Troubleshooting of Different Troubles by Parameter Optimization in Cylindrical Grinding and its Effect on Grinding Process with Remedies

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Abstract - *Grinding machine become important in now days because of its ability to high surface finishing and MRR. But now days there is demand of continuously increasing quality, MRR and cost reduction, especially in automotive, and aerospace industries, require enhanced processes that provide optimal yield. The aim is to maximize the production rate while maintaining the specified product quality by reducing different types of machine setup and adjustments time losses and chance of rejections. Here author is going to find out root causes of different trouble in grinding which will help to take some preventive actions to reduce rejections. Also it will make easier to find out solution of that particular trouble earlier as possible. So aim of this research is to avoid and reduce time loss due to different problems occurs in grinding process by providing solution guide on it and reduce rejection chance. In this research we are going deal different trouble like RA not ok, chatter on grinding surface, taper, corner radius not ok, grinding mark, burning marks, ovality not ok, run out not ok, etc. Here in this research author going to find root causes that is factor affecting of that's problem's and possible solution's on it by using different techniques like Fish Bone, 5whys. All experiments are carried outs on plane carbon steel on micromatic cylindrical grinding machine for six months*

Key Word- high quality and high MRR, troubleshooting, root causes, Roughness, Ovality, Chatter, Roundness, Fish Bone, 5why's etc.

1. INTRODUCTION

As we all of know how grinding is become important final surface finishing process in industries like automobile, aerospace, robotics etc. Because of its ability to grind very hard surface like harden steel. As we know grinding is the process of removing material by the application of rotating abrasives which are bonded to form a rotating wheel. When the work piece contact to the moving abrasive particles, then abrasive act as tiny cutting tools, each particle cut a tiny chip to form the final shape of work piece. In modern manufacturing industry, the main objective is to high MRR, high quality parts and manufacture low cost within short time. The main machining operations are turning, drilling, thread cutting, milling, grinding etc.

Among them grinding has been employed in manufacturing for more than thousands years. The applications of grinding are mainly for making products requiring a high degree of accuracy and precision.

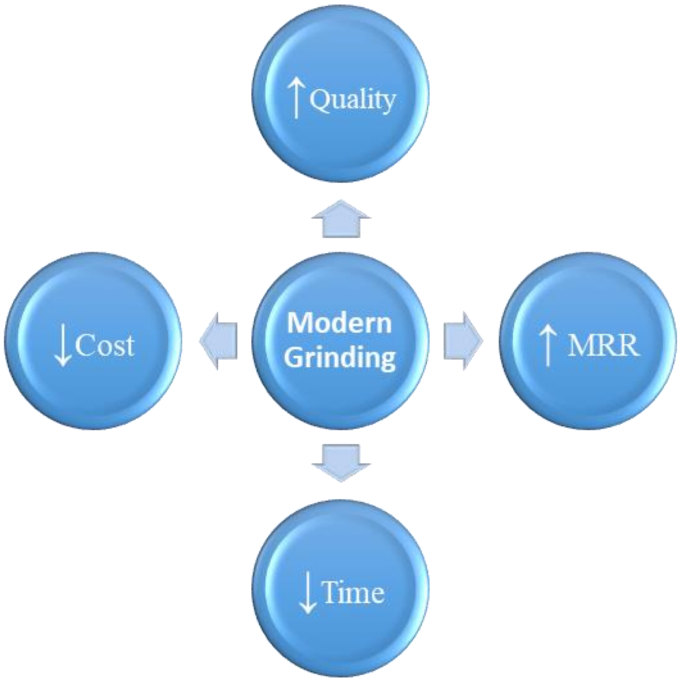

Fig. 1: performance characteristics of high performance grinding processes

Final shape and finish of the part depends on this operation; so it is a very important process in order to meet stringent specifications and tolerances for the output job. Grinding is a large and diverse area of manufacturing due to its intrinsic ability to produce fine surface finishes and accurate dimensions, cut difficult-to machine materials, and achieve high material removal rates. However, there are some challenges as well, especially when it comes too practically. During this experiments different types of grinding variations observed by author was surface finishing not ok, ovality, grinding tapper, run out not ok, chatter marks, grinding burn marks, grinding wheel wear etc. And observed possible causes for the grinding variations was feed, work rpm, wheel rpm, grinding wheel properties, grinding force and power, dressing frequency, dressing amount, no of passes, work material properties, tail stock clamping insufficient, tailstock headstock center misalignment, coolant flow, nozzle angle, grinding wheel unbalance, coolant temperature, coolant filtration, center wear, hardness of the material, dressing coolant, dresser condition, grinding drive motor belt tension etc.

The major operating input parameters that influence the output responses i.e. Metal removal rate and surface roughness are speed, feed and depth of cut. There has been a bit of experimental study, but more extensive research is necessary. Good surface roughness values and high MRR may obtain through process optimization, which needs a deep practical knowledge. The aim of this research is to finding out root causes of grinding troubles and providing possible solution's on it. So it will reduce time require to finding out root cause of any grinding trouble and which will make help to grinding operators. So ultimately is will reduce the machine setup and adjustment time, chance of work rejection and then there will be improvement in MRR and surface quality. In this research techniques used for root causes are 5 whys, Fishbone diagram etc.

