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Investigation Of The Material Removal From The Edges Of Brass Metal, When The Edges Are Stationery In Horizontal Position In A Vibratory Finishing Machine

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Abstract: Vibratory surface finishing (VF) is a widely used manufacturing process for deburring, edge removal, polishing, burnishing, texturing, cleaning etc.The aim if the Investigation is understand the edge wear characteristic of Brass(90° & 60° Edges) kept at fixed horizontal positions in the vibratory bowl finishing machine, due to abrasion with respect to time. It also helps to study more about the edge wear mechanisms of Brass metal used.

Key Words: Brass, Edge removal, Vibratory finishing, Mass finishing.

1.Introduction.

Mass finishing is the processing of components to be finished, usually with abrasive or nonabrasive media, water and compound. Action or movement of the container is created to cause media to move against component surfaces, edges and corners, or components to rub against each other, to remove burrs, radius edges and corners, improve surfaces, alter and enhance characteristics. Mass finishing can economically enhance the utility, attractiveness, and value of the metal, plastic, ceramic or other parts manufactured for industrial or consumer use.

Edge, corner, surface finishing, including the removal of burrs, defects, and sharp edges, improves part appearance, handling safety and prepares surfaces for subsequent coating. Other benefits include easier assembly, improved operating performance, increased strength (in part by elimination of surface stress concentrations), and longer product life. By imparting compressive stresses to the surface, fatigue strength can be improved. Mass finishing processes can develop active metal surfaces—usually with random scratch patterns. Vibratory surface finishing (VF) is a widely used manufacturing process for deburring, edge rounding, polishing, burnishing, texturing, cleaning etc. Impacting media acts as a bed in which material to be finished is placed. This bed is fluidized using vibrations and the eccentricity gives a movement in circular motion.[1]. Vibratory finishing is very much efficiently applicable to the ductile and brittle materials as per the previous researches. The study is focused to the edge wear of the Brass specimen used due to erosive wear with respect to time. It also helps to study more about the edge wear mechanisms of Brass.

2. Literature Review.

Erosive wear at low impact velocities is the operative mechanism in many surface finishing processes such as tumbling, fluidized bed machining, centrifugal disk finishing, and vibratory finishing. It involves large numbers of particles colliding with the surface at relatively low speeds. Thus improving the surface appearance, smooth edges, and change surface finish. They have been applied to metal, plastic, and ceramic parts using a wide variety of abrasive and non-abrasive media in different shapes such as spheres and angle-cut cylinders. Edge wear is influenced by the binder content, abrasive size particles, and geometry of the edge. Wear is a type of damage that can occur when the surfaces are moving over each other. Although it involves the removal of small amounts of material, it reduces greatly efficiently and lifetime of devices. Wear causes structural changes, plastic deformation and surface cracking. Different wear mechanisms can occur depending on the lubrication, nature of the surfaces, chemical environment and operation conditions. Abrasion and erosion are types of wear, produced by hard particles. In abrasion, material is displaced from the surface by hard protuberances on a counter face. Erosion is produced by hard particles striking the surface. Adhesive wear is produced when two surfaces are pressed against each other. An important type of adhesive wear is fretting. It is based in an oscillatory movement between the surfaces in contact

2.1. Definition of wear.

In materials science, wear is erosion or sideways displacement of material from its derivative and original position on a solid surface performed by the action of another surface. Wear is related to interactions between surfaces and more specifically the removal and deformation of material on a surface as a result of mechanical action of the opposite surface. [1].

2.2. Wear Mechanisms.

2.2.1. Abrasive wear.

Abrasive wear is classified as the removal of material from a surface by hard particles sliding between two surfaces. There are two main types of abrasive wear:

a) Two-body abrasion that is produced by hard protuberances in the counter face or hard particles embedded into the counter face. Some examples are grinding, cutting and machining.

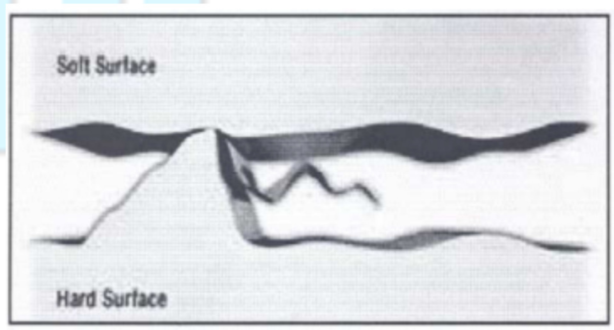

Fig.2.1 Illustration of two-body abrasive wear [2].

b) Three-body abrasion that is caused by hard particles that roll or slide between the contact surfaces. An example is bearings.

