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## Survey on the Use of Locally Sourced Additives for the Production of Polypropylene Plastic Products

Madueke Chioma Ifeyinwa

Department of Materials and Metallurgical Engineering, Federal University Oye-Ekiti, Ekiti State, Nigeria

### Abstract:

*Polypropylene is a thermoplastic which is one of the classes of plastics. Thermoplastics when subjected to heat, they melt and on cooling they solidify. Polypropylene is used as matrix in so many materials which include chairs, car bumpers, accelerator pedal, bottle crates and others. Some of the additives for the formulation of these products could be replaced with locally sourced additives available in Nigeria. This will save enormous resources that go into the importation of some of the additive materials needed in their formulations. Additives such as filler additives which include snailshell, eggshell, seashell, which are abundant in form of waste in Nigeria could be used in the production of polypropylene plastic products.*

**Keywords:** Polypropylene, chairs, additive, local, filler, seashell, eggshell

### 1. Introduction

Plastics have become very essential in today's world. They have numerous applications which range from household articles like chairs, plates, buckets, to sophisticated medical and scientific equipment. They are polymers of high molecular mass and may contain other substances to improve or boost or enhance performance and reduce cost. These other substances are known as additives. Additives include flame retardants, colour pigments, plasticizers, lubricants, fillers. Before one makes a choice of which type of plastic to use for a particular application, it must be clearly defined, the purpose and function of the proposed plastic and identify its service environment as there are different types and grades of plastic. These different types of plastics differ in properties and therefore in applications. 1(Herman V.B, 2001). In the study of physical and mechanical properties of oil palm empty fruit bunch fibre reinforced polypropylene composite, the tensile and flexural modulus significantly increases with fibre loading [2]. In the work on the mechanical properties of composite materials based on pp and Vietnamese rice husk filler, the results showed that the mechanical properties as well as thermal stability were significantly improved[3]. When the silica flour was introduced into the polypropylene matrix, its mechanical properties were increased[4].

The plastics with the best fatigue resistance are polypropylene, ethylene-propylene copolymer and PVDF. Some plastics are inherently very tough like in some thermoplastic whereas others are inherently brittle as in thermoset. Those which are inherently tough may become embrittled due to processing conditions, chemical attack, prolonged exposure to constant stress etc [5]. Additives aid better performance and functionality and this translates to better processing efficiency in terms of better stabilization and cycle time reduction[6]. The strength and high flowability of the plastic enables a unique transition from a thick to thin cross section[7].

In the study of stone-ground wood pulp-reinforced polypropylene composites: water uptake and thermal properties, the incorporation of mechanical wood pulp into polypropylene matrix produced a clear nucleating effect by increasing the crystallinity degree if the polymer and also increasing the temperature of polymer degradation [8].

Sanadi et al (1995) investigated the renewable agricultural fibres (Kenalf composite) as reinforcing fillers in plastic. In their experiments, the fibres and polypropylene were blended in a thermo kinetic mixer and then injection moulded with the fibre weight fractions varying to 60%. A maleated polypropylene was used to improve the interaction and adhesion between the nonpolar matrix and polar lignocethelotic fibres. The specific tensile and flexural moduli of a 50% by weight (39% by volume) of Kenalf propylene composite compare favourably with a 40% by weight of glass fibre –polypylene injection moulded composite. These results suggests that kenalf fibres are a viable alternative to inorganic mineral based reinforcing fibres as long as the right processing conditions are used and they are used in applications where the higher water absorption is not critical[9]

In the study on polypropylene composite system via fillers and compatibilizers, it was found out that the interaction parameter is higher for coated and lower particle size fillers [10]. This review paper is on the incorporation of locally sourced filler additives such as eggshell, snailshell and seashell additives into the polypropylene blend for plastic production via injection moulding process or any other plastic processing method.

