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**Lecture - 51**
# Design of Threshing Equipment

Welcome students to my lecture number 51 which talks of Design of Threshing Equipment; as I said my in my previous lecture that we will talk of the design of such an equipment in my different next lecture. So, this is the one where we will talk of the design of threshing equipment. What is there in the design as such you have seen what a threshing equipment is, what are the principles on which threshing takes place, what are the essential components in which through which the crop has to move and what should be their dimensions, what should be the power requirement, what should be the speed at which it is should be depending upon the type of the crop. These are the things which we need to design. So, let us have a look at what we have for you about designing of threshing equipment.

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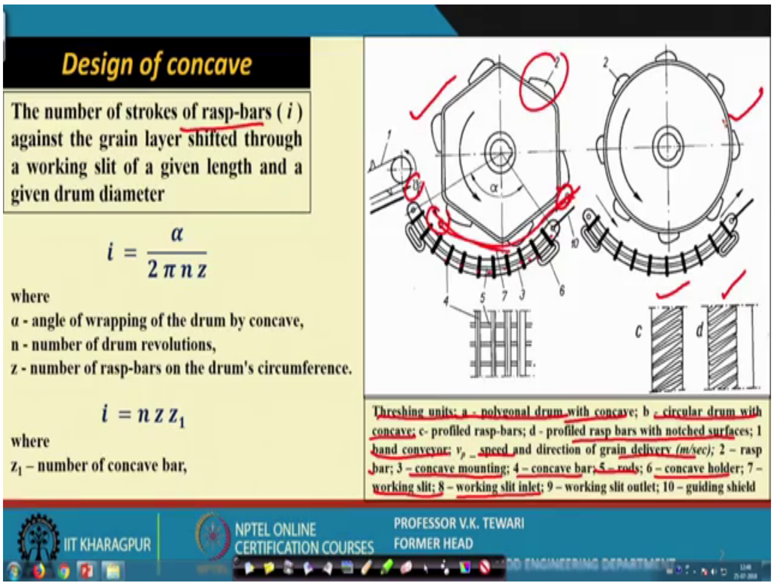


Design of the concave see we as I said the different components the corned components. We taught that cylinder then the concave, then the entry point of heat, the exit point of heat the size of the concave size of the cylinder the speed at which it works and powers amount of power which is required. So, with these let us have a look at these aspects of what it is. See design of the concave the number of the strokes of the rasp bar you know that this; let us have a look at first these and then will come to the design of the concave here.

The threshing units a is a polygon drum with concave how this is the design a here, threshing unit a and threshing unit b. Now in this circular drum with concave. So, this is the circular drum with concave and this is polygon drum with concave, this is the concave here. Now profiled and see the profiled rasp bar see this is the profiled rasp bar and this profiled rasp bar with notched surfaces. You can see that this is notched surfaces which are there, then bend conveyor this is the conveyor which is the here. Now you can see this is the conveyor v is the speed, v p is the speed yes. This is the speed which is shown here, then direction of grain delivery meter per second. This is the grain delivery through this then rasp bar where rap bar is 2. So, this is the rasp bar, this is the 1.

Then concave mountings, you can see the concave mountings. This is this is the one which is concave mounting on which the concave is there. Concave bars, this is the concave bar. These are the concave bars which are there in these then rods number 5 is this is these are the rods which are there to create. The concave then concave holder, 6 is concave holder. This is a concave holder which is holding it with the whole system. Then 7 is working slit this is the working slit here, this is the working slit in which the material will come and then go away. Then working slit inlet, this is the inlet of the working slit which is 8 here this is the inlet here and this is the outlet here. This is 9, this outlet and this inlet is this place. So, 10th is guiding shield this is the guiding shield; so, after it is been threshed where it will go.

So, as such now, you see here that this is the thresher which is of a polygon type of drum and this is circular drum and we have talked of each and every element here. Now we see what we mean by the design of this as such here. The number of strokes of rasp bar i is given as i is equal to alpha by twice pi n z. What is this? That alpha is the angle of wrap. Now you can see the angle of wrap this is the angle of wrap which is shown here. The number of drums the number of drum revolutions. What will be the rpm of that n is talking the rpm z is number of rasp bars on the drums conference circumference sorry. So, how many rasp bars are there? These are rasp bars here or there both this, this, this are the rasp bars here are these rasp bars over here. So, how many are there in this? So, this will talk of this.

