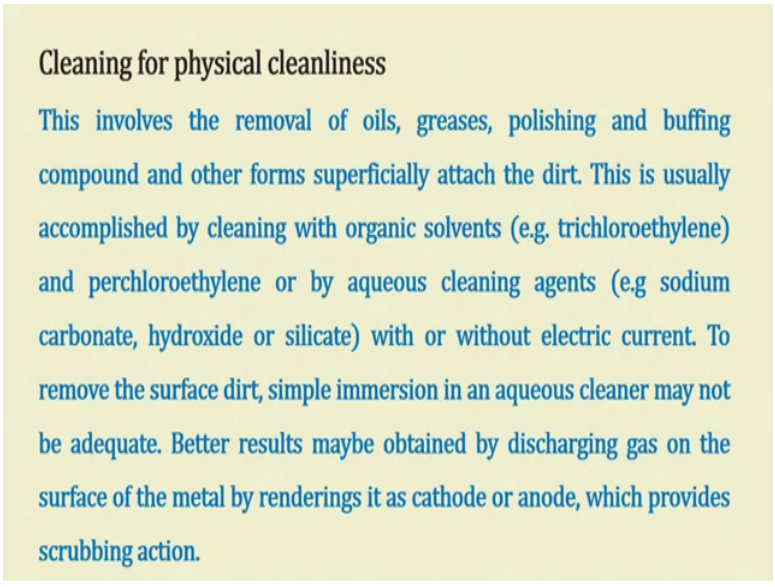

So, next step involves physical cleaning of the metal part that is to be electroplated this involves the removal of oils, greases, polishing material, buffing material and any other dirt and dust and other things attaching to the metal surface during cleaning. So, this is usually accomplished by cleaning it with organic solvents using trichloroethylene or perchloroethylene and ultrasonic application ah.

So, you may be wondering, why this trichloroethylene and perchloroethylene. Actually, these two compounds are not very environment friendly they are implicated in ozone hole formation in the arctic regions. And, somehow they are not favoured nowadays internationally, but unfortunately their use keeps on increasing at least not veining too much. And, perchloroethylene you may be you should know that when you give your clothes for dry cleaning then people use perchloroethylene.

So, that is a very well known application of perchloroethylene for dry cleaning. Same similarly, they use trichloroethylene also sometimes. And, these two organic compounds are usually not favoured, but ultrasonic cleaning wave; that means, ultrasonic cleaning is useful, perchloroehtylene is useful, trichloroethylene is useful for catching the dust and removing it from strongly adhering metal parts or fabric.

So, what we need to do if we have to use these compounds. We have to be extra careful to see that the vapours of these compounds should not escape into the atmosphere otherwise avoid them all together. That is a new level of technology that is usually employed, but for the 90 percent of the time, this ultrasonic cleaning is still being used in India. Then it can also be cleaned with alkali, sodium carbonate, sodium hydroxide, sodium silicate etcetera as mixtures or as individual compounds also with or without electric current with or without heating also.

So, I have not written heating here, but quite often I have not written heating here now. So, but you should understand that higher temperature makes difference in cleaning. That is why we wash the clothes also in warm water to see that the dirt is blown away. So, the sodium hydroxide, sodium carbonate, sodium silicate are used individually or with in mixtures.

To remove the surface dirt simple immersion in aqueous cleaner may not be adequate at all. Just dip and taking it out is not very effective, better results are obtained by bubbling the bubbling a gas on the surface of the metal by rendering it as cathode or anode that also provides very good scrubbing action; that means, we not only do the cleaning um, but aid it mechanically by bubbling a gas. We can bubble air itself does not matter, but required.

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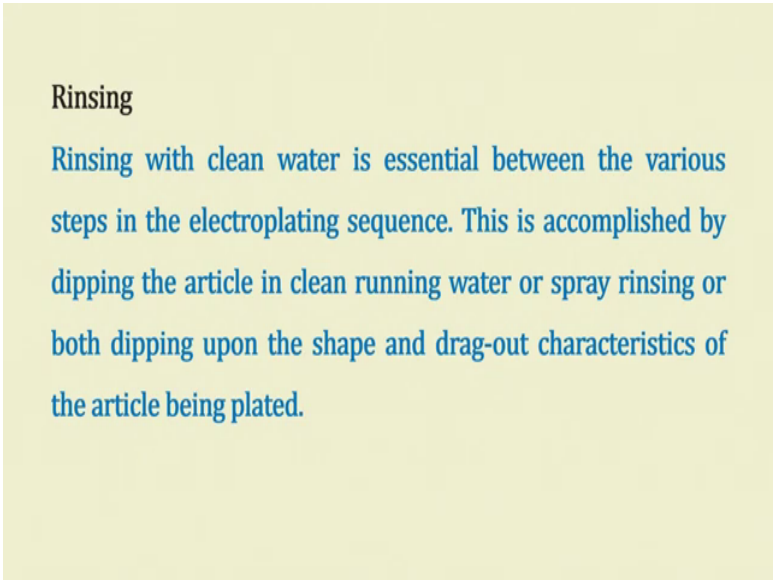