1.1 5Why's -

It is very simple and effective technique widely used in industries. In this technique why question is repeated until root cause not find out. Generally why is repeated up to 5 five times. Because it's well sufficient to find out root cause.

EXEMPLE – Chatter occurrence on grinding surface.

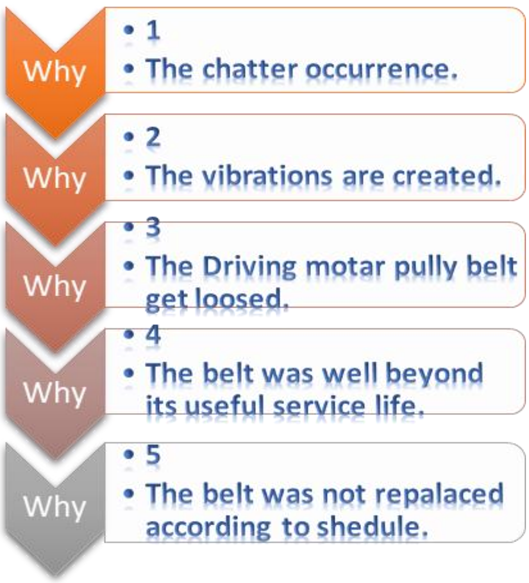

Fig 2- 5 Why's on grinding chatter.

2. METHEDOLOGY

Grinding is the important operation because it is the final operations. So there are more chances of rejections. And grinding rejections means rejection in all previous operations done before grinding. So there is huge waste of money. In the firm where research carried out there was following operations before grinding.1) rolling 2) grooving 3) induction hardening 4) magnetic test 5) grinding 6) crack check.

This research is carried out in firm GKN Driveline Pune. The main product of that firm is to make CV joints with drive shaft. In that firm there are different section in production department namely Inner race, Outer race, Cage, Tripod, Tulip. This research carried out in tulip section. Because lots of rejections happened in tulip section. Tulip is one of the part of CV joints.

Fig. 3 Tulip

Grinding is most critical operation in tulip manufacturing. Because there are lots of causes of grinding rejections. The aim of this research is to concentrate in grinding rejection by finding its root causes. And to avoid chance of rejection. In that firm author is going to operate micromatic grinding machine for more than six months. So this research will be based on practical experience. Our method to finding out root cause is by using 5 why's and Fishbone Diagram. The step sequences in methodology of this research is shown in fig 4 below.

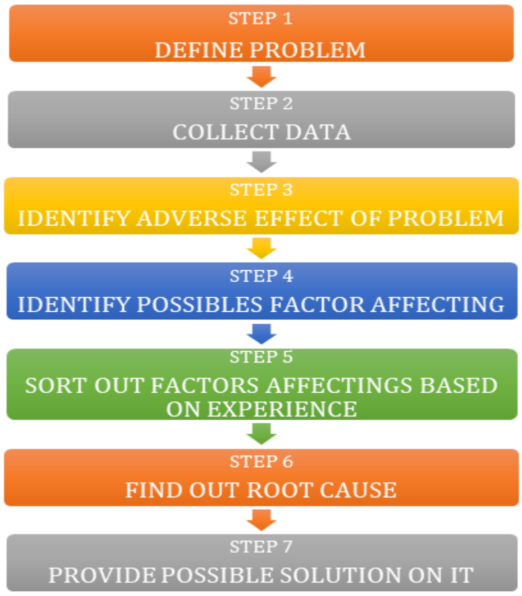

Fig. 4 Methodology

3. EXPERIMENT SETUP

The experiments are carried out on micromatic cylindrical grinding machine in the firm. All experiments are done under supervision of skilled person and production manager. The work specimen is tulip. Which is used in CV joints of automobiles. Fig. 5 shows the design of tulip.

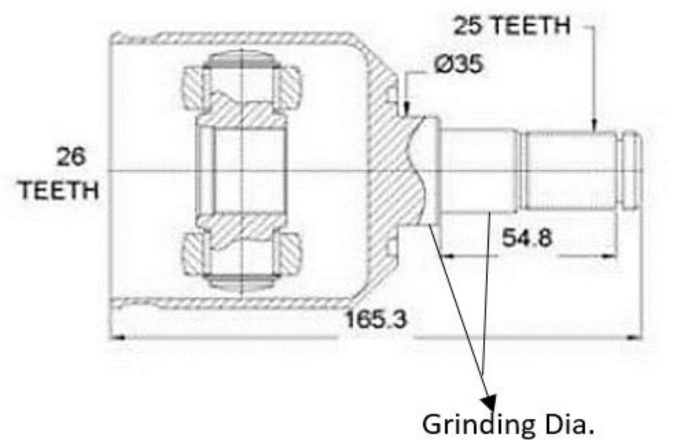

Fig 5 Tulip

The cnc micromatic machine used for grinding of tulip is showed in Fig. 6 below and grinding mechanism of tulip is showed in Fig. 7 below

