IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
National Conference on Design, Manufacturing, Energy & Thermal Engineering (NCDMETE-2017)
AGTI's Dr. Daulatrao Aher College Engineering, Vidyanagar Extension, Karad
Vol. 4, Special Issue 1, January 2017

Review of Failure of Grinder Wheel

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Abstract: The findings of this paper are to study failure of grinding wheel by various methods. It also show that during grinding the grain is subjected to forces that create fracture initiation zones in the sharp abrasive grains where tensile and compressive stresses dominate in certain parts of the abrasive grains. The grinding process relies on wear of the abrasive wheel, and the rate of wear plays an important role in determining the efficiency of the grinding process and the quality of the work piece. Vitrified grinding wheels are typically used to remove large volumes of metal and to produce components with very high tolerances. It is expected that the same grinding wheel is used for both rough and finish machining operations. Therefore, the grinding wheel, and in particular its bonding system, is expected to react differently to a variety of machining operations. In order to maintain the integrity of the grinding wheel, the bonding system that is used to hold abrasive grains in place reacts differently to forces that are placed on individual bonding bridges. The structure of a vitrified grinding wheel is composed of abrasive particles, a bonding phase, and distributed porosity to collect detritus and provide access for lubricants. The approach used in this seminar is based on using finite elements to model fracture wear processes in vitrified grinding wheels.

Keywords: Bond Faacture, Wear Model, Failure Model.

I. INTRODUCTION

Formation of cracks, damages of shapes due to excessive stresses in grains of grinder wheel is nothing but the failure of grinder wheel. Grinding wheels are a multipoint cutting tool composed of selectively sized abrasive grains held together by a bonding material. Abrasive materials are Aluminum oxide or Silicon Carbide in conventional range. Grinding is a process of material removal, which happens in the form of chips by the mechanical action of regularly shaped abrasive particles bonded together. Grinding is done to get required Size, Form, and Finish.

The grinding process relies on wear of the abrasive wheel, and the rate of wear plays an important role in determining the efficiency of the grinding process and the quality of the work piece. The structure of a vitrified grinding wheel is composed of abrasive particles, a bonding phase, and distributed porosity to collect detritus and provide access for lubricants. The wear behavior observed is similar to that found in other wear processes; high initial wear followed by a steady-state wear regime. The third accelerating wear regime usually indicates rapid wear of the grinding wheel, which means that the wheel will need to be sharpened. This type of wear is usually accompanied by thermal damage of the machined work piece.

II. OVERVIEW

The overview of this seminar are to model failure of grinding wheel by various methods. In our daily life breaking or damaging of grinding wheel occurs many times. To avoid injuries and to increase efficiency of grinding process it is very important to predict the failure of wheel before its operation. It also show that during grinding the grain is subjected to forces that create fracture initiation zones in the sharp abrasive grains where tensile and compressive stresses dominate in certain parts of the abrasive grains. Analyzing forces acting in grinding mechanism and solve problems by using various techniques like fem, mat lab programming. Experimental processes are ring test, x-ray & ultrasonic monitoring, shadow monitoring etc.

Basically this is a review of all the work done on modelling of failure of grinding wheel. Many scientist have done dominant work on this chapter. Summary all that work is tried to compensate in this seminar. Various methods to detect and analyze the failure are systematically carried out in all this work conducted by such persons. X- Ray method, ultrasonic method, ring test, hardness test are various methods to detect such failure. With the study of this new method is discovered to detect misalignment of wheel. Name of that method is Shadow technique. In future scope main focus will be on new methods to detect failure of wheel and that methods should be cheap.

III. RESEARCH WORK

Alireza Vesali & Taghi Tawakoli [1] created hydrodynamic pressure zone model of grinding. Lubricant plays important role in grinding and also affects the efficiency of grinding process is explained by this two people. In the grinding process, coolant lubricant is used to lubricate and mainly to transmit the heat generated in the contact zone. Grinding wheel accelerates a portion of the coolant lubricant into the contact zone. As a result of the wedge effect between grinding wheel and work piece in the contact zone a hydrodynamic pressure is generated, which influences the grinding results. The simulation results show that the hydrodynamic pressure is proportion to grinding wheel velocity, and in inverse proportion to the minimum gap between wheel and work piece. Deniz Aslan and Erhan [2] designed semi analytical force model to calculate total forces in grinding. Normal force and tangential force also calculated by assuming some basic parameters which are required and then total forces of grinding are calculated. This model is developed for grinding process is developed by modeling abrasive grits.

