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Wood Flour Moulding Technology: Implications for Technical Education in Nigeria *(Pp. 233-242)*

Usoro, Hogan S. **-** Department of Vocational Education, University of Uyo, Uyo, Nigeria
E-mail: docsolo2002@yahoo.com
GSM: 08037367264

Akpan, Godwin A. **–** Department of Vocational Education, University of Uyo, Uyo, Nigeria.
E-mail: akpanga2020@yahoo.com

Essien, Okoro A. – Department of Vocational Education, University of Uyo, Uyo, Nigeria.

Abstract
The intent of this article is to demonstrate how wood waste called sawdust or wood flour can be transformed by plastic moulding machine into items of economic value. Wood flour is wood reduced to very fine particle form. It can be waste product from saw mills, wood working plants or produced from selected dry wood by grinding. Interest in this modern industrial practice in wood anchors around the high level of unemployment among the youths in Nigeria. This unemployment is attributable to great emphasis placed on white collar jobs to the detriment of psychoproductive skills. In an effort to solve this problem, the informal sector has taken up the challenge through

entrepreneurial exploits, and set small scale industries of concern. One such industry suggested in this article is the wood flour woulding industry which is yet to gain prominence outside laboratory experience. Wood flour moulding process converts wood particles or wood flour into functional products like toilet seats, trays, coasters, tool handles, toys and other novelty items; wood flour moulding technology minimizes atmospheric pollution, reduces cost of wood waste disposal and curbs, unemployment among youth.

Introduction

Wood flour moulding technology is an advanced development in wood processing industry. It offers a means of utilizing wood waste that is normally disposed of along with other scrap materials from the woods laboratory or saw mills. In the past wood flour or sawdust was usually incinerated, but today, it is used in combination with various plastic resins to produce a wide variety of commercial products. These products include coaster or wood flour dish (see figure 1), toys, tool handles, toilet seats, trays, core doors, formed parts of furniture and sports items (Feirer, 1979).

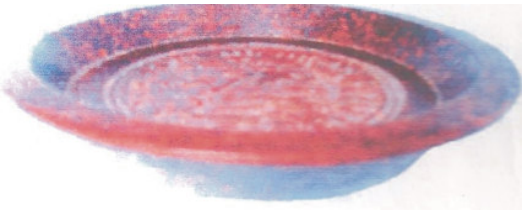

Figure 1. Wood Flour Dish

Wood flour can also be produced by grinding selected dry wood. It is an important source of raw material for various wood products such as hollow core doors and many other useful items for building trades. Roof tiles, siding, window framing and decking are among such items (Stark, 2006).

It is instructive to mention that wood flour is closely related to but different from the wood fibres used in manufacturing hardboard and the wood particles used to produce particle board. Wood flour consists of particles which resemble those of cereal flour in size, appearance and texture. Wood flour with plastic grain can be subjected to three manufacturing processes namely, extrusion, compression and injection moulding. In this article, only

the compression process is described sequel to laboratory experience. The differences observed in the processes are the differing effects on the properties of the products after exposure to hours of weathering cycles. Wood plastic composites often fade and lose mechanical properties (Stark, 2006; Anderson, Zhang and Wolcott, 2006).

Wood flour moulding technology is a venture of worthwhile economic importance. It has been developed in the advanced nations like the U. S. A., Germany and some European countries. It is yet to be appreciated and practiced in Nigeria where employment needs are high.

With growing urbanization following industrialization and the search for white collar jobs, as well as incidence of high level of unemployment, a large population of the Nigerian youth can be seen roaming the city streets. An attempt to engage these youths has led to the development of a new form of urban activity referred to as "informal" sector. Here people perform a variety of functions, services, construction and manufacture of goods on self employment basis. This sector has utilized simple tools, equipment and locally sourced raw materials to produce goods needed by the society. One of such materials that has been long neglected by this sector is the wood particle/flour/sawdust. Though presently used for the manufacture particle boards and chip boards, this raw material has continued to remain an untapped resource for small scale industries. When this area is given full attention, it will not only yield economic and aesthetic gains, but also reduce the degree of pollution following the basest method of wood disposal-burning/decay. The intent, of this article is to share with the technologist audience or readership the practicality of transforming wood flour or sawdust into purposeful products.