Fig.6 Micromatic Grinding M/C

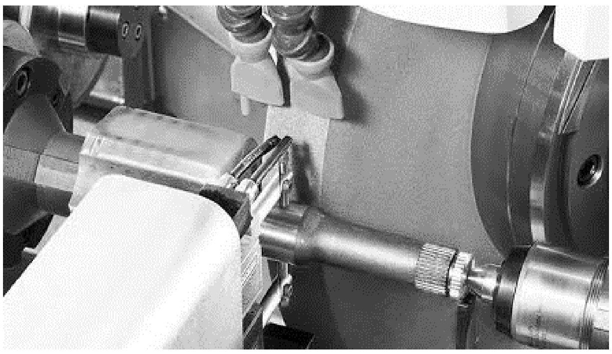

Fig.7 Tulip Grinding Mechanism

Aluminium Oxide grinding wheel used for experiments. During experimentation wheel rpm is kept around 2000 rpm, work rpm kept between 300-400rpm, Feed 5 - 15mm/min, Depth of cut 0.1-1mm. Water immerse soluble oil coolant used. The material used for tulip is not specific. In the firm there are lots of type of tulip according to different customers and theirs different designs. And for each type there is change in material. But two most common material used are mild steel and medium carbon steel which are EN24 and AISI 1045 steel. The grinded tulip is shown in below Fig. 8

Fig.8 Tulip after Grinding

4. FEED

Feed is the one of important parameter which has direct effect on surface roughness. The feed of the grinding wheel is the distance of wheel moves laterally across the work piece for each revolution in cylindrical grinding.

4.1 Effect of Feed on Roughness (RA)-

To analyses the effect of feed rate on Ra, the experiment is carried out practically on micromatic cylindrical grinding machine. During experiments all parameters kept constant. Wheel speed 2000rpm, depth of cut 0.1mm, work speed 300 rpm and coolant flow also kept constant. The no of feed used for experiments are 3mm/min, 5mm/min, 8mm/min, 10mm/min, 15mm/min. after experiments the value of Ra for each feed is measure in standard quality lab on roughness tester. Below graph shows relationship between Ra and feed which we obtained.

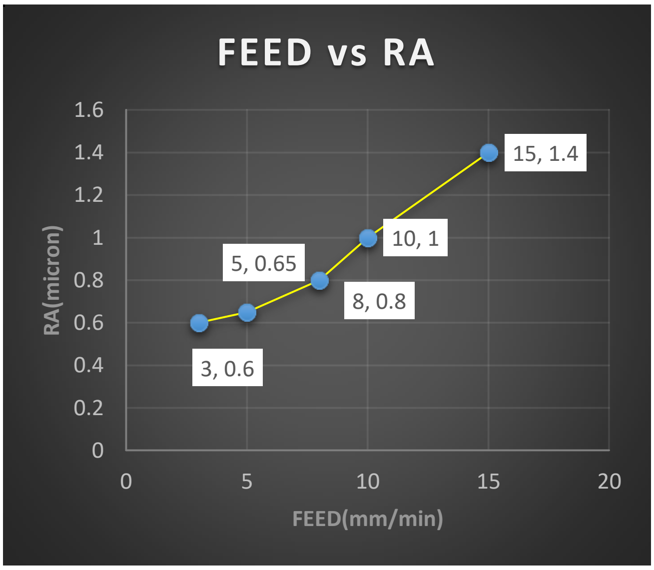

Chart -1: Feed vs. RA

It can be seen from Graph 1 that feed has a huge impact on roughness value Ra. The graph shows that, increase in Feed results in increase of Ra value and decreasing feed rate improve surface finishing.

a) Effects of High Feed-

1) Increase of Ra value because increasing of feed rate, it may lead to increase loads for each abrasive, and higher grinding temperature in contacting area, which in return will further aggravate the abrasive wear. Thus it results in worse machined surface.

2) Excessive feed causes thermal damage, rapid tool wear.

b) Effects of Low Feed-

1) Law feed causes high cycle time because of low material removal rate.

c) Selection of Feed- The feed amount should be select as optimum value which will produce required Ra within shortest cycle time. For this experiments require value of Ra is 0.65 micron, so the optimum value of feed is selected as 5mm/min.

d) Solutions to Avoid Adverse Effects of Feed-

1) The low feed rate produce high finishing surface and reduce MRR, increase cycle time. So by using multiple stages of feed i.e. rough feed, supper feed, and fine feed. The require Ra can obtain within short cycle time.

2). to avoid adverse effect, feed should be proportional to the width of wheel face and the finish desired. In general, the narrower the face of the wheel, the slower must be the traverse speed; the wider the wheel face the faster can be the traverse speed (1).

3) Feed rate can be optimize for best surface quality by using Taguchi Method and Response Surface Methodology (2).

4) Acoustic emission signal sensor can be used to monitor thermal damage due to high feed (3).

5) Also power sensor, force sensor can be used for improve feed performance (4).

5. DEPTH OF CUT-

The depth of cut is the thickness of layer of metal removed in one pass of the work w.r.t. the grinding wheel. During experiments we founds the important of depth of cut and its effect on work.

5.1 Effect of Depth of Cut on Ra-

To analyse the effect of depth of cut on Ra, the experiment is carried out practically on micromatic cylindrical grinding machine. During experiments all parameters kept constant. Wheel speed 2000rpm, feed rate 3mm/min, work speed 300 rpm and coolant flow also kept constant.