J. A. Williams [4] approached wear model by analytical method. Some guidance and reconciliation between analytical and computational models and empirical observations can be provided by plotting wear maps for specific materials so that the dominant wear mechanism for particular operating conditions can be established and some indication provided on probable wear performance. A challenge facing the research community is the production of a sound theoretical framework to underpin such design aids.

However, because of the variety and complexity of the surface conditions it is not straightforward to relate tribological performance to more easily established material parameters. These difficulties are illustrated by looking at the mode available for two particular classes of wear involving metallic materials severe abrasive wear. Humphreysa, Gerrit [5] monitored cylindrical grinding which is complex grinding process. Complex grinding is very difficult to analyze so they used FPGA monitoring method to get readings of various parameters. Sensor systems for machine condition monitoring face many challenges in the world of digitized data with an emphasis being placed on the application of high performance feature extraction computing systems. These systems must be robust, reliable and economically viable before being adopted by industry.

This paper describes a platform for condition monitoring that has been developed using a field programmable gate array (FPGA) for the real time signal processing in a complex grinding process. M J Jackson [6] has done analysis of controlled wear model by FEM using various software's. Soft wares used by him are Ansys and mat lab. The study of bonding hard materials such as aluminum oxide and cubic boron nitride (CBN) and the nature of interfacial cohesion between these materials and glass is very important from the perspective of high precision grinding. In order to maintain the integrity of the grinding wheel, the bonding system that is used to hold abrasive grains in place reacts differently to forces that are placed on individual bonding bridges. William examines the role of verification heat treatment on the development of strength between abrasive grains and bonding bridges, and the nature of fracture and wear in vitrified grinding wheels that are used for precision grinding applications. J Yang and M. Oden [7] worked on surface integrity and flexural strength of wheel in grinding operation. In their study, the correlation existing among grinding, surface integrity, and flexural strength is investigated for cemented carbides (hard metals).

A fine-grained 13 wt % Co grade and three different surface conditions: ground, mirror-like polished, and ground plus high-temperature annealed, are investigated. Surface integrity and mechanical characterization is complemented with fractography. The grinding strongly affects both surface integrity and flexural strength. During grinding, a damaged thin layer together with high compressive residual stresses is introduced. The layer results in considerable strength enhancement compared to the reference polished surface condition. Fractography reveals that the improved strength mainly stems from grinding-induced changes on effective location, from surface into subsurface levels, of the strength controlling flaw.

IV. MATERIAL REMOVAL MECHANISM

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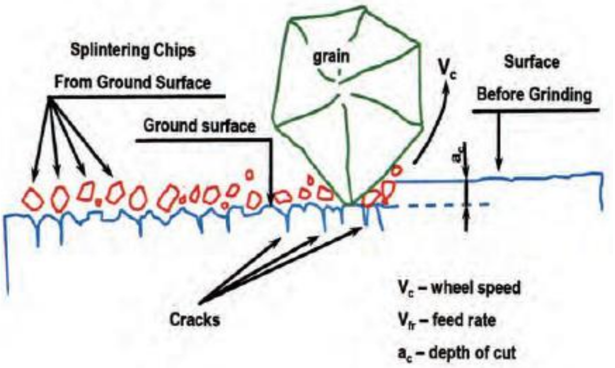

Fig 1: Mechanism of Grinding Operation [1]

V. CAUSES OF FAILURE

Number of causes of failure of wheel are not too large. Many failures are due to less operating skill and faulty operating conditions. But there are some few parameters cannot be detected easily that will cause failure of wheel. Such as breaking of bond between grains & abrasives, Misalignment of wheel on shaft, formation of excessive inside the wheel etc. Some of them are as follows – Breakage of bond between grains & abrasives, Maximum stress exceeds the ultimate tensile stress & Improper handling by the operator.

