Introduction to Mineral Processing
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Lecture – 27
Grinding (Contd.)

Hello welcome. So, we are discussing about grinding, we have discussed about various types of mills and we have discussed about that your different features of a ball mill, your pebble mill, rod mill, semi auto genius grinding mill, auto genius grinding mills. We had also discussed about the critical speed of a ball mill and as you see that these are all basically tumbling mills so that your critical speed plays an important role in any type of tumbling mill.

So, in this lecture what we try to do this is the other lecture actually I try to use it as your tutorial that is how do I apply that equation what we had derived for the critical speed calculation and then how do I use it for solving different problems.

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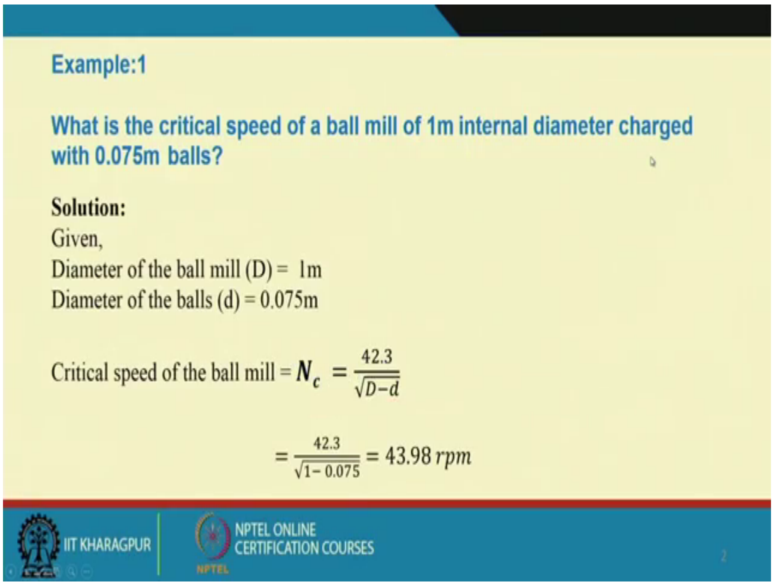

There is an example one the question is what is the critical speed of a ball mill of one meter internal diameter charged with 0.075 meter balls. That means, we are having only one type of ball and that your say diameter of these balls are 0.075 meter and the ball mill diameter is 1 meter. So, we need to calculate what is the critical speed of a ball mill.

How do I do it? Now, the given parameters are the diameter of the ball mill is 1 meter be very careful about the unit's diameter of the balls are 0.075 meter.

So, the critical speed of the ball mill if you remember the equation is critical speed denoted as N c is equal to 42.3 divided by square root of capital D minus D, where capital D is the diameter of the ball of the mill and small d is the diameter of the balls. So, if we put the values of the capital D that is the diameter of the mill is 1 meter minus small d is 0.075 meter. So, that will give you an rpm of 43.98 rpm so; that means, this is the critical speed.

Now, if you are asked that you have to run this mill at 60 percent of these, of the critical speed so; that means, it is 43.98 or say it is 44 rpm multiplied by 0.6. So, that gives you your 26.4 rpm so; that means, you have to rather you have to set the rpm of this mill at that 60 percent critical speed. So, there is a very simple example of how we can calculate the critical speed of the ball mill. Let us go to other examples also.

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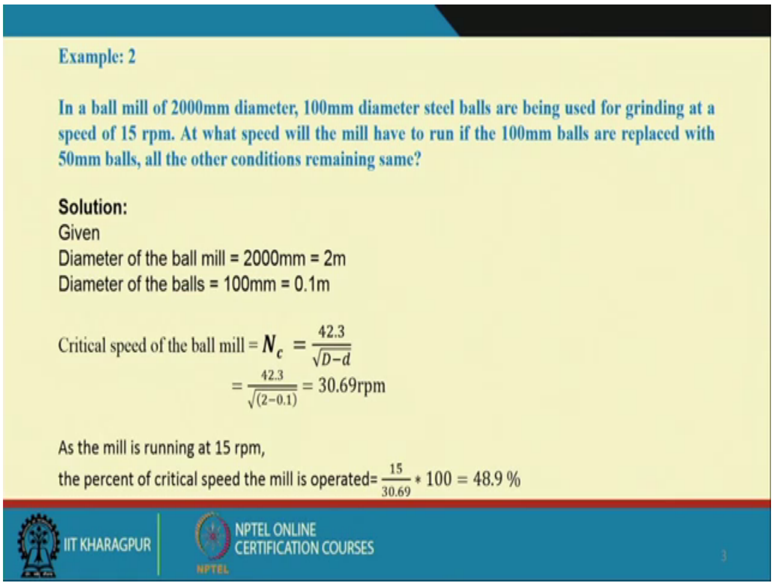

This example two the question is in a ball mill of 2000 millimeter diameter, you see that I have now changed them your dimension to your units. So, in a ball mill of 2000 millimeter diameter 100 millimeter diameter steel balls are being used for grinding at a speed of 15 rpm. So, I have given the mill diameter, I have given the ball diameter, I have given the rpm, now question is at what speed will the mill have to run if the 100 millimeter balls are depressed with 50 millimeter balls. So, what the question is that is if we replace this balls with a 50 millimeter balls at what speed the mills should be run, all other conditions remaining same ok.