Now, where I can also you put at n into z into z 1 where z 1 is the number of concave bars and z is number of rasp bars on the drums circumference and z 1 z 1 is the number of concave bars. So, as such what we get the number of strokes of rasp bar I; see number of strokes how many strokes. It will have this is important for the design. What it is? It depends on the angle of wrap. It depends on the speed, it depends on the number of rasp bars which are there and then the it depends on what is the number of concave bars which are there. So, the design of the concave will require this aspect first. Then if you go to the next slide, let us see what else is there.

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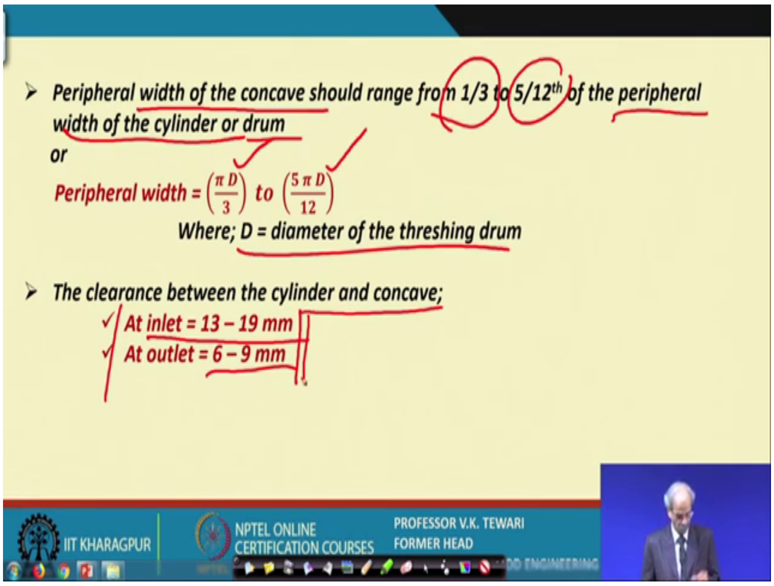


Peripheral width, peripheral width of the concave should range from now what is the diagram of this, what is the value of this, what is should be this length of that. Now you see here the peripheral width of the concave you have seen that the width of the concave and length of the concave. If you are talking of the drum, then the length will be of the concave is the total length of the drum and width here will slightly more than that because it will have something from entry and something to come out output material. And the other side is your the walker where the stressed I mean the thresh travel go.

So, how what should be this distance now? This is given here that the concave should the width of the concave should range from one-third to five-twelfth of a peripheral width of the cylinder or drum. This is the concept which is given. Now let me tell you that how we have got. This is out of the experience of the researchers on that basis we are in a position to design you can. Design depending on this and therefore, the periphery; if the diameter is D if the diameter of threshing drum is D which you need to think off. So, if the diameter is D according the peripheral widths will vary from this value to this value that is pi D pi 3 to 5 pi D by 12.

Now, clearance between the cylinder and the concave; now this very important as such because you as I have explained earlier that when the material is there along with the crane and the straw. When it comes here, it has to be beaten and then it has to be compressed and then only there will be rubbing action taking place and grains will be removed. So, they the size of the concave is very important. So, inlet varies between 13 to 19 and the outlet is smaller; so, that when you take it out and with the beating action, then they threshing will be proper. So, the cylinder and concave inlet and outlet dimensions or these you can choose any anyone between this.

