Inorganic Chemical Technology
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Lecture - 28
Surface Coating Industry

Welcome to the MOOCs course Inorganic Chemical Technology. The title of today's lecture is Surface Coating Industry. Now, surface coating industry; that means, you know the products that are produced in these kind of industries are usually applied to cover a surface or a material that has been produced by industrially ok. That is how we can see it from the title of the lecture point of view, right.

So, why do we need to do the surface coatings is basically you know in order to protect the surfaces are the structures whether architectural structures or you know industrial products etcetera from the attacks of the weather. That is one purpose and another purpose is that for a pleasing look for aesthetic appealing of material then also often this kind of surface coatings are applied on different types of structures and then industrial products as well ok.

So, now, we see what are the surface coating, industry products etcetera those things we are going to discuss, then their properties, their purposes etcetera and then we are going to see their production process all those things we are going to discuss in this particular lecture ok.

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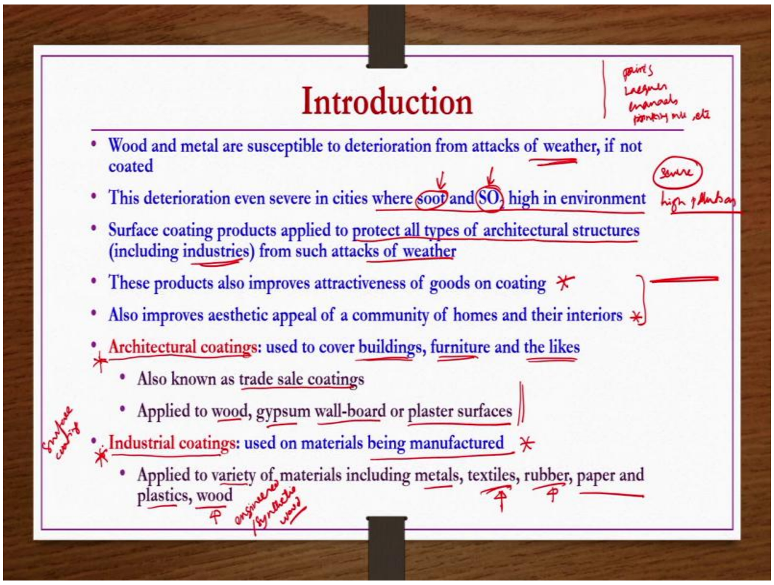

So, first we see the introduction. Introduction like what are these material, what are these surface coating materials in general. Often, we may be knowing that these are nothing but paints, lacquers, enamels, printing ink etcetera these kind of things are known as a surface coating material that we already know.

So, then what are the purpose and then how they are prepared and then what are the ingredients constituents of these surface coating, industry products that are you know essential to know. So, primarily before knowing their constituents and then production and then property utilization or application, how to apply them all those things you know before going to see those things we will have a kind of a requirement of these things, right.

So, usually if you do not covered wood or metal surfaces then what happens because of the attacks of the weather you know these surfaces may get deteriorated; deterioration may be in different terms. If it is wood then you know some kind of you know pest may be attacking the surfaces and then completely destroying the wood material.

If it is a metal, then it may be corroded or you know it may be rusted because of you know exposing to the open atmosphere these kind of problems may be there. So, because of because of the need to protect them from the weather attacks so, these wood and metal kind of structures are often covered with surface coating, industry products such as paints etcetera.

So, now the another issue is that you know these problems whatever the deterioration of the surface from the attacks of the weather are much more severe in the cases of the cities where suit and sulphur dioxide are high in the environment. If these are high in the environment, so, they may cause a severe deterioration of these surfaces or structures something like that or you know material whichever we wanted to protect by coating them.

So, if you coat them properly then it is possible that you know these material would be protected from such kind of attacks and then these attacks are to and these attacks found to be severe in cities because of this suit and then sulphur dioxide that is present in the environment and then these are present because of a high pollution high environmental pollution in the cities, ok.

So, surface coating products in general applied to protect all types of architectural structures – all types of architectural structures including industries from such attacks of the weather, right. So, depending on the surface or the structure which you are coating accordingly you have to select a surface coating industry product.

It is not like that one particular product is going to be useful for coating all kind of surfaces, and then that is giving all kind of required protection from the attacks of the weather. It is not like that. You have to be very specific as per the product or as per the surface or as per the structure whatever the architectural structure you have as per the requirements you have to select a product and then obviously, different types of products are there.

So, then production and then properties and then utilization application also you cannot apply always these paints or lacquers or enamels by brush only there are different application methods as well are available. So, then we need to understand all of them. Not only from the protection point of view they also provide attractiveness of goods on coating, right.

If you let us say if you have a architectural structure – household, interior, exterior or whatever if you properly coat using paints and different colors and then different you know designs painting if you do the appearance also improves. Aesthetic appeal of the structures also increases. It improves the attractiveness of the goods as well.

Let us say you have a paper right you have a normal paper and then when you have a glossy paper coated with some kind of paints or you know surface coating material. So, then the appearance between normal paper and the other coated paper looks very different, right.

Let us say if you have a photograph if you take the picture of that photograph on a normal paper it looks different and then if you take a the same picture on a photographic paper it is going to be looking very very differently. In fact, very you know beautiful it appears because of the coating that is provided on the photo photographic papers right. So, those kind of products are also coming under this surface coating industry products.

Also improves aesthetic appeal of a community of homes and their interiors as well, that is the purpose. So, not only from the protection point of view or protection from the environment point of view, but also improve their appeal and then to improve the attractiveness of the goods and then structures also this surface coating products are often used to cover different types of structures and then goods that are being industrially produced.

Paper is industrial production, right. So, paper coating different types of you know layers, glossy layers etcetera as per the requirement you know that is you know done by the surface coating industries. Or products of the surface coating industries are used in paper industry to make such kind of a glossy papers etcetera. That is one example only.

You have rubbers, you have plastics, different types of rubbers, plastics etcetera are there you that are being you know produced or plastic items are being produced you know you know by a plastic industries, right. So, you may be having some designs or writings on the materials that have been produced in the plastic industry. So, then again for those writings you need to have a printing ink etcetera all those things are you know produced by or comes under surface coating industry products ok.