Wood Particle/Flour Moulding

The wood particle or wood flour moulding follows the same basic process as used by industry in producing particle board. The process uses sawdust or wood particles and melamine urea resin as a bonding agent. Since resin production is costly, efforts have been made to reduce this cost by introducing Poly (hydoralkanovates) PHAs into the process of moulding. PHAs are another family of thermoplastic biopolymers that can be produced on a large industrial scale at a lower cost (Anderson, Zhang and Wolcott, 2007).

The basic machine used in the moulding process is the same plastic moulding machine. The school model machine is the one used for laboratory practice. The mixture of wood particles and melamine resin may be varied to produce varying densities. The present report is based on the use of phenolic plastic chips of various colours to give the product (coaster) a specific colour. It has, however been observed through laboratory work that wood flour from cedar tree does not easily lend itself to satisfactory moulding process (Usoro, 1976).

Wood flour or particles from some other tropical trees does not yield satisfactory moulding results. They lack natural resin and to use their flour or particles in moulding means the application of great amount of plastic grains to the moulding process. This is expensive considering the huge cost of producing plastic resin or grains. These trees, mainly tropical, are presented in Ibibio language (Akwa Ibom State of Nigeria) and their botanical nomenclature in table 1

Equipment Tools and Materials for Moulding a Wood Flour Coaster or Dish

These are:

A. A hydraulic Press/Wabash Press – A plastic moulding machine – figure 2a. The listing of parts corresponds with the numbers on the figure

Parts and Functions

1. **Jack handle:** Moved up and down to apply pressure on the mould
2. **Pressure release knob:** Turn it counter clockwise until it is tight before No. 1 is operated.
3. Balance beam used to weigh materials for moulding process
4. Moisture detector – used to ascertain the state of wetness or wood flour
5. Water - for moisturizing wood flour
6. A sieve for sifting and grading wood particles
7. Container with wood flour
8. Cymel resin 405 or melurac 305 Resin
9. Atomiser: used for moisturing the wood flour

10. Stop watch-used to indicate the exact time the mould has remained in the press before wood flour product formed and ready for release.
11. White glue – used to stick a metal label or logo of the institution or organization to the base of the upper mould. As
12. Bestos gloves – worn when handling the hot mould from the hydraulic press.
13. Silicon Mould Release – used to loosen product from the mould
14. Phenolic plastic chips (optional) used to bond the wood before and after moulding process.
15. Steel wool 3/0 – used to clean the mild steel mould before and after moulding process.
16. O-rubber ring – that fits into the recess in the lower mould plunger to give smooth circular shape to the rim of the product
17. Putty knife: used to scrape off the glue that sticks to the flat end upper mould.

Steps of Procedure

1. Preheat the platens for about 30 minutes or until the desired temperature, 280-325^{0}F is reached. To increase heat turn the thermo switch in a counter clockwise direction or in the arrow direction and to decrease heat turn it in a clockwise direction.
2. Collect wood flour or chips from the lathe or table saw or vertical sander from other machines that produce the desired wood particles/ sawdust. If it is possible grind appropriate dry wood for use.

Note: *Wood flour or chips from cherry, maple (temperate trees) mahogany, teak and walnut (ekom in Ibibio language) and most West African trees have been found to yield satisfactory results. Wood flour from pine (temperate tree) does not yield satisfactory moulding results because it presents difficulties due to its high resin content. Wood flour from cedar does not yield satisfactory moulding results due to its complete lack of resin (laboratory experience)*

3. Sift wood particles through a sieve (made of standard screen wire). Screens with 20 to 40 mesh are recommended depending on the grain size of flour or size of particle used.