The no of depth of cut used for experiments are 0.025mm,0.05mm,0.1mm,0.5mm,1mm. after experiments the value of Ra for each depth of cut is measure in standard quality lab on roughness tester. Below table 1 shows relationship between Ra and depth of cut.

Table -1: Relationship between Ra and Depth of cut.

RA in micron	Depth of cut in mm
0.4	0.025
0.41	0.05
0.5	0.1
0.75	0.5
1	1

Also chart 2 shows trend line of depth of cut vs. RA

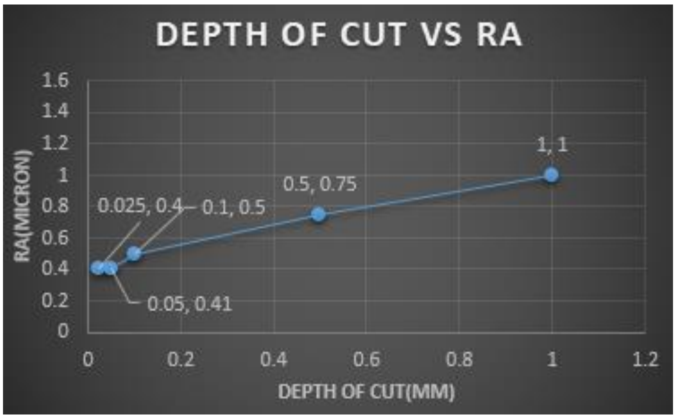

Chart -2: Depth of Cut VS RA

It can be seen from chart 2 that feed has an impact on roughness value Ra. The graph shows that, increase in depth of cut results in increase of Ra value and decreasing depth of cut improve surface finishing.

a) Adverse Effects of High Depth of Cut-

1. As the depth of cut increases, tool wear increases. An optimum value of depth of cut is recommended for work piece made of hard and brittle materials. If higher value of depth of cut will be used, the cutting tool may break

2. Cutting force is dependent on chip which is itself proportional to depth of cut. Hence larger depth of cut can increase cutting force which can hamper machining performance by inducing vibration (5).

3. When Depth of cut is increased then grits become dull. The dull grits led to raised grinding force and effect the geometry of work surface. Such conditions present excessive heating of surface, burn marks and may be small cracks (6).

4. Large depth of cut will also lead to less cutting and more rubbing or ploughing due to more wear, abnormal fracture and completely break-off of wheel grains. Thus an optimum value needs to be determined depending upon material and machine process (7).

b) Adverse Effect of Low Depth of Cut –

As material removal rate is (MRR) is expressed by the multiplication of cutting velocity, feed rate and depth of cut. So decreasing in depth of cut decrease material removal rate (MRR). When material removal rate decrease the machining time increase and hence the productivity decrease so large depth of cut should be used when higher productivity is required

c) Selection of Depth of Cut-

The depth of cut amount should be select as optimum value which will produce required Ra within shortest cycle time. For this experiments require value of Ra is 0.65 micron, so the optimum value of depth of cut is selected as 0.1 mm

d) Solutions to Avoid Adverse Effect of Feed-

As the depth of cut increases, Roughness value increased and MRR also increases linearly. For minimum Ra value depth of cut need to keep at lower side while for maximum MRR its value depth of cut need to be at higher side. So it's make difficult to select depth of cut. As we selected depth of cut as 0.1mm with feed 3mm/min. so for this feed and depth of cut we got cycle time 56 sec per part. So definitely there was need to reduce cycle time. That's why we used feed and depth of cut in steps. And we reduced cycle time from 56 sec to 30 sec per part. So we improve our production rate by huge amount. The stepped feed and depth of cut we used given in table 2.

Table -2: Stepped Feed and Steeped Depth of cut

Stepped Feed	Steeped Depth of cut
rough feed-(15 mm/min)	1 mm
super feed-(5mm/min)	0.5mm
fine feed- (1mm/min)	0.020 mm

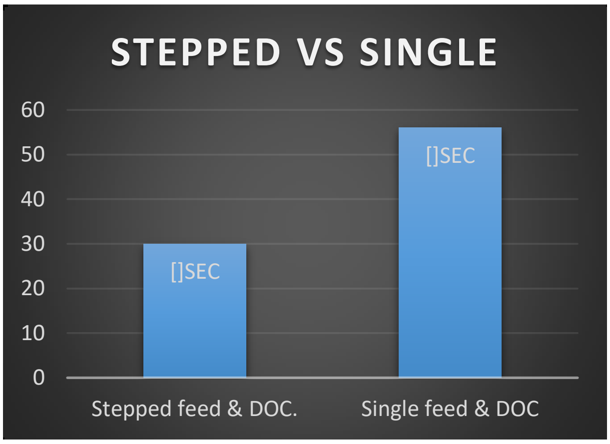

Chart -3: Stepped VS Single feed & DOC

6. EFFECT OF WORK AND WHEEL RPM-

During experiments author notice some effects after changes in speed i.e. rpm of wheel and work. When we kept low speed (150rpm) of work we observe increase in RA. And when we increase speed of work to 350rpm, RA get reduced. So we increase work speed again to 450rpm. It reduce RA by small amount but simultaneously it induce vibration in machine. So we kept the work speed between 250 to 350 rpm. Same things we observe with wheel rpm, i.e. reducing speed increase RA and increasing speed increase vibrations. So we kept it as 2000rpm. As the work piece speed increases, the rubbing of the abrasive grain also increased so the MRR also increased. Also for reduce grinding wheel wear it is must to operate with optimum wheel speed (8). Also due to very high work speed there is chances of chatter formation (9). And also excessive wheel speed increase chances of wheel exploding (1)

