

MANUFACTURING OF EMERY CLOTH (SAND PAPER) FROM LOCAL RAW MATERIALS

J. J. WAI and M. T. LILLY

(Received 13 March 2001; Revision accepted 17 September 2001)

ABSTRACT

This paper identifies surface finishing (grinding) as a major engineering process in production industries and that emery cloth otherwise known as "sand paper" is used for this purpose. The grinding process is discussed in details.

The materials and their sources required for the production of the emery cloth are discussed and also the physical properties of the materials are considered.

The paper discusses the manufacturing stages of the cloth. Three main stages were identified – sand preparation, backing paper preparation and the emery cloth production. Finally the required quality control processes were considered, a detailed cost analysis was carried out and conclusions were drawn.

Keywords: Emery Cloth, materials production, cost

INTRODUCTION

The process of grinding is a very useful operation in the manufacturing industry. The idea underlying grinding goes back to ancient times and in its simplest form involves the drawing or rubbing of one substance usually metallic in nature over the surface of harder crystalline materials when this is done minute particulars of the metal are removed.

Man probably learnt by accident that a blunt instrument or weapon could be sharpened by rubbing it over a piece of natural sand stones. Afterwards it was from the idea of using two sand stones to construct a crude mill for the grinding of cereal came the power that was supplied by slaves, oxen, horse in a similar manner to the horse operated cyder mills. At a later stage came the idea of revolving manually a sand stone wheel for sharpening tool and weapon. Hence, over a long period of time the way was prepared for the introduction of a power driven abrasive wheel using water, steam, electricity etc. (Sarnaus, 1963).

To perform a good job of grinding one must be able not only to operate the machine but also to understand abrasives and grinding wheels. Surface finishing of metallic and wood product is very important to the production engineer. Also when a material gets rusty it is necessary to clean it using a grinding process. All these are surface finishing operations where abrasives are used. These abrasives are called emery cloth or sand paper, so an abrasive is any material that can wear softer materials. (Collins and Eric, 1976). Abrasive can be classified into two groups – natural abrasives like sand stone or solid quartz, emery, corundum or garnets and manufactured abrasives like Silicon Carbide (SiC), Aluminum oxide (Al_2O_3), Boron Carbide (B_4C) and Zirconium (ZrO_2). Manufactured abrasives were not known until the later part of the 19th century (Rosenthal, 1964). It should be noted at this juncture that the abrasives whether natural or synthetic can be crushed and moulded into grinding wheel or coated into sand paper for industrial use.

This work concentrates on sand paper

production. The sand paper is used in the following areas:

- i) It is used to improve surface appearance of jobs by polishing.
- ii) It is frequently used to shape edges of tools and sharpen tools for example knives.
- iii) They are used to obtain specified sizes by removing a small amount of the material.
- iv) It has proved to be an economical method of removing materials from forging, casting and various stock shapes (Higgins, 1983).

All the sand paper used in this country is imported when they can be produced within using locally available raw materials. Therefore, this research work is on the development and manufacture of sand paper using locally available raw materials.

REQUIRED RAW MATERIALS AND SOURCES

The sand paper is made up of two parts, the abrasive area and the backing or paper carrying the abrasive. Aster series of studies (Lindberg) it was concluded that sea sand will be used for the abrasive. The basic materials needed for this work are sea sand, which supplies the silicon (tool) and diluted hydrochloric acid, which eliminates the iron content and the impurities that are in the sand. The sand (Silicon) should have the following physical properties:

- i) Hardness – it is based on the abrasive power of the sand.
- ii) Brittleness – the sand should have the ability to shear during operation

- iii) Other properties – these are properties relating to grain shape and accuracy of sizing. These are means of improving the adhesion between the abrasive and the bound.

There are basically three types of sand, they are named as follows:

- i) Silicon sand (Quartz) which consists mainly of silicon oxide (SiO_2).
- ii) Zircon sand, which consists mainly of Zircon or Zirconium silicate (ZrSiO_4).
- iii) Olivine sand – this sand is coloured and it is composed mainly of iron and magnesium.

The sand chosen for this research work is the silicon sand because of the reasons stated below:

It is available in abundance and hence it is easily obtainable, so it is cheap, available in wide variety of grain sizes and it is composed for silicon oxide (SiO_2). The source of sand is any river or sea. The other raw materials required are Sodium Hydroxide (NaOH), Zinc Oxide (ZnO), Epoxy resins and paper. All the materials can be bought in a local shop that is they are locally available. The paper is in various grades and they are classified according to the thickness and uses of the paper as shown in table 1.

In this work the grade of paper selected is of C and D because of its availability and relative cheapness compared to others. After this careful selection of required raw materials we shall move to the treatment and preparation of the raw materials for the manufacturing processes.

Table 1: Paper grades.