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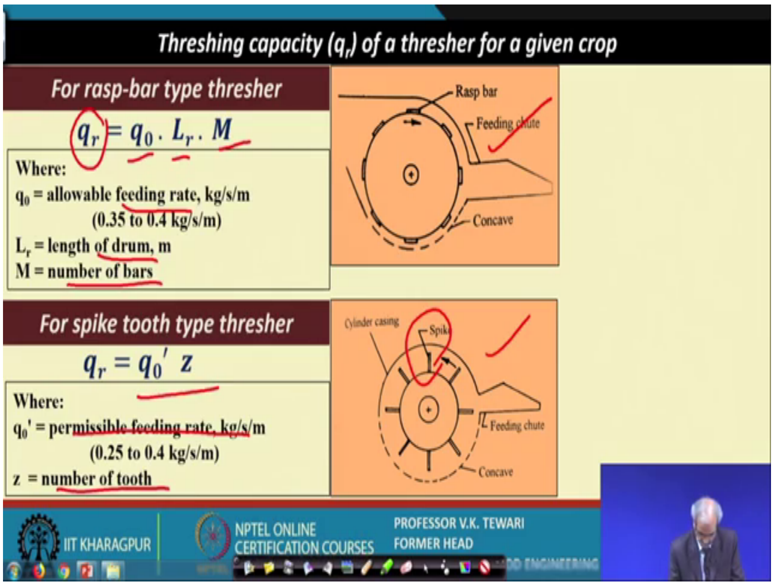


Now, what is threshing capacity of a thresher for a given crop? Now for any given crop, what is mean by threshing capacity? How do you get threshing capacity? How do you calculate threshing capacity? When it will depend on the feeding rate at which you design the feed the material. You it depends on the length of the drum and the number of bars which are there. So, you can see here that threshing capacity threshing capacity is dependent on q 0 L r and M where q 0 allowable feeding rate. What is the feeding rate? Then what is the length of the drum in meters and the number of bars which are there?

So, using this you can get what is the threshing capacity of a rasp bar type of thresher. Now in case of a spike tooth type of thresher, now where the design is different you can see here we have shown you rasp bar type is this and the threshing these are threshing elements. This is spike tooth type threshing element. So, they are the two are two different designs and therefore, one has to understand this accordingly you can find out the total capacity of this thresher.

Generally this the wheat for a wheat crop spike tooth type of the threshers are used or for multi crop threshers has this element. So, for this q r is given as q dash z where permissible feeding rate is this and the number of tooth number of tooth which are there these spike tooth which are there. So, depending on this the spike tooth type of thresher will give you a threshing capacity of this here.

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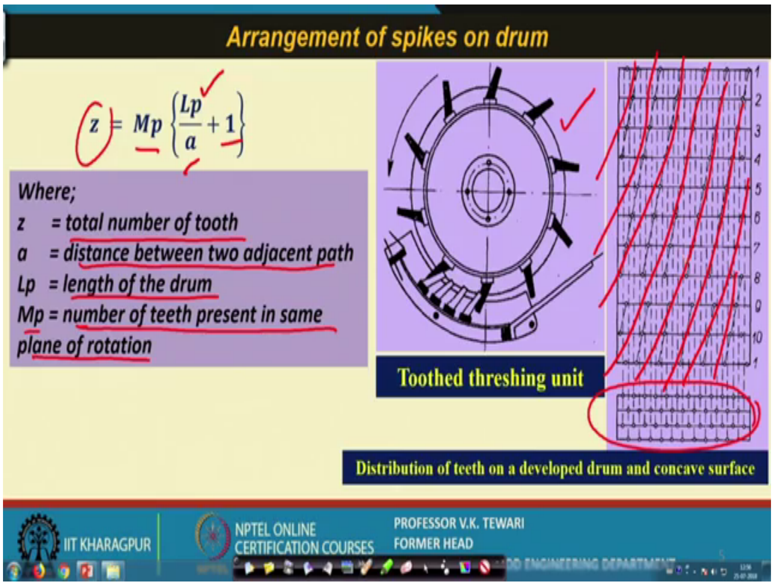


Arrangement of spikes on the drum yeah, how they are arranged; it is worth understanding them the design of the spike, how they are designed. You can see that in a spiral fashion. It is designed for example, you can see here it goes from here to there like this like this; this how they are put in the fashion tooth threshing unit. Now this is the tooth threshing unit which is there and details are already given now arrangement of a spikes and what is the arrangement is given to you distribution of tooth on a developed drum and concave surface.

Now, this is what it is and this is the design in which they are connected. What are these total number of tooth here? You can see the total number of teeth you can say, but now we will call because spike tooth. So, we will call this a total number of tooth z is given by M p into L p by a plus 1 the here. Distance between two adjacent path is a and then the length of the drum. So, if number of teeth present in the same M p talks of the number of the in the same plane of rotation number of teeth, you can see here. These are the ones which are there. So, one has to understand what is this what is the tooth here and what is the total number. So, depending on the number you can know, what should be the arrangement and how it should be kept.

