Technology of Surface Coating
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Lecture 39
Performance Evaluation of TiN Coated Tool

Performance Evaluation of TiN Coated Tool, now this TiN coating that is the first generation of coating just came into being after TiC CVD coating, the whole idea here is to improve the performance of a cutting tool particularly the carbide cutting tool and at that point of time the CVD technology became well established and it was scaled up to the level of industrial application and TiC was followed successfully by TiN and TiN become one of the better candidate in terms of wear resistance, chemical stability and performance in comparison to TiC.

And this TiN, also it was possible to use this TiN by the PVD method later on and now both are well established technology for use in cutting tool, not only in cutting tool but in many other areas of application, there can be forming tools, which are also used for metal forming application in addition to that various wear parts and also for decorative purposes.

But here we are discussing on this TiN coating and this TiN coating when it is used as the top functional coating of a cutting tool, then it becomes almost like we submit it to the most difficult assignment or task, because in cutting tool we have both high level of shear stress or sliding stress associated with high temperature.

So can we can safely call this is going to be some kind of acid test for the coating and when it is on the cutting tool. So this Significance of TiN Coating in Mechanical Manufacturing, that we understand immediately that most of the material are centered around iron that means these are all the steel, varieties of steel, starting from low alloy, high alloy, low carbon, medium and high carbon, and in large domain could have been covered by this TiN and the impact was immediate, benefit was immediate and one could realize the benefit and the capability of such TiN coating at that point of time.

Now this significance of Ti coating is understandable when one find the capability of the cutting tool in terms of cutting velocity could be raised and even if we get a 30 to 40 percent rise in velocity that is fantastic in terms of productivity and also for tool life it can be many fold, but in application, in the production field, production floor, it is mostly that the speed or the production rate that becomes more important than preserving the life of the tool.

And it is also an established fact that (())(04:25) cutting edge of the tool, the life can be maintained within 15 to 20 minutes and that should be good enough to keep the economy and at the same time to extract a maximum possible from one of the cutting edge.

Now we have CVD PVD TiN coating on cutting tool, now both are established technology, each has its own domain, its capability, strength, weakness or say or limitation. So just we have to find out which one is the best application area for one of the process and accordingly one can derive the maximum benefit out of a TiN coating which can be a CVD or PVD product, it can be medium temperature CVD or it can be also plasma assisted CVD or it can be classical PVD coating.

So ultimately the job is that one has established or explored the strength or capability of TiN and then according to the requirement of the substrate, one has to find out the best coating process which can suit the purpose without doing any damage to that substrate.

Now here we can look at that two major cutting tool we are using though there are many more like ceramic, diamond, cermet, CBN there are many other combination of those hard materials by getting the nitrites, carbides, borides of all transitional elements, but even after that the major task, a major role is pressed by on one side it is HSS and on the other side it is carbide. And the reason is that HSS has its own domain of activity and this is almost unchallenging that particularly for complicated geometry making of that HSS is one of the, has the greatest advantage for giving the shape and grinding.

Plus where we need the toughness, unfavorable machining condition, there also HSS is unchallenged and at the same time if we like to use a tool with a positive break in that case also HSS is going to be the best candidate. So we understand that the applicability or the scope of use of HSS is still there, but on the other side we have the carbide and with carbide, the speed could be raised to a higher level in comparison to that what is prevailing with HSS, so the whole idea is here that how to improve further, the performance of this HSS or carbide by use of a coating on the top.

So here we have HSS and Cemented Carbide, so obviously for the reason known to us HSS, we have to restrict the deposition temperature well within 500 and for carbide it can go around 1000 without having much problem and that is why we have PVD coating and CVD coating and PVD coating can be now the temperature requirement can be now brought down to say around 200 degree , so we can restrict this temperature even at 200, getting the same quality or even better quality coating in terms of density hardness, residual rest situation and stress situation and also the adhesion, wear resistance, all sort of qualities, smoothness of the coating, so all sort of desired qualities we can obtain even at a very low temperature.

So for cemented carbides, CVD is quite obviously a choice from economic point of view but nowadays there is also growing demand for this PVD say carbide, particularly in those areas where we have much impact on the cutting tool, particularly the edge strength has to be reinforced and should be preserved properly and in that case low temperature coating process will be always beneficial.

So we understand HSS and carbide, these are the substrate which need to be modified the surfaces to improve their capability and to raise their capability in terms of say cutting velocity, material removal rate. So that is the whole idea behind this coating operation.

Now Action of a Cutting Tool, this we have to understand and the action of a cutting tool and how this coating is going to serve its purpose or play its vary significant role in enhancing this cutting action in raising, improving this cutting action.

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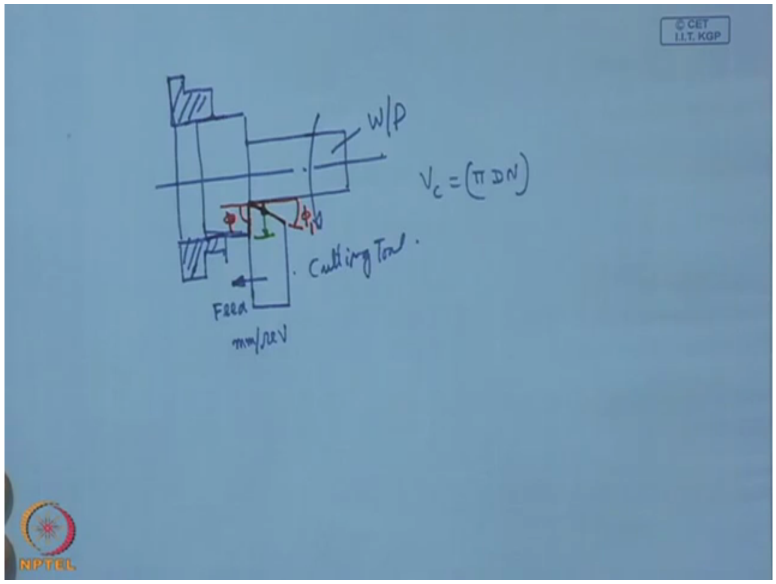

So here we can have a quick look that, say this is one cutting tool which is engaged in turning. Ok this is the work piece, this is the cutting tool and this is a turning operation, job is spinning and we have this motion that is the Feed Motion and this is the job holding device, this is a chalk and the whole operation may be carried out in a lathe. Now here actually we have to see this thing that this is called the geometry, so here we see this phi, this is called the principle cutting edge, this is called the auxiliary cutting edge, this is either principle cutting edge or major cutting edge, this is auxiliary cutting edge or minor cutting edge and this is the point where the, this is the major cutting edge and this is the minor cutting edge.