GRADES	THICKNESS (mm)	USES
A light paper stock micro thin-thin	0.039-0.109	For hand sanding
C & D intermediate weight paper	0.112 – 0.211	Use for cabinet work
E strong and durable paper	0.213 – 0.483	Use in cabinet machine belt sanding.

Sand Preparation

The sand preparation state can be divided into the following processes cleaning of the sand and sieving of the sand.

The sand collected from the river is impure, so we need to clean it. The first cleaning is with water and the cleaning is repeated several times until the sand is clean. This is done in a container then the sand is dried. The second cleaning is done with diluted hydrochloric acid (HCl prepared in the volume ration of 500cm³ of acid to 1000cm³ of water) to remove impurities like clay and iron. Like the first cleaning process it is repeated until the sand is clean and then it is dried again.

The next stage is the sieving of the dried sand. The sieve process and analysis are necessary to determine grain size of the sand to be used in producing the abrasive ranging from rough to smooth grade. In this work it is the fine and coarse grade that is used and the grits sizes are fine grit-180mm and coarse grade = 50mm. Then the sand is poured on top a rack and by shaking the rack the sieving process is carried out. The complete process is shown in figure 1

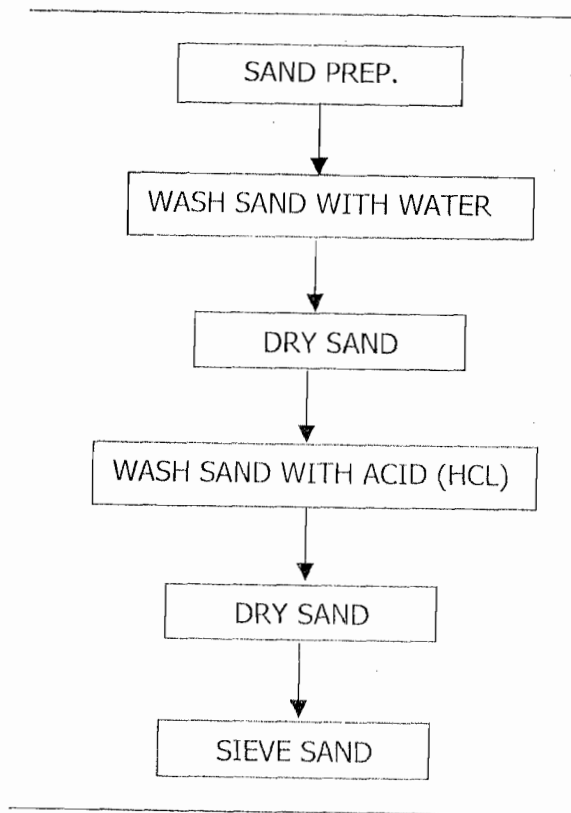


Figure 1: Sand Preparation Stage

BACKING PAPER PREPARATION:

The preparation of the paper to serve as backing for the sand paper consists of two processes cleaning and water proofing.

The surface preparation of the backing is to get rid of dirt and promote excellent bonding.

The following factors are necessary in the selection of surface preparation methods (Lindberg):

- i) The bond strength required
- ii) The type of backing materials
- iii) The environmental conditions.

MANUFACTURING STAGES

The manufacturing stages can be divided into three distinct areas:

Sand preparation, backing paper preparation and the sand paper production state.

The general methods used in surface preparation of sand paper backing are chemical cleaning, solvent wiping, degreasing, abrasive cleaning, vapour honing or ultrasonic cleaning. Surface treatment has the following functions:

- i) Removal of contaminants
- ii) Control of absorbed water
- iii) Control of surface roughness
- iv) Control of oxide formations
- v) Protection of the adhesive from the adhered
- vi) Match the adhered crystal structure to the adhesive molecular structure.

The backing material is paper so it must be

waterproofed for it to withstand any weather condition. The chemical used is zinc oxide because it has waterproofing property. A solution of sodium hydroxide (NaOH) (salt) pellet, water and zinc oxide is made and the backing paper is soaked in the solution for about five minutes. After that the paper is removed dried and smoothened with the aid of a roller. This state is shown in Figure 2.

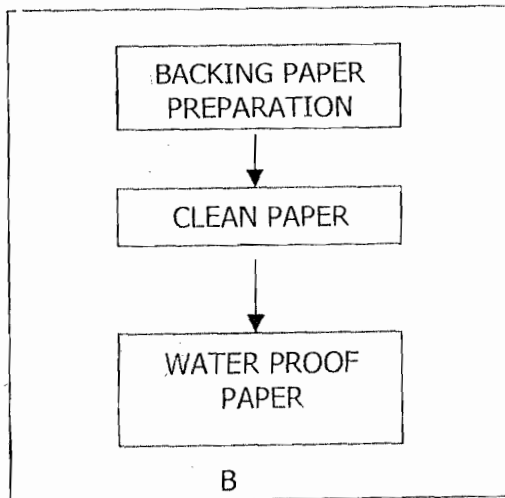


Figure 2: Preparation stage for backing paper.