So, the surface coatings can be divided into two – one of them is architectural coatings which are used to cover buildings, furniture and the likes in general, ok. So, these are also known as the trade sale coatings as well that is the other name given to this kind of coatings. These are applied to wood, gypsum, gypsum wall board or plaster surface etcetera different types of surfaces you know you know blackboards etcetera.

We have earlier only black color is used to paint the surface boards. Nowadays different types of boards whiteboards and then other kind of boards are also there. So, there all we often see such kind of you know coatings are applied you know these kind of coatings are usually known as the architectural coatings which are applied to the buildings, furnitures and the likes; likes in the sense like you know for example, like boards etcetera ok canvases etcetera those kind of things ok.

Another one is the industrial coatings, right. So, these are used on materials being manufactured, materials being manufactured different types of products let us say plastic products or paper products you manufacture and then you need to have a proper coating or you know proper design making on those kind of products is required as per the consumer requirements or in order to improve the appeal, aesthetic appeal of those products also you know these are applied.

So, based on the applications view point of as well the industrial coatings are different from the architectural coatings right not only the applications you know on which these are kind of applied you know applying paints etcetera and furnitures buildings is a different task than applying some kind of coatings on papers or plastic materials etcetera is going to be different.

So, obviously, the paint or you know the surface coating product that is been used for two different types of applications are going to be different ok. These industrial coatings are applied to variety of materials including metals, textiles is one another important example where surface coating products are used in a large quantities.

Then rubber products, paper and plastic products, wood products also sometimes of wood products also like you know engineered woods or synthetic wood etcetera that we have in general you know they are often having some kind of coating. So, these coatings are also known as the industrial coatings. So, whatever the surface coatings are there so, these may be categorized as two types one is the architecture coatings another one is the industrial coatings ok.

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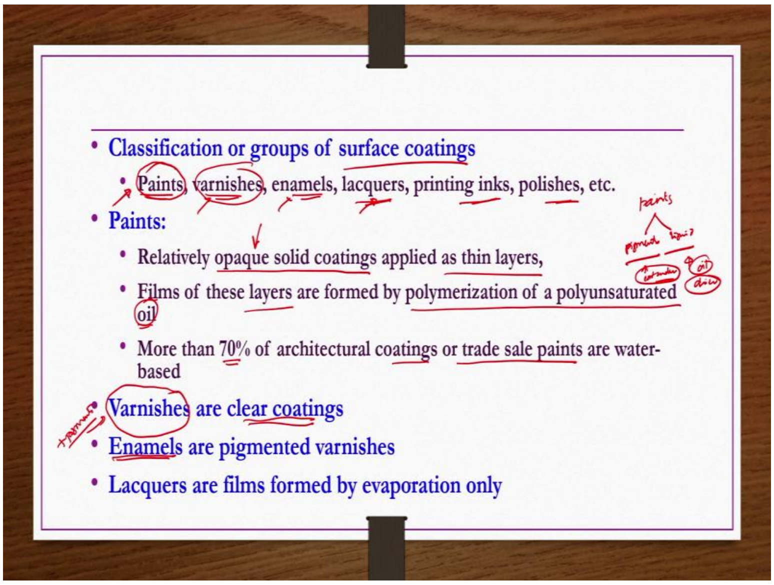

Now, we see classification of surface coatings or groups of a surface coatings what are they primarily they can be classified as paints, varnishes, enamels, lacquers, printing inks, polishes etcetera ok. Now, what we do we are going to see a few basics about each of this groups like paints, group varnishes, groups enamels and then lacquers etcetera in this class and then later on we are going to discuss in detail about each of them all as well.

So, let us say paints first we see what are its constituents etcetera what are the purposes and then what are the additives drying, driers etcetera are used in general for the paints, what are the pigments etcetera those kind of things we are going to see now. Later on we are going to see how to manufacture paints etcetera and then pigments we are using in these paints.

So, then how to what are the; what are the different types of pigments how are they being produced or manufactured industry industrially those kind of things we are going to see. Similarly, for varnishes enamels, lacquers etcetera we are going to see more details in the subsequent classes ok. But now we see a few basic points about these different types of surface coating products.

Let us say paints are relatively opaque solid coatings applied as thin layer if they are not opaque then obviously, the surface may be exposed. And, then if the surface is exposed then required color or aesthetic applied that you are looking for may not coming in. Also, usually they are you know this if they are opaque they will be reflecting the different types of lights.

So, then they will not allow the lights to pass through and then they will not allow the lights to destroy or you know attack on the you know surface on which these things are being you know applied. Films of these layers are formed by polymerization of a polyunsaturated oils. So, then what is oil these kind of things we are going to see.

Actually, paint is nothing but is you know you know dispersion of a pigments in a liquid solution or solvent, right. So, if dispersion has to be uniform and then you know it should not be settling quickly or you know pigment should not settle at the bottom and then liquids you know suspending on the top it should not be like that.

A proper uniform dispersion has to be formed and then that has to be stable for a years to come. So, for that purpose you know in the liquids some kind of oils etcetera also included and then some kind of dryers etcetera also included; pigments some kind of extenders also included for different purposes all those things what are these extenders oils, driers etcetera those things we are going to see anyway.

More than 70 percent of architectural coatings or trade sale paints are water based and whereas, the varnishes are clear coatings without any pigments, right. These are natural mostly most of the varnishes are natural, but nowadays there are synthetic varnishes are also available, right.

So, if you add pigments to this if you add pigments to these varnishes, then whatever the surface coating product that you are going to get that is known as the enamel. So, enamels are pigmented varnishes whereas, the lacquers are films formed by evaporation only.

