Fabrication of wet grinding machine and measure the metal removal rate using different grades emery paper

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***Abstract*-Polishing is the process of creating a smooth and shiny surface by rubbing it or using a chemical action, leaving a surface with a significant spectacular reflection. When an unpolished surface is magnified thousands of times, it usually looks like mountains and valleys. By repeated abrasion, those "mountains" are worn down until they are flat or just small "hills." The process of polishing with abrasives starts with coarse ones and graduates to fine ones. The surface of a metallographic specimen is prepared by various methods of grinding, polishing, and etching. After preparation, it is often analyzed using optical or electron microscopy. The process of polishing is divided into rough polishing and fine polishing. The wet grinding machine is used for rough polishing in which we use different grade emery papers. In an industry, making the surface of the material fine and polished is done using highly sophisticated and automatic surface polishing machines which uses abrasive belts rolling over the metallic rollers and the job is being done on it. In our project we have to fabricate a wet grinding (surface polishing) Machine and test its effectiveness also.**

Keywords- Wet grinding, polishing, metal removal rate

I. Introduction

Metallography is the study of the internal structure of metals and alloys, and of the relation of structure to composition and to physical, chemical, and mechanical properties. Many methods have been devised to determine internal structure, but microscopical examinations have always been among the more important. For most of the history of metallography, they have been carried out by means of the optical microscope.

The optical microscope has been joined in more recent years by the transmission and the scanning electron microscope, both of which now play significant roles. Nevertheless, there still is, and seemingly always will be, a place for optical microscopy in both industry and research, just as there is still a place for the visual examination offhand specimens and macro-examinations at low magnifications. Any examination to reveal the structure of metals by optical microscopy involves three distinct Processes: the preparation of a sectioned surface; the development of the structure on this prepared surface by a suitable etching process; and the actual microscopical examination of the surface. The three stages form an integrated whole, and the achievements of the over-all process are inevitably limited by the lowest standard attained by any one of the three. No one stage can be overlooked, and arguments as to their relative importance are pointless [1].

Polishing is the process of creating a smooth and shiny surface by rubbing it or using a chemical action, leaving a surface with a significant specular reflection. Polishing is a multistage process. The first stage starts with a rough polishing and each subsequent stage uses a finer emery paper of different grades until the desired finish is achieved. In this stage metal removal takes place. Then in second stage we come across the Fine polishing in which minimal or negligible metal removal takes place. It is mainly used to remove scratches from the surface of specimen. Finally, Etching is the operation of revealing micro-structural features (grain boundaries, phases, precipitates and other micro-structure constituents) of the polished specimen through selective chemical attack on the surface. A common misconception is that a polished surface has a mirror bright finish, however most mirror bright finishes are actually buffed [2-3].

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Mechanical preparation is the most common preparation method. In a series of steps, successively finer abrasive particles are used to remove material from the sample surface until the desired surface quality is achieved. Many different machines are available for doing this grinding and polishing, able to meet different demands for quality, capacity, and reproducibility.

A systematic preparation method is the easiest way to achieve the true structure. Sample preparation must therefore pursue rules which are suitable for most materials. Different materials with similar properties (hardness and ductility) will respond alike and thus require the same consumables during preparation. Metallographic specimens are typically "mounted" using a hot compression thermosetting resin. In the past, phenolic thermosetting resins have been used, but modern epoxy is becoming more popular because reduced shrinkage during curing results in a better mount with superior edge retention. A typical mounting cycle will compress the specimen and mounting media to 4,000 psi (28 MPa) and heat to a temperature of 350 °F (177 °C). When specimens are very sensitive to temperature, "cold mounts" may be made with a two-part epoxy resin. Mounting a specimen provides a safe, standardized, and ergonomic way by which to hold a sample during the grinding and polishing operations.

After mounting, the specimen is wet ground to reveal the surface of the metal. The specimen is successively ground with finer and finer abrasive media. Silicon carbide abrasive paper was the first method of grinding and is still used today. Many metallographers, however, prefer to use a diamond grit suspension which is dosed onto a reusable fabric pad throughout the polishing process. Diamond grit in suspension might start at 9 micrometers and finish at one micrometer. Generally, polishing with diamond suspension gives finer results than using silicon carbide papers (SiC papers), especially with revealing porosity, which silicon carbide paper sometimes "smear" over. After grinding the specimen, polishing is performed. Polishing is done with slurry of alumina, silica, or diamond on a nap less cloth to produce a scratch-free mirror finish, free from smear, drag, or pull-outs and with minimal deformation remaining from the preparation process.