So, that we get the proper design otherwise what will happen the threshing will not take place properly. So, the tooth must be design on that on the periphery of the drum. If you have if you get an opportunity to see the unit yourself in the laboratory or in your location or a unit which you have purchase, you will be able to understand and appreciate what exactly I am trying to say here with respect to the arrangement of the spike tooth. Otherwise the threshing will not be proper you will not get clean grains you will not grain the get the straw which is properly removed from the grains.

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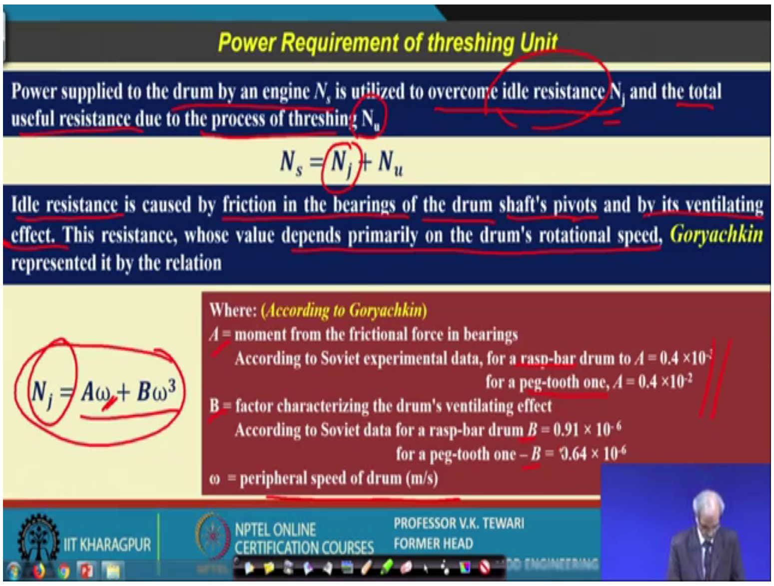


Power requirement: yes, once we talked of this the important things. Now we talked of the power requirement. What is the power requirement of the threshing unit ? How much is the power requirement? What are the things which happen in this power? How why power is required? What are the elements which require power? So, here just see power supply to the drum by an engine say, N s is utilized to overcome the resistance N j overcome the ideal resistance anything that when you start initially it will require some idle resistance to overcome and then the next part of it. So, and the total useful resistance due to the process of threshing

So, initial idol resistance for to start system from there, you required certain force say for example, an engine you might have seen that the frictional forces are overcome and then only the power goes to the kinds after the crack operates. Similarly in just like battery you have internal resistance to the battery. So, if you take a, you can say the corollary from there or a analogy from there, then we say that in this drum the total power required will be of two kinds; one to overcome the idle resistance which we call here as N j and the next is for the useful work that will be done which we call as this.

In fact, why I have used because we have taken this information from the Goryachkin theory of threshing and well you may say that why I have taken there because of the literature available as such must also be presented to you in the form that are available. And we have tried to concise that and just give you the basis of that. We have not changed the nomenclature as such because we want to give credit to the person or the scientist who has developed this, but we want to explain the thing which is behind this the whole aspects of finding out the power. How do you get the idle resistance? Now question is how do you get the idle instance? This is caused by the friction in the bearings of the drum shafts pivots and by ventilating effect ventilating effect, when it rotates.

This resistance whose value depends primarily on the drums rotational speed; so, it depends primarily on the rotational speed that this N j we are calling of the resistance. At this he is given as this, where it has two components a omega plus B omega. Now here it is important to note that the here this omega is given as the peripheral speed of the drum meter per second; that means, it is not as omega which we generally take as connotation or notation for the angular speed it is not. So, here it is talking of the peripheral speed of the drum in meter per second is the answer here. Now A and B are the two factors which has been taken by Goryachkin and this is a relationship which he developed to find out N j.

The idle resistance for the power which is utilized and the next part is the actual work which is done. So, and the values there he has given certain values for the depending upon with there is a rasp bar type or it is a peg tooth type where is have been given, which will help you to use them and find out the factors which are this. Of course, the empirical equation which has been developed over a period of time and he is done lot of work on finding out, then only he is in a position to get the values of B at various types of threshing elements. When it is peg tooth type or rasp bar type a and b both the values. So, using these you can find N j.

