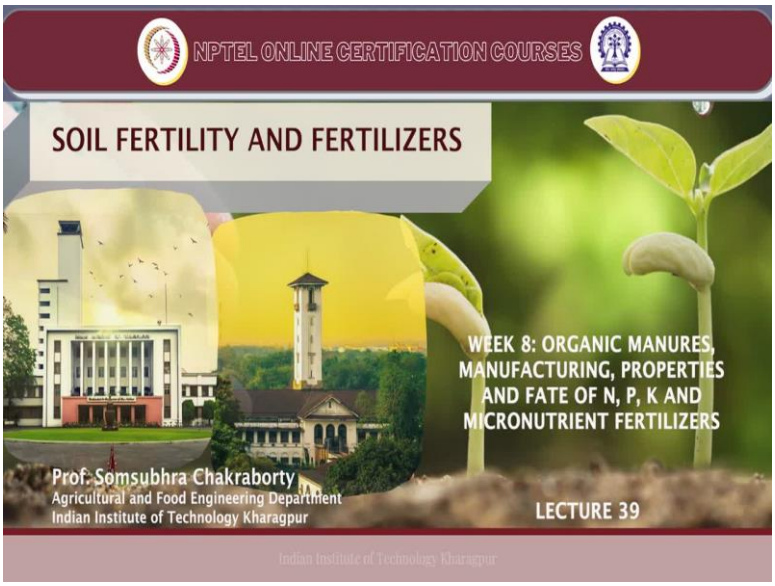
Soil Fertility and Fertilizers
Professor Somsubhra Chakraborty
Agricultural and Food Engineering Department
Indian Institute of Technology, Kharagpur
Lecture: 39
Organic Manures, Manufacturing, Properties, and Fate of N, P, K and Micronutrient Fertilizers (Contd.)

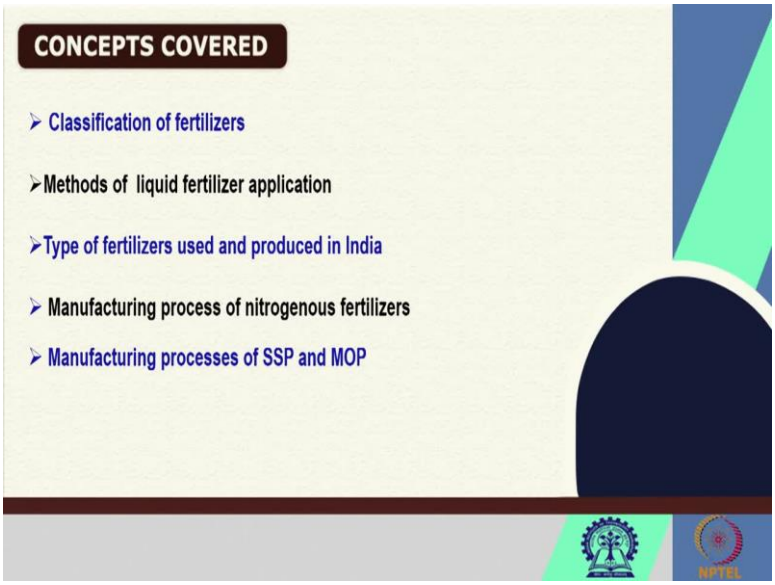
(Refer Slide Time: 0:21)



Welcome friends to this 4th lecture of week 8 of NPTEL, online certification course of Soil Fertility and Fertilizers. In this week, we are discussing about organic manures, manufacturing properties and fate of N, P, K and micronutrient fertilizers. In our previous lectures of this week, we have discussed in details about different types of manures.

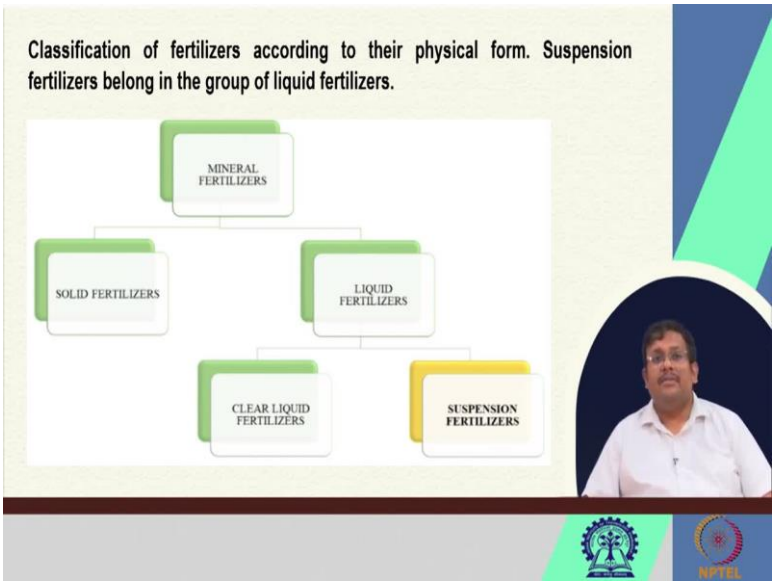
And we have discussed about how to preserve and how to maintain the quality of those manures, what are the fates of the nutrients from those manure during the decomposition, and also, we have seen the basic classification of chemical fertilizers. And we have also discussed about some of the important concepts in fertilizers like fertilizer conditioner, fillers, fertilizer ratio, fertilizer grade, et cetera.

(Refer Slide Time: 1:34)



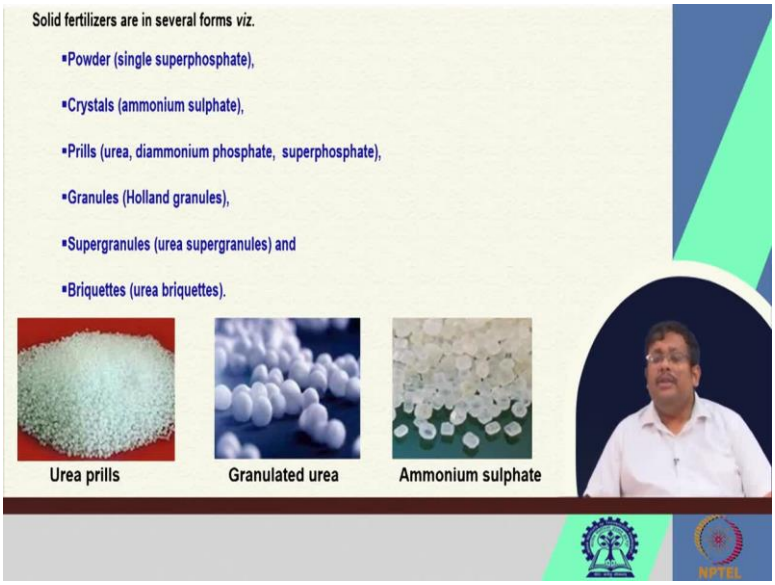
Now, in this lecture, we are going to discuss about the fertilizer manufacturing process of different chemical fertilizers. And these are the following these are the concepts which we are going to discuss in this lecture. First of all, we are going to discuss the classification of fertilizers. And then we are going to discuss the methods of liquid fertilizer application. We are also going to discuss the type of fertilizer used and produced in India. Then manufacturing process of nitrogenous fertilizers and manufacturing process of SSP single super phosphate and Muriate potassium. So, in this lecture, we are going to mainly focused on the chemical fertilizer their application and their manufacturing.