## 2. Materials and Methods

### 2.1. Polypropylene

Polypropylene is a polymeric substance. In other words, it is a macromolecule formed by repetition of one structural unit of propylene several times. Each of these polypropylene molecules is bonded with each other by means of covalent type of chemical bonds. Polypropylene is a type of polymer which gets transformed into liquid polymer on heating while on freezing it turns into a glassy state. Therefore it is a thermoplastic polymer. Polypropylene are viscoelastic which means that their mechanical properties reflect the characteristics of both viscous liquid and elastic solids. Its tensile strength is high and it shows strong resistance towards stress and cracking. It is crystalline in nature and has a regular geometrical shape. It is an excellent insulating material with very low moisture absorption. Polypropylene is one of those versatile polymers which are practically used in many areas such as fibres, automotive, construction, domestic and industrial appliances. Its melting point is 160<sup>0</sup> centigrade, therefore unlike other polymers, it is capable of being operational even at a very high temperature. Polypropylene has a tensile strength of 0.95-1.30N/mm<sup>2</sup>. Notched impact strength of 3.0-30.0KJ/m<sup>2</sup> and density of 0.905g/cm<sup>3</sup>

It is a vinyl polymer and is similar to polyethylene only that on every other carbon atom in the backbone chain has a methyl group attached to it. Polypropylene monomer is represented by the chemical formula C<sub>n</sub>H<sub>2n</sub>, n is the number of atoms. Polypropylene is obtained from crude oil. It is a by product of crude oil. Polypropylene is also obtained from propylene gas with the help of titanium chloride as a catalyst. It is cheap and easily available. It has a tensile strength of 0.95-1.30N/mm<sup>2</sup>, its notched impact strength is 3.0-30.0KJ/m<sup>2</sup> and its density is 0.905g/cm<sup>3</sup>. pp comes in grades. There is polypropylene homopolymer (PPHCP) which is a general purpose grade, polypropylene copolymer (PPCP) that is pp that incorporates 5-15% ethylene; this has much improved impact resistance extending to temperatures below -20 degrees centigrade. Tough. Pp Raffia; this grade of polypropylene is used in the production of raffia tapes for woven sacks manufacture. It has high toughness even in thin sections and is of considerable strength hence its adaptation for chair production.

### 2.2. Additives

Polymers are rarely used directly as plastics, elastomers, fibres etc. this is because they do not fulfil all technological requirements that will make them commercially useful [6]. For this, additives become very necessary.

These additives include;

Fillers; fillers play an important role in modifying the desirable properties of polymers and reducing cost of their composites. Some fillers such as short fibres and flakes of inorganic materials improve the mechanical properties of plastic. Others called extenders permit a large volume of plastic to be produced with relatively small resin. Fillers include silica, clay, CaCO<sub>3</sub>, talc, wood flours.

Lubricants; these reduce the viscosity of the molten plastic and improve forming characteristics. Examples are calcium stearate, wax.

Plasticizers; plasticizers can improve the flexibility, ductility and toughness, produces reduction in hardness and stiffness. The interchain forces are effectively reduced e.g. butyl stearate, amyl. They are low molecular weight materials.

Coupling Agents; mineral fillers can be coupled into various plastic resins. Coupling agents are added to improve the bonding of the plastics to inorganic filler materials, such as glass fibre. A variety of silanes and titanates are used for this purpose. Also certain chromium complexes are used as coupling agents. Coupling agents are used to diminish the loss of some mechanical properties relative to the uncoupled, filled materials.

Colorants; colorants are subdivided into dyes (soluble in polymer matrix) and pigments (insoluble). Textiles fibres are dyed mainly with dyes while pigments are preferred for plastics because they have a higher fastness and not stable against migration dyes. These colorants are also processing aids.

(I) Gathering of local palm kernels which is to be used as lubricant and processing it either locally by cracking the palm kernel to get the nut, the kernel is placed inside the pot, covered and heated with firewood. The heat allows the oil to drain out of the nuts or the oil could also be extruded (by screw pressing the palm kernels) using palm kernel expeller machines to crush the palm kernel for extracting the oil.

(ii) Wax can also be used in place of palm kernel oil. Wax is made from paraffin and paraffin is a bi product of crude oil. There are paraffin wax, bee wax, Soya wax and palm oil wax.

2 Extraction of castor oil by known processes. This could be done by using continuous screw presses and solvent extraction. Or hot pressing using a hydraulic press followed by solvent extraction. The castor oil is to be served as the plasticizer. The functional nature of castor oil contributes toughness to the plastic resin. It has a low molecular weight therefore high penetration and hence can act as softening oil/plastizer. It is inexpensive oil and is viscous.

3 Sourcing of snailshell and eggshell as the filler additive. This is chosen because of its abundance. They are mostly compounded with a carrier resin medium in this case polypropylene.

4 Procurement of polypropylene granules or powder in forms of Polypropylene copolymer (PPCP), Polypropylene Homopolymer (PPHP