So this is the major cutting edge, minor cutting edge or we can call it principle cutting edge and auxiliary cutting edge and then this width, this particular width, so that is the engagement, this particular width that we call the depth of cut, so DOC, so these are the cutting parameters and at this point with this diameter we know VC, that is equal to pi DN and in appropriate unit we should express it in meter per minute or meter per second, feed is given as millimeter per revolution, depth of cut is expressed in millimeter per revolution. Now what we can do we have to understand the geometry of the tool and here we have to a section.

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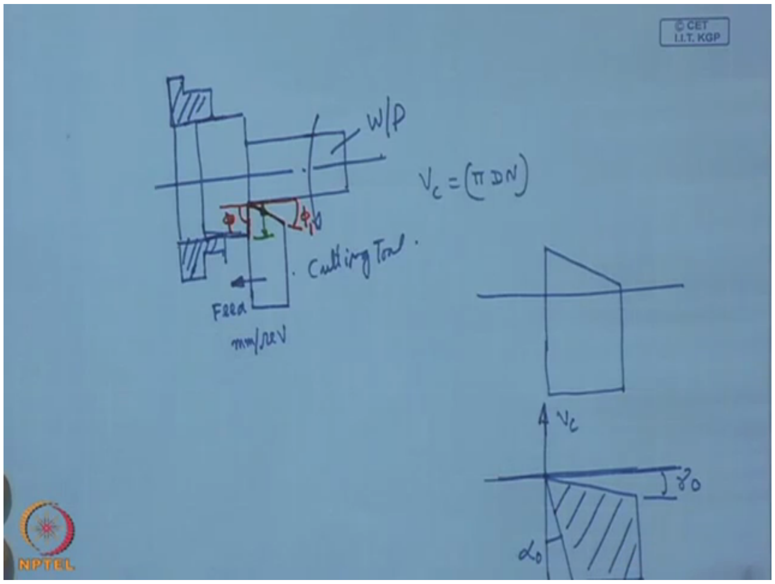

Now if this picture, if we redraw it here little in a bigger scale, we can see that this is actually the section if we take this section here we can find that, so this is actually the direction of velocity and this is a line perpendicular to that velocity, so this we call orthogonal rake and orthogonal clearance. So these are the basic thing for any cutting tool to understand the role of this coating. Now this particular tool is actually removing the material as it moves.

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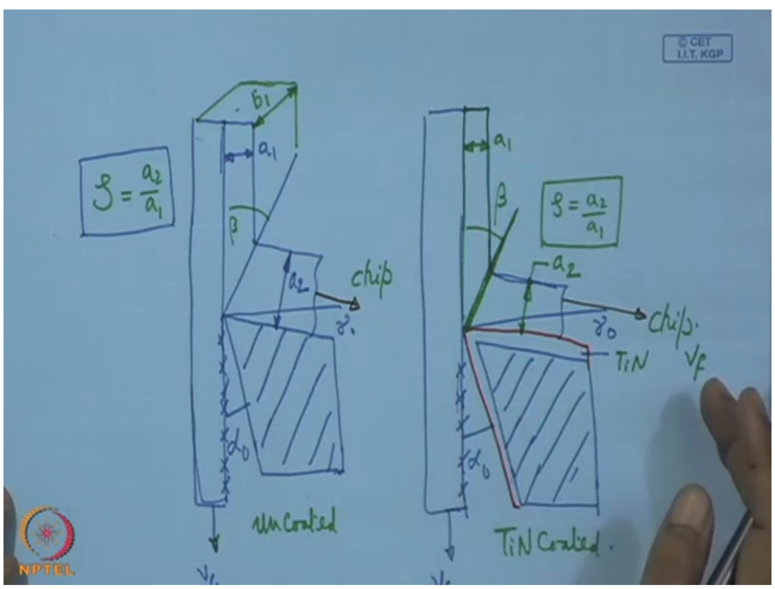

So to show the action of this tool, what we can draw, we can just add a another diagram here, that means this is the cross-section, what we have shown just we have to show it again here. So is the tool, this is the cross-section, that means in the orthogonal section, and on the top of that this is a tool without coating.

Now we can have another tool with coating, so here we have another tool and here we can put a coating on the top of that, so this is actually the cross-section, now what we see that here we have to draw this thing, this is a classical way of showing the cutting action of a tool. So this is the classical figure, so let us look here also then we can compare.

So this is another diagram, so this is clearance angle, rake angle, here also this is clearance angle, this is also rake angle that means the same tool, say it is a carbide tool on that we have put a coating of TiN, if it is CVD then it should be a TiC plus TiN, if it is a PVD then we can have a buffer layer of Ti followed by TiN. So that would be the only difference and here the job can move in this direction or the tool can move in this direction relatively so the situation will be same, effect will be same.

So now what we see here, this is the thickness of the uncut layer, so we put a symbol a1, thickness of the uncut layer and then we can show another thickness, that means what we see here this strip which is moving in this direction then it is actually this movement is this motion is diverted by this phase of the tool and it takes this course, so this is the course, this is now the change course because of the very existence of the phase, so this is also the phase so here also we can show that this is actually, and the line.