So, we are given the diameter of the mill ball mill is 2000 millimeter that is equal to 2 meter diameter of the balls is 100 millimeter that is equal to 0.1 meter. So, the critical speed of the ball mill is 42.3 divided by a square root of capital D minus small d. So, now, we put the value of 2 and 0.1 we get a value of 30.69 rpm. So, the critical speed of the mill is 30.69 rpm. So, we have to now calculate that 15 rpm when it is being rotated; that means, what percentage of critical speed is being used to run this mill. So, we have to maintain that identical percentage of your critical speed for rotating that mill.

So, now we can calculate as the mill is running at 15 rpm, the percent of critical speed the mill is operated will be equal to 15 by 30.69 that is the critical speed and this is the rpm at which you are running the mill, so 15 by 30.69 into 100 so that is equal to 48.9 percent. That means, at the given condition the mill is being run at 48.9 percent of the critical speed now when we change the ball diameter we have to run the mill at the same 48.9 percent of the critical speed. So, what we have to do now? We have to now recalculate the critical speed of the mill when the ball diameter is 50 millimeter. Let us do that.

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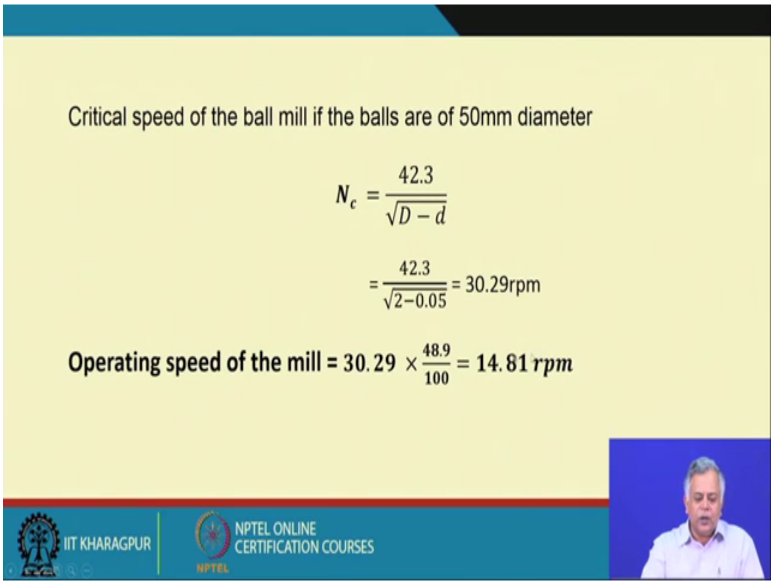

So, critical speed of the ball mill if the balls are of 50 meter millimeter diameter. So, N c that is the critical speed will be equal to 42.3 divided by a square root of capital D minus d that is equal to 42.3 divided by square root of ball mill is 2 meter diameter and this is 50 millimeter means is a 0.05 meter so that will give you 30.29 rpm.

So, the critical speed of the mill changes when you change the ball diameter. So, now, you have to run this mill at the identical condition means at 48.9 percent of the critical speed. So, we can easily calculate that what would be the operating speed of the mill that is 30.29 into 48.9 divided by 100 that is equal to 14.81 rpm. So, this is how these are the two examples you can see that how these equation of critical speed we can use even to monitor or even to your optimize the parameters of my mill. I will show you some more examples similar to this.

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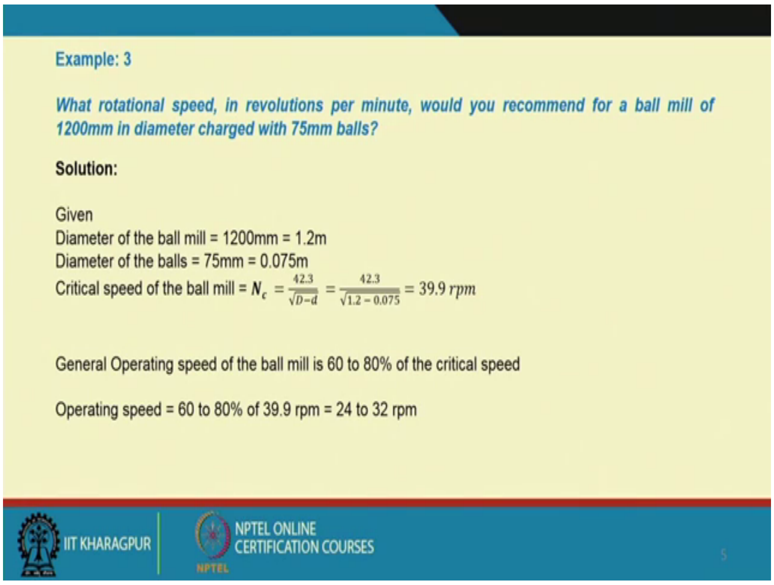

Another example 3 where the question is what rotational speed in revolutions per minute that is rpm would you recommend for a ball mill of 1200 millimeter in diameter charged with 75 millimeter balls.