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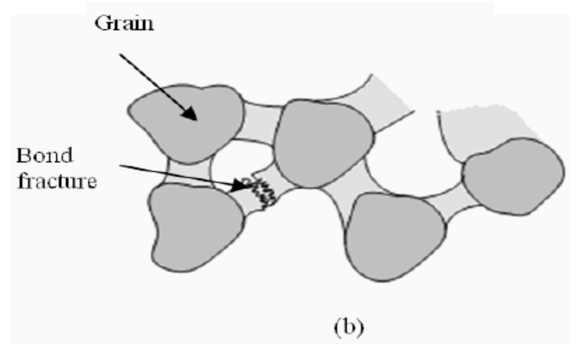

Fig 2: Bond Fracture [4]

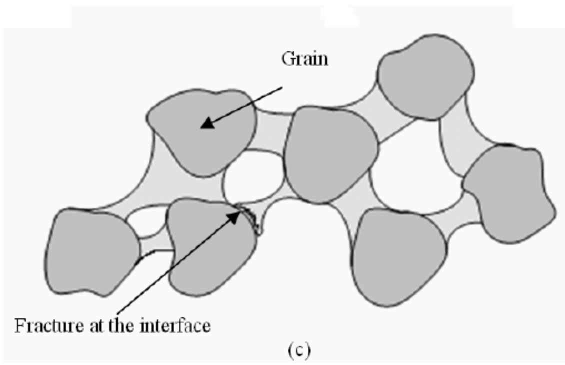

Fig 3: Fracture at interface [4]

VI. TEST TO DETECT FAILURES

Regular quality check must be done on wheels are: Visual Inspection, Geometry of wheel Ring test Density of wheel which affects the performance of wheel Speed, testing of wheels, Hardness test. Sometimes the wheels do qualify critical test of the ring and speed test but still would break at customer end. Hence the need for introducing the other test for wheels is felt.

This method are here, some of them explained further.

- Liquid penetrant method
- Magnetic & eddy current testing
- Ultrasonic test methods
- X-ray Method
- Shadow test

Ultrasonic test method:

Pulse echo technique adopted and US waves are allowed to propagate in the material by means of a transducer. The US waves get reflected at interfaces, which are then received.

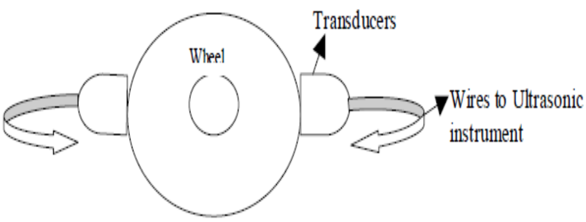

Fig 4: Ultrasonic Test [3]

The elapsed time of sending and receiving the waves is measured. Depending on the presence of the flaw the transit time will vary. Knowing the depth of the travel of the waves, velocity and thereafter the young modulus can be calculated. This method was attempted to check the Transit time of the wheel for interpretation.

X-ray test:

To identify the internal defects another method is X-rays radiography. X-ray imaging technique is an important tool for the real time radiographic inspection and it is commonly used in the medical and industrial application. These systems can be classified for the low and high X-ray energy applications. Application an X-ray in the energy range of on the good wheel and also on the cracked wheel. Output pictures shows clear image of good wheel and cracked wheel. It is very easy method to detect failure in grinder wheel. But this method also have one disadvantage machinery required for this method is very bulky so test becomes expensive. Hence this test is not mostly used in daily engineering applications

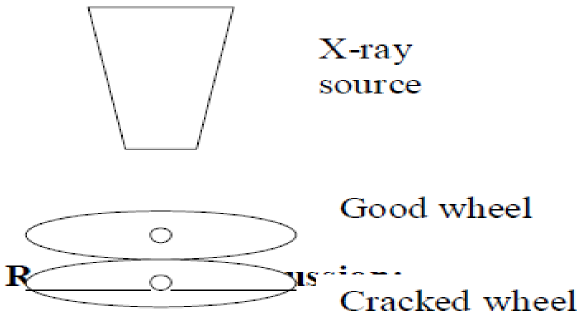

Fig 5: X- ray Test [3]

Ring test:

Method of grinding wheel inspection is called ring testing it must be performed BEFORE the wheel is mounted on a grinding machine. Ring testing depends on the damping characteristics of a cracked wheel to alter the sound emitted when the wheel is tapped lightly. It is subject to interpretation by the inspector and is primarily applicable to vitrified bonded wheels. To perform the ring test, wheels should be tapped gently with a light nonmetallic implement, such as the handle of a screw driver for light wheels, or a wooden mallet for heavier wheels. Tap wheels about 45 degrees each side of the vertical line and about 1" or 2" from the periphery. Rotate the wheel 45 degrees and repeat the test.