4. Weight the amount of wood flour needed using the balance.
5. Determine the amount of resin needed. This should be 30% to 60% of total weight of the mixture
6. Place wood particles or flour and resin in a container and tumble (for 20-25 minutes) until the two materials mix thoroughly.
7. With the atomizer, moisten the mixture. Test the moisture content with moisture detector to ensure that moisture content is 10-15%.
8. Cover the can or container to prevent moisture loss.
9. Clean the mild steel mould with steel wool to remove any residue from previous operations. Clean also the vent holes of any obstacles so as to allow the gas to escape as steam is produced during the moulding process.
10. Spray the inside of the would with mould release and fit the 0-rubber ring into the recess in the lower mould.
11. Load the mould with the mixture obtained in step 6 until the material levels up with the top of the rubber ring. Pack the material properly along the edge of the project. The amount of material required for one operation of the mould is called a SHOT.
12. Assemble the mould and place it in the hydraulic press between the two heated platens. Ensure that the loaded mould is centered between the platens if a satisfactory product is desired.
13. Tighten the pressure release knob and apply hydraulic pressure with up and down movement of jack handle until pressure index points at 25000 1b of force or 8000 psi or 55152 Kilopascals (kPa) on the guage. Maintain pressure for duration of the process.
14. Subject the mould to the above pressure for 6 to 8 minutes if you use formaldehyde resin is used; 8 to 11 minutes if cymel resin is used; 8 to 11 minutes if melurac resin is used.
15. Release the hydraulic pressure by turning the knob in a counter clockwise direction until the pointer or index returns to zero point on the pressure guage.

CAUTION! *Do not use this guage with oxygen or similar oxidizing agents. Turn the knob slowly to prevent a sudden escape of gas which can produce a startling explosion. As the gas from the formaldehyde mixture irritates the eyes like tear gas, it is advisable that you use goggles while engaged in wood flour moulding process. Do not overload the jack above the rated capacity. Prevent "side loading"-make sure the load is centred. Do not push or tilt load off from the jack.*

16. Wear asbestos gloves and remove the mould from between the platens. The temperature of the mould at the time the product is ready may be as high as $300 – 400^0$F
17. Allow the mould sometime to cool down. Then dismantle it and remove the moulded product.
18. Scrape off any glue with putting knife that sticks to the mould and do final cleaning with 3/0 steel wool.
19. Turn off the switches to platens and make sure pressure is released.
20. Clean the work station and return all tools to their right places.
21. Compute the Bulk Factor of the product: $\frac{\text{volume of a shot}}{\text{Volume of moulded}}$

Bulk factor is used to determine the consistency of the product quality. Repeated consistency of bulk factor sequel to the moulding process indicates stability of product quality.

Conclusion and Implications for Technology Education

The wood particle/flour molding process described above sequel to laboratory experiment is a relatively recent industrial development involving wood as an engineering material. The products that are made with wood flour are mentioned in the introductory part of this work. So far much of the work done in wood flour moulding is laboratory – based. The potentials of wood flour moulding technology in minimizing environmental pollution and reduction of unemployment among youth are clear. The challenge facing technical education programme in Nigeria is that of including wood flour moulding in its curriculum. There is abundance of saw dust the source of which is the replenishable wood resource while plastic moulding machines

are available at affordable costs. In the absence of imported equipment, it is possible to use an improvised type. Work in this respect is going on in the Department of Vocational Education, University of Uyo. What remains is the hitch-free will of the government at federal and state levels to aggressively embrace this relatively modern dimension of technology education for capacity building as well as beefing up the nation's economy. There are advanced developments such as biocomposites of wood flour and poly, wood derived fillers, effect of weathering cycle and manufacturing method on performance of wood flour and high density polyethylene composites, wood plastic rotational moulding (Stark, 2005; Anderson, Zhang and Walcott, 2007). The present efforts at wood flour moulding technology appear to be a prerequisite which must be studied in order to intelligently and productively pursue the higher level of wood flour technology.