So, we can also do this rinsing operations. What is rinsing? As in as I already told you; rinsing has to be done in clean water correct. So that clean water is a highly polar compound. It can it is known to dissolve many of the organic and inorganic compounds and clean water is essential between the various steps in the electroplating sequence as I have already told you number of times. This is accomplished by dipping the article in the clean running water or I

can even do the spray rinsing. Spray rinsing is very simple; you just take a jet hand jet and then spray it on the metal that also is known as spray rinsing.

But, after sometime, whenever you start doing these rinsing operations what happens is the water will get will catch all the chemicals and its quality will go down. So, you need to remove the rinsing water and replenish it with more and more good water. So, there water requirement in electroplating industry is enormous and good water also and the bad water that is polluted is equally bad in the most of the cases.

So, that needs to be treated very carefully and we have I have included number of lectures on water treatment in this course also. So, we will discuss it further again in the process waste handling operations. So, coming back to this slide; we need to dip it in the clean water running water and spray rinsing we can do and then the article has to be selected specifically, for dip rinsing or spray rinsing depending on the drag out characteristics of the article being plated.

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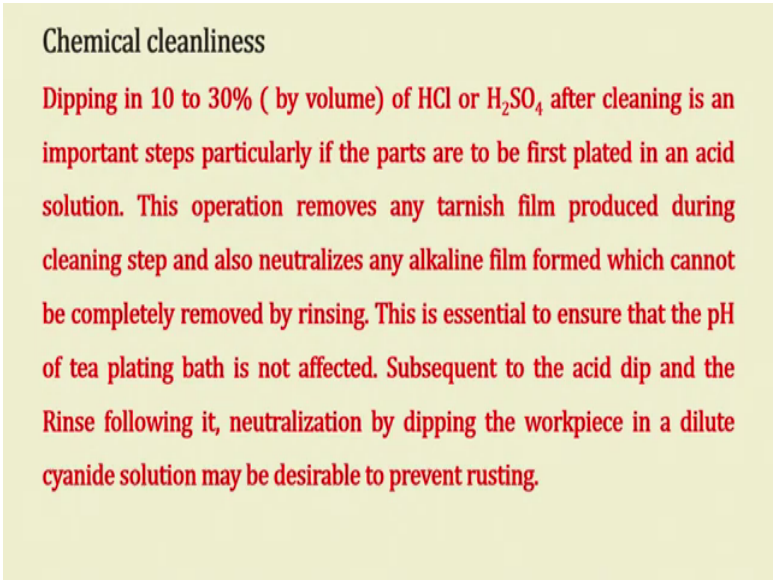

Then, in chemical cleanliness; coming back to this I said just now that we use alkali. Sodium carbonate and then sodium silicate, but it can also be done by dipping in 10 to 30 percent by volume of HCl or H 2 SO 4 after cleaning. Is it is that is important particularly, if the parts are to be first plated it in acid solutions. You cannot take an article which is dipped in alkali and then put it immediately in the acid for electroplating our you know train that is not possible.

So, whenever you do alkali cleaning; there is again a requirement of acid cleaning because we need to plate and we plate it with the with acid. So, what happens instead of that it is a better to include one more acid rinse, if you want to plate it immediately. So, with what you will clean it up you can use hydrochloric acid, sulphuric acid, nitric acid, perchloric acid, hydrofluoric.

So, many acids are there best among the lot is hydrochloric acid. We know its chemistry, we know what it can do and what it cannot do and approximate. It is a fairly good reactive acid not very harsh to the hands like sulphuric acid or nitric acid, but 10 to 30 percent nitric acid HCl is fairly good enough to clean most of the dirt and other things for chemical cleanliness. H 2 SO 4 also should be approximately 10 to 30 percent.