So we have drawn, this is the line, this is also the same line but this is with the coated tool, so this TiN coating and this is without coating. Now this part, from this to this, this part we call uncut layer and after this diversion which takes place, it is coming like this and then taking this turn, this part we call it chip that means basically it is a chip production process and in this process, this is also chip production.

Ok, so this is the classical way and this angle we call it shear angle and we can put a symbol beta. Now here one can put this question, what is the role of this coating? Now the role of this coating will be, this is high speed movement of the chip, so it was velocity VC with which it was approaching the tool then the motion was diverted by this angle of pi by 2 minus gamma O, so that is the diversion and with this diversion it is now moving with a velocity VF, that is the velocity of the chip.

Now with this velocity, so what we find on the tool we have actually two surfaces, this is called the face over which the chip is sliding and this side, that is called the flank of the tool and that flank is actually facing the machine surface that means this thickness is removed so out of this, this portion is removed, so this is actually this surface, this surface is actually machine surface that mean machine to the machine to dimension, cut to dimension.

So this is machine surface, so flank is actually facing this machine surface, so here we find at least two zone where there is severe rubbing on the face and on this side which is facing this machine surface. So this rubbing, rubbing in particular in, on the face of the tool that determines lot of thing, first of all the friction between the tool and the chip. So if we can reduce this friction between the chip and the tool, then this thickness, so this is actually thickness what we call a2, thickness of the chip.

So here also we show this is a1 and this is a2, what would be most interesting that for the uncoated tool and this TiN coated tool, what is the advantage of this coating? Advantage we can find immediately on this, that here, advantage we find here, what we have written as chip thickness and chip reduction co-efficient.

So these are the two things, one machinist has to have a careful look that we have same value of a1 for both the tool and they are moving with the same velocity say for example, however since we have a coating which is anti-welding and anti-adhesive coating giving a lower value of friction at this interface expectedly the value of chip thickness will be smaller than the value of chip thickness here.

That means for this part we have a2 by a1 and that is also given by the symbol zeta and here also we have zeta that is also a2 by a1 only the difference is that, this is for the coated tool and this is for the uncoated tool so here one has to find the difference that whether for the same chip thickness that means this a1 is one of the parameter of material removal rate.

So this material removal rate will be given by this a1 on one side then the width of the chip, this is only one dimension, so it is in fact, it is something like this which we are not showing here, so it is actually a 3D. So 3D means here we, this is the width of the chip and this is actually b1, that means the width of the chip.

So a1 into b1 into VC that gives us the volume of material removal rate, so a1 is a part of that so with the same value of a1 if we can reduce the value of a2 by this coating, definitely that is going to be one advantage that means we allow less deformation to get the work done, that means the energy spend is less, force is less and that is a saving but keeping the same material removal rate.

So what we can say here that the question here how to evaluate this TiN coating, we have seen that we can measure hardness, critical adhesion then tribometry, all sort of thing, these are all characterization. But even after that, we must go for the actual field test that means the field test if it is a cutting tool then it should be on a machine tool, it should be put in some machining engagement, it can be turning, it can be milling, it can drilling, anything which are commonly used but most conveniently we use it for turning for simplicity of the approach but it is actually a real life test considering one of the turning process.

So here Chip Thickness and Chip Reduction Coefficient, chip thickness and chip reduction coefficient that is going to be we say we call it an index of machinability. That means with what, what ease we can machine this material, this material may be a carbon steel or the low end of the carbon but nevertheless this is going to slide and there may be a high value of friction in this case and this is going to be indicated by a2.

So when it is lower value of a2 that means a good sign, that means machinability has improved and here in this case we expect that this TiN is going to improve this machinability just by reducing this welding characteristics that means just by putting this anti-welding characteristics over this and this is some sort of inertness and that goes in favor of machining.

So now comes the Cutting Force, so these are the some of the parameters one has to measure to see how good this coating is or how good this coated tool, it can be. Now here we are mentioning TiN by way of illustration, but it can be any other coating also, so by this what is what we like to mention, emphasis, impress upon that this is a test procedure one has to follow to establish that this coating is capable of doing the actual machining work and when we put it or place it on the cutting tool.

So that means this is an actual coating on a product of utility. So following the same we can also say that cutting force is also another parameter for measurement, for assessing this capability of the coating.

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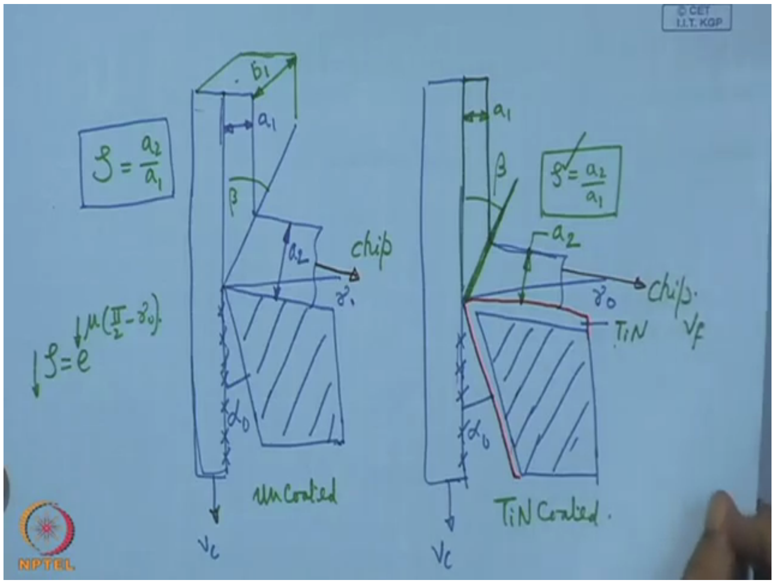

Now here we can write a small relation, small relation means this is also given from the theory of machining, various theories that this zeta we can put in this form, very commonly used relationship, mu into pi by 2 minus to the power gamma O. Now this gamma O means it is the rake angel, that means the inclination of the face of the tool which could have been horizontal but in this case we have shown that this is sloping downwards, it can also be like this sloping upwards, it depends upon the material of the tool and also the work material.