(Refer Slide Time: 2:18)



So, these are some of the keywords which we are going to discuss in this lecture solid fertilizer, liquid fertilizer, fertilizer mixtures, urea, SSP. So, if we consider the classification of the mineral fertilizer according to their physical form, we can classify them into solid fertilizer as well as liquid fertilizers. Now, the liquid fertilizers can be further divided into clear liquid fertilizers and suspension fertilizers. Now, this suspension fertilizers belong in the group of liquid fertilizers.

(Refer Slide Time: 3:07)

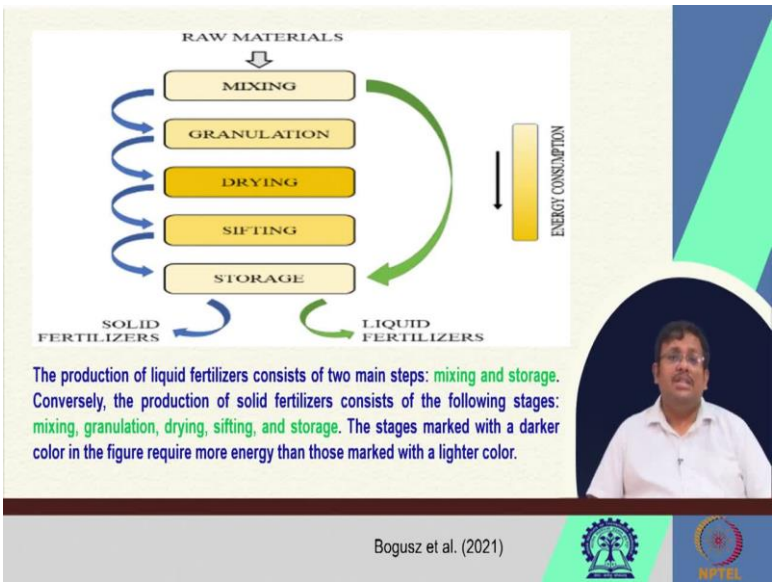


So, if we consider the solid fertilizers, solid fertilizers can be produced in several forms. For example, in the powder form, for example, single super phosphate, crystal, crystalline form like ammonium sulfate, in prills like urea, diammonium phosphate or DAP and super

phosphate or single super phosphate. So, single super phosphate can be produced both in powder form or in pills form.

Also we can see the Holland granules form in the granular form. And then we are going to see that urea super granules and also the urea briquettes. So, you can see from powder to crystals to pills to granules to super granules and decayed. So, there are several forms available in the market for the solid fertilizers.

(Refer Slide Time: 4:11)



Now, the production of these solid fertilizers and liquid fertilizer can be summarized in this following flowchart. So, you can see the production of liquid fertilizer consists of 2 major steps one is mixing and that is storage. Now, conversely, the production of solid fertilizers consists of the following stages like granulation like mixing then granulation then drying, then sifting and finally, storage.

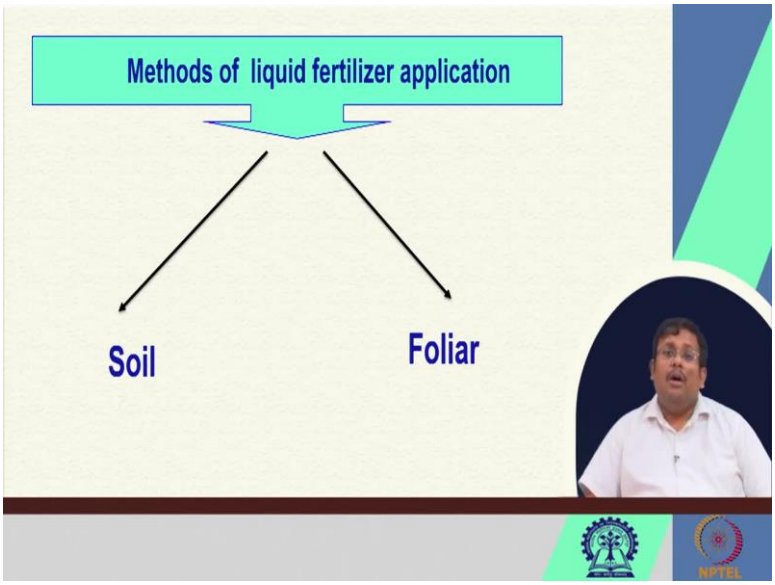
So, this stage is here among the stages you can see drying, sifting are marked with a darker color to imply that these steps are the require more energy than those which are marked with a lighter color. So, we can see that they are drying, sifting and to some extent granulation requires more energy than mixing and storage. So, these are the major steps for production of solid fertilizers and liquid fertilizer from the raw materials.

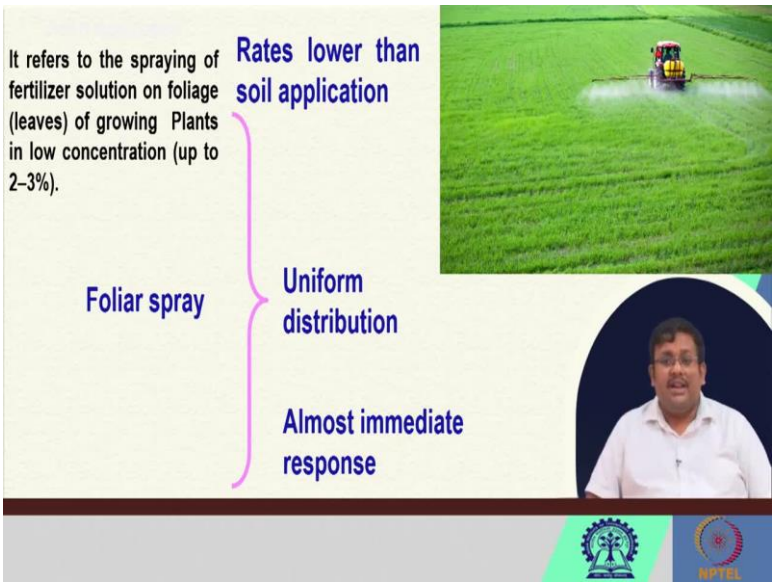
(Refer Slide Time: 5:28)

Now, if we consider the suspension fertilizer, which is a form of liquid fertilizer, there are different types of advantages of suspension fertilizers, what are these first of all the application accuracy that means, it gives the better efficiency, the suspension fertilizers. Secondly, these liquid forms of the suspension fertilizer ensures better digestibility third important aspect of this suspension fertilizer is it produce it does not produce any waste during the production.