So, after cleaning, the parts are removed and checked for tarnish again. If the tarnish is gone then the next step can be just neutralizing and then going ahead with electroplating. So, this is essential to ensure that the electroplating bath is not affected. Subsequent to the acid dip and to the rinse following it neutralization by dipping workpiece in dilute cyanide solution also is employed if we want to detect the, if we want to plate with zinc or gold or anything then cyanide bath dip also is quite essential. So, quite often we do employ that.

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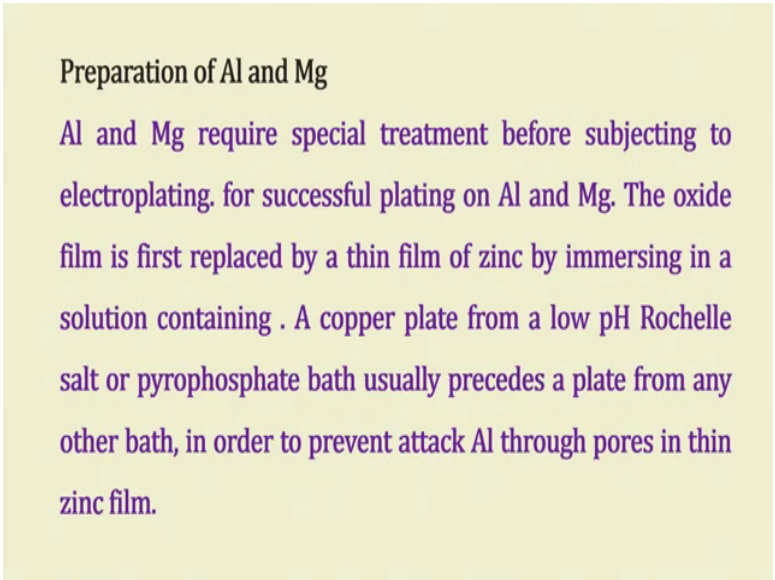

Now, regarding the preparation of aluminium and magnesium; aluminium and magnesium requires special treatment as I had already mentioned to you because of the oxide coating on the metals. The oxide film is first replaced by thin film of zinc immersing in a solution containing a small amount of alkali. A copper plate from a low pH Rochelle salt or pyrophosphate bath usually precedes a plating co operation from any other bath in order to prevent aluminium attack on aluminium by force in thin zinc film.

If we want to do zinc thin films know then it is better to take the copper article dip it in Rochelle bath or pyrophosphate bath before proceeding. So, in that brings us to almost the end of our discussion on metallic plating, there are many other platings actually. I have already discussed yesterday that gold, titanium, silver and many other elements indium many other elements are there for the, we are there is no need for us to go into details of the operations, because the volumes are small and very specific.

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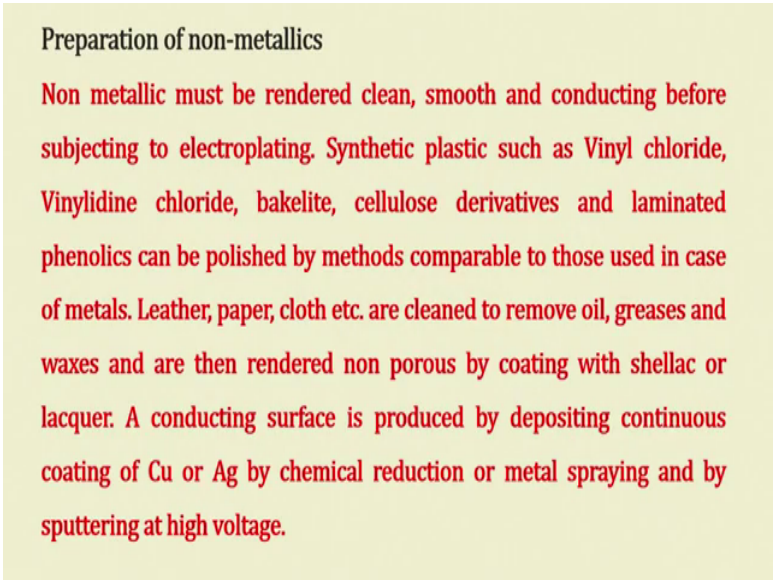

So, coming back to our electroplating technology; non-metallics can be rendered clean smooth and conducting before subjecting it to electroplating. Synthetic plastic such as Vinyl chloride, Vnylidine chloride, bakelite, cellulose derivatives laminated phenolics, all can be polished by methods comparable to those used in the case of metals leather paper etcetera if you want to clean.