Sand Paper Production:

Here the first process is the selection of the adhesive to be used. An adhesive is a substance that is capable of holding materials together by surface attachment. It can also be defined as any material that causes one body to stick or adhere to another. For an adhesive to be useful it must not only hold materials together but also withstand the operating load and last the life of the product. Modern structural adhesives are primary synthetic materials based on plastics or electromagnetic compounds. The adhesives are usually classified by functions, chemical composition, mode of application and setting, physical form, cast and specific application. In the selection of adhesive for any adhesive process there are certain factors to be

considered. These factors are stress, chemical exposure, temperature, biological and work properties. The selection of adhesive in this work is based on exposure, work properties, temperature, chemical, biological and stress factors. From information available in literature (Partner and Taylor, 1996), it will be seen that thermosetting adhesives such as epoxy resin, formaldehyde melamine or melamine formaldehyde have the basic characteristics needed in this work. The adhesive used in this work is epoxy resin because of the following reasons:

- i) Its durability, waterproof and weatherproof properties and also it is locally available.
- ii) It also has a higher service temperature than others.

The second process is the application of the selected adhesive using the brushing method on one surface of the backing paper gently and smoothly (Harper, 1975). Then the sieved sand is sprayed with a hand on the same face that the adhesive is applied. The sand is then calendared to produce a uniform surface.

To provide a fast bonding process, a hand roller is used to exert some reasonable pressure for some time.

This is the end of the production process as shown in figure 3.

QUALITY CONTROL

This is the aspect of production that ensures that the products produced meet standard specifications. To achieve this quality control should cover all stages of production. A good quality control should start from the inspection of the raw materials before receipt to the inspection of the completed assembly before the acceptance of the product.

Several pieces of the sand paper were produced for testing. Series of quality control analysis were carried out. These tests were:

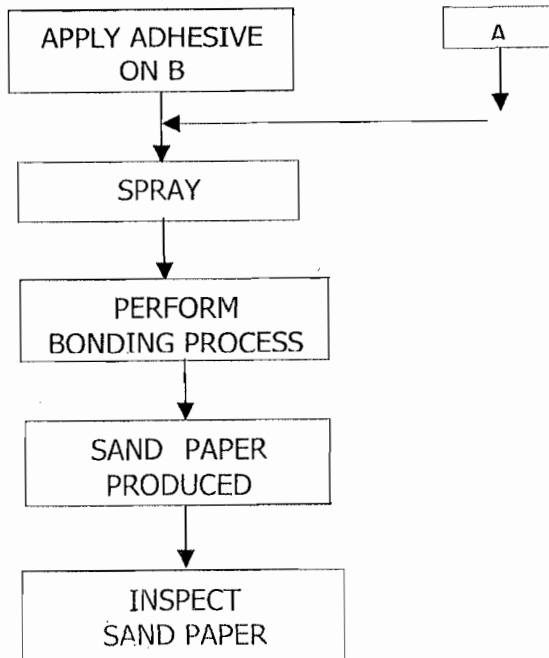


Figure 3: Sand paper production Processes.

- i) Quality control of pre-handling conditions
- ii) Quality control of adhesive and surface treatment,
- iii) Quality control of the bonding processes

i) QUALITY CONTROL OF PRE-HANDLING CONDITIONS

In abrasive production the high percentage of defects can be traced to poor workmanship. This generally is conspicuous in surface preparation stage even at the application of the abrasive. Keeping to the following rules can eliminate this problem.

- a) Proper motivation and training of the worker in adhesive-bonding technology.
- b) The design Engineer of the joint should stick to specification

c) The bonding area should be kept clean by isolating it from the other manufacturing operation

d) The cleaning and bonding operations should be separated from each other.

ii) QUALITY CONTROL OF ADHESIVE AND SURFACE TREATMENT

Surface preparation must be carefully controlled by reliable production of adhesive bonded parts. Using a test specimen before the actual production of the materials can do this.

iii) QUALITY CONTROL OF THE PROCESSES

The adhesive mattering and mixing operation should be monitored by periodically sampling the mixed adhesive and testing for adhesive properties. This can be done by visual inspection.

iv) BONDING INSPECTION

After the adhesive are used, the bonded area is to be inspected to detect flaws and defects. The inspection is either destructive or non destructive in nature. Destructive testing results to waste of material and hence it is not economical. So in this work non-destructive testing was used.

Only visual inspection was used to ascertain the quality of the bond between the backing paper and the abrasive (sand) in this work. Some possible faults to look for are shown in Table 1.

COST ANALYSIS

For this research work to be of any useful value a detailed cost analysis is necessary (Urieto, 1999; Warper). The cost of locally producing the materials must be compared with the cost of the imported ones.