Whatever may be the case, if we follow that is a model. Now from this mathematical model, ofcourse with some assumptions and restrictions but still it is so useful to explain the role of this mu, so here if we have a low value of mu because of the very presence of TiN then definitely with this lower value of mu, we can bring down the value of zeta and because of this bringing down the mu and then definitely that goes to in our favor and that is a good sign of machining.

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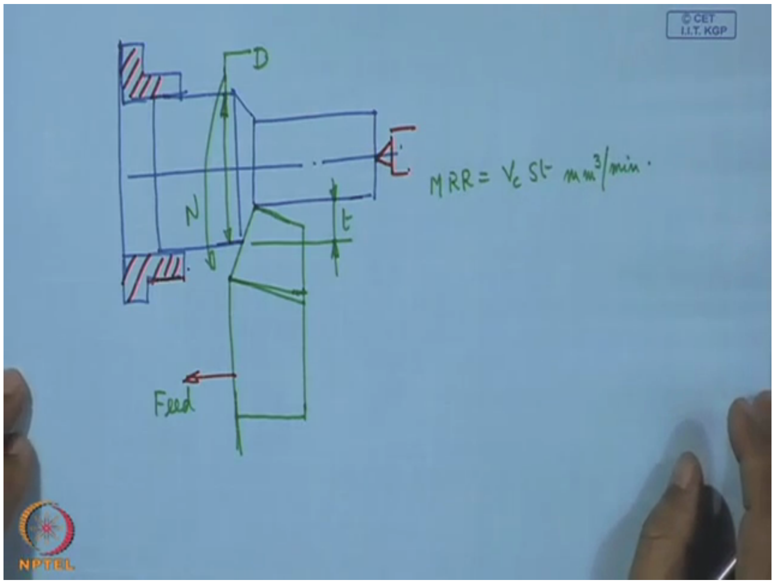

Now comes the cutting force, now cutting force means when we are using this tool, say a tool is being used like this, this a turning tool, and here we have the job like this, this is the work piece and here, so this the job holding device. So this is the cutting tool, now this cutting tool can be engaged for measurement of the force, so this can be used for collecting the chip and measuring the value of chip thickness and at the same time it can be also used for measurement of the force.

Now measurement of the force is important in that so here we can have some support and this a four jaw chalk depending upon the size of the job. So as usual we can have if it has a rake angle, we can just put this thing symbol, and this is actually the feed, this is the direction of spinning in with an RPM N, this is the diameter D and this is going to be the depth of cut. So here we know MRR, material removal rate that is given S into T and in appropriate unit when you put it we get so many millimeter cube per minute that is the usual way of expressing the material removal rate.

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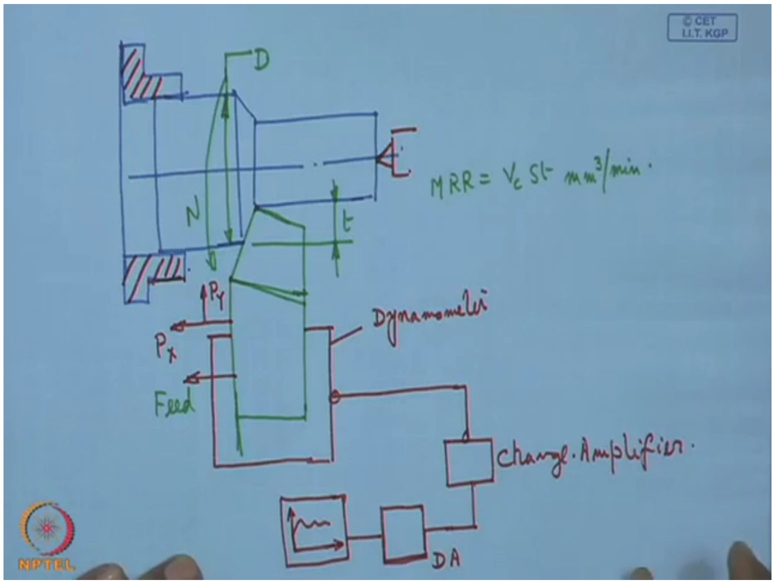

Ok, now here what we can see that this thing, this is the tool holder that is put on the carriage, on the tool post but over that there should be a dynamometer. So this is going to be a place where we put a dynamometer, so this is actually a turning dynamometer, which can record the force in three orthogonal direction, that means in this direction, that is the longitudinal direction in the transverse direction that means in the radial direction and in the direction perpendicular to this, that means perpendicular to this paper.

And this way we can resolve the forces and this is called PX, this is called PY and the force which is perpendicular to this paper that is called the force PZ, that means which is perpendicular to this paper. Now here this dynamometer, actually it is a piezoelectric dynamometer with a piezoelectric transducer and from there the charge, so it generate charge from the mechanical signal that means from newton to pico coulomb that will be the generation and then there will be a charge amplifier.

Then we have one network for data acquisition, so here we have a data acquisition, data acquisition card is there and from there it will be this plaid, either in oscilloscope or in some computer, something like that. So this is going to be a display of cutting force like this. So with time, so this the force and this is the time. So most important thing is that from here it comes to charge amplifier, so this is a charge carrying cable , from this to this, and then we have a data acquisition and then from data acquisition, so from this point to this point it is actually output is bold. So anyway, so this is the force measurement.