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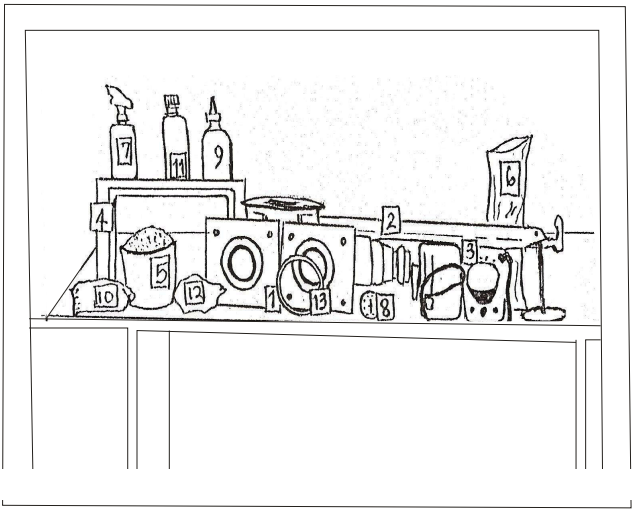
Vicor Plastic Equipment. Inc. 231 East First Avenue, Roselle. New Jersey, U. S. A.

Table 1 : Some tropical trees that lack natural resin

S/ N	Name Of Tree In Ibibio Language	Botanical Identification
1.	Uyot (Light White Wood)	None
2.	Uno: Grows where underground water is abundant	None so far
3.	Akpap (Light white wood)	Hook tree: none so far
4.	Ukpa (White light wood)	Pterocarpus
5.	Eto matis	Gmalina Aborea
6.	Ukim	Cotton Tree: Ceiba Pentandra

Source: Asuquo, P. E, Essien, B. O. and Ekpo, T. U. U. (Eds.) (2000) *Man and Ecology*, Uyo Nigeria: MEF Nigeria Limited.

Figure 3:Tools and Materials for wood flour moulding



C. Tools and Materials (Figure 3)

Volume of moulded product

3. Pressure gauge: To open turn it in clockwise direction, graduate from zero tons 30 tons of pressure. The pointer indicates the amount of pressure applied on the mould

4 Temperature gauge

5 Control switch for temperature gauge

6 Power switch for platen 1 or No 8.

7 Power switch for platen 2 or No. 9

8 Platen 1
9 Platen 2
1. hold and heat the mould

10 . Power cord Connects power supply to the equipment

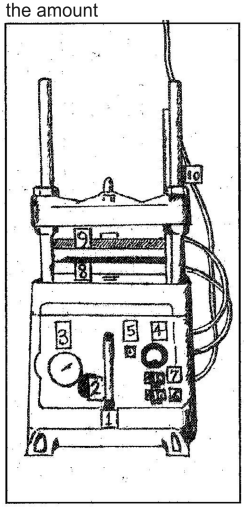
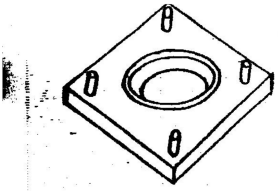
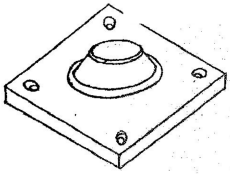


Figure 2a Hudraulic Press and Parts

B. Mild Steel Mould (Figure 2b)
This is used for packing and moulding wood flour



Female part or upper mould



Male part or upper mould

Figure 2b Mild Steel Mould

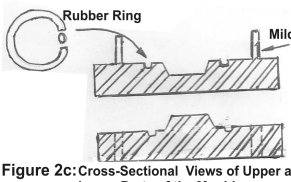


Figure 2c: Cross-Sectional Views of Upper and Lower Parts of the Mould

7