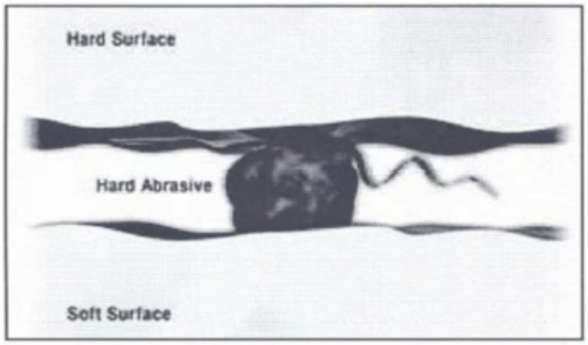

Fig.2.2 Illustration of three-body abrasive wear. [2].

2.2.2. Erosive Wear.

Erosive wear is caused by the impingement o particles (solid, liquid or gaseous), which remove fragments of materials from the surface due to momentum effect. The rate of erosive wear is dependent on a number of factors. The material characteristics of the particles, such as their shape, hardness, impact velocity and impingement angle are the primary factors along with the properties of the surface being eroded.

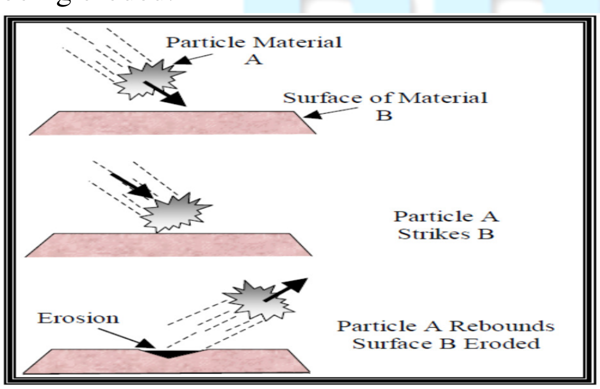

Figure2.3.Illustration of Erosive wear.

2.2.3. Oxidation wear.

During sliding of the counter bodies, the high surface temperature induced by frictional heating and the reduced activation energy of oxide formation caused by plastic deformation, can increase the oxidation rate. Thus, rapid oxidation can be achieved and the oxide layer can grow thicker during sliding than under static conditions.

3. Materials and Experimental Procedure.

Microbalance weighing machine with weighing scale up to 200gm is used for measuring the weight of specimen and video measuring system is for measuring the radius of curvature.

3.1. Vibratory finishing.

Vibratory surface finishing (VF) is a widely used manufacturing process for deburring, edge rounding, polishing, burnishing, texturing, cleaning etc. Impacting media acts as a bed in which material to be finished is placed. This bed is fluidized using vibrations and the eccentricity gives a movement in circular motion. (Fig.).

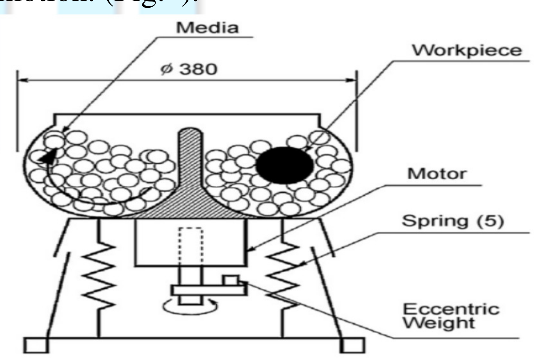

Figure 3.1. Illustration of Vibratory Bowl finishing machine. [1].

3.2. Media.

The primary functions of media are: Cleaning, Deburring, surface improvement, Developing surface luster, Drying, Parts separation. Tetrahedron plastic resin bound silica media are used for our work. Tetrahedron (tets) has points to reach difficult areas and flats for deburring, radiousing and extended surface contact.

Figure 3.2.Tets Media.

3.3. Work pieces.

The Brass specimen (fig.) 50mm long and 25mm wide, were cut from Brass blocks. Hardness number of brass is checked using Rockwell hardness testing machine and the found to be 65B. Both the (90° and 60° edges were made on the same specimen)

Figure 3.3. Brass Specimen with 90° and 60° Edges.

3.4. Experimental Procedure.

Samples are subjected for the process of edge rounding in the Bowl type vibratory machine with polyester silica tetrahedron shaped abrasive media used. Abrasive are used for low velocity impact on the specimen causing erosive wear on edges. Experiment is performed on two edges with angles 60° and 90° made in Brass material in the form of a triangular prism. Time is an important consideration in the study and data are recorded six time periods ranging from 60 minutes to 360 minutes. Radius of curvature is measured using video measuring system and the weight is taken using microbalance at each interval of one hour. Readings are tabulated and are used for plotting the characteristic curves. Radius of curvature Vs Time graph plotted. Weight VS Time graph plotted.