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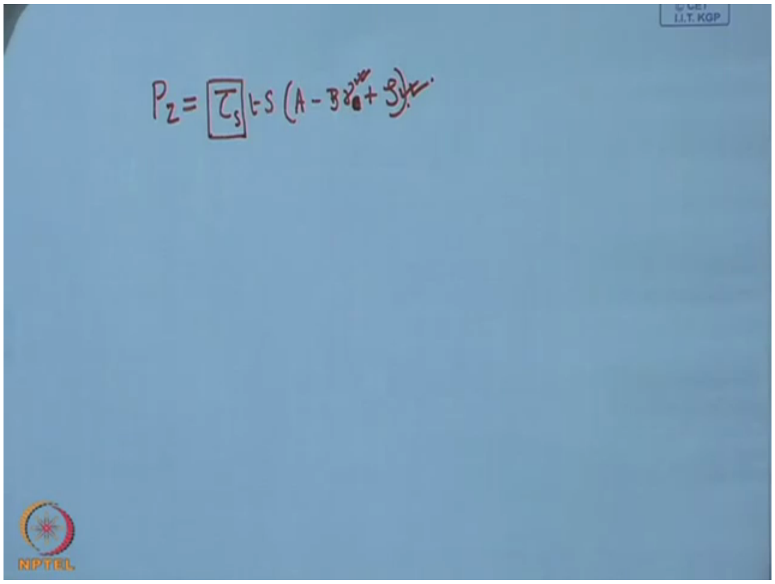

Now how this force measurement is going to be beneficial. Now this is also another index of machining in that we can also express this force by this equation that means PZ is equal to tau S into TS into A minus B gamma plus zeta. So in this case what we find that the value of zeta also comes very much here and this is the orthogonal rake angle, this is the chip reduction coefficient that means the dynamic (())(33:54) strength of the material that means this material, this material which is being machined, its dynamic (())(34:02) strength, this is T, and that is the feed which is say S millimeter per revolution.

So this is the way we put everything inside and get the value of PZ, now what we mean to say here that means here also titanium nitrite is playing a role indirectly because the value of zeta will be influenced by this titanium nitrite, if it offers a low friction. So definitely value of PZ will be brought down and also what we can see further to these.

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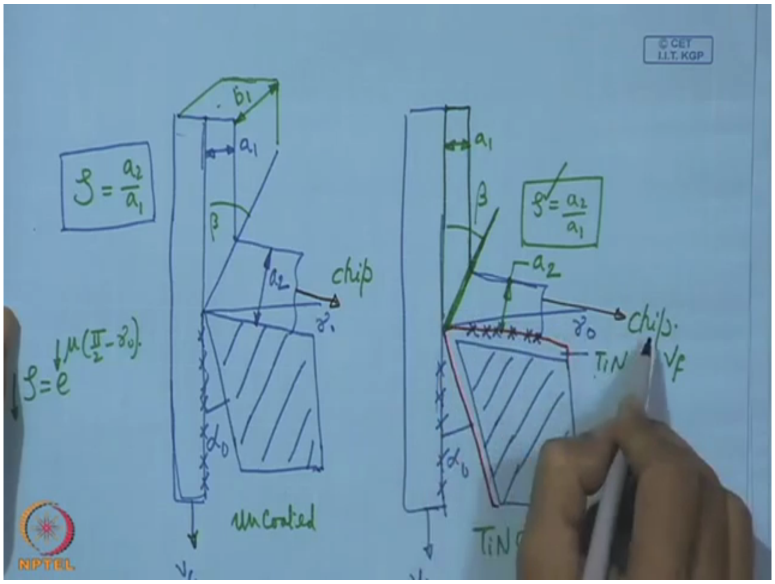

Here looking at this diagram in this here, what we have shown just now that here in this zone if we lower the friction then the friction force that means the drag force necessary for moving the chip in this direction that will be also reduced in comparison to what we expect here, it is because of the coating.

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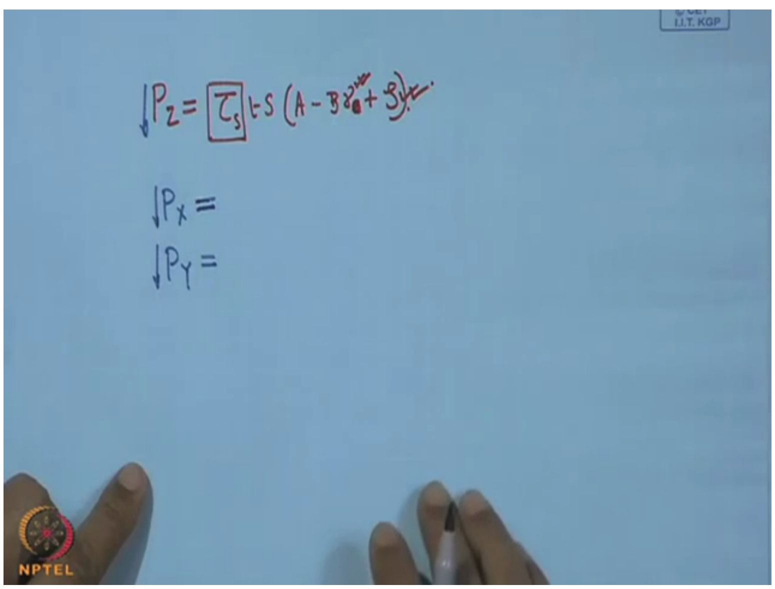

So it is a twofold advantage that means, PZ value can be also brought down then PX which is the axial force, but this axial force is very close to the friction force which is prevailing at the chip tool interface. So this PX and then we have a value PY, but what is important, this PX value can be reduced but since PZ is reduced then overall PX will be also reduced, PY will be also reduced because there are interactive and this PZ value that can be reduced by this reduction of zeta.

So cutting force, measurement of the cutting force that also appears to be one of the important step in determining the capability of the TiN coating, now what can be done that means we can deposit the coating under various conditions. So there are various process variables and also the condition, but the condition under which we get the best coating in terms of this chip reduction coefficient or PZ that appeared to be the one which is most acceptable from the application point of view and there this measurement of PZ is very significant. So we understand that chip thickness measurement and PZ that means the force measurement that is also important.