So, it is waste free production, also suspension fertilizer when you prepare the suspension fertilizer, these are made of wastes. So, ultimately the production of suspension fertilizer limits the extraction of natural resources. And secondly, the production of suspension fertilizer produce less waste in landfills. So, since the production of the suspension fertilizer use the waste. So, ultimately it reduces the waste in the landfill.

(Refer Slide Time: 6:47)



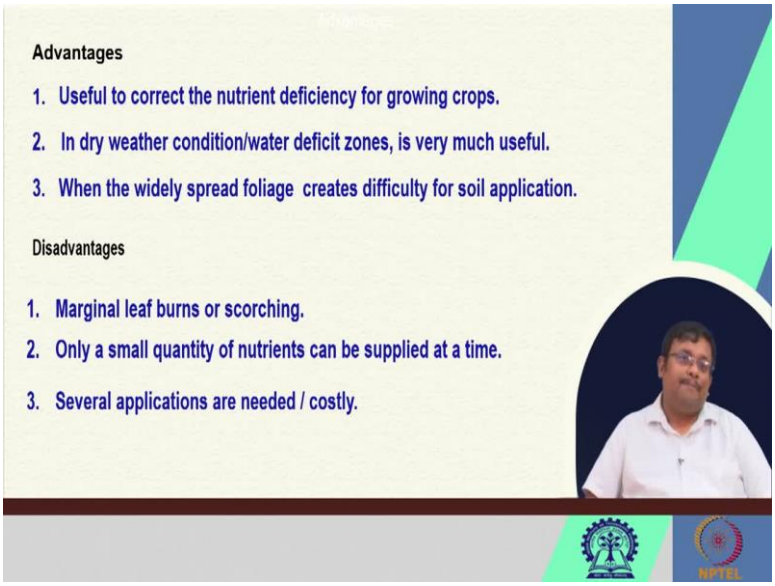


Now, if we consider the fertilizer application or methods of fertilizer application, these are of 2 types one is soil application and that is foliar application. So, soil application or foliar application. Now, what is foliar application? Foliar application or Foliar Spray refers to the spraying of fertilizer solution on foliage or leaves of growing plants in low concentration up to 2 to 3 percentage.

Now, this Foliar Spray ensures uniform distribution, the folly and the rates of the foliar spray is lower than the soil application and the most important aspect of foliar sprays it provides immediate response almost immediate response since we are applying directly in the crops. So, this is called a foliar spray. However, when we apply the foliar spray, we cannot apply in

high concentration otherwise that will damage the leaves. So, we apply the foliar spray to the up to the concentration of 2 to 3 percentage.

(Refer Slide Time: 8:06)



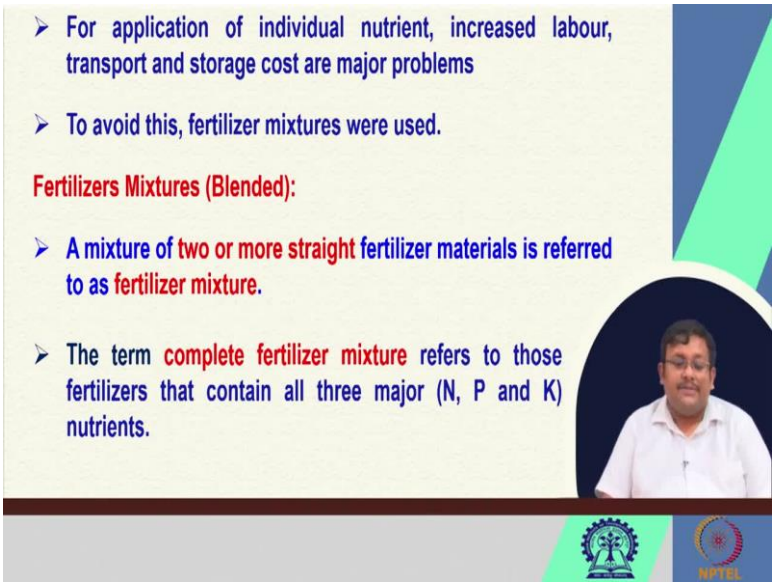
Now, what are the advantages and disadvantages of foliar application? First of all, the foliar application is useful to correct the nutrient deficiency for growing crops because it gives the immediate response almost immediate response. So, it useful to correct the deficiency of the growing crops. Secondly, in dry weather condition or what a deficient zone is very much useful. And thirdly, when the widely spread foliage are there in the field that can create the difficulties for soil application and as a result, we go for the foliar application from the operational simplicity point of view also.

So, these are the advantages of foliar application. However, there are several disadvantages also first of all, marginal leaf burns or scorching as I have mentioned if we increase the concentration of the nutrients in the foliar application that can create leaf burns or scorching. Secondly, only a small quantity of the nutrients can be supplied at a time. Thirdly, we required several applications and as a result, the foliar application can be costly sometime. So, these are the disadvantages of foliar application.

(Refer Slide Time: 9:32)

Now, the chemical fertilizers can be classified into 3 categories. We already know that that straight fertilizer, complex fertilizer and fertilizer mixtures. Now these mixtures of fertilizer can be also seen in either powdery form or granulated mixtures. As you can see here, these 2 are straight fertilizer like urea is a straight fertilizer this is also ammonium sulfide which is a straight fertilizer. However, here it is a mixed fertilizer, which has the grade of 15 15 15. So, sorry 15 15 7.5.

(Refer Slide Time: 10:19)



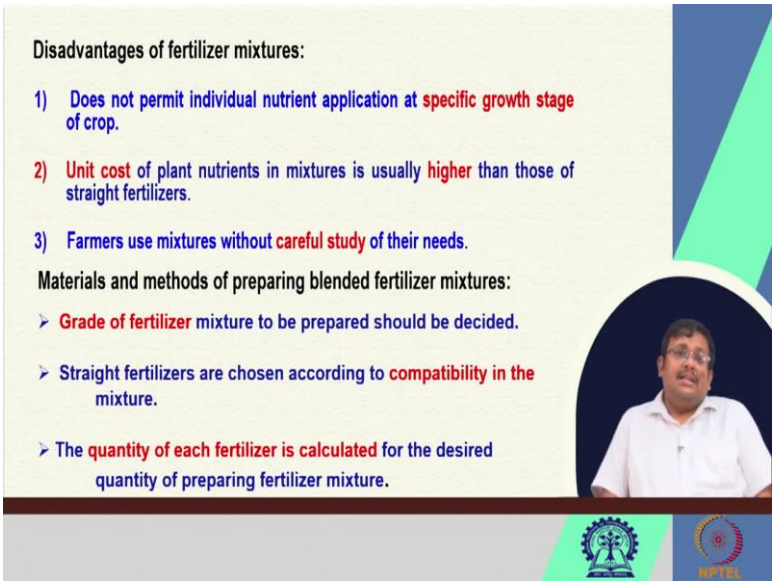
So, these are the classification of chemical fertilizers, one of the major drawback of application of straight fertilizer is straight fertilizer can supply only one nutrient at a time. So, for the application of individual nutrient will require increased labor in transport cost and

storage cost. So, these are the problems of application of straight fertilizer. So, to avoid these generally we apply fertilizer mixtures, fertilizer mixtures also known as blended fertilizers. So, a mixture of 2 or more straight fertilizer material is referred to as fertilizer mixture. So, the term complete fertilizer mixture refers to those fertilizers that contain all 3 major nutrients like N, P and K.