4. Results and Discussions.

4.1. Observations and Graphs.

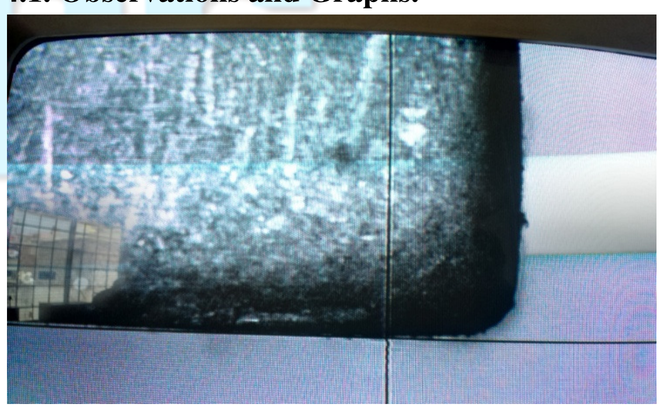

Figure 4.1. 90° Edge enlarged after 360 minutes.

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4.1.1. Radius of curvature in mm Vs Time in minutes (90º edge fixed Horizontal).

Sl.No.	Specimen.	Time in Minutes (90º edge fixed Horizontal).						
		0 min.	60 min.	120 min.	180 min.	240 min.	300 min.	360 min.
1	Brass.	0.235	0.597	0.739	0.82	0.905	0.96	0.977

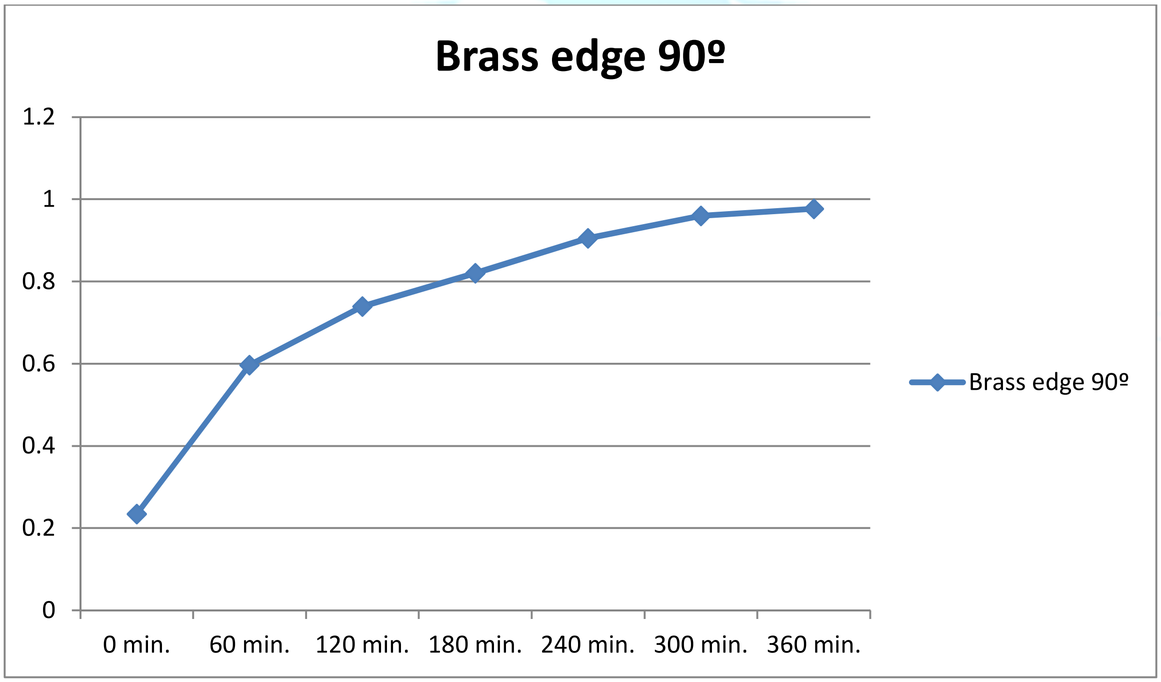

Figure 4.2. Time in Minutes Vs. Radius of curvature mm. (90º Edge fixed Horizontal).

Edge wear rate in terms of Radius change.