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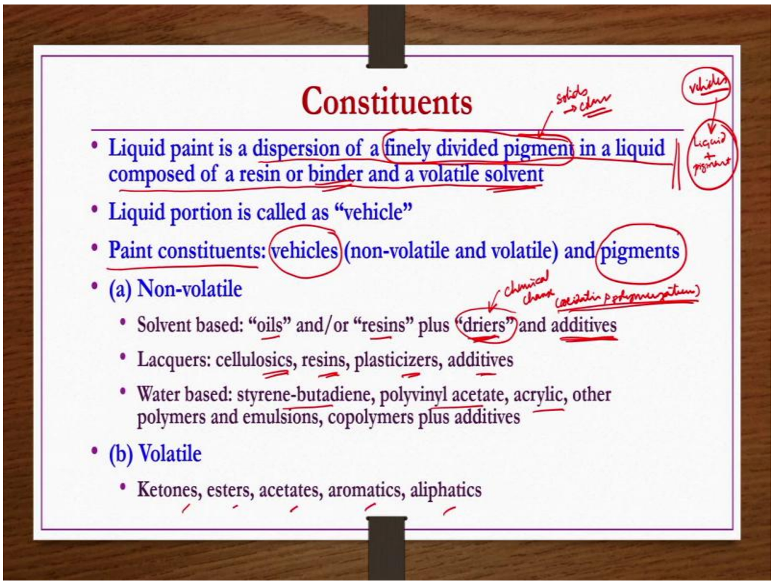

Now, we see the constituents of the paints ok. What are the constituents? As I mentioned paint is nothing but is a dispersion of a finely divided pigment in a liquid composed of a resin or binder and a volatile solvent, right. So, now finely divided pigment so, by terminology also if you see this finely divided pigments; that means, they are some kind of solids very fine solids.

They are providing some kind of color because liquids color whatever is there that may not be there on drying the paint. When you apply a paint and then once it dries off, if the color is coming because of the liquid then that color may not be stay for long, right. So, if the color is coming because of the solids that are being dispersed in a liquid then you know that color is going to be you know lasting long, ok.

So, these pigments are nothing but solids which provide color some kind of color required as per the requirement of the consumer or customer, right. Now, there are some kind of binders also there and then solvents also there, right. So, what are they we are going to see.

So, now, basically you know from this statement what we understand? The paint is nothing, but a mixture of liquid and then solid pigments and then when they add together a dispersion is being formed that is what we are going to see how it is formed etcetera, right.

So, now this liquid you know what it is? What are the constituents? Is the pure solvent or is there any you know addition or additives etcetera are there in this one all those things we are going to see. But, however, this liquids whatever are there we call them vehicles in the technical or terminology we call them vehicles because these are the vehicles they are carrying the colored pigments.

Color may be white, black, green whatever the colors blue, orange, different colors are possible accordingly different pigments are there. So, these colored pigments are the very fine solids which are providing color to the paint. Those pigments are being carried by the vehicle liquids right in the dispersion, right. So, the dispersion is formed because of the addition of these two liquid and then solid pigments, right. So, these liquids are usually acting as a vehicle. So, that is the reason they are known as the vehicles.

These vehicles can be volatile as well as the non volatile. So, what we understand now? Paint is nothing, but it is constituents vehicles and then pigments. Now, we see individually what are these vehicles, non-volatile and volatile vehicles and then what are the pigments those things we are going to see now. Non-volatile vehicles may be solvent based like oils and or resins plus driers and additives.

Driers drying of the you know paint when you apply; when you apply paint on a surface usually you apply as a thin layer alright as a thin layer so that hardening of that layer takes place that hardening of that layer is nothing but you know drying is nothing but drying in this you know surface coating industries terminology point of view that hardening of the layer formed by applying paint is known as drying, right.

So, this drying is a chemical change obviously and then these chemical change usually include oxidation and polymerization of a components that are present resins etcetera that are present in the paint. Oxidation of a you know solvent etcetera that are present in the things. So, you know some kind of chemical change is occurring after applying the paint as a thin layer. So, that is leading to the drying of the surface and then the surface or the thin layer is becoming hard, right.

So, that hardening may be improved by adding some kind of driers. So, whenever the process is improved by addition of something so, then usually the general common terminology that we can use; we can use I can a promoters or catalyst. So, driers are nothing but some kind of promoters or catalyst materials which improve the hardening of the thin layer that has been applied by applying the by use of the surface coating materials something like paints etcetera, right.

Like that additives may also be there in order to improve the you know appearance, color or whatever different purposes may be possible. Lacquers – cellulosics, resins, plasticizers and additives are possible. Water based things may be styrene-butadiene, polyvinyl acetate, acrylic, other polymers and emulsions, co-polymer, co-polymers plus additives. Then, volatiles, under the volatile vehicles we may have something like ketones, esters, acetates, aromatics and aliphatics ok.

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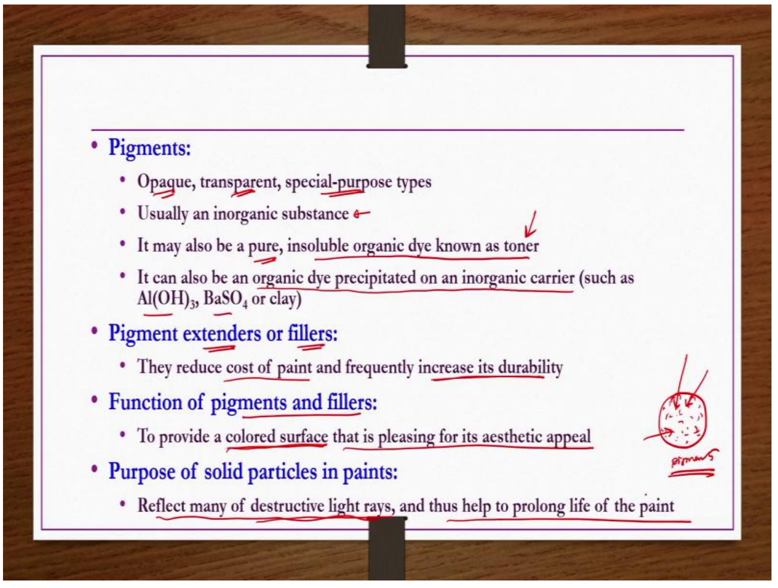

Now, we see individually about the pigments and then individually about the liquids, what are the things present in the liquids like oils, driers etcetera, what are those oils, what are those driers, what is their purpose etcetera, those things we are going to see now.

So, now, we discuss about pigments. Pigments are opaque, they can also be transparent, they can also be special purpose types, they can be of any different three types ok. Usually, these pigments are inorganic substances, right. Pigments may also be pure insoluble organic dye known as toner as well, ok. Sometimes these can also be organic dye precipitated on an inorganic carrier such as aluminum hydroxide, barium sulphate or clay.