What rotational speed in revolutions per minute would you recommend for a ball mill of 1200 millimeter in diameter charged with 75 millimeter balls? So, what I have to do that is I have to calculate first the critical speed and then I have to say that mill if I want to operate the mill from 60 to 90 percent of the critical speed, so what is the range of that rpm, very simple problem.

So, again we will do the similar fashion the diameter of the ball mill is 1200 millimeter that is equal to 1.2 meter where the diameter of the balls is 75 millimeter that is equal to 0.075 meter right. So, the critical speed of the ball mill that is N c is equal to 42.3 divided by square root of 1.2 minus 0.075 that will give you an rpm of 39.9 rpm. General operating speed of the ball mill is 60 to 80 percent of the critical speed or a miss right in this type of our problem that we assumed that the ball mill that is being operated at a critical speed in between 60 to 80 percent. So, the 60 to 80 percent of 39.9 will give you a range of 24 to 32 rpm.

So, now if I say that at what rpm you expect the much more finer product. So, if you remember that when you run the mill at a slower speed because of your cascading action you generate more of finer product. So, I would select at 60 percent of the critical speed that is the 24 rpm or the question is that at what rpm you think that the productivity will be more. So, definitely when the rpm is at the highest that is 80 percent so that is at 32 rpm.

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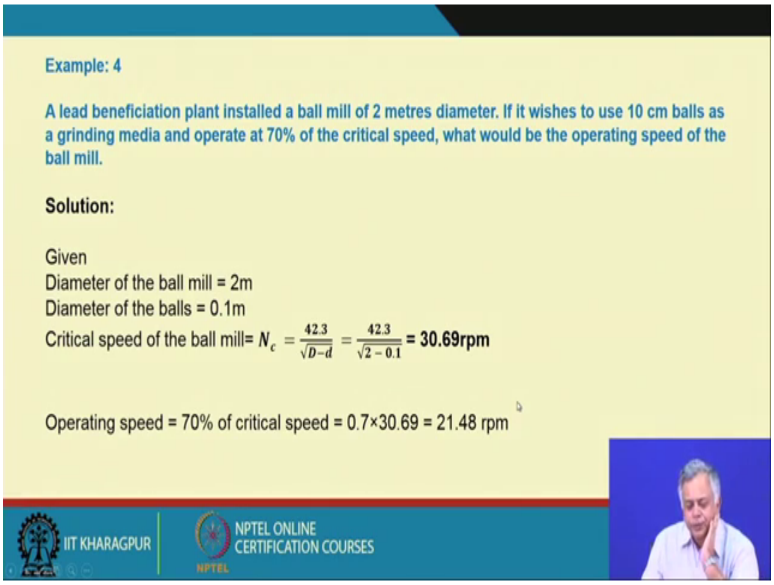

There is an example 4, I would suggest you to practice this type of problems. Although I will be giving this type of problems in assignments and maybe your final exam also you will be asked this type of questions.

A lead beneficiation plant installed a ball mill of 2 meters diameter if it wishes to use 10 centimeter balls as a grinding media and operate at 70 percent of the critical speed what would be the operating speed of the ball mill the similar question what we have solved. So, the diameter of the mill is 2 meter diameter of the balls is 0.1 meter. So, the critical speed we can calculate 42.3 divided by square root of 2 minus 0.1 so that is 30.69 rpm. And you want to operate it at 70 percent of the critical speed; that means, the operating speed should be 0.7 into 30.69 that is 21.48 rpm.

What I wanted to show through these examples that is, say suppose you are getting very relatively finer product through a closed circuit guiding or say your say through a say closed circuit guiding operations. So, now, what you can do, that is I do not want that much of finer material you see that you want a p 80 of say suppose 40 micrometers and now you see that p 80 becomes 30 micrometers. So, why do you have to do? One option is that you can optimize the parameters of the cyclone circuit, but at the mill also what you can do that is your more finer product being generated means the more of cascading action so that means, the mill is being run at a too slow speed. That means, you can increase the rpm. But remember it that when you are increasing the rpm your discharge rate that is your capacity will increase; that means, your discharge rate will keep on increasing and whether your cyclone can cope up with that increased feed concentration and then whether the cyclone performance will get decorate it or not they have to look at.

So, this is how you can optimize your closed circuit guiding operations different parameters. So, if I want to optimize the parameters I must know the, I must be very clear that how a ball mill works or how a tumbling mill works and what are the parameters that controls my product size distribution and as well as the capacity.

Similarly, you should also be familiar with that how hydrocyclone works and what are the parameters what are the design and operating variables that affect the performance of my hydrocyclone. So, when we are very clear about hydrocyclone is nothing, but classify the size separation device. So, if I have thorough knowledge in the both unit operations that is your tumbling mill as well as the classifier we can optimize the parameter as per your ways.

So, this is the end of the lectures on grinding, or say we say that on combination. So, next lecture we will start with industrial screening.

Till then, thank you very much.