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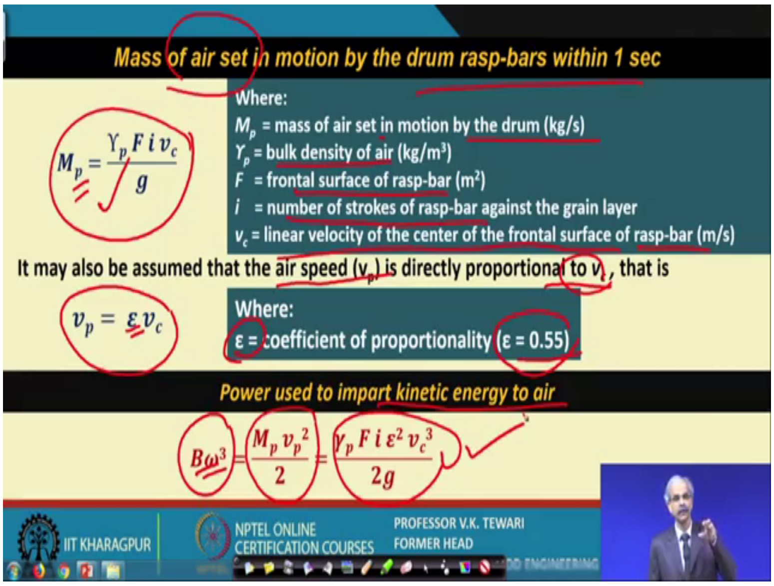


Mass of air set in motion by the drum rasp bars within 1 second or per second because we would like to know: what is the mass of air set in motion. See what happens when the drum is rotating there will be an air which will be also moving along with that. So, what is the mass of air which is put in motion when the drum is rotating and that when you have the concave. So, this air is coming inside when the material is thrown inside the concave between the drum and this.

So, it is very important to understand about the mass of the about the mass of air which is set in motion by the drum rasp bars. What is this? This is the value which is given Mp. Mp is the mass of air set in motion by the drum which is an kg per second and then it depends on what? The bulk density of air which is there the frontal surface of the rasp bar what is the frontal surface, then the number of the strokes of rasp bar against the grain layer how many strokes it gives while in rotation and then the linear velocity of the centre of the frontal surface of rasp bar or if the liner velocity. So, depending upon these factors, then the mass of air which is set in motion will be found out using this particular equation.

Now it is also true that this air speed V p is directly proportional to V c which is the linear velocity central of the front surface. So, the airspeed which is there outside with this air will definitely have a relationship with the V c which is the linear velocity of the centre of the frontal surface. So, and this once it is proportional this proportionality constant is xi here and this value of this is taken as 0.55. Now this value has been taken by him and that is why we would like to say tell that well this is out of experience and the design and the mechanics which he has developed to find out the pressure sorry the power; that is why we must use this value whenever it is required to be used.

So, the b part of it; that means, a second part B omega cube is nothing, but high this is the kinetic energy power used for imparting kinetic energy to the air. So, what is the kinetic energy which is imparted to the air is half m v square. So, you can use this and then the ultimate equation is this part of it. So, what you get is this is the there are two portions which he gave for N j; one is a omega the other is B plus B omega 3 and how they are calculated? This is what he has given.

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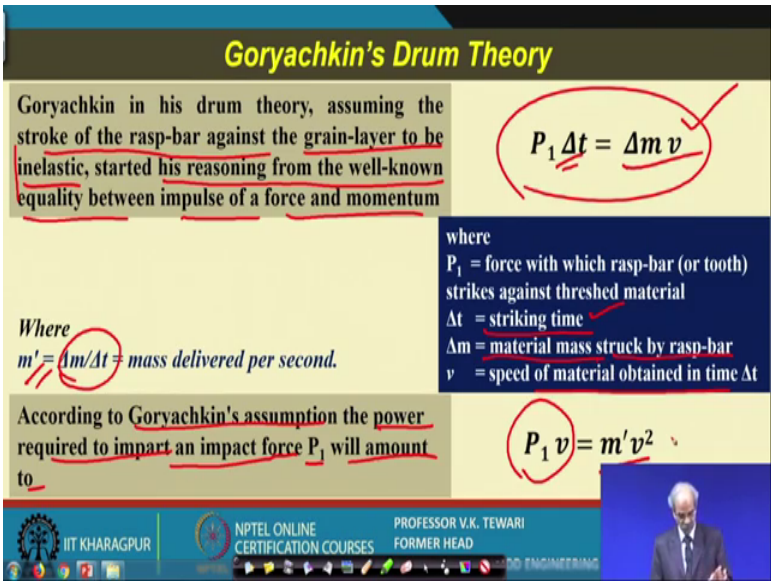