7. EFFECT OF COOLANT FLOW-

The type of coolant we used for all experiments in the firm is water soluble oil immersed. The coolant flow helps to remove away works chips also it helps to explore new work surface to grinding wheel. Another main purpose of coolant flow in wet grinding is to maintain temperature of grinding zone to avoid grinding burn. The lack of coolant flow has direct effect on surface roughness. So coolant flow should be maximum. Hemant S. Yadav, Dr. R. K. Shrivastava conclude that increasing coolant flow increase MRR But too much excessive coolant flow increase the grinding force require and decrease MRR(10)

7.1 Presence of Filter Paper-

The presence of clean filter paper is important in grinding. It means it is necessary to change filter paper time to time. We observe that if filter paper not changed then wear out grinding wheel particles and work chips flow back again in grinding zone which makes dotted marks on grinded surface of the work which can see easily. So its increase the RA of work surface. So the presence of filter paper is not only important but the presence of clean filter paper is important. So operator have to change coolant filter paper as per schedule.

7.2 Effect of Foaming In Coolant-

Foaming is the one of most common problem in cnc grinding. But it is important because during experiments author observe one interesting effect of foaming on grinding operation.

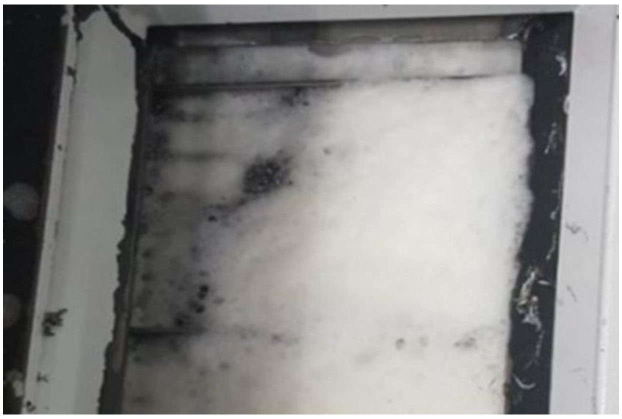

Fig 9. Foaming of coolant

Due to Excessive forming instead of circular the ovality shape of grinding diameter produced. So it increase the chance of work rejection as shown in fig 10 below.

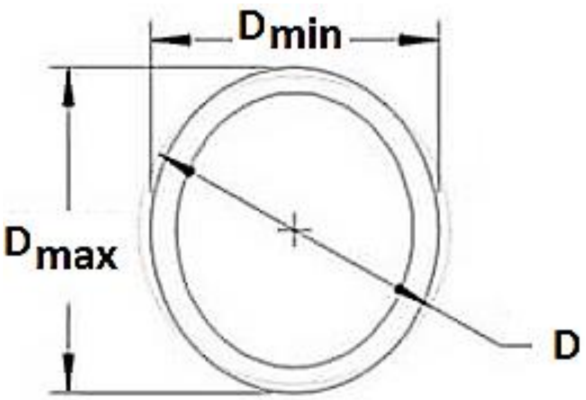

Fig 10. Ovality shape of work

When foaming increase then no. of air bubbles creates between contact of work and grinding wheel and the bubbles creates gap between work and grinding wheel. So that's why uneven contact of work and wheel happens during grinding which produce oval shape of grinding diameter. The foaming of coolant happens when PH concentration of coolant change. If water in coolant become too soft then it increase foaming. So add defoamers' oil in coolant to avoid foaming. The operator should have to check PH level of coolant daily to avoid foaming.

8. OVALITY-

Ovality is the major problem which we faced during experimentation. Our lots of rejects due to very high ovality. Ovality is nothing but tendency to producing two diameters major and minor instead of circular shape as shown in fig 11 below. We used snap gauge to measure ovality in the firm as shown picture 12 below. Our tolerance for ovality was maximum 30 micron. Ovality can give by = Dmax – Dmin

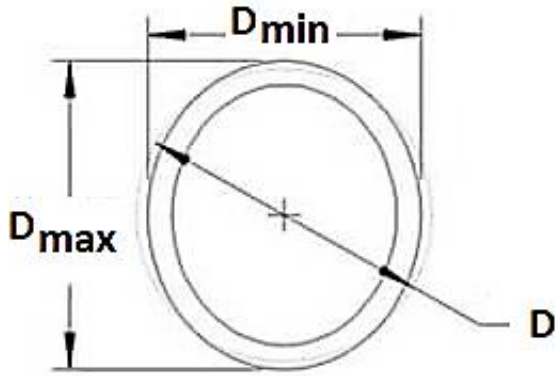

Fig11 Ovality

Ovality Measuring Dial Snap Gauge-

Fig 12 Ovality snap gauge

8.1 Ovality due Insufficient Teal Stock Clamping Force-

This is one unpredictable reason which we found during experiment. In cylindrical grinding headstock is fixed only tailstock moves to hold work piece and it is done by hydraulic pressure. Due to insufficient clamping force part produced with very large ovality up to 100 micron so parts get directly rejected. Due insufficient hydraulic oil in hydraulic system or due to blockage of oil filter tail stock clamping forced get reduces. Also there is flow control valve to adjust hydraulic pressure so we can adjust tail stock clamping force. It is operator responsibility to check hydraulic pressure before start working to avoid rejections.