Pigment extenders are fillers right. Sometimes pigments you know they may only provide the color right, but they may not able to provide the required the shelf life of the paint or emulsion. Shelf life of the paint or emulsion in the sense that pigment whatever is dispersed in the liquid that should not settle, that should be under the dispersed condition for longer time.

So, in order to improve the shelf life of the pigments or paint you know pigment extenders are fillers are used. So, these pigment and extenders are used to reduce the cost of a paint and frequently increase its durability as well ok that is the purpose of extenders. Then function of both pigments and fillers, if you have to see these fillers are also known as the pigment extenders, right.

So, what are they? Some examples also etcetera we are going to see anyway. These pigments and fillers are used to provide a colored surface that is coming from the use of pigments that is pleasing for its aesthetic appeal. And, then purpose of solid particles in paints is in general to reflect many of the destructive light, thus help to prolong life of the paint. In the paint you know it is a suspension actually particles and then liquids and all there are there.

So, when these are exposed to the light you know many of the lights are you know very destructive. They may spoil the chemical composition of the paint by some kind of you know chemical changes taking place, that is also possible. So, then you know sometimes you know physical changes may also take place.

This when these paints are exposed some of the particles may be you know forming agglomeration kind of thing on exposure to the lights. Then again, the paint may become you know non uniform. These kind of problems may be there or there may be other kind of problems also possible in general. So, in order to avoid such kind of problems you know solid particles are added in the pigments or you know in the paints along with the pigments, right.

So, they will actually the solid particles we can take as a pigments. In fact, these are the pigments and then these pigments usually reflect many of destructive light rays. Once the light rays are not allowed to pass through the pigment or not allowed to pass through the paint then obviously, the life of the paint is going to be prolonged.

Because these lights are found to be destructive from the chemical and physical nature of the paint prospective as well or from the physical and chemical requirements of the paint as well these lights are found to be destructive. That is the reason you know some pigment selection should be such a way that, the pigment particle or the solid particles reflect such kind of destructive lights and improves the life of paints.

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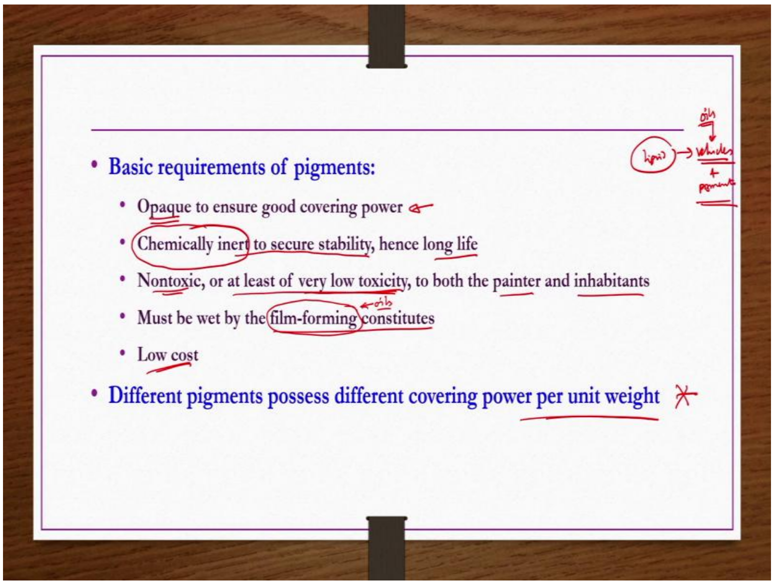

So, now what we understand till now you know paint is having two important constituents – one is the vehicle that is liquid portion another one is the pigment that is the solid finely divided solid particles. So, these are mixed together and forming a kind of a uniform emulsion kind of thing that is what we understand.

So, now we need to understand what is the purpose of adding these pigments; then we should also understand what is the purpose of having liquids as a vehicle different types of vehicles while why volatile, while why not non-volatile – all these kind of requirements one has to understand.

So, we start with basic requirements of pigments. They should be opaque to ensure good covering power obviously, if they are opaque in opaque in nature. So, then they can cover the surface much better way and then they should be chemically inert to secure stability hence long life, right.

Let us say you have a pigment which is chemically active and then when it is applied to a metal surface and then it this is reacting with a metal surface, then you know some reaction if taking place so, then that is much dangerous rather it is protecting the surface it is destroying the surface. So, that is the reason whatever the pigment you have chosen for a paint based on the applications that should be chemically inert, ok.

Then they should be non toxic or at least very low toxicity. Sometimes it is unavoidable because pigments are you know some kind of chemicals only like TiO_2, ZnS etcetera, $BaSO_4$, barium sulphate, zinc sulphide etcetera these kind of chemicals are there. Sometimes you know whenever there is a chemical, we cannot say that chemical is completely non toxic.

For one particular application or for one kind of inhabitant it may be non-toxic, but for other it may be toxic. So, if you cannot avoid having completely non toxic pigment in the paints you have to make sure that it should be very low toxic and it should be both to the painter as well as the inhabitants.

They must be wet by the film forming constituents. Actually, the liquids that we are using you know they are having some kind of purpose like vehicles only vehicles carrying these pigments. But, if this vehicle is not wetting with the pigments or the solid particles so, then it is not going to be useful at all. It has to be properly wetting that must be wet by the film forming constituents.

So, this vehicles again will include some kind of film forming agents which are known as the oils. So, those things we are going to see it is anyway, ok. So, liquids are not individual single components they may be having some oils as well and then they may be having some driers additives as well, ok. So, whatever the film forming nature that is coming into the paints on application onto a surface is coming because of some kind of oils, ok.

Those oils improve the film forming nature or you know or help film forming capability of the paint, ok. So, whatever the pigment that you select, that must be wet by the film forming constituents as well. It is not sufficient that it is forming a uniform dispersion or emulsion that is stays longer and does not settle that itself is not sufficient.

It should also be wettable with the film forming constituents that are present in the vehicles. Obviously, any product that you have or any raw material that you wanted to take for your product they should be low cost. Different pigments possesses different covering power per unit weight, ok. So, there should be some kind of a quantification how much pigment should be used for a given type of paint is very essential to understand, alright.