Goryachkins drum theory, now that he was talk of the air he was talked of the concave and he is talk about the various aspects of the drums threshing elements etcetera. Now, he is talking of the drum theory, what theory he has given it is must one must appreciate see the. Assuming that the strokes of the rasp bar against the grain layer to be inelastic; this is assumption which is given.

Now it is important to take care this it is inelastic; that means, there is there is no elasticity. Starting this reasoning from the well known equality between impulse of the force and momentum; so, impulse and momentum is known to us. So, p I into delta t where p I is the force with which the high force working for a short division of time impulse nothing, but change in momentum delta m into v where delta m is the striking time and delta m is the material, delta t is the striking time, delta m is the material mass struck by rasp bar.

And v is the speed of the material obtained in time, speed of the material obtained in time delta t; this is the speed it will achieve. So, this is the basic vision which he wants to take assuming that the grain layer or the rasp bar or the strokes of stocks of the rasp bar against the grain layer is inelastic. This is the basis of that and where he also further takes that delta m by delta t that is must meters per second used by mth dash. Now Goryachkins assumptions according to Goryachkin's assumption the power required to impart an impact force P 1 will amount to, what is this P1 will amount to? P1 into v is equal to m dash v square this is what it will be because the force is p one into v will give you power and then m dash v. This side is also power. So, this is as per his assumption, this is what the power will be.

Now you will be see how carefully and very meticulously he is picked up each and every component of the thresher and the threshing elements and try to find out the power required as such if somebody ask you what is power required you say that let us find out the torque of the axial and then speed. So, tau into L, you will see this is the power required, but then when you go into details of the actual threshing how much is the power required because it is essential to know that. So, if you go into details maybe that you will have to follow this theory to get into some idea. You can say that well I will have a different theory, then you must have a different argument of understanding this.

As he says that the air movement, yes air movement is taking place revolving the drum when the drum rotates; you will find that there is air definitely. So, he has taken that part of this, what is the mass of that air, how to account for the mass of that air, how to account for the velocity of that air.

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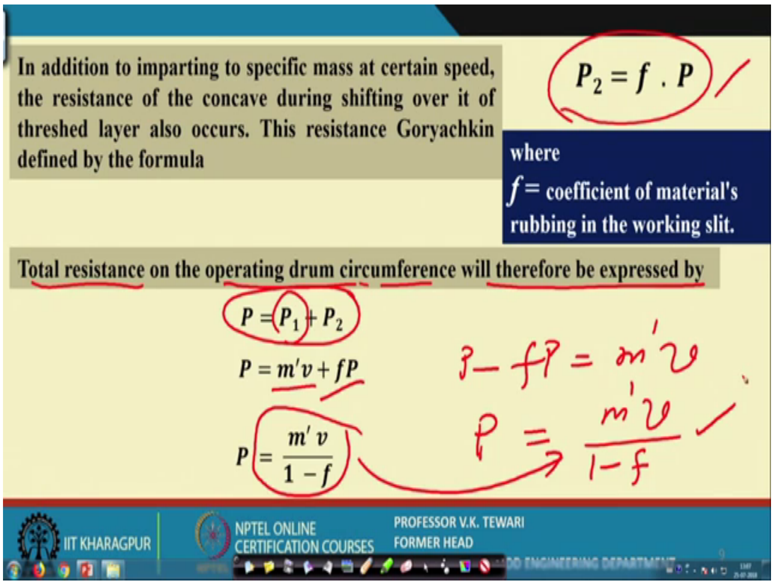


So, in addition to imparting a specific mass at certain speed the resistance of the concave during shifting over it threshed layer also occurs. So, using this now what we get here is P2 is equal to f into P where f is coefficient of material rubbing in the working slit. This is what it is; P you have got the force earlier. So, therefore, total resistance on the operating drums circumference will be expressed by this P total force P1 plus P2.