8.2) Ovality Due To Foaming In Coolant-

This reason we already discussed above. This is also one of the unpredictable reason of ovality. When PH concentration of coolant disturb then there is foaming in coolant which creates bubble unbreakable and uneven air gap between contact point of wheel and work. And this uneven contact lead to ovality.

9. EFFECT OF DRESSING PARAMETERS ON GRINDING SURFACE-

Dressing is the method of reshaping to cutting tool. And also it used to restore original shape of grinding wheel profile. During practical experimentation we observe some effect of dressing. Dressing play important role in grinding. We used multi point diamond dresser shown in picture below. We used dressing frequency of grinding wheel after every 20 experiments.

Fig. 13 Dresser

A) Effect of Dresser Condition-

The diamond point of dresser is only important. When it wear out then it not produce require shape profile on grinding wheel so when grinding is done on work then it form step in corner, taper on surface, corner radius of wrong dimension also after dressing we got high surface roughness. Dresser tip may also breakout due to high cross feed cut and due to material defect. Below fig shows the step formation at corner due to wear out and broken dresser.

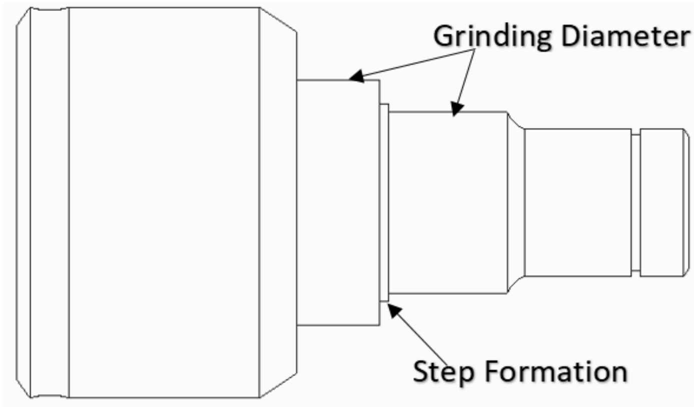

Fig. 14 Step formation

Worn dresser produce corner radius either over dimension or either under dimension, shown in fig below-

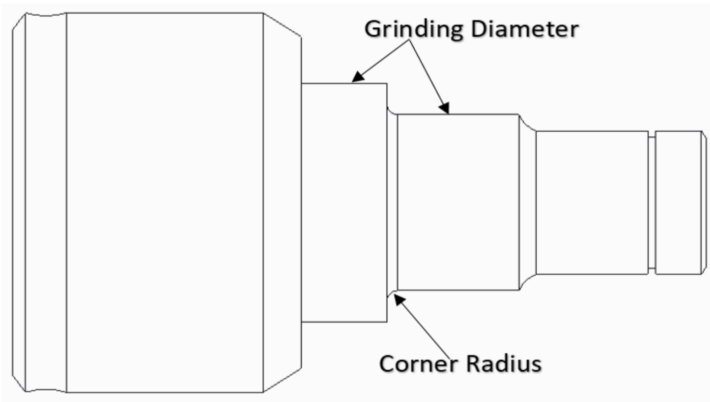

Fig 15. Corner radius

We observe that the worn and breakout dresser produce line marks on grinding wheel which produce rough surface of work. We measured the Ra value after dressing by worn out dresser and new dresser in quality lab and we observe huge difference. Showed in graph below-

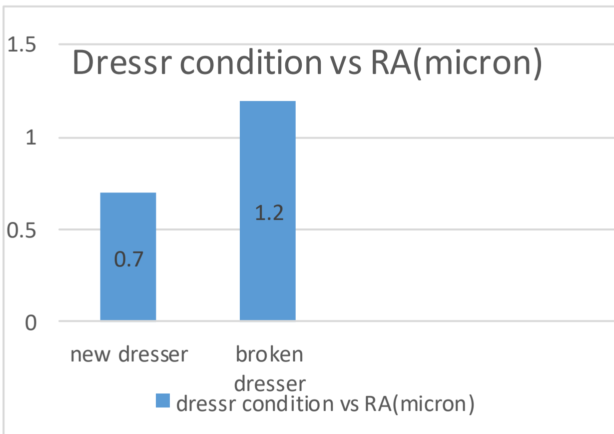

Chart- 4 New Dresser VS Broken Dresser

B) Effect of Dressing Coolant-

In cylindrical wet grinding, the dressing coolant also important because we observe its direct effect on dresser life and surface roughness. During the dressing operator have to check dressing coolant flow and its direction. Its direction should be toward the diamond point of dresser. Lack of dressing coolant reduce dresser life as well as it increase surface RA.