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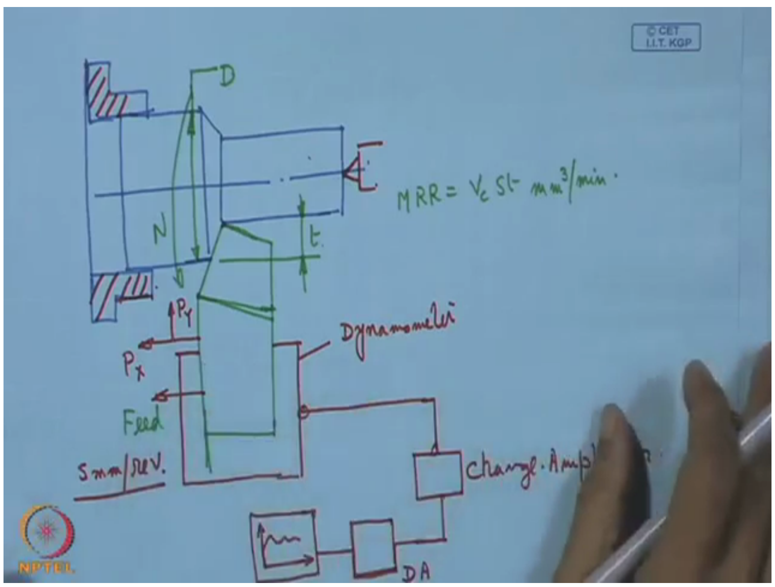

And also from this measurement PZ, PX, PY, which can be directly measured from this dynamometer because this dynamometer has three crystals so they can record directly PX, PY and PZ.

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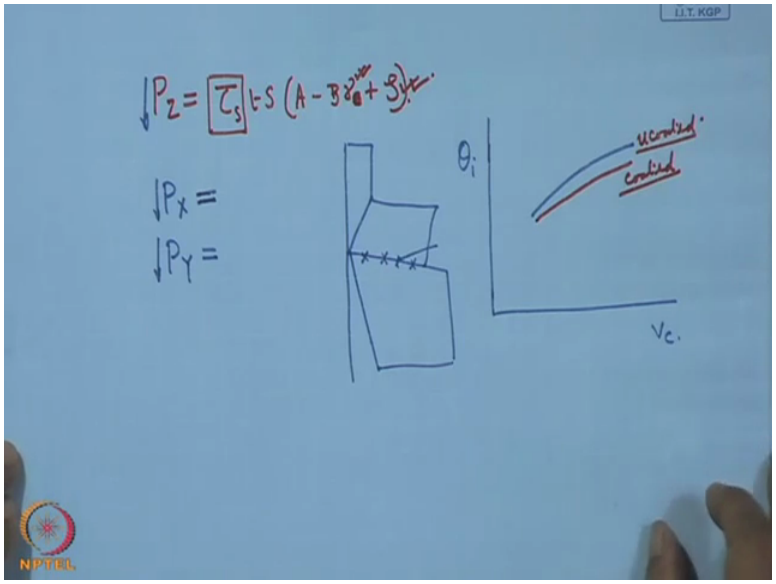

And then by this mathematical relationship it is also possible to find out what is the actual force which is prevailing here and which will be a function of this PX and PZ and since PZ and PX can be brought down by this mu, so naturally that friction force can be also reduced. So this way we understand that the cutting force is an indicator of good machining or poor machining.

Now comes Cutting Temperature, so cutting temperature means it is actually the temperature at the chip tool interface, so this is going to be the chip tool interface. So here we have intimate contact and serial rubbing and this is the zone what we also call the zone of secondary deformation, but this becomes another source of temperature rise, so if we like to protect the face of the tool and the flank, particularly the face, then this temperature should be brought down.

So this could be another study to see that if we plot this value of theta I, that means the interface temperature at this zone and then the velocity VC or other parameter then we can see that the temperature depending upon the speed range or operation range we can find that this is going like this, now this is a graph which is a representative of a tool now say if it is one uncoated tool and if we put a titanium nitrite coated tool what would be our benefit, whether we can see a graph like this in that case we can find a benefit.

So we can also say, comment, that measurement of a cutting temperature and this will be during the machining, so these are all during the machining that means cutting force measurement, cutting temperature measurement this can go simultaneously, however chip thickness measurement that is done just after machining but this thing can be done along with measurement of force so this interface temperature depending upon the work material and the tool material definitely the theta I will be influenced because of the secondary deformation at this point because of this stagnancy, this is a stagnant zone.

However if we have good situation so far as friction is concerned in that case perhaps this value of this temperature that can be brought down and that will be indicated by this line shown here. So expectedly this will be for one uncoated tool and this one for a coated tool. But one has to look in what is the benefit we can derive out of this coated product.

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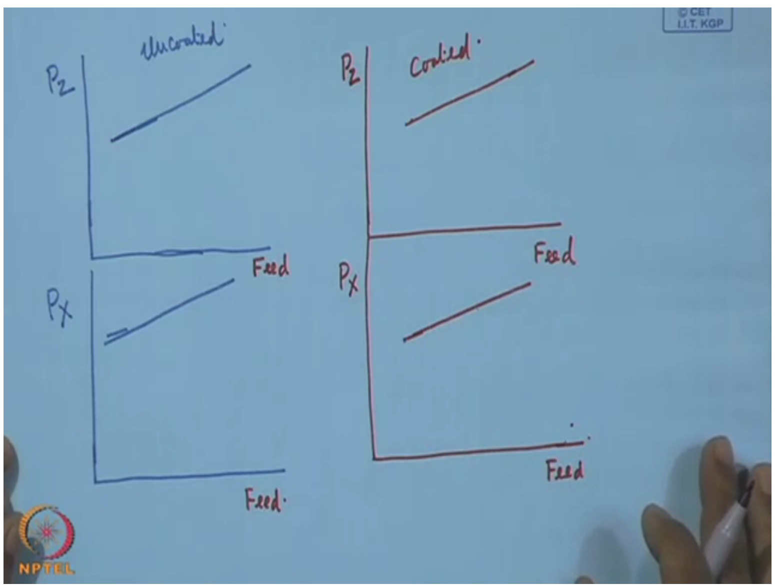

Now one thing we can see here that both the tools we have to use, that means a carbide tool and a HSS tool but one thing also we must know that means particularly say for the force measurement, say this is the force PZ and we have a PX force which is the feed force in the direction of feed. So this is for uncoated tool and we have similar thing we can have another plot for the coated tool, so this side we have say feed value, feed. We like to increase the feed with different value of velocity, now here we have to see what is the benefit.