(Refer Slide Time: 11:09)

What are the advantages of fertilizer mixtures, first of all less labor is required to apply a mixture then to apply its components separately. Secondly, use a fertilizer mixture leaves to balance manuring. Thirdly, the residual acidity of fertilizer can be effectively controlled by using the proper quantity of lime in the fertilizer mixture. Micronutrients can be incorporated in fertilizer mixture and finally, mixture has better physical condition. So, these are the advantages of fertilizer mixtures.

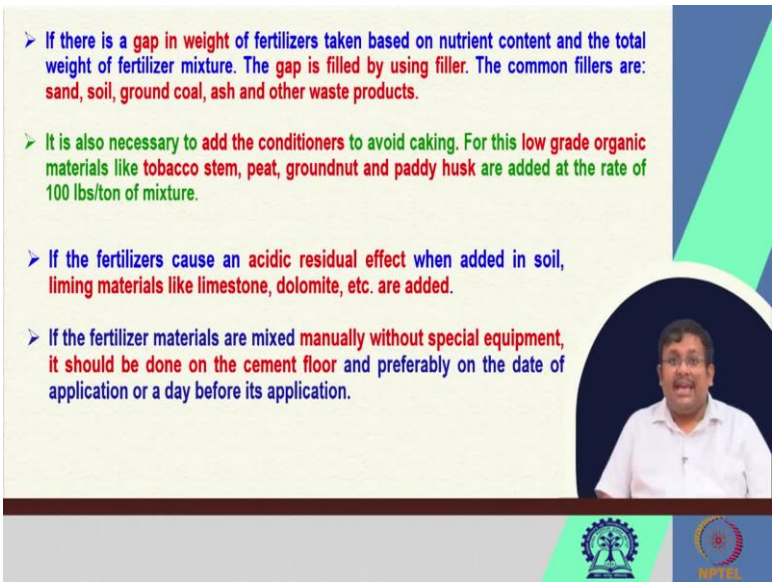
(Refer Slide Time: 11:52)



At the same time, there are several disadvantages of fertilizer mixture first of all, fertilizer mixtures does not permit individual Nutrient Application at specific growth stage of crop, unit cost of plant nutrients in mixtures is usually higher than those of straight fertilizers and farmers use mixture without careful study of their needs.

So, what are the materials and methods of preparing blended fertilizer mixtures? So, grade of fertilizer mixture to be prepared should be decided first. Secondly, straight fertilizers are choosing according to compatibility in the mixture. And third the quantity of each fertilizer is calculated for the desired quantity of preparing fertilizer mixture.

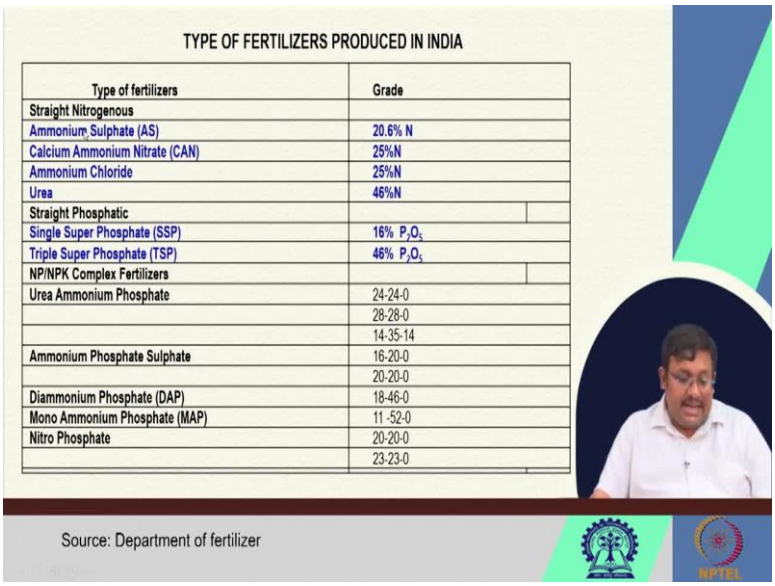
(Refer Slide Time: 12:51)



Now, if there is a gap in weight of fertilizer taken based on nutrient content and the total weight of the fertilizer mixtures the gap is generally filled by using filler, what is filler? We have already discussed. So, the common filler material sand, soil, ground coal, ash and other waste products, it is also necessary to add the conditioners to avoid that caking that means clumping of the fertilizer that is called caking.

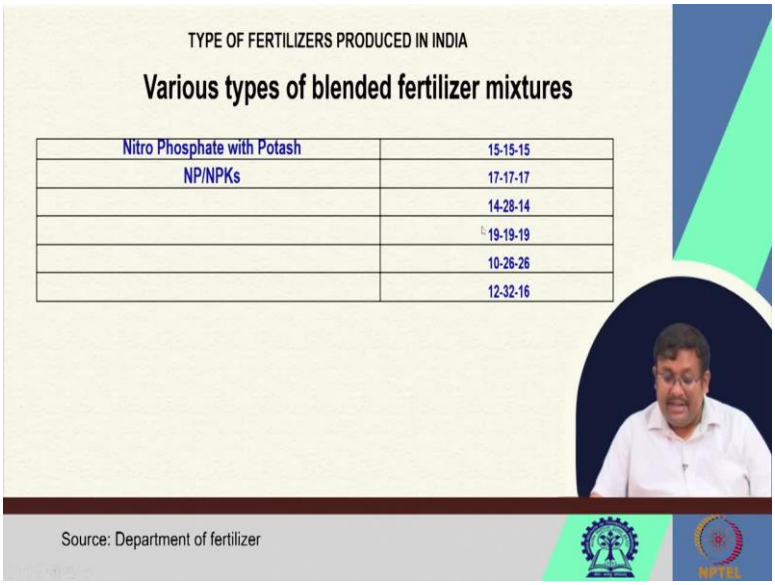
So, for these low grade organic materials like tobacco stem, peat groundnut and paddy husk are added at the rate of 100 pound per ton of mixture. Now, if the fertilizer cause and a fertilizer cause an acidic residual effect, when added in soil lining materials like limestone, dolomite et cetera are added if the fertilizer materials are mixed manually without special equipment, it should be done on the cement floor and preferably on the date of application or a day before its application. So, these are the steps for preparation of fertilizer mixtures.