C) Effect of Dressing Parameters-

We studied no of dressing parameters during experimentations which dressing feed, dressing depth of cut, dressing angle, dressing frequency and no of passes. Among them dressing feed and depth of cut has more impact. Optimum range of dressing parameters can give the higher grinding efficiency. A slow feed and small depth of cut gives the wheel a fine finish, but if the feed is too slow, the wheel may glaze. A fast feed and high dressing depth of cut makes the wheel free cutting, but if the feed and depth of cut is too high, the dresser will leave tool marks on the wheel also there is chances of dresser brake. The correct feed and depth of cut can only be found by trial, but a uniform rate of feed and depth of cut should be maintained during any one pass. Dressing time is non-productive so dressing frequency is should high as possible. The surface roughness increases with increase in drag and angle of the dresser, and decreases with increase in number of passes (11)

D) Solutions to Avoid Adverse Effects of Dressers-

a) Optimize dressing parameters by practically trials

b) Set the frequency for dresser change and change the dresser at that frequency

c) Make sure presence of dressing coolant flow during the dressing at right angel or direction

d) Check dresser condition in between cycles if it brake out then replace it.

10. ROUNDNESS

Out of roundness is the critical parameter to control. It is very difficult to find out exact root cause of roundness error by practical experimentation. Out-of-roundness is of great importance in case of shafts, axles, pistons, piston pins, crankshafts, roller bearings as out of roundness in these components can lead to excessive noise, vibrations, component failure, etc. so there is need to optimize the input parameters to have minimum out of roundness error. In the firm we used two different methods to measure roundness which are Checking roundness by dial indicator by using v block is one of simplest method used by operator. And for more accuracy we used CMM machine for roundness measurement. Roundness is nothing but waviness profile of work OD.

Below fig 16 shows profile of roundness –

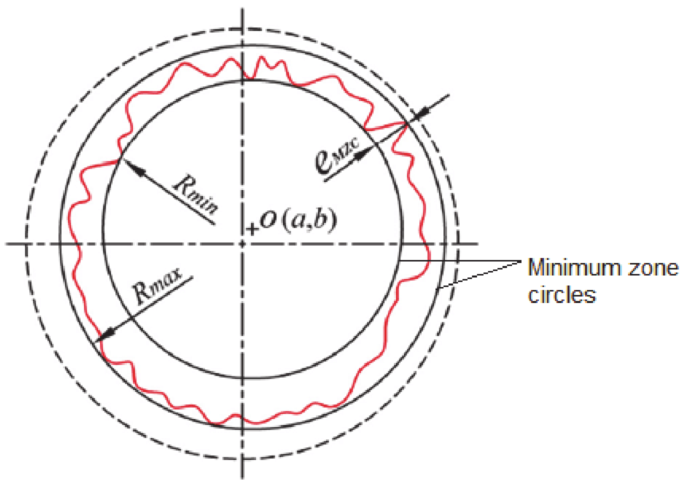

Fig. 16 Roundness

During machining we observe that the ratio of wheel and work speed play important role to control roundness. When we increase wheel speed from 2100rpm to 2500rpm then we observe increase in roundness error to 7 micron. A.A. Ibrahim conclude in their research is that when the work and wheel speed ratio is an integer value then roundness error increases (12). Also we observe that when depth of cut is high then it lead to increase in roundness error. Better solution which we found out to avoid roundness error is that spark out period or dwell time for 1 to 2 sec after fine grinding. I.e. grinding wheel will remain steady at final position for dwell time. Another one reason of out of roundness is vibration. As we know increase in vibration increase chances of chatter marks but it also effect on roundness of work piece. Increase in vibration also increase roundness. A.A. Ibrahim conclude that the initial waviness on the workpiece contour excites the wheel-work system and the forced vibration exists between the wheel and workpiece which increase roundness error (12). Taranvir Singh, Parlad Kumar, Khushdeep Goyal conclude that increase in grain size of wheel increase roundness error (13).

According to Minke (1999), the high friction levels generated during the grinding process may be considered as an extremely important factor, which contributes to the roundness errors formation. The employment of cutting fluids with higher friction reduction capacity is important for roundness reduction (14). There are two methods which can be used for roundness optimizations. Artificial intelligent (AI) technique for improvement of roundness error used by A.A. Ibrahim in their research and optimizations of various parameters for roundness by taguchi method (15).

10.1) Run out- it is one of the difficult parameter to control. Run out is nothing but rotation of work piece about an axis away from its centroid axis. It is non desirable characteristics. Increase in run out increase vibration of revolving parts and part may fail due to fluctuating load. Out of roundness as well as ovality are the causes of run out. Also we observe that head stock and tail stock center miss alignment that is not in co-axial is the major reason for increase in run out. One of major reason which we observe during practical experiments is the tail stock center tip wear.

When center tip wear out then work piece does not revolve at an idle axis during machining and run out increases. So by controlling ovality, roundness, tailstock and headstock center misalignment and replacing tail stock wear out center we can control the run out.

11. CHATTER MARKS

After surface roughness (RA) chatter in grinding is the most common and critical cause observe in cylindrical grinding. During experiments our lots of part get rejected due to chatter marks on grinding surface. Below picture shows chatter marks on grinding surface. The chatter marks can easily detects by visual inspection.