Then they are also used to remove oils, greases, waxes and then rendered non-porous by coating with shellac or lacquer. A conducting surface is produced by depositing continuous coating of copper or zinc by chemical reduction or metal spraying and by sputtering at high voltage. These are all special technologies that can be employed.

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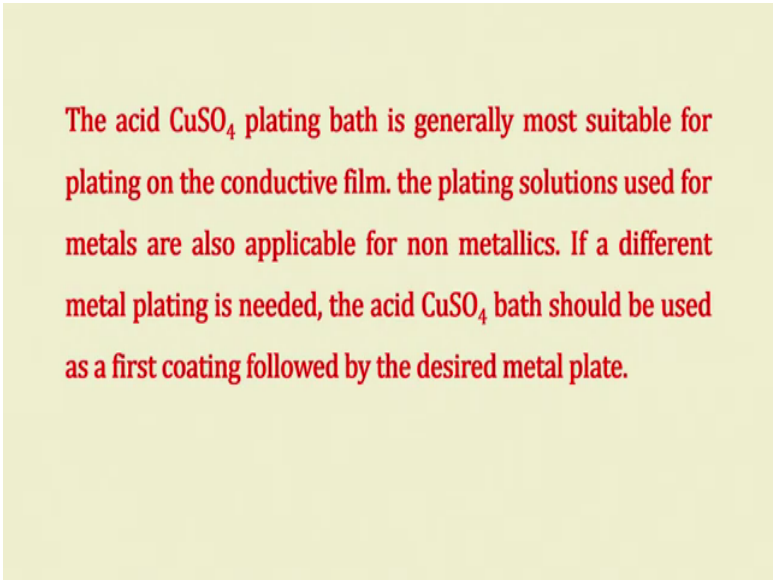

So, the acid copper sulphate plating bath is generally most suitable for plating on conductive film, then plating operations used for metals are also applicable for non-metals usually same metal baths. But, if a different metal plating is required then copper bath should be used first as a coating followed by the other metals coatings.

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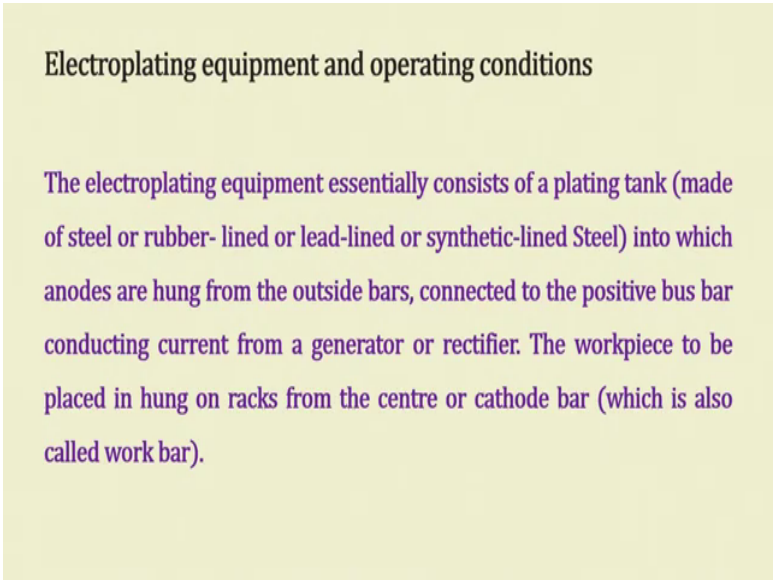

So, we will discuss briefly about the electroplating equipment and operations, operating conditions; the electroplating equipment essentially consists of a plating big tank into which anodes are hung from the outside the bus connected to the positive bus bar on the top. It is known as bus bar a big metal plate and conducting current from a generator or a rectifier because we need very low currents. We do not need 5 amps 10 mps like what we get in our surroundings normally, but very low currents. And, work piece to be placed is hung on racks like as if it is a cathode or we make a cathode bar on which we place lot of articles to be plated on the cathode

So, multiple electroplating operations are quite possible. And electroplating is one operation where maximum number of automation happens. So, look at the number of articles being produced especially very small-small screws and metal plates and bushes and other things they are done in barrels in thousands and thousands of materials. So, it is important to have

automation. So, that we the rejection percentage will become less and chemicals can be used more economically. We will continue our discussion in the next class and then we will go onto batteries.

Thank you very much.