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Mechanical Properties of Particle Boards from Maize Cob and Urea-Formaldehyde Resin

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Abstract**—**Particle boards were prepared from Maize cob (MC) and urea-formaldehyde resin (UFR) on compression moulding machine. The amount of MC was varied from 50-120g while 30g of UFR was kept constant. Some mechanical properties of the particle boards were tested using the standard ASM methods. The results show that as the MC content increased from 50- 120g in 30g UFR, the hardness increased from about 6.89 x 10^2 to7.51 x 10^2MPa. Impact strength decreased from 3.3x 10^{-2} to 0.45 x 10^{-2}J/M^2, while tensile strength initially increased from 2.63 x 10^2 to 3.14 x 10^2 MPa as the MC increased from 50 to 60g in 30g UFR, thereafter, it decreased to about 1.35 x 10^2MPa at 120g in 30g content.

Keywords**—**Hardness, Impact strength, Maize cob, Tensile strength and Urea-formaldehyde resin.

I. Introduction

PARTICLE board has been defined as generic term for a panel manufactured from linger cellulosic materials, usually wood, primarily in the form of discrete pieces or particles, as distinguished from fibers, combined with a synthetic resin or other suitable binder and bonded together under heat and pressure in a hot press by a process in which the entire inter particle bond is created by the added binder, and to which other materials have been added during manufacture to improve certain properties [1].

Historically, the products from the light wood technology were very expensive and exclusive. They were used in the aeronautic field or in the automotive field. Over the time, the light wood products could be produced cheap, but with a better quality through increased efficiency in production processes, research and development. This trend is very strong in the furniture industry [2].

Particleboard is cheaper, denser and more uniform than conventional wood and plywood and is substituted for them when appearance and strength are less important than cost. However, particleboard can be made more attractive by painting or the use of wood veneers that are glued onto surfaces that will be visible [3]. There are over a hundred particle board plants in operation today worldwide and particle board is one of the strongest reconstituted panel products and is considered as an ideal substitute to wood and plywood. Urea-formaldehyde is a non-transparent thermosetting resin, made from urea and formaldehyde heated in the presence of a mild base such as ammonia or pyridine. It is characterized by high tensile strength, flexural modulus, and heat distortion temperature, low water absorption, mould shrinkage, high surface hardness, elongation at break, and volume resistance [4]. It is used in many manufacturing processes due to its useful properties. Examples include decorative laminates, textiles, paper, foundry sand moulds, wrinkle resistant fabrics, cotton blends, rayon, corduroy, etc. It is also used to glue wood together. Urea formaldehyde was commonly used when producing electrical appliances casing (e.g. desk lamps).

The use of Urea-formaldehyde for the production of particle board and as an adhesive resin has been widely reported due to its high reactivity, good performance, and low price [5]. The use of Urea-Formaldehyde for the production of particle board using saw dust has also been reported [6]. Studies on the use of buckwheat stalk in particleboards bonded with urea-formaldehyde resin adhesive have been reported [7]. It has reported that one of the major difficulties in the processing of wood based particle boards with urea-formaldehyde is that urea-formaldehyde is a volatile gas with strong odor [8].

Maize cob is obtained after removing the maize seeds from the cob. The corncob is made up of cellulose and lignin. One of the most important characteristic of corncob products is their absorbency—their capacity to hold up to four times their weight in fluid. This absorptive quality enables corncob products to be used to absorb finishing fluids, oil and water in industrial applications and to clean up industrial or environmental spills. The abrasive quality of corncob particles makes them valued for their use as industrial abrasives. Corncobs, as well as other biomass resources, have the potential to be transformed into valuable bio--products for industrial and consumer use. Compelled by environmental concerns and the desire to reduce the use of imported oil, government and private research is producing technological advances that continue to redefine the potential for corn and its components to be converted into products as diverse as structural materials, chemicals, fabric and fuels [9].

This research is aimed at producing particle boards from maize cob with urea- formaldehyde as a binder as well as studying some of the most properties of the boards so as to add value to maize cob and reduce the demand and reliance on the dwindling petroleum resources.

II. Methodology

A. Preparation of Urea-Formaldehyde Resin (UFR)

120ml of formaldehyde solution was measured in to a clean dried Pyrex 250ml beaker standing on a hot plate and the solution was stirred vigorously in a fume cupboard. 60g of Urea was added, followed by 20g of sodium hydroxide after about 5mins 10ml of ammonia was added and the mixture was continuously stirred with magnetic glass road for two hours at

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about 80°C. The temperature was then raise dot about 90°C and the mixture heated for 2hrs with constant checking and maintaining the pH at 8. The pH was finally brought to about 5.5 using sodium hydroxide solution to terminate the polymerization reaction.

B. Preparation of Maize cob (MC)/Urea-Formaldehyde resin (UFR) particle board

Maize cob was obtained from Samaru, Zaria, Nigeria. The cob was thoroughly dried and grinded and sieved to particle size of about 255μ. 30g of Urea-Formaldehyde was taken in to a beaker and 15ml of ammonia chloride was added and the mixture was stirred vigorously until the Urea-Formaldehyde was completely dissolved.