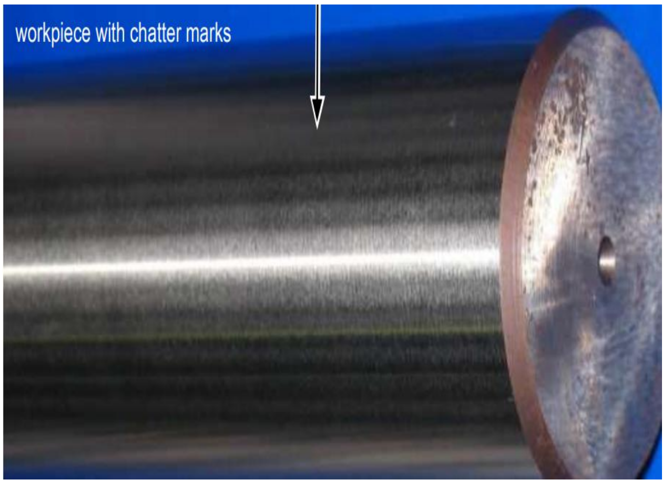

Fig. 17 Chatter marks

The chatter occur due to vibration in machine. Due to vibration there is uniforms contact of grinding wheel and work. So to prevent chatter occurrence it is necessary to reduce vibration magnitude in machine. The chatter phenomenon also reduce grinding wheel life. The vibration may force excited or self-excited. The root cause of Self excited vibration are generally critical to detect. After experiments we found out some main reasons of chatter occurrence.

a) If depth of cut is too heavy then it increase the chance of chatter marks. Very high depth of cut and high feed increase the load on cutting wheel which create bouncing effect cause chatter on work surface
b) Another main cause we observe which is belt condition. The belt which is connected to driving pulley of motor and driven pulley of grinding wheel as shown in fig below. When belt tension reduce then during rotation at particular rpm belt oscillate which create vibration on grinding wheel so chatter occur.

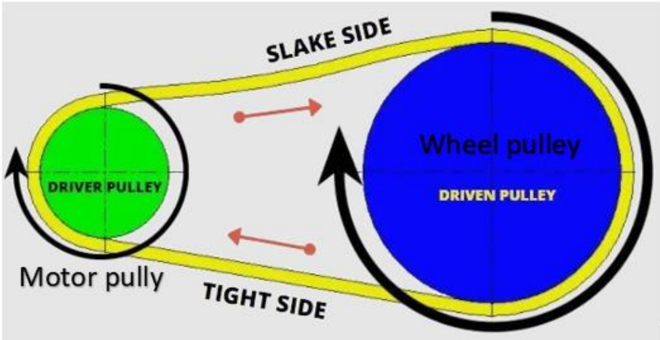

Fig 18. Pulley

c) Another one cause of chatter is very high work speed of rotation. So it is necessary to maintain work speed in optimum range. When we kept our work speed as 450 rpm then we observe chatter formation on work. So again we reduce work speed to 350 rpm. The work speed has direct effect on arc of contact with grinding wheel. And the optimum work rpm varies from machine to machine and we can only find out it by practical experiments.
d) Another and most important root cause of chatter is wheel out of balance. When wheel balancing is not ok then definitely there will be chatter formation. Wheel may be out of balance due to dressing by worn out dresser or due to when there will be cracks in wheel and material removed out. Generally wheel is balanced while installing. Another one way to balance wheel is auto balancing.

Felipe Aparecido Alexandre and Wenderson Nascimento Lopes conclude in their research paper is that chatter formation can be monitors by digital signal processing (16). Prof. Dilip Khedkar and Vinod Hange found out various root causes for chatter formation in their research paper also they suggested corrective action to avoid chatter (17). Mate Toth, Neil D Sims, David Curtis conclude that chatter formation occurs due un even wear of grinding wheel and uneven wear of grinding wheel can quantified by an uneven specific energy distribution around the circumference of the grinding wheel (18)

12. CONCLUSIONS

In this paper we discussed different kind of problem occurs in cylindrical grinding and we found out root causes for that. From that following conclusions are concluded.

1. High feed and high depth of cut increase surface roughness and tool wear also low feed and depth of cut reduce material removal rate so we can maintain both roughness as well as MRR by using steeped feed and depth of cut. Also we can use different techniques to optimize feed and depth of cut like Taguchi method, Response surface methodology, Acoustic emission signal analysis, by trial and error method.

2. Reducing wheel and work rpm increase roughness and increasing Rpm speed increase vibrations. Also due to very

high work speed there is chances of chatter formation. And also excessive wheel speed increase chances of wheel exploding.

3. Increasing coolant flow increase MRR But too much excessive coolant flow increase the grinding force require and decrease MRR. Foaming of coolant increase ovality of work piece. Coolant foaming increase when PH concentration not ok.

4. When tail stock hydraulic clamping pressure is insufficient then it increase work ovality and increase in ovality increase run out.

5. Worn dresser produce line marks on grinding wheel which produce rough surface of work. High dressing depth of cut and lack of dressing coolant increase surface roughness.

6. Increase in wheel rpm and depth of cut increase roundness of work. Also high vibration increase roundness.

7. Tailstock and head stock center axis miss alignment increase run out. Also tailstock center tip wear increase run out.

8. Reduction in pulley belt tension, high work and wheel rpm, out of wheel balancing introduce vibration result in chatter formation on grinding surface.

From above conclusions we can take quick and right corrective action to avoid grinding trouble.

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