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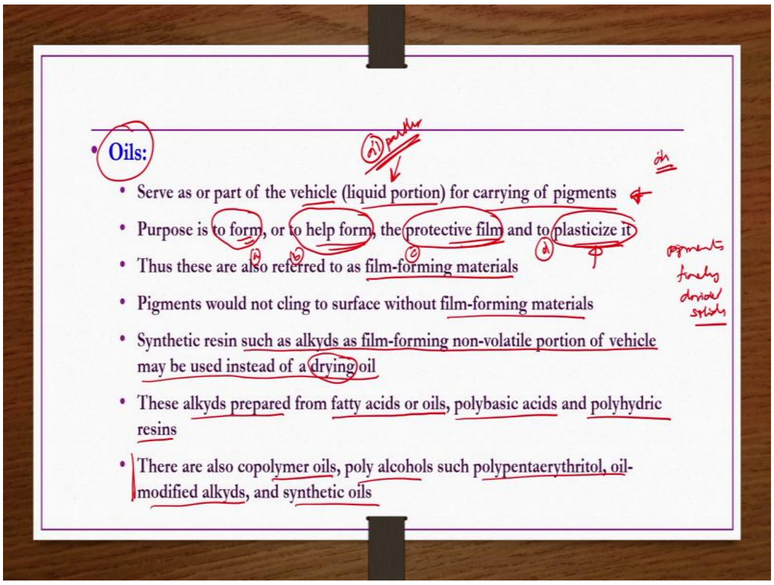

So, now we see oils, ok. As I mentioned oils are you know film forming agents are they assist or help depend to form films, ok. So, now we see a few details about such oils as well. They serve as or part of the vehicle liquid portion. So, the liquid portion entirely can be of oil or partly only it can be oil not necessarily be mixed with some other liquid. Entirely if you take oil as a kind of a vehicle that is also possible, right.

So, it serves as a liquid portion or vehicle for carrying pigments or it can be part of the vehicle or the liquid portion of the paint for carrying the pigments. Either way it is possible or either way it has the application ok based on the requirements and then profit also you have to see. Then you know oils may be expensive in general compared to the liquid vehicles, pure other pure liquid vehicles.

So, then rather having completely oil vehicles, it is better to go for a vehicle which is a mixture of oil and some kind of liquid. So, those things one has to take into the consideration. Purpose of these oils either to form films or to help forming films and then protecting them and to plasticize it also, ok.

So, oils are having several purposes. They are used to form films or they will be helping to form films or they will be protecting the films or they will be used to plasticize the film that has been formed. So, oils may be doing any one or more than one of these four purposes, ok.

Thus, these are also referred to as film forming materials. Pigments would not link to surface without film forming materials because these pigments are what? These pigments are finally, divided solids right whether TiO 2 solids or ZnS solid or whatever they are providing some kind of colors etcetera, ok. But they are finally solids, right. You know on a vertical surface or in architectural structure if you apply finally, divided solids you know they may not cling. They will not cling engine indeed, right.

So, if you want these pigments to be clinging to the surface you know these oils should be used which are nothing but film forming materials. Synthetic resin such as alkyds as film forming non-volatile portion of vehicle may be used instead of a drying oil. So, oils may also do the drying also. Plasticizing is nothing but you know kind of drying only, hardening the surface or the hardening the layer that has been applied on a surface, ok.

So, some kind of drying activities also being done. So, instead of using drying oils, one can use synthetic resin such as alkyds as film forming non-volatile portion of the vehicle. These alkyds prepared from fatty acids or oils, polybasic acids, polyhydric resins etcetera. There are also copolymer oils poly alcohols such as polypentaerythritol, oil modified alkyds and synthetic oils which are having or serving such kind of purposes whatever we expect oils to be doing in a given paint.

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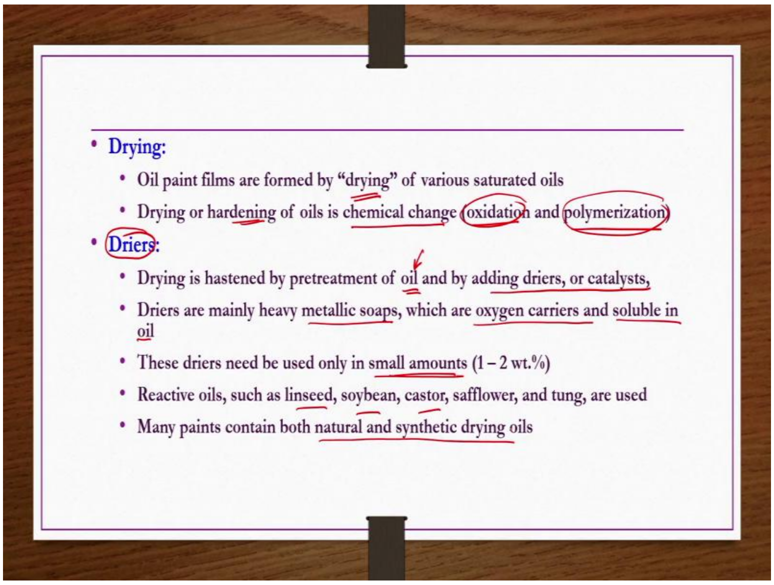

Now, drying: so, drying as I mentioned you know it is nothing but the hardening of the layer thin layer that has been applied that has been formed by applying the paints on a given structure etcetera so that hardening drying you know hardening is known as the drying in the surface coating industry terminology point of view, right.

So, this drying is a chemical change and this chemical change is occurring either by oxidation or by polymerization or by both or other kind of a chemical reactions as well. So, it is a chemical change. Oil paint films are formed by drying of various saturated oils. Drying or hardening of oils is chemical change occurring because of the oxidation and polymerization.

So, what are these driers? So, we understand that drying is hardening of the oils or you know whatever the film formed because of the presence of oils in the paint you know that film has to be dried right. So, that drying is happening because of oxidation and polymerization kind of reactions. These are very general reactions we are not going into the details of individual reactions that is not part of the course anyway, right.

So, now if these changes to occur or drying to occur you know you need sometimes you need to have a kind of you know promoters or fasten the drying process. So, promoters or catalyst are required. So, those promoters or catalyst which can improve the drying process of films formed by the applying of paints on a given surface are known as the driers, ok.

Drying is hastened by pretreatment of oil and by adding driers or catalyst, ok. So, this oil has to be pretreated. So, there are some options some methods are there we will be listing we cannot go in details of all those methods anyway. So, driers are mainly heavy metallic soaps which are oxygen carriers and soluble in oils different types of oils that we are choosing for film forming purposes.