(Refer Slide Time: 14:15)



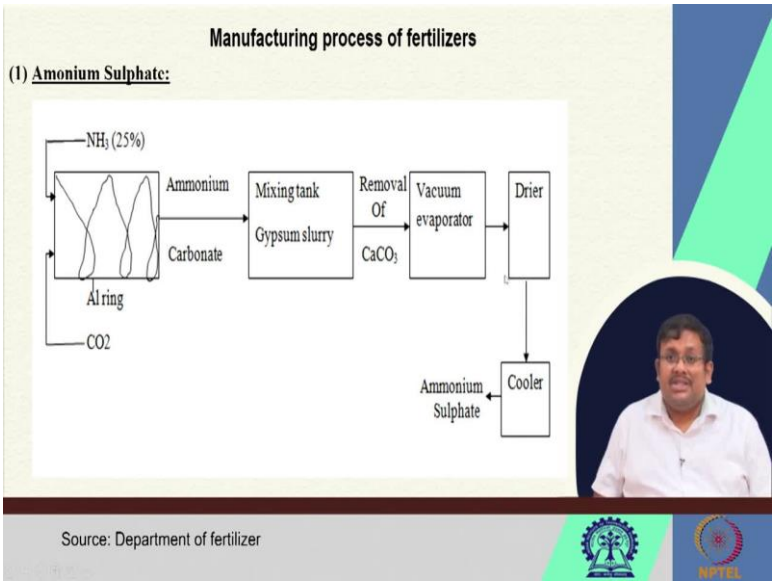
Now, let us see the type of fertilizer produced in India we can see the state fertilizers some examples are given like ammonium sulfate contains 20.6 percent Nitrogen, calcium ammonium nitrate can contain 25 percent Nitrogen, ammonium chloride contains 25 percent Nitrogen, urea contain 46 percent Nitrogen, straight phosphatic fertilizers like single super phosphate contain 16 percent P2O5, triple super phosphate content 46 percent P2O5, NPK complex fertilizers like urea ammonium phosphate contain these grades like 24 25 0, then 28 28 0, then 14 35 14 then ammonium phosphate sulfate has 2 grades like 16 20 0, 20 20 0 Diammonium phosphate it is a complex fertilizer contains 18 46 0, mono ammonium phosphate grade 11 52 0, then nitro phosphate has the grade of 20 20 0 and 23 23 0.

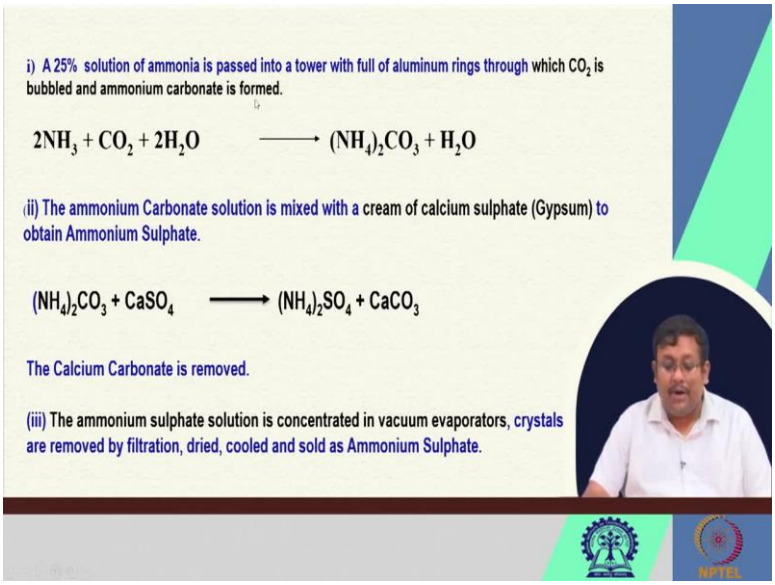
(Refer Slide Time: 15:20)



Various types are blended or mixed fertilizers, we can see here 17 17, so, nitro phosphate with potash 15 15 15. Different NPK fertilizers are 17 17 17 then 14 28 14, 19 19 19, 10 26 26 and 12 32 16. So, these are different fertilizer mixtures or mixed fertilizers available in Indian market.

(Refer Slide Time: 15:52)





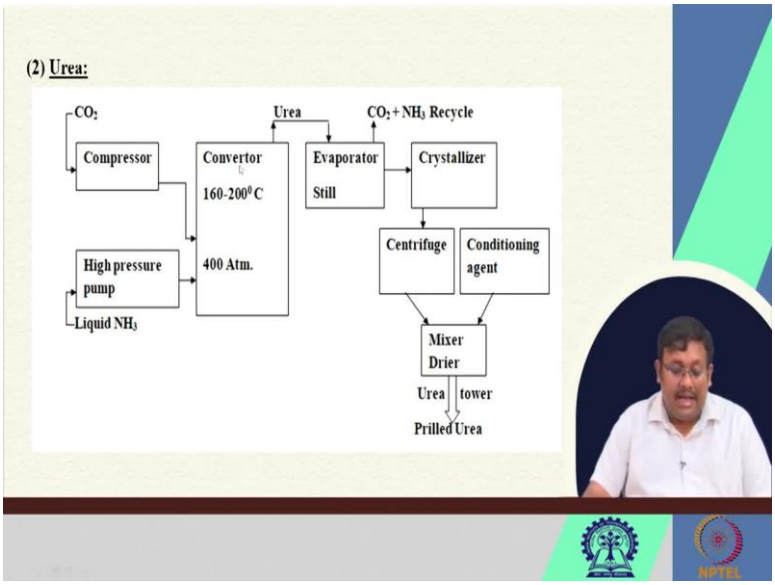
Now, let us see the manufacturing process of different fertilizers. So, let us first focus on ammonium sulfate which is a straight nitrogenous fertilizer. So, this is the ammonium sulfate process and let us discuss. So, a 25 percent solution of ammonia is passed into a tower with full of aluminium ring through which carbon dioxide is bubbled and ammonium carbonate is formed.