So, what is P? P1we have got from the previous slide, we have seen m dash v and P2 is P f times P which is you have got here. So, then if we take these, then we can get from here this value P minus f P is equal to m dash v and therefore, P is equal to m dash v by 1 minus f. This is what exactly shown over here this how it comes. So, this is the way he is try to understand the theory of that and given a concept. We need to appreciate the concept given by Goryachkin and to worth understanding. If we have something edition, if you can add to the system why not, but yes somebody has given a concept let us appreciate that part.

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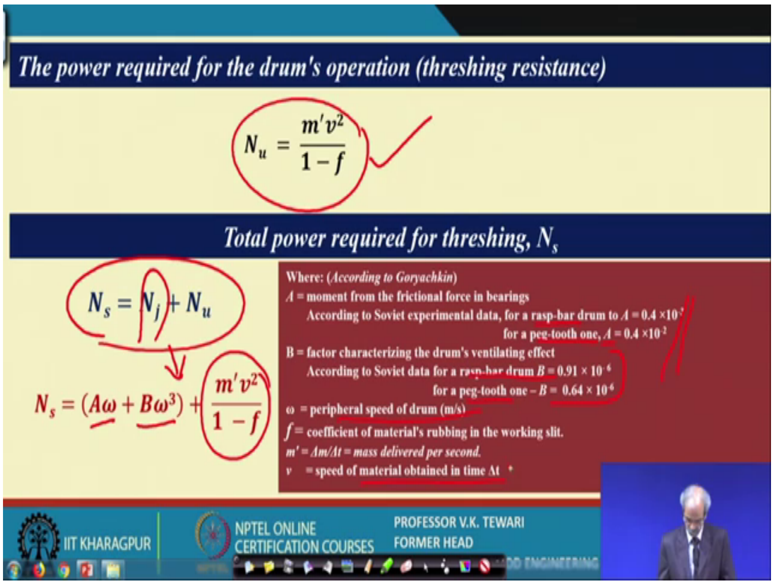


Power required for the drums operation; then what is the power required for the drums operation? What is that power then ? N u will be nothing, but this is what it is which we had got earlier power which we which we had. In fact, nominated as that power now with this is equal to here because we got the force over there that force was m dash v by 1 minus f; and when it is coming to power that that force into velocity will give you that power which has come over here. Therefore, the total power required as we started in the beginning N is equal to N j u is now given by this particular equation here. We discussed all in detail about what is A w A omega, what is B omega cube and what is this component.

We had talked of two things: first one was the resistance of the ideal resistance connected and then is the useful work. And with that we also talked of the of air which is moving there and how that air is taking into account, what is the mass of that air etcetera. We have taken that into account, you can see here that the details values are given we where for these values are given here for the rasp bar type, peg tooth type drum values of A, then rasp bar type and peg tooth type values of B ok.

And then peripheral velocity of the drum here, it is written still peripheral velocity you must keep in mind that this omega here as we say generally I repeat is not radians per second, but here is given nomenclature as peripheral velocity and v is the speed of the material obtained in time delta t. So, as such I think this is this talks of the total power required in the drum.

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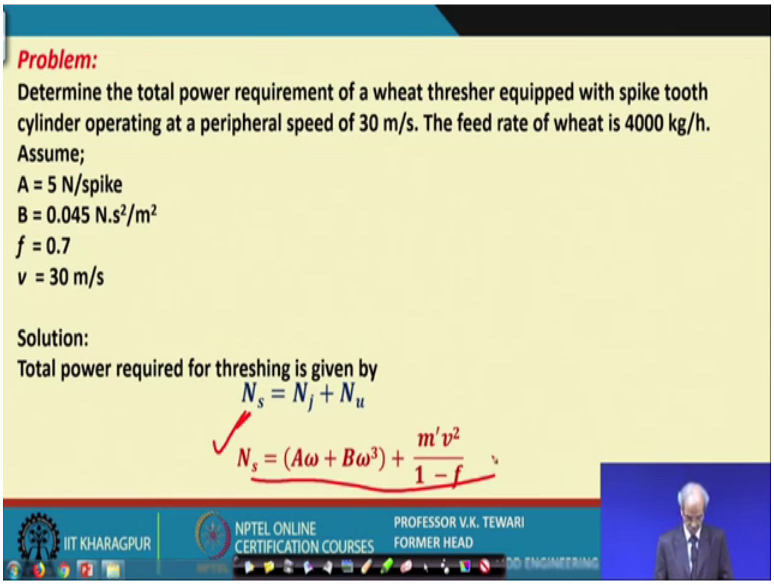