These driers need to be used only in small amounts 1 to 2 weight percent only. Reactive oils such as linseed, soybean, castor oil etcetera are used as driers in general. Many paints contain both natural and synthetic drying oils as well.

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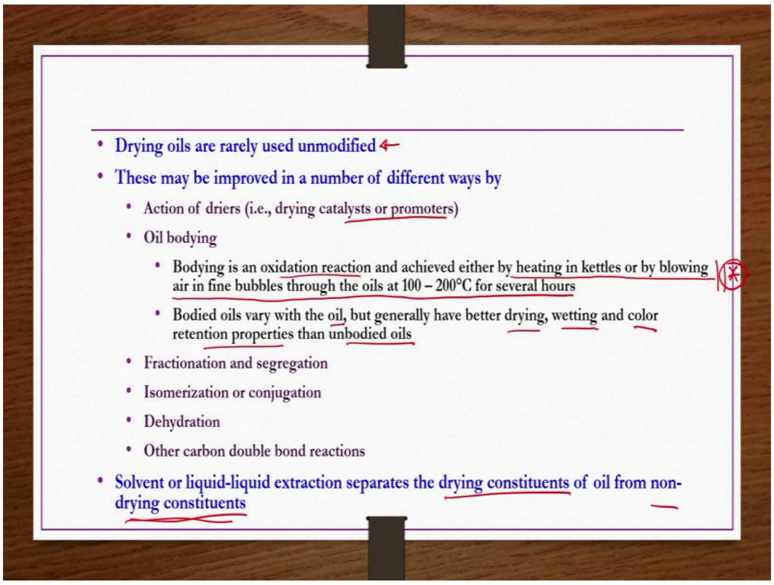

Now, drying oils are rarely used unmodified whatever the reactive oils like castor oil etcetera, linseed oil etcetera we are talking about the we are talking as drying oils. They are not used you know purely unmodified condition, they are modified by some kind of pretreatments, right. So, we have seen previous slide. If we do some kind of pretreatment of oil. So, drying oils capability will increases improves. So, what are those kind of pretreatments that we are going to see now.

These may be improved in a number of different ways by action of driers that is adding drying catalyst or promoters to these drying oils or by oil bodying. Oil bodying is an oxidation reaction and it is achieved either by heating in kettle or by blowing air in fine bubbles through the oils at 100 to 200 degree centigrade for several hours. By this way whatever the final oil that you get you know that is known as the bodied oil or the process is known as the oil bodying.

Bodied oils vary with the oil, but generally have better drying, wetting and then color retention properties than unbodied oils. So, that is the reason you know as mentioned pretreatment of oil is going to be beneficial anyway and then some of the pretreatment methods are these example like drying or action of driers, oil bodying etcetera. Then some more are fractionation and segregation, isomerization or conjugation, dehydration, other carbon double bond reactions etcetera.

So, solvent or liquid extraction separates the drying constituents of oil from non-drying constituents, right. So, oils you know as mentioned they are not pure, they are not used in a pure condition they are you know modified by different processes and while doing these things, some constituents may be soluble some may not be soluble. So, you know non-soluble or non-drying constituents are separated out by solvent or liquid – liquid extraction processes.

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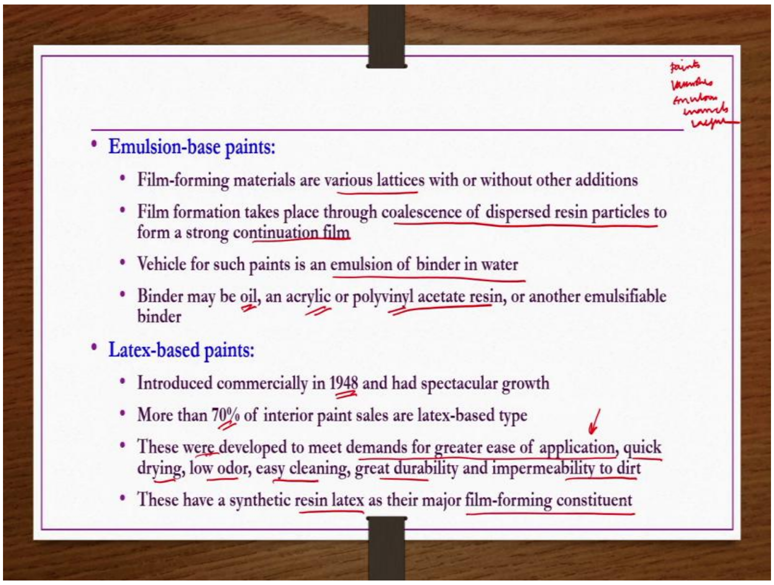

Now, what is emulsion base paints that is what we are going to see. So, now actually what as I mentioned at the beginning of this class, we are going to see a few basics about the paints, varnishes, emulsions, enamels, lacquers etcetera, right. So, we are discussing one by one. So, now we are discussing about the paints. So, then emulsion based paints we see a few basics.

Film-forming materials are various lattices with or without other additions. And, then film formation takes place through coalescence of dispersed resin particles to form a strong continuation film. And, then vehicle for such emulsion base paints is an emulsion of binder in water. Binder may be oil, an acrylic or polyvinyl acetate resin, or another emulsifiable binder.

Now, coming to the latex-based paints, it introduced economically in 1948 and had spectacular growth. More than 70 percent of interior paint sales are latex based type. These were developed to meet demands for greater ease of application. Application is also there are n number of applications about dozen type of application methodologies are there.

Application in the sense how are you applying these paints or surface coating material, right. So, depending on the you know coating whether it is architectural coating or industrial coating accordingly these application methods are different, ok. We are going to see them anyway.

There were also this latex based paints were also developed to meet quick drying requirements, low odor, easy cleaning, great durability and impermeability to dirt in addition to ease of application. These have a synthetic resin latex as their major film forming constituent.