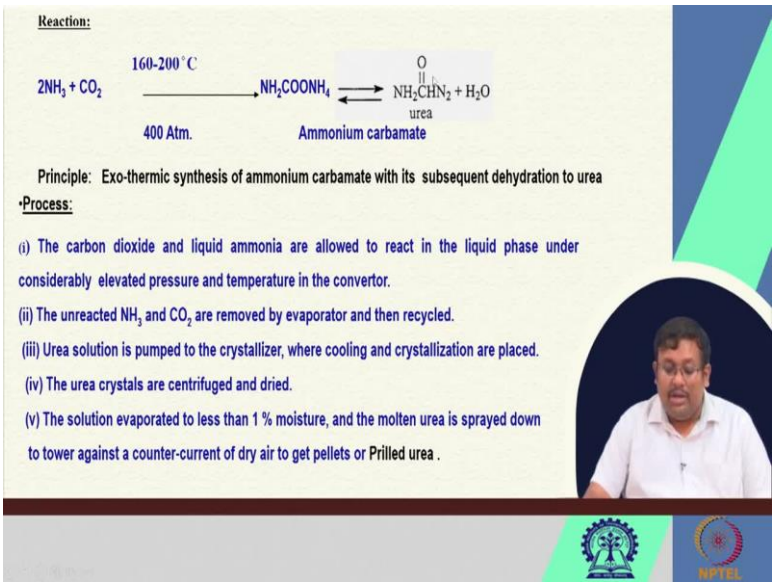
So, here ammonium is injected in this tower where carbon dioxide is bubbled through this aluminium ring and ultimately this ammonium and carbon dioxide reacts to form the ammonium carbonate, the reaction is here. So, there is ammonium plus carbon dioxide plus water produced the ammonium carbonate plus water.

In the second stage the ammonium carbonate solution is mixed with a cream of calcium sulfate or Gypsum to obtain ammonium sulfate. So, here you can see in the mixing tank these ammonium carbonate is mixed with the gypsum slurry to produce these ammonium sulfate. So, these ammonium carbonate plus calcium sulfate produced ammonium sulfate plus calcium carbonate. So, this calcium carbonate is removed.

So, we can remove these calcium carbonate and subsequently in the vacuum evaporator and these materials is transferred to the vacuum evaporator and then dry it to cooler to produce the solid ammonium sulfate. So, we can see that the ammonium sulfate solution is concentrated in the vacuum evaporator and crystals are removed by filtration dried and cooled and sold as ammonium sulfate. So, this is how ammonium sulfate is being manufactured.

(Refer Slide Time: 17:34)





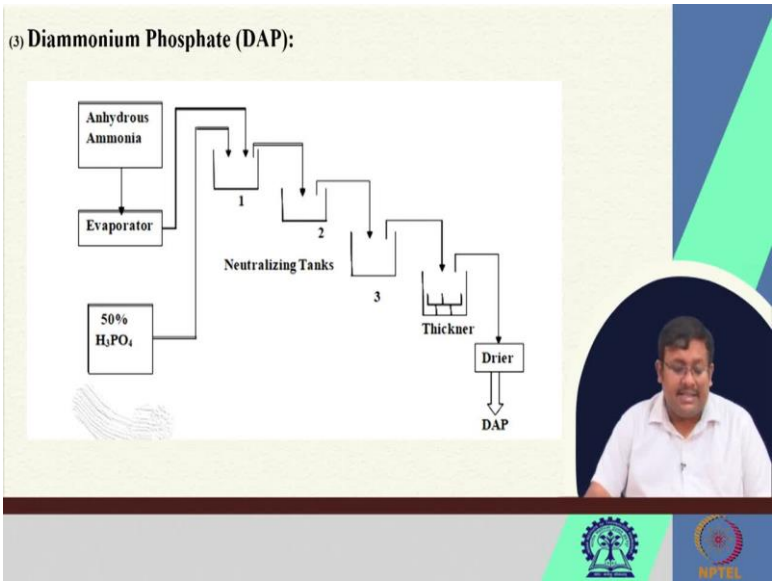
Next important nitrogenous fertilizer is urea. So, in the converted we first compress the carbon dioxide and liquid ammonium in high pressure with 400 atmosphere and with the high temperature 160 to 200 degrees centigrade ultimately urea is form and then we produce, it goes to the evaporator and then crystallizer and (())(18:04) to centrifuges and ultimately to mixer dryer. So, ultimately produce the prilled urea. Let us see the process.

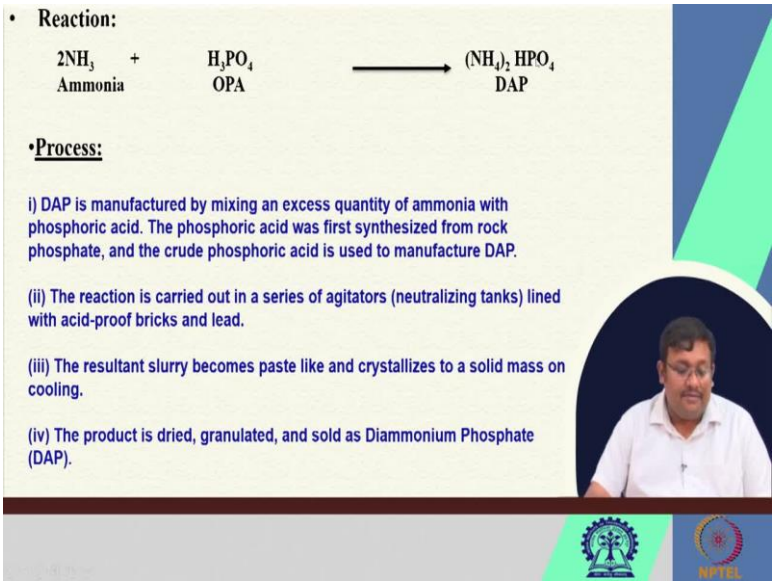
So, this is the reaction. So, firstly ammonia plus carbon dioxide which produce the ammonium carbamate and this ammonium carbamate will dissociate to form these urea and water molecule. So, this is an exothermic synthesis and you can see this ammonium carbonate is dehydrated to form the urea. What is the process? So, the carbon dioxide and liquid ammonia are allowed to react in the liquid phase under considerably elevated pressure

and temperature in the converter we know that so, they are they are mixed in the converted to react to form the urea and the unreacted ammonia and carbon dioxide removed by evaporated and then recycled.

So, the unreacted ammonia and carbon dioxide are evaporated are extracted by these evaporated and then they will be recycled and the urea solution is pumped into the crystallizer where cooling and crystallization are placed and the urea crystals are centrifuge and dried. So, you can see we can we can send this mixture urea into the crystallizes and then centrifuge where they will be crystallized and cooled and then the solution evaporated to less than 1 percent moisture and the molten urea is sprayed down to tower against a counter current of dry air to get the pellets. So, ultimately they will go to the dryer and ultimately they will be sprayed into the counter current of air in a tower to produce the prilled urea. So, this is the urea manufacturing process.