Large and thick wheels may be given the ring test by striking the wheel on the periphery rather than the side of the wheel. A sound and undamaged wheel will give a clear tone. If cracked, there will be a dead sound and not a clear ring and the wheel shall not be used. Wheels must be dry and free of sawdust when applying the ring test, otherwise the sound may be deadened. The ring test is not applicable to certain wheels because of their size, shape or composition.

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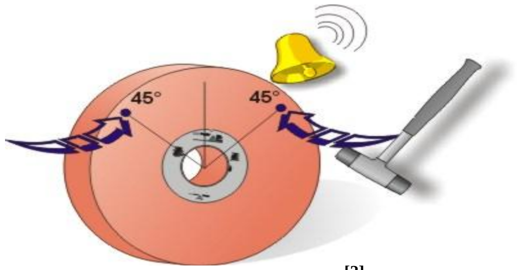

Fig 6: Ring Test [2]

Shadow test:

Shadows of good wheel and misaligned wheel with their front view and side view are shown in figure further. This method is newly implemented. It is very easy to carry out. The main advantage of this method is very cheap and can be conducted in any workshop where sufficient space is available. This method have some limitations also. Very small misalignment can't be detected by human eyes, so to achieve this very high quality apparatus are to be used. If shadow doesn't give any misalignment then zoom the shadow by various equipment's. By doing this misalignment can be detected further. If again further shadow doesn't give any misalignment then at this stage test fails. Misalignment point can also be detected on shadow screen where exactly shadow deviates. By finding some point on screen a radial line can be drawn on wheel as per points on screen. Failure parameter must be present on that line. So it is easily detected.

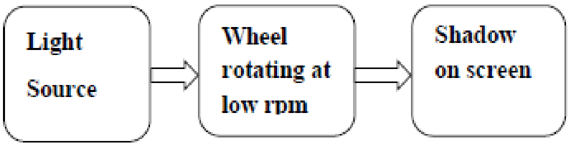

Fig 7: Layout of shadow Test

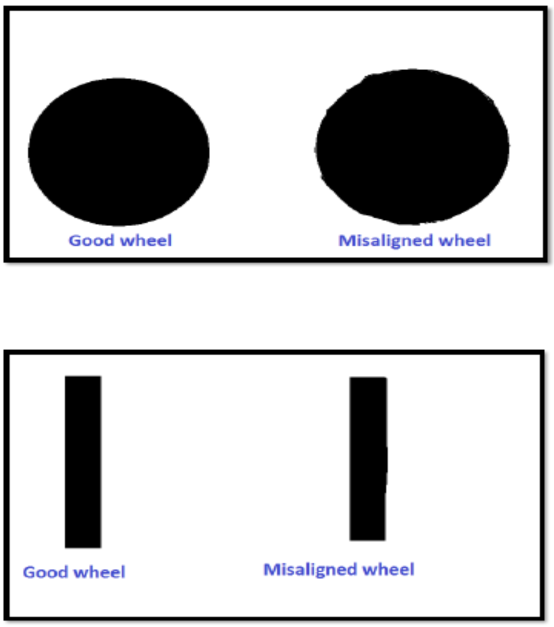

Fig 8: Projections of shadows on screen

VII. CONCLUSION

Strength of the wheel increases with increase in number of wires per grid & by increasing number grains per grid. All models which are used to detect failure of grinding wheel are studied successfully. Ring test, Shadow test are done. In ring test normal wheel gives clear & long sound while cracked wheel gives unclear & short sound. In case of shadow test aligned wheel gives steady shadow and misaligned wheel gives unsteady shadow. Failures of grinding wheel cannot be eliminated but it can be minimized by regular checking of geometry of wheel as well as shape, density, ring tests etc.

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