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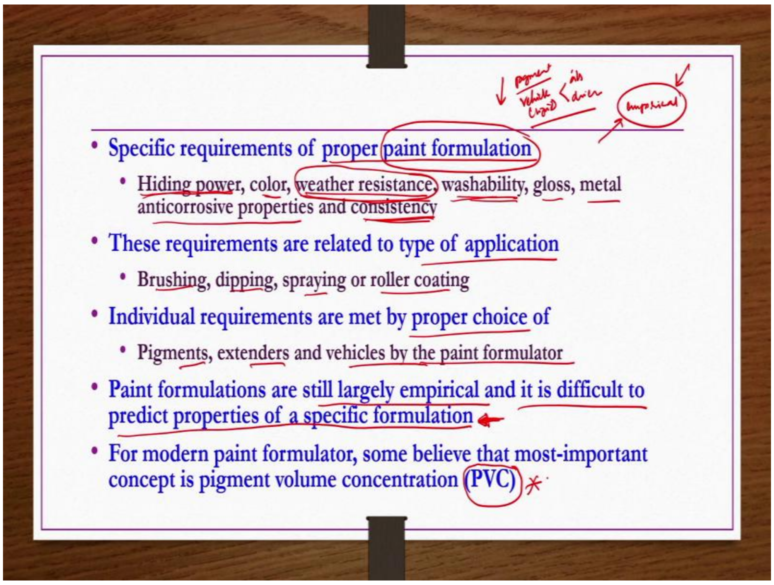

Now, we see specific requirements of proper paint formulation. Paint whatever is there you know what do you mean by paint formulation. So, what is the pigment? What is the vehicle or liquid? If at all if it is required to have oils, if at all it requires to driers what are they? How much percentage should be there?

All those things you know you need to have a priori information as a you know train engineer you prefer to have so that you do not want to do experiment each and every time that is the reason in general, we develop the equations. However, unfortunately paint formulation is still empirical.

There are no standard ways of defining or doing the calculation to get the number of these numbers that is you know weight percent of pigment or weight percent of the liquid etcetera. These kind of things you know that is you know how much weight percent of the liquid or how much weight percent of the you know pigment has to be supplied so that to make a proper paint or to have a final paint formulation.

Such kind of relations are not developed based on fundamental requirement fundamental aspects of the engineering. So, most of them are a kind of empirical only. Empirical in the sense you try to do experiments, right and then you try to analyze the results and then you come to a final picture. Let us say if you wanted to have these requirements of A, B, C, D etcetera. This kind of pigment is required and this much of volume percent or weight percent of pigment is required.

This percent of liquid is required, this much percentage of driers or additives are required that kind of you know empirical you know the relations you develop for yourself. So, that is what empirical formulation. So, most of the paint formulations till date are empirical there are no fundamental ways to have a proper paint formulations ok most of them are empirical.

So, specific requirements of this paint that has been formulated if you see first is hiding power you know you are applying different color paint so that you know the background, the original color or structure of the material that should not appear otherwise there is no point of applying this paint. So, they should have a proper hiding power.

Color should be pleasing; aesthetic appeal should be there. Most importantly weather resistance, beauty and then attractiveness or later on. All the surface coating products are developed to improve weather resistance of the products or you know structures. This is very essential washability once you applied paint it should not be there for the life. You after a year or so you may wanted to apply the different one. So, then there should be easy washable glossy.

And, then metal anti-corrosive property should also be there and there should be consistency. Let us say you take a paint and apply that paint on a vertical structure after a month same paint if you take and then you apply on a similar vertical structure you should have a similar kind of appearance. Exactly the same one is better, but more or less similar appearance that should be giving right. So, that is the consistency is required, ok. Then only you can say that the paint formulation is successful.

Other requirements are these requirements are related to type of application what type of application for which you are using these you know paints etcetera you know that also matters like whether are you doing brushing, dipping, spraying or roller coating or fluidized bed coating, different types of you know coatings are there or electro-beam coating etcetera are there. So, all those things we are going to study in the subsequent lectures of this chapter anyway, ok.

Then individual requirements are met by proper choice of pigments, extenders and vehicles by the paint formulator as well, ok. Paint formulations are still largely empirical and it is difficult to predict properties of a specific formulation a priori because of the reasons that I mentioned, ok.

For modern paint formulator many believe that most important concept is PVC that is pigment volume concentration. How it is, how to get it – those things we are going to see now.

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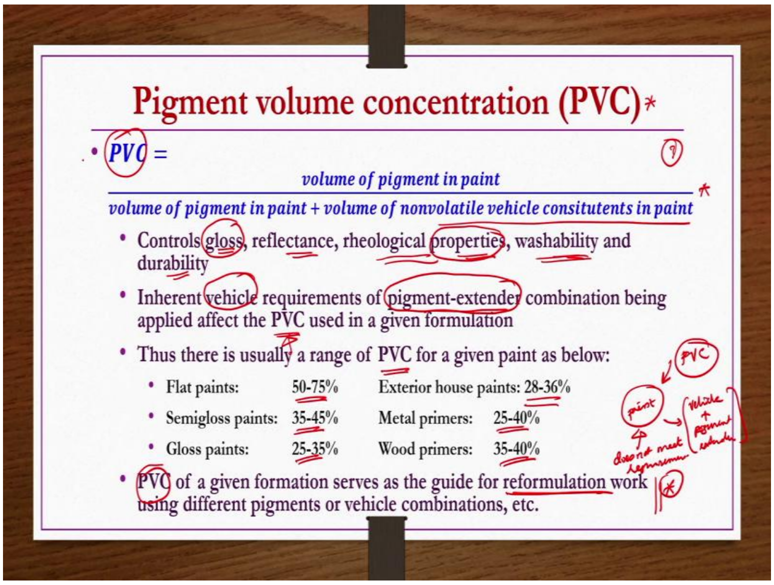

Pigment volume concentration it is nothing, but you know by the terminology if you see it is nothing but the ratio between the volume of the pigment divided by the volume of the pigment plus volume of the vehicle, because in a paint you have only two things pigment and then vehicle. In the vehicle there are other constituents there that is a different things or sometimes driers may be there in 1 or 2 percent, right.

So, basically pigment volume concentration you can see volume percentage of you know pigment that is present in a final paint formulated, ok. PVC is nothing but volume of pigment in paint divided by the volume of pigment in paint plus volume of non-volatile vehicle constituents in paint. This is the definition of PVC.