Now since HSS tools are working in the low speed range even with coating hardly we can cross hundred meter per minute, normally we restrict the speed limit for normal HSS around 30, so with putting a coating of titanium nitrite perhaps we can safely go to 60, 70 meter per minute however within this range our attention should be concentrated on the capability to look at the capability of this titanium nitrite or its capability in particular whether it can reduce the cutting force or not.

That means in this case if we say this is the curve for, for HSS so we draw this two curve, that means here we increase the feed with a same speed and we see that these are rising and when with is drawn for coated tool whether we have to see what is the location of this one and where is the location of this one. So this is very important to compare because in the low speed range it is mostly sticking tendency built up edge formation, those thing will be more critical rather than the wear on the tool because it is the low speed and in the low speed wear does not takes place in such a rate or with such mechanism which leads to rapid growth of wear.

But what is important here anti-welding property, how good the tool is in having that anti-welding property and reducing the friction so that we can get a low value with this coated tool, so this blue line and this red line which are for the tangential force, the main cutting force, that should be compared, their location with identical feed value, similarly PX force which is the axial force, axial feed force actual thrust force for that also we have to see where is the location of this curve for the identical condition of machining, what will be the value of this PZ and PX.

So this is most important that whether the line has been brought down quite substantially and that will simply recognize, can recognize the capability of titanium nitrite coating in particular in the low speed operation range. Now when it comes to high speed operation range, it becomes the wear on the tool, that means in simple term what we can say in simple term this titanium nitrite that has two role, to play, one role is that in the low speed range it has to be an anti-welding coating, not allowing the material, chip material to stick and to form a built up layer.

So that will be realized in the magnitude of the cutting force or in the chip thickness so if there is too much of friction, stagnancy then the value of a2 will grow up automatically, immediately. So this value of a2 will give us immediate an impression that the friction co-efficient is rather high and titanium nitrite is not effective in doing that. So this is important for low speed operation, but when it is going to be high speed, in this case mostly we have seen that in, when it is high speed even for uncoated tool which has a sticking tendency in the low speed range.

That sticking tendency becomes insignificant, much less in high speed range though in the low speed range it has a high sticking tendency, the chip material sticking to the tip or the cutting edge but in the high speed this chances are remote but when we put a coating, definitely the result will be better but that difference will not be that significant, so what we mean to say that if the requirement is that anti-welding or anti-sticking then titanium nitrite is not playing that significant role in the high speed range because in the high speed, already the material develops a character not to stick to that tool surface.

However here what is important what is the major role played by TiN that is how to combat tool wear, so it is actually holding the tool wear reducing the rate of tool wear and that is the greatest role played by titanium nitrite and that will be the greatest contribution of titanium nitrite in holding the geometry of the tool, in holding the capability of the tool even at that high speed where the uncoated tool will reveal it weakness and it will exhaust its life so quickly, so in the high speed range what we can see that if we measure the tool wear.

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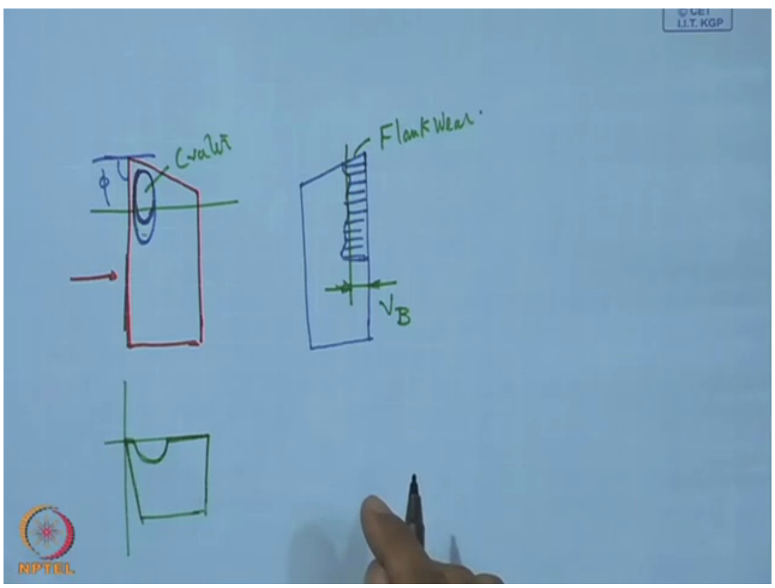

So this is also another issue what we have to measure that means if we see a tool we can show the tool like this, this is the top surface of the tool and if we see the view from this side, we can have a look like this, this is the tool and here we can have wear. This is called the flank wear that means over this contact zone, this wear on the flank has taken place because of the severe rubbing between the work piece and the side surface of the tool and this surface here it becomes parallel to the direction of velocity and clearance is zero.

So in that case that will simply lead to rubbing area will increase, force will increase and that may lead to vibration and that is why we do not allow this tool to operate for longer period of time similarly, what is also going to happen because of the movement of the chip over this surface which we can quickly illustrate here.