Weighed quantity of the maize cob was then added to the Urea-Formaldehyde solution and thoroughly mixed. The mixture was then poured in to a mould containing aluminum foil. The mould was then placed in a hydraulic press at a pressure of 5 tones and temperature of 120°C for 20minutes. The procedure was carried out for 50, 60, 80, 100 and 120g maize cob particles.

C. Samples Testing

Hardness test was performed with Duro hardness tester according to ASTM 5091; Izod impact strength analysis was performed according to ASTM 6957 while Tensile strength test was carried out using Hounsfield Tensometer. The results are shown in Figs. 1-3 respectively.

III. Results and Discussion

A. Hardness of Maize Cob Particle Boards

Generally, the hardness of UFR/MC particle board can be seen to be good in the range of 6.89x102-7.51x10^2MPa as depicted in Fig. 1. Particle boards of UFR/MC appear to have good range of hardness values. At higher MC content 80-120g the increase in the hardness values can be seen to be little. Hardness is the ability of a material to resist indention this implies that when considering UFR/MC particle boards, compositions of 30/80g UFR/MC can produce boards of adequate hardness value of useful applications.

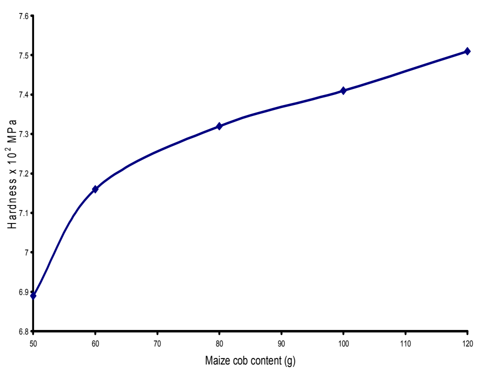

Fig. 1 Effects of Maize cob loading on the hardness of MC/UFR particle boards

B. Impact Strength

This is the ability of a plastic to withstand high energy impact without fracturing or breaking. The values recorded for UFR/MC particle boards range from 3.3 x10^{-2} to 0.45 x 10^{-2}J/M^2. The values can be seen to be moderate. This means that the particle boards of UFR/MC can withstand medium energy impact without fracturing. Fig. 2 shows that particleboards with MC content of 60 to 100g/30g UFR have the highest impact resistance values. As the MC content increased to about 120g/30g UFR, the impact resistance of the particle board drastically reduced. Similar observation has been reported on the study of rubber wood characteristics, its supply and development of its utilization [10]. The decrease in impact strength can be attributed to saturation of the UFR by the MC filler, thus preventing proper bonding of the MC particles to form the strong board.

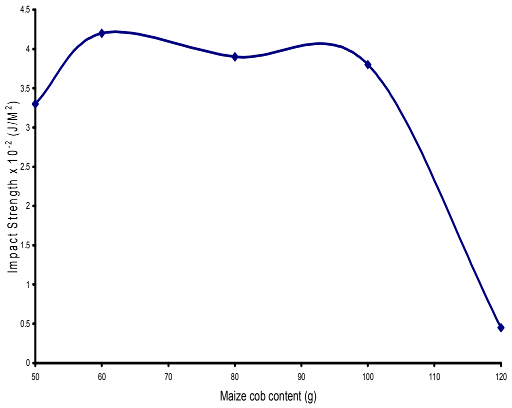

Fig. 2 Effects of Maize cob loading on the Impact strength of MC/UFR particle boards

C. Tensile Strength

Fig. 3 shows that as the content of MC increased from 50 to 60g, the tensile strength of the UFR/MC particle increased from about 263 to 314MPa, thereafter, the strength of the particle boards decreased to a minimum of 135MPa observed for 120g MC/30gUFR board. This shows that particle board of 60gMC/30g UFR composition gave the highest tensile strength value. The decrease in the strength could be attributed to the fact that as the MC filler content increased, the possibility of getting a through and homogenous mix of the UFR decreases, this invariably decreases the bonding effect of the UFR which eventually leads to decrease in the tensile strength of the particle boards. Similar observations have been made while studying the mechanical properties of urea-formaldehyde particle boards [11].

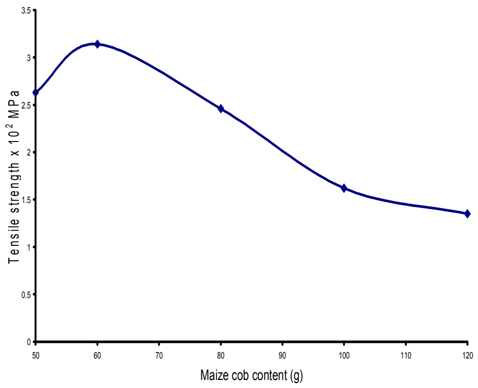

Fig. 3 Effect of Maize cob loading on the Tensile strength of MC/UFR particle boar

IV. Conclusion

From the results of the work reported, it can be seen that production of particle boards using MC and UFR is feasible. The fundamental properties of the particle boards studied show that the boards are strong enough to meet the essential requirements for useful outlets. Perhaps it will be necessary to put the required finishing having aesthetic products.

The boards produced can be used for general purpose requirements such as partitioning materials, ceiling, table tops etc.

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