What is the purpose of having this number? Actually, from this equation you can see that it gives a number some kind of numbers that is in some volume percents, right. It controls gloss, reflectance, rheological properties, washability and durability. Let us say you wanted to have a glossy structure or semi-glossy structure. So, how much PVC should be there in a given paint formulated that kind of information you can have.

Let us say you wanted to have a control over rheological property properties whether should it be highly shear thinning or moderately shear thinning or Newtonian or you know any other kind of rheological properties as per your requirement. So, then what should be the PVC of that given you know paint in order to meet these kind of requirements.

So, it gives a kind of you know idea if you wanted to have a glossy you know if you wanted to have a glossy paint formulation, so, then what should be PVC? If you wanted to have a paint which should be easily washable then what should be the PVC that kind of a priori information you can have. These informations are you know empirical only.

Inherent vehicle requirements of pigment-extender combination being applied will affect the PVC used in a given formulation. So, what is the vehicle requirement? What is the pigment extender combination? All these also you know have a role on final PVC calculations, ok.

Thus, there is a usually a range of PVC for a given paint as below because vehicle pigment extenders their composition you know changes it. It is not going to be you know fixed one for a given kind of paint formulated, right. So, that is the reason because of these combinations you know there is a range for PVC.

For example, flat paints 50 to 75 percent PVC; exterior house paints 28 to 36 percent PVC; semi-gloss paints 35 to 45 percent PVC; metal primers 25 to 40 percent PVC; gloss paints 25 to 35 percent PVC; wood primers 35 to 40 percent PVC are expected to be there.

PVC of a given formulation serves as the guide for reformulation work using different pigment or vehicle combinations etcetera. What does it mean by let us say you started with some kind of vehicle, and then pigment and extenders, additives etcetera and then you made a paint. Paint is being formulated.

But, if this paint does not meet requirements of the consumer or customer, then what you do? you try to you know reuse it rather throwing it because you are not producing them in a few kgs you may be producing in tons one particular given type of paint formulation you are producing in tons. So, you cannot throw them.

So, then this PVC of this formulated paint is available. If the PVC of this formulated paint is available that information may be used for the reformation or reformulation of the paint. You can make if you have this PVC information you make certain kind of corrections and then improve the paint formulation subsequently rather throwing them. For that purpose, also this PVC is very much useful, ok.

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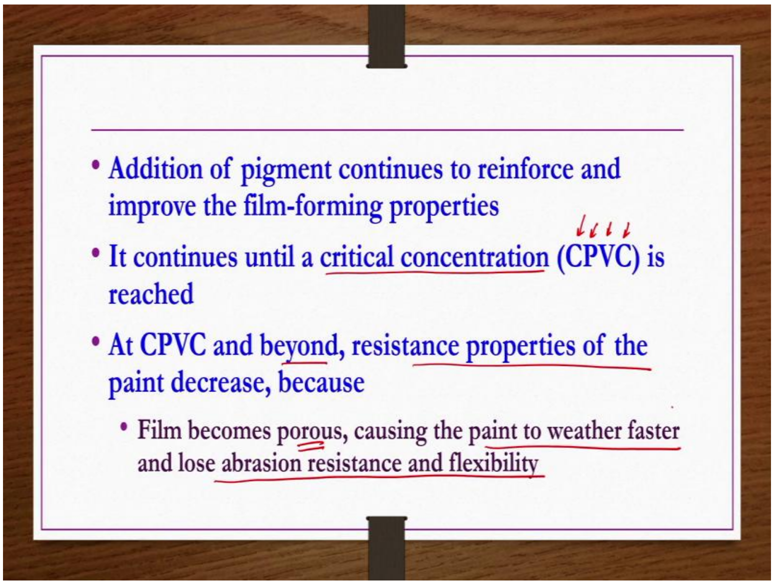

Addition of pigment continues to reinforce and improve the film-forming properties. In general, that we understand anyway, but it continues until a critical concentration only critical pigment volume concentration only, ok. After that what happens? At this critical pigment volume concentration or beyond resistant properties of the paint decreases. Why?

Because film becomes porous or causing the paint to weather faster and lose abrasion resistance and flexibility because of these reasons one should not go beyond this CPVC, ok. So, in the next lecture we will be discussing about the paint to manufacture and then other aspects of surface coating industries like pigment manufacturing etcetera those kind of things we are going to discuss in the next lecture, ok.

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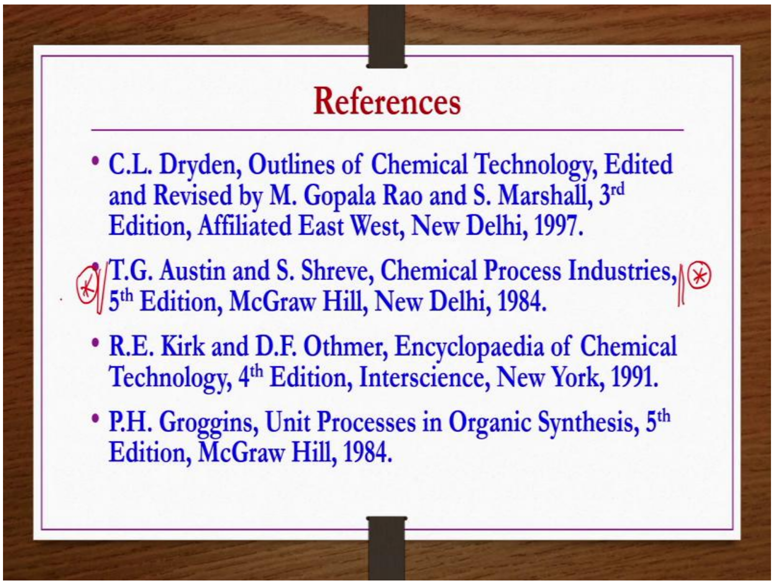

The references for today's lecture are provided here. Outlines of Chemical Technology by Dryden, edited and revised by Gopala Rao and Marshall, 3rd Edition. Then, Chemical Process Industries by Austin and Shreve, 5th Edition. Then Encyclopaedia of Chemical Technology by Kirk and Othmer, 4th Edition and then Unit Processes in Organic Synthesis by Groggins, 5th Edition.

But the lecture notes that has been prepared for today's lecture is prepared from this reference book, Chemical Process Industries by Austin and Shreve.

Thank you.