(Refer Slide Time: 19:55)



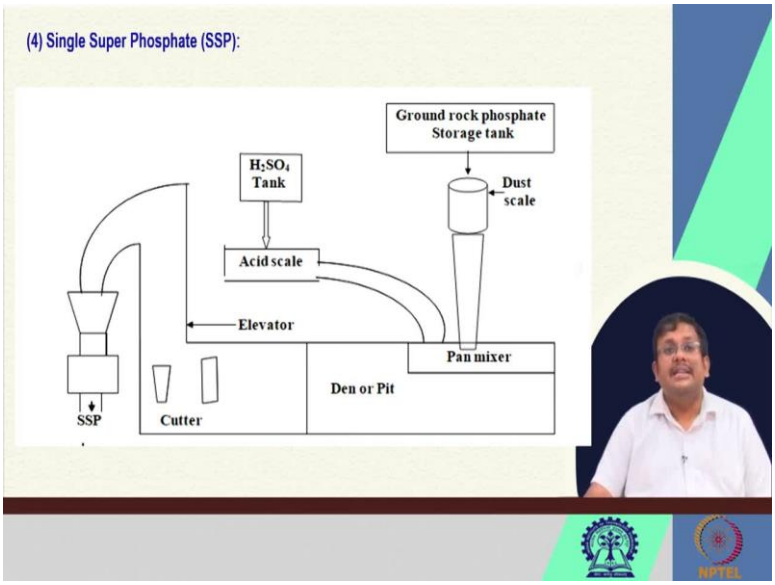


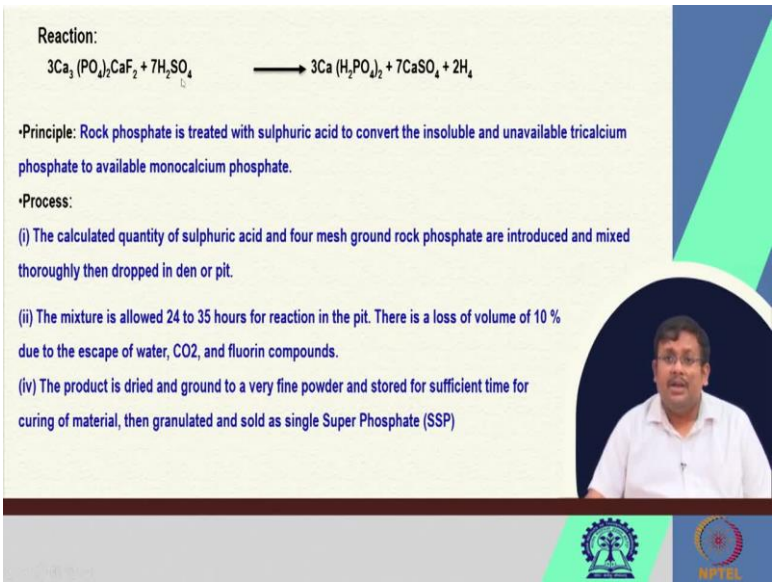
Third important fertilizer that is phosphate fertilizer is DAP or diammonium phosphate in the diammonium phosphate basically in the evaporator we mix these anhydrous ammonia and orthophosphoric acid to produce these diammonium phosphate in series of neutralizing tanks and ultimately we produce the DAP. So, the reaction is ammonia which mix with orthophosphoric acid to produce this diammonium phosphate.

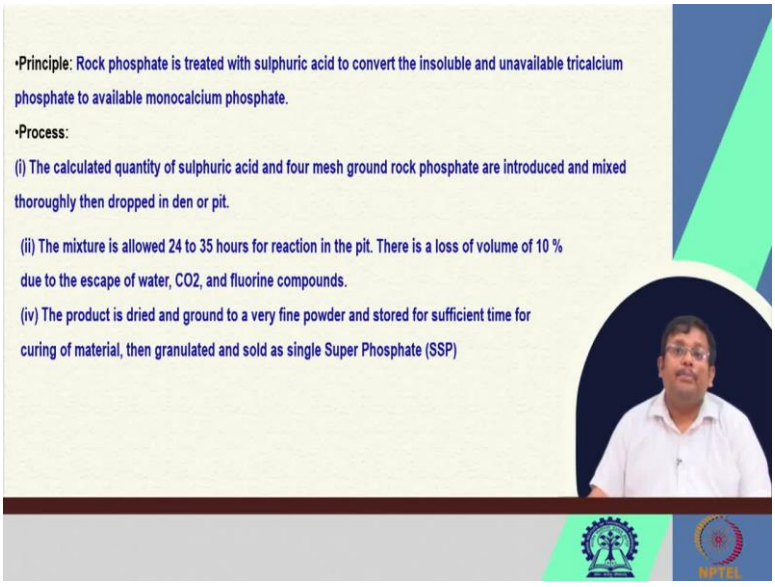
Now, the DAP is manufactured by mixing an excess quantity of ammonia with phosphoric acid. The phosphoric acid was first synthesized from the rock phosphate and then the crude phosphoric acid is used to manufacture this DAP. So, the reaction is carried out in a series of agitators or neutralizing tank as you can see, the series of agitators or neutralizing tanks lined with acid proof bricks and lead so lined with acid proof bricks and lead. So, the resultant slurry becomes paste like and crystallizes to solid mass on cooling and the produce product is dried and sold as diammonium phosphate.

So, what happens so, this reaction between the orthophosphoric acid and ammonia takes place in a series of neutralizing tanks and these resulted and a slurry is formed, which is a paste like so, and this paste is crystallizes to solid mass on cooling and then subsequently they are being dried granulated and sold as DAP fertilizer.

(Refer Slide Time: 21:35)







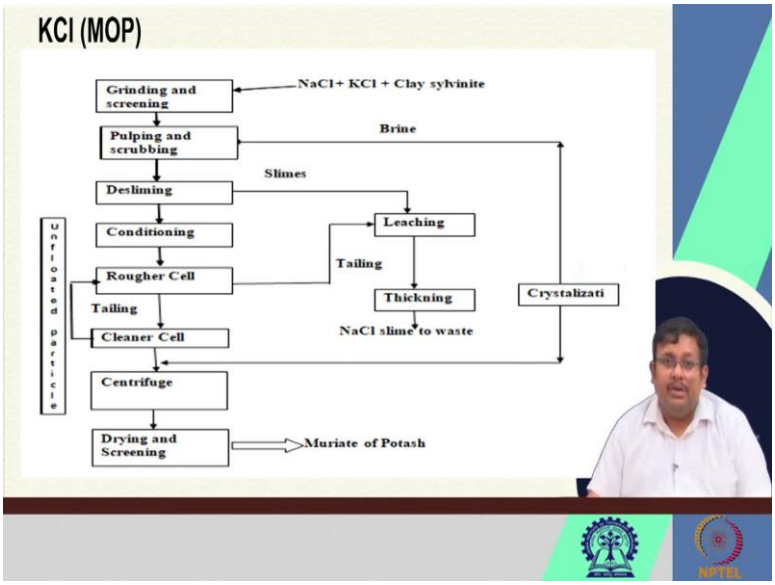
Now, the next important fertilizer, phosphoric fertilizer is single super phosphate or SSP. So in the single super phosphate this is the process. So, here we generally produce the single super phosphate from the ground rock phosphate and then it goes to the pan mixture and den or pit where it is being mixed with the sulfuric acid and then it produced the single super phosphate. Now, the process is given here.