The materials required are sea sand, sodium Hydroxide (NaOH), Zinc Oxide, Epoxy resins

Table 1: Some possible faults.

FAULT	CAUSE	REMEDY
No appearance of adhesive around edges of joint or adhesive bond line too thick.	Clamping pressure too low	Increase pressure, apply more
Adhesive bond line too thin	Clamping pressure high Curing temperature too high starved joint	Reduce pressure use lower curing temperature. Apply more adhesive.
Adhesive flash break easily away from substrate	Improper surface treatment	Check treatment procedures.
Adhesive flash is excessively porous.	Excess air stirred into adhesive Solvent not completely dried before bonding Adhesive material contains volatile constituent.	Vacuum degas adhesive before application increase drying time or temperature seek manufactures advice.

paper (grade C and D) and diluted Hydrochloric acid, (for cleaning).

The processes are cleaning of sand, sieving of sand, cleaning and waterproofing of backing paper, using adhesive on backing paper, which is finally followed by the spraying of the sieved sand on the paper.

The sea sand is obtained free; the cost associated with it is the labour cost of collection and preparation. A cup of sodium Hydroxide (salt) pallet costs N250.00 and it can be used for the production of 100 pieces of the sand paper. Hence unit cost of sand paper = N2.50. The Zinc oxide is also sold by weight. 1kg of ZnO costs N250.00 and it can be used to produce about 50

Hence the cost of one piece = N5.00 Epoxy resin is sold in tins (6 litres) one tin costs N2,000.00 and one tin can be used for the production of 500 pieces, so unit cost of one piece = N4.00. Hydrochloric acid is sold in bottle, the cost of a bottle (100cm³) is N700.00

and it can be used for the production of 200 numbers, hence unit cost = N3.50.

A ream of paper (500) costs N1,500.00. Therefore each sheet will cost N3.00. The labour cost of production of one piece of emery cloth is estimated to be N1.00. Therefore, the total production cost of one sand paper

$$= N2.50 + N5.00 + N4.00 + N3.00 + N1.00$$

$$= \underline{\underline{N19.00}}$$

The retail price for an imported sand paper in the market is N70.00 for the rough type and N60.00 for the smooth one.

The locally produced one can be sold at half the price of the imported one that is N35.00 this gives a profit margin of about 84%. In an eight (8) hour working day a small scale business set up can produce 1000 pieces, this generates a daily profit of N29,470.00. For a 25 working days per month the annual profit will be minimum N8,841,000.00. The set up cost of this very profitable small-scale industry is less than N5000,000.00; the manpower and

equipment required are very low. Government can give loan to several school leavers to set the industries. If ten companies are established in the country for this purpose and each is producing at least 1000 pieces per day the country can save at least N60 X 1000 X 25 X 12 X 10 X 16 = **N108,000,000.00** equivalent of foreign exchange. Hence this business will provide employment and conserve foreign exchange.

CONCLUSION

- i) Sand paper scientifically called emery cloth is a very useful tool in the manufacturing industries.
- ii) Sand paper is used in removing rust, shaping, smoothening and polishing of materials.
- iii) It is amazing to note that local production of this simple but very useful tool has been considered impossible, hence were always imported.
- iv) The manufacturing of sand paper has been successfully done locally sourced raw materials.
- v) This research work has proved the following:
 - a) That the materials required for sand paper production are locally available and they are simple.
 - b) With little capital it is easy to establish a small-scale industry to produce sand paper.

- c) Our foreign exchange base will be conserved, as importation of sand paper is no longer necessary.
- d) The project is economical, feasible and viable.
- vi) Finally, government, oil companies and individuals should be encouraged to invest in this project to provide job opportunities for our school leavers.

REFERENCES

Sarnaus, C. H. 1963. *Metallic Materials in Engineering*. Macmillan, New York.

Collins J. S. and Eric, A. B. 1976. *Metals reference book*, 5th Edition, Butterworth and Company.

Rosenthal, D. "Introduction to properties of Materials" Van Nostrand, Princeton N. J. 1964.

Higgins, R. A. 1983. "Engineering Metallurgy", 6th Edition, E.I.B with Edward Arnold Publisher.

Lindberg, R. A. "Process and Materials of manufacturing". 4th Edition Boston.

Partner, R. S. R. and Taylor, P. 1996. *Adhession and Adhesive*, 1st Edition Pergamon Press.

Harper, C. A. 1975. *Handbook of Plastic and Elastomers* . McGraw Hill Company.

Uricio, J. E. 1999. "Handbook of feasibility study" Published by Royal Express International, Port Harcourt Nigeria.

Warper, H. H. "Management Accounting", M. and E Handbooks, Richard Clay (the Chaucer Press) Ltd Bungay, Suffolk, U.K.