Well we wanted that let there be a small problem using this the theory which we just talked of and virtual this will this is nothing, but. In fact, a application of that theory and putting these values. Now you see the problem says that determine the total power required for a wheat thresher equipped with the spike tooth cylinder operating at a peripheral speed of 30 meter per second. The feed rate has been taken as a 4 tons for 4000 kg per hour.

Now, the details for the type of is this is a spike tooth cylinder. So, a spike tooth means the values as feed. So, the value of A and B you know, then what is the value of f which is also given to you earlier. So, this value you can take as this and v is given as 30 meter per second. This is the velocity because this is the velocity of the this is the peripheral velocity as well as the velocity this which is achieved by the mass when to moves along with that. Because there is a relative motion between these two and so, we can use this equation direct right way. This equation can be used, can be used and we can find the value because all data are over here and you can just put the values.

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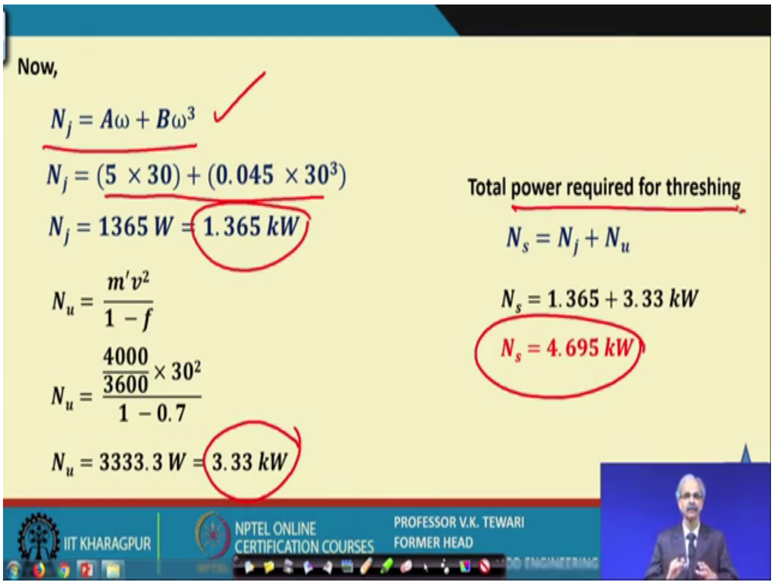


So, you can just if you put these values, you can see here that N j the force and which is talking of the idle resistance can we find out from putting all these details and this is the value of N j which is. So, 1.365 kilo watt possibly this is higher value than when you are talking of a bigger one, you may find that this is the ideal resistance which is required; if you talk of the total and then is useful one which talk; so, this.

So, if you can get this way; so, the total is 4.695 kilo watt is the power required for the threshing in the problem which is given it is for wheat and the speed at which it is given. Now remember that this is just a representative problem. You can be given different problems maybe that another lectures or in our assignments will give you certain problems which will have slide more intricacies and more concept to be utilized. Here I just wanted because the theory I just talked to you. So, it is very relevant to give you a small problem by just putting these values and get the answer. Well I think through this design what I have tried to explain to you is: what are the components which must be looked into from the point of their design, which are sizes and the capacities and the power requirement etcetera.

How to choose whether any crop is there wheat or a paddy or whatever else; so, depending upon the crop, depending upon the type of the design which you take whether a circular drum or you talking of hetragonal drum; you have to think of the design. Now we I am sure that there could be many questions after hearing me, those questions we would like to answer as and when you are firing it to us and we will have more dialogue, once you understand better this. And, I think you will be in a position to design with this knowledge. I would like to close here.

Thank you very much.