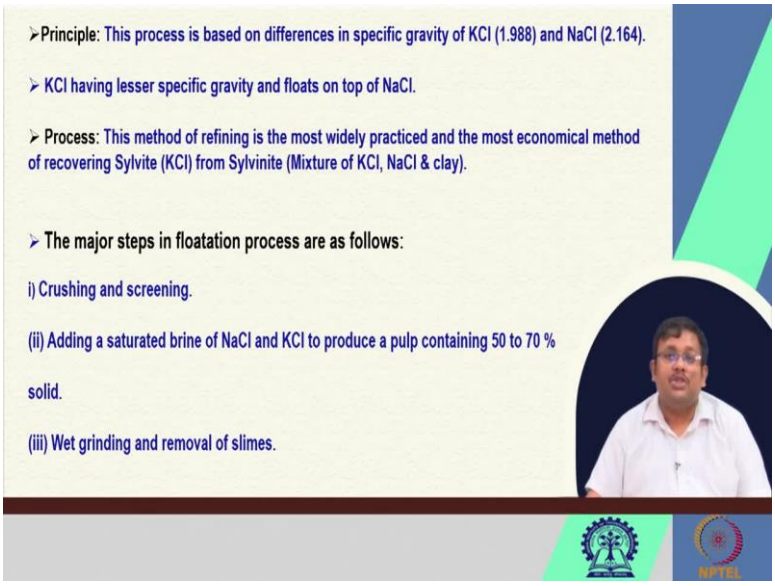
So, you can see here this is the rock phosphate, when it mixed with the sulfuric acid it produces the single super phosphate or mono calcium phosphate and so the rock phosphate is treated with sulfuric acid to convert the insoluble unavailable tri calcium phosphate to available monocalcium phosphate.

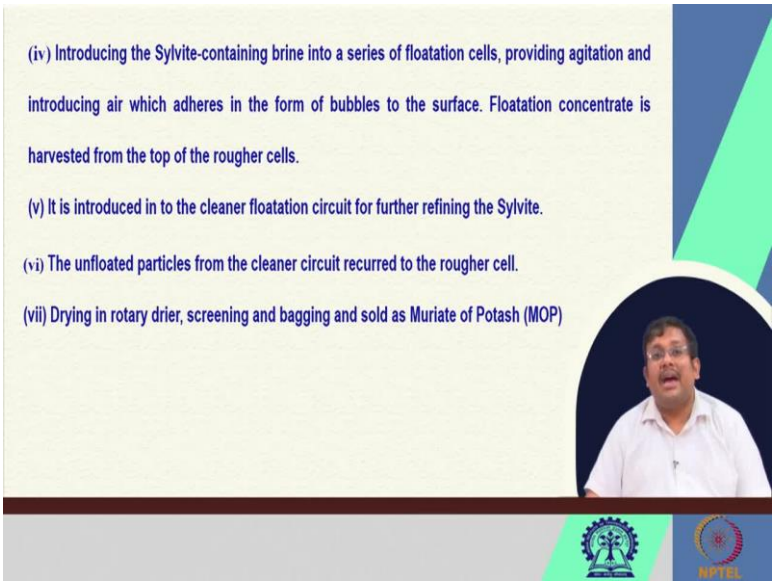
Now, the process is the calculated quantity of the sulfuric acid and 4 major ground rock phosphate and introduced and mixed to the mix thoroughly then dropped in den or pit. So we can see here these H2 SO4 tank will release the acid into this pan mixture and ultimately it go to the den and then ground rock phosphate and see rocks phosphate will form a C will go to the pan mixture and then mix with the Den or pit and then so the principle of single super phosphate formation is basically here we will react the rock phosphate with the sulfuric acid to convert into the soluble single super soluble mono calcium phosphate.

So, the rock phosphate it is a tri calcium phosphate which is insoluble and when it reacts with the sulfuric acid it produced the mono calcium phosphate or single super phosphate. So basically what happens here in this process we generally ground rock phosphate and it receive it through 4 massive and then we mix it with the H2 SO4 in a den or pit we keep it for 24 to 35 hours in this reaction pit and there will be a loss of volume of 10 percent due to the escape of water, carbon dioxide and fluorine compounds and the product is dried and ground to a very fine powder and stored for sufficient time for curing of material and then granulated and sold as single super phosphate. So, this is how single super phosphate is being formed.

(Refer Slide Time: 24:22)







And finally, this is Muriate of potash or as the name suggests, it is basically potassium chloride and this is the process of formation or manufacturing of these Muriate of potash or potassium chloride. So, the process is described in the next slide. So, the process is based on the differences in specific gravity of potassium chloride and sodium chloride. Sodium chloride has a specific gravity of 2.16 whereas the potassium chloride has a specific gravity of 1.98 so KCL having lesser specific gravity and floats on the top of sodium chloride.

So, in in this process the method of refining is the most widely practiced and the most economical method of recovering silver aid from the sylvite from the sylvinite which is basically mixture of KCL sodium chloride and clay. So basically, we extract or recovered the sylvite or KCL from the sylvinite which is basically mixture of KCL, sodium chloride and clay.

So, what are the major steps in this process first of all crushing and screening and then adding a saturated brine of sodium chloride and potassium chloride to produce a pulp containing 50 to 70 percent solid and wet grinding and removal of the slime. So, you can see here first of all we are grinding the sodium chloride, potassium chloride and clay that is sylvinite and then we are making it a pulp and then we are removing the slimes from this pulp and ultimately, so, this is the steps.

And the next is introducing the sylvite containing brine into series of flotation cells providing agitation and introduction of air which adheres is in the form of bubbles to the surface and flotation concentrate is harvested from the top of the referred cells. So, here as you can see this mixture is basically goes into these agitators or these flotation cells and these flotation cells will be also will add the air to form the bubbles and the bubbles and these floated materials will be harvested subsequently.

So, after harvesting, it is introduced into the cleaner flotation circuit for further refining the sylvite and the unfloated materials, unfloated particles from the cleaner circuit occurred to the rougher cell and drying in a rotary dryer screening and bagging and sold as Muriate of potash. So, you can see here these unfloated materials to those which are not floated will be again going to this rougher cell from this cleaner cell and the materials which are there in the cleaner cell will be centrifuge and drying they will be subsequently dried and screened and ultimately sold as Muriate of potash.

So, basically in this flotation process, which occurs in these cells, which we call the flotation cells, so, in this flotation cells, you can see that they the sylvite is basically recovered from the silver night mixture based on the difference of the specific gravity. Since the specific gravity of KCL is less than the specific gravity of sylvinite, it will be floated in the mixture and then it will be easily separated or recovered from this mixture and then it will undergo drying process and the screening process and bagging and finally, it will be sold as Muriate of potash.

(Refer Slide Time: 28:40)

So, guys, this makes the end of this lecture. Let us wrap up this lecture and we will start from here in the next lecture. And we will do we will see more about these fertilizer calculations and other important aspects of chemical fertilizer in our next lecture. So, thank you let us meet in our next lecture.