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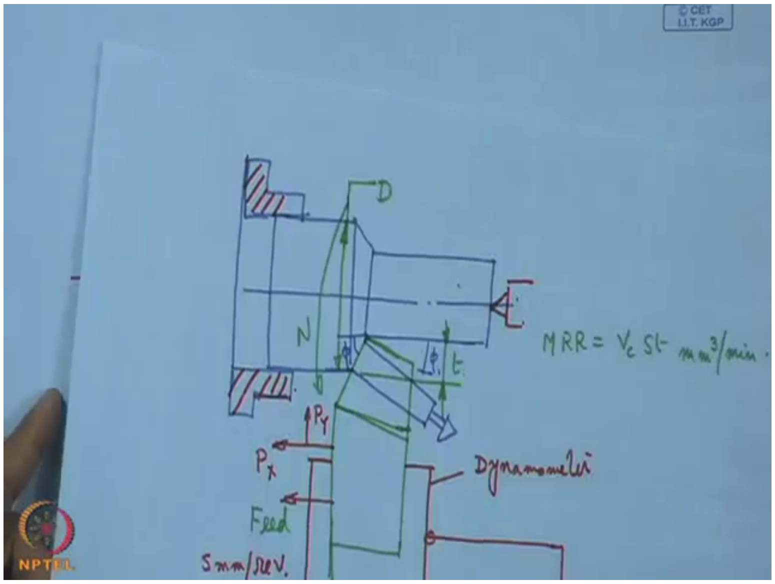

This face, this figure, here the chip will flow in this direction and as a result of this we can expect this tool, here this is the angle, this is called the principle cutting edge angle we have already described, this is the auxiliary cutting edge angle.

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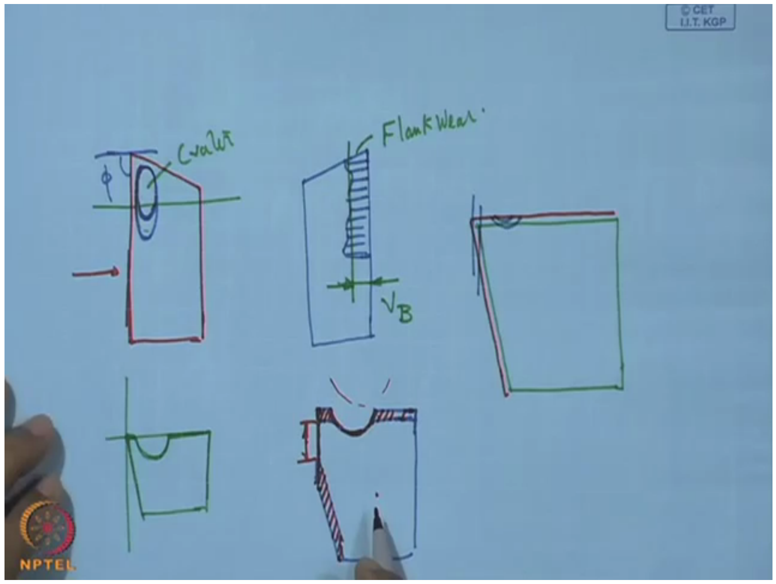

So here the principle cutting edge angle we have considered as 90 degree, whatever may be the case, now as the chip is moving, we can also have a crater like thing over this surface, now with this cratering cavity formation and this wear (())(51:23) formation on the flank, the tool will lose its cutting capability so this width will be actually equal to the width almost coming very close to that because the contact zone is equal to the width of the chip.

So here we get such a thing and this has an average value, say we can show this average value by this line, average value that is called the average flank wear. So this is actually the flank wear and this is called the crater wear. So this is a cavity formed on the face of the tool and this is the flattening of the wear and this one if we take a section to this here what we find that this is going to be a face with such thing.

Now what this coated tool can do, this is an uncoated tool but what this coated tool can do that is quite interesting so if we take a cross-section of this tool, of a tool where we have a coating so this is the coating. Now with wear, there will be wear (())(53:21), so this will be continuous rubbing and there will be also cavity formation, so with that finally we land up with one situation which we can quickly redraw here.

So this will be a situation where we have a portion which is not no more existing and we have a situation something like this, so this is going to be a situation, so here we have the coating, here too we have the coating but the coating is removed from this zone which is become almost like this flank wear, similarly coating is also removed.

However this tool with such formation still can hold the wear rate much slower compared to uncoated tool because of the simple reason that this two edges and this two edges they will act like wear pad. So with this wear pad though coating is removed from this cavity, I mean center of the cavity or from this zone of the flank, however since we have two edges which will support this tool which will be in contact, direct contact with the machine surface and here this will be contact with the chip.

So these two wear pad on the flank and on the rake surface they will still control the growth of the crater so the wear rate of this particular tool will be less compared to that uncoated tool. Now what is important here that this test should be also conducted, that means this test for wear, this is very important particularly when it is high speed operation in that case it is not the question of force or chip thickness but it comes out to be the wear on the cutting tool which changes its geometry position from the contact surface with the job and because of the high rate as the tool moves along the axis of the job because of the wear rate on the tool there could be a shortfall in the depth of cut which may lead to a taper turning.

So if we have a proper coating like titanium nitrite, then that can be also useful in holding that accuracy of the job. So what we mean to say that this test are essential apart from all screening test or characterization test, it is actually the final or ultimate field test which can give us fair conclusion and clear idea about the suitability of the coating in actual application and we can find out all potential of various coatings in the particular application area which may vary from material to material which can also depend on the process variables, cutting speed, feed depth of cut or also the cutting environment whether it is dry cutting or cutting with some cutting fluid or lubricant or coolant or something like that.

So this machining test or the field test that can give us the real picture on the actual performance of the cutting tool. So with that we can summarize the discussion that this coated tool has enormous potential to improve the quality of machining, performance of the tool. However actual machining test in the test base has to be considered and has to be conducted considering the chip morphology, chip size then the cutting force because this cutting force is an index of machinability, what is the force level then it also gives a clear idea about the frictional characteristics at the chip tool interface in particular.

And at the same time last but not the least, it can be also useful, the (())(58:34) test, because the (())(58:36) test is essential for all modern coating which are going to be used for all high speed operation for very difficult to machine material even with under dry condition without the support of any lubricant or cooling, coolant agent. So this kind of performance test is required to recognize the potential of any coating which is going to be used in any of the cutting tool application.