After polishing, certain micro structural constituents can be seen with the microscope, e.g., inclusions and nitrides. If the crystal structure is non-cubic (e.g., a metal with a hexagonal-closed packed crystal structure, such as Ti or Zr) the microstructure can be revealed without etching using crossed polarized light (light microscopy). Otherwise, the microstructural constituents of the specimen are revealed by using a suitable chemical or electrolytic etchant. A great many etchants have been developed to reveal the structure of metals and alloys, ceramics, carbides, nitrides, and so forth. While a number of etchants may work for a given metal or alloy, they generally produce different results, in that some etchants may reveal the general structure, while others may be selective to certain phases or constituents.

Wet grinding machine [4, 5] is used for rough polishing, which is the base step in the process of metallographic operations.

Grinding Machine

Grinding machines remove material from the work piece by abrasion, which can generate substantial amounts of heat; they therefore incorporate a coolant to cool the work piece so that it does not overheat and go outside its tolerance. The coolant also benefits the machinist as the heat generated may cause burns in some cases. In very high-precision grinding machines (most cylindrical and surface grinders) the final grinding stages are usually set up so that they remove about 200nm (less than 1/100000 in) per pass.

Fig 1. Belt grinder[4]

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Fig 2.Belt grinder [5]

Bench grinder, which usually has two wheels of different grain sizes for roughing and finishing operations and is secured to a workbench. It is used for shaping tool bits or various tools that need to be made or repaired. Bench grinders are manually operated. **Cylindrical grinder**, which includes the **center less grinder**. A cylindrical grinder may have multiple grinding wheels. The work piece is rotated and fed past the wheel/s to form a cylinder. It is used to make precision rods. **Surface Grinder** which includes the **wash grinder**. A surface grinder has a "head" which is lowered, and the work piece is moved back and forth past the grinding wheel on a table that has a permanent magnet for use with magnetic stock. Surface grinders can be manually operated or have CNC controls. These usually can perform the minor function of the **drill bit** grinder, or other specialist tool room grinding operations. **Jig grinder**, which as the name implies, has a variety of uses when finishing jigs, dies, and fixtures. Its primary function is in the realm of grinding holes and pins. It can also be used for complex surface grinding to finish work started on a mill. **Gear Grinder** which is usually employed as the final machining process when manufacturing a high precision gear. The primary function of these machines is to remove the remaining few thousandths of an inch of material left by other manufacturing methods (such as gashing or hobbing). This machine is very useful in rough polishing operation in specimen preparation for micro structural characterization in heat treated steel samples. Alloy steel (AISI 4140) is medium carbon chromium steel that finds use in those applications where strength and impact toughness are both required. With proper selection of heat treatment processes it is possible. But for studying the effect of heat treatment processes on mechanical properties of steels micro structural examination plays an important role.

In this operation wet grinding machine is used for rough polishing which is an important step of sample preparation for micro structural examination.[6]. The mechanical properties to include fracture toughness of high strength steel are often governed by the independent or conjoint influences of (a) chemical composition, (b) processing history and development of intrinsic micro structural features, (c) geometry or part thickness, (d) temperature operation, (e) loading rate and presence of constraints at the crack tip [7-13]. So now we can say that wet grinding machine plays an important role in metallographic examination to study about microstructures of various materials and their mechanical properties.

II. Model Construction And Solution

In this chapter, we discuss about the design and construction of the WET GRINDING MACHINE. First of all, we analyzed the various design parameters and the conditions of the various working components, then the basic design of the machine and the different parts is being made which are being discussed here.

2.1 PARTS OF WET GRINDING MACHINE:

Water Tank

As the name suggests it is used to store water which further acts as a coolant. Source of water inlet and outlet are provided for the supply of water at a time of rough polishing.

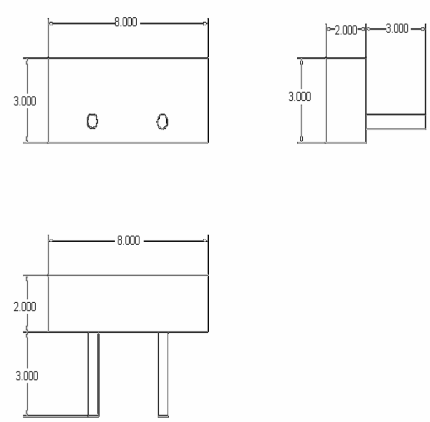

Fig 3. Water Tank Layout

Rollers

Rollers are used to drive the abrasive or emery paper belt further on which specimen will be rough polished. These can be made up of plastic, rubber or steel depending upon the type of usage.