4.1.2. Radius of curvature in mm Vs Time in minutes (60º edge fixed Horizontal).

Sl. No.	Specimen.	Time in Minutes (60º edge fixed Horizontal).						
		0 min.	60 min.	120 min.	180 min.	240 min.	300 min.	360 min.
1	Brass.	0.16	0.453	0.652	0.66	0.752	0.781	0.788

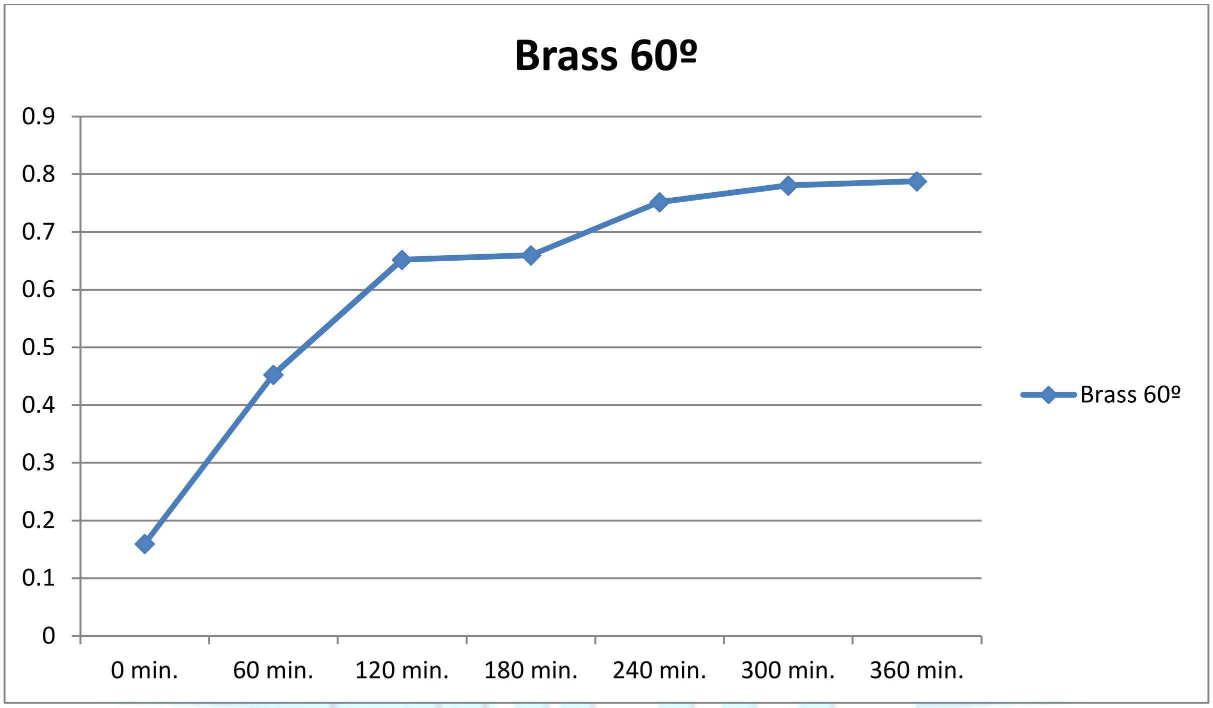

Figure 4.3. Time in Minutes Vs. Radius of curvature mm. (60º Edge fixed Horizontal).

Edge wear rate in terms of Radius change.

4.1.3. Material removal rate of Brass w.r.t. Time.

Sl.No.	Specimen	Time in minutes						
		0 min	**60 min**	**120 min**	**180 min**	**240 min**	**300 min**	**360 min**
1	Brass (Wt. in gms).	185.680	185.445	185.217	185.002	184.812	184.636	184.461

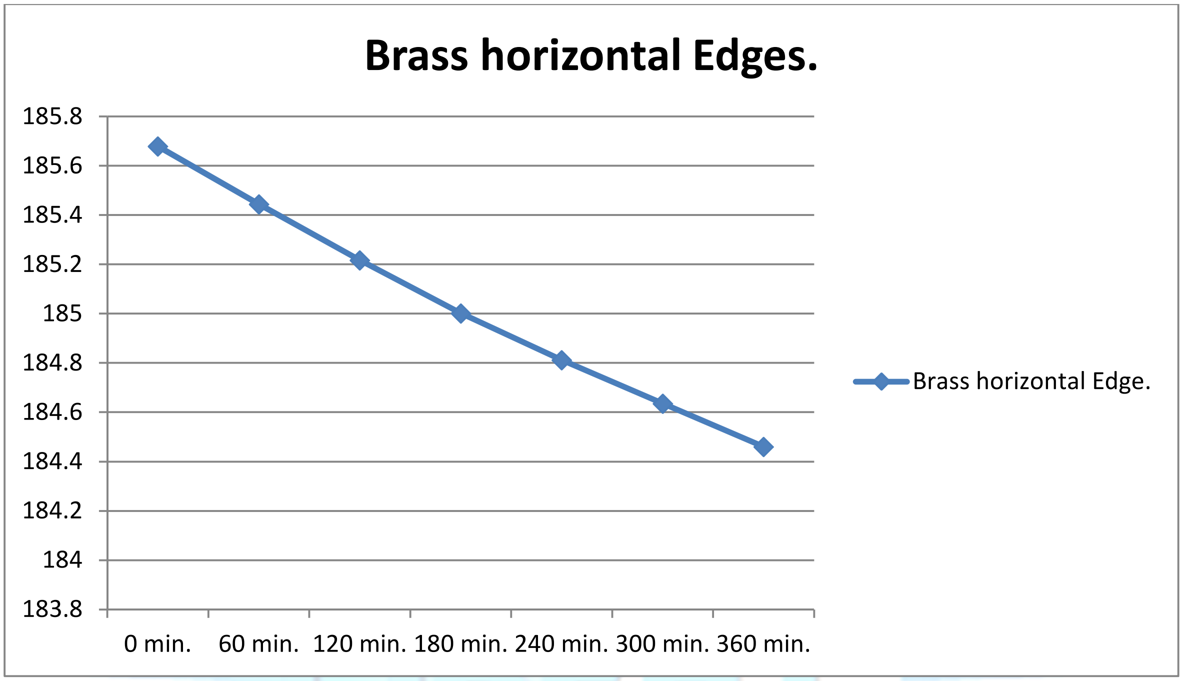

Figure 4.4. Time (mins.) Vs. Weight (gms.)

Material removal rate of Brass w.r.t. Time.

4.2. Analysis.

4.2.1. Brass 90° Edge fixed Horizontal (Figure 4.2).

From the figure, it can be seen that the wear rate (in terms of edge radius change) initially increases rapidly (almost 0.4mm. in 60 minutes) From there onwards, the rate of edge wear becomes slower and finally attains a more or less steady state towards the end of 300 minutes (5 hrs).

This may be due to the formation of a tribolayer. An oxidation layer on the metal surface due to the frictional heat generated between the metal and the abrasive media. Because of this haet generation, a rapid and continuous metal surface oxidation occurs, thus replacing the oxide film removed by abrasion immediately and continuously.

This oxide layer prevents contacts between the brass surface and the abrasive media surface.ie, solid to solid contacts. This is the reason for the edge wear reaching a negligible or zero state towards the end of process time.

But at the beginning of the abrasion process, the metal wear rate is higher, as the arrangement and the materials are in the ambient conditions.

The main mechanism of edge wear occurring here are abrasive wear and erosive wear. Erosive wear will be the prominent phenomena. Micro level chipping is the mode of material removal in Erosive wear. Since the edges are in fixed horizontal position immersed in the abrasive and against the media, the edges will be subjected to media impact at an angle of 90° from the front and normal from the top simultaneously. This impact leads to the formation of microchips and thereby material removal from the metal surface.

4.2.2. Brass 60° Edge fixed Horizontal (Figure 4.3).

In the case of Brass 60° edge fixed horizontally, against the eccentrically flowing media, the edge wear rate in terms of edge radius is much higher in the initial stages compared to that of Brass 90° horizontal Edge.ie. almost 0.7 mm in 120 minute compared to 0.5 mm for the same time period for 90° edge.

This shows that the edge angle is an important factor in the edge wear procwess in vibratory nfinishing.The sharper the edges. The wear rate will be more for fixed edges. The other factors which influence the edge wear are the geometry and properties of the material. In 60 edge, the zero wear state is attained at an early time (240 minutes) compared to the 90 edge. This is again because of the formation of the oxide layer due to the frictional heating between the metal and media surfaces.

The material removal rate is shown in Figure 4.4.It a downward slope. Almost 10 gms. of metal removed at the end of the process. Both the 90° and 60° edges are made on the same specimen.

5. Practical Implications.

The outcome of the study finds applications in many mass finishing processes for various Industrial products like Automobile parts which includes piston, valves, cylinder, engine blocks, wheel alloy rims and other structural elements. The results will be useful to carefully plan and control the removal of sharp edges and corners to the desired level.

6. Conclusion.

An investigation into the egdge wear of brass metal with a 90° edge and a 60° edge, both fixed in horizontal in a vibratory bowl machine. The results show that the edge wear is determined by the material properties, edge angle and the geometry of the specimen.

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Appendix.

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