Fig 3 Rollers

Drive System

We can apply two type of driving system depending upon the distance between the driving and driven shaft. This can be of following two types:

Belt Drive

It is a loop of flexible material used to link two or more rotating shafts mechanically. Belts may be used as a source of motion, to transmit power efficiently, or to track relative movement.

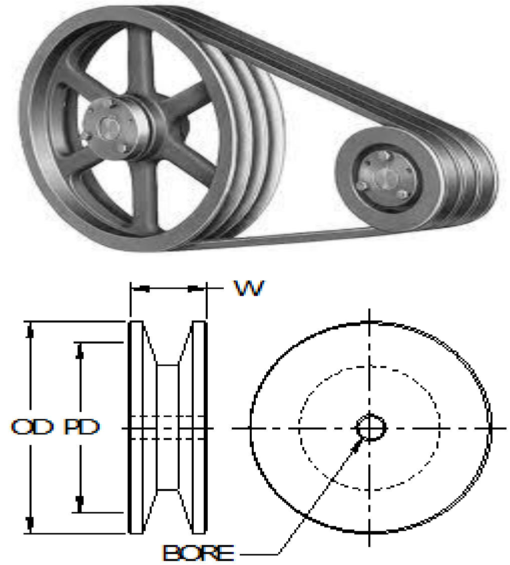

Fig 4 Belt Drive System

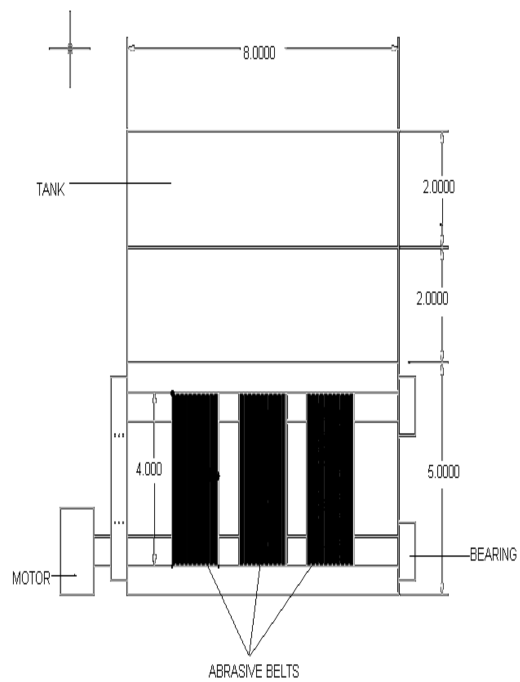

Fig 5 Layout of Roller and Belt system

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Electric Motor: An electric motor uses electrical energy to produce mechanical energy. Here it will be used to rotate the shafts on which rollers are mounted.

Fig. 6 Electric motor

2.2 Proposed Layout of Wet Grinding Machine

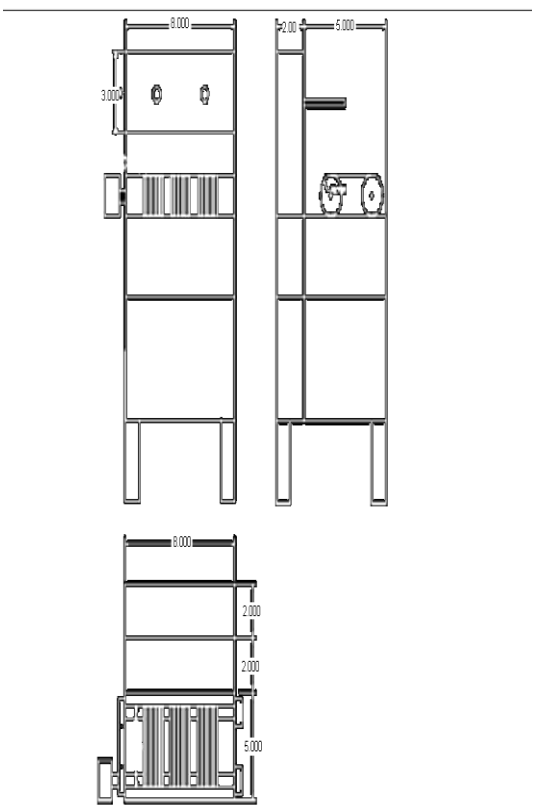

Fig. 7 Proposed layout of Wet Grinding Machine

Specifications of the machine:

- Total Height : 48 cms
- Total Length : 80cms
- Total Width : 50 cms
- Power Input : 1 h.p.
- Speed : 2100 rpm
- Grades of Abrasive : 100,220, 320

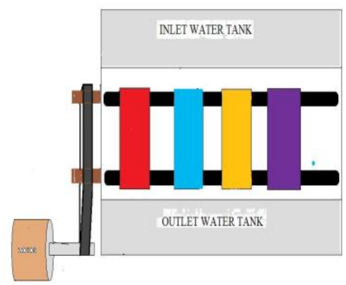

Fig. 8 Layout of wet grinding machine

Fig. 9 Machine Structure

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III. Validation and Discussion of Results

3.1 Experimental Part of Project

Calculate the metal removal rate using different grades emery papers
Let the mass of the job material before starting the rough polishing operation
= **x gm**
Time for which the material is fed upon the emery paper of grade "A" = 30 sec
After the process is done, weight of the material = **x' gm**
Therefore,
Metal Removal Rate = (x – x') / 30 gm/sec

Table 1 MRR of different grades Belts

	Mass of the specimen(gm) worked upon on different Grades of Abrasive belts 100,220 and 320			Time (sec)
S.No.	**100**	**220**	**320**	
1. Initial mass	101.08	100.35	99.96	30
Final mass	100.35	99.96	99.78	30
Difference = IM-FM	0.71	0.39	0.18	
2. Initial	103.56	102.87	102.46	30
Final	102.87	102.46	102.29	30
Removal	0.69	0.41	0.17	

Metal Removal Rate for Grade 100 belt

Mass before operation = 101.08 gm
Mass after operation = 100.35 gm
Time taken = 30 sec
Therefore,
Metal removal rate = (101.08 – 100.35) / 30
MRR = 0.0243 gm/sec

Metal Removal Rate for Grade 220 belt

Mass before operation = 100.35 gm
Mass after operation = 99.96 gm
Time taken = 30 sec

Therefore,
Metal removal rate = (100.35 – 99.96) / 30
MRR = 0.0133 gm/sec

Metal Removal Rate for Grade 320 belt

Mass before operation = 99.96 gm
Mass after operation = 99.78 gm
Time taken = 30 sec

Therefore,
Metal removal rate = (99.96 – 99.78) / 30
MRR = 0.006 gm/sec

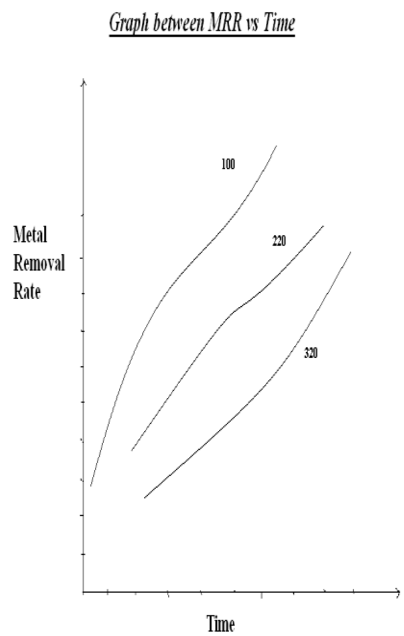

Fig 9 Graph between MRR and Time taken

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IV. Conclusions And Recommendations For Future Work

In this project an idea about the fabrication of the wet grinding Machine is given. Some experiments were done using various grades of belts to check their material removal rate. From results we verified that as number of belt increases, the material removal rate increases. So for large material removal rate low number belt should be used .The main advantage of this machine over the existing machine is that it consists of motor and belt drive system which reduces the mechanical effort of the users. We can use three belts simultaneously for polishing. Also, the system of two separate water tanks for water inlet and outlet is also there. Some of the major advantages of this machine over other machines are:

- Wet grinding machine will consist of three different grades emery papers, which mean different jobs, can be performed simultaneously on the machine.
- As we know, the rough polishing machines used in an industry costs in lakhs. Hence, we can employ wet grinding machine for small scale use which will cost mere 9000-12000 Rupees.
- The machine can be used in the college premises in the **Material Science Lab** and the students can easily work upon the machine simultaneously and learn the process of rough polishing.
- For viewing the crystal structure of any material (Metallographic), rough polishing is the first and one of the major operations in which metal removal takes place and the surface becomes more visible. It is then followed by fine polishing and etching. Hence, rough surface polishing machine is required.

Future work

Further automation of the machine can be done by using gear drives, and also the speed of the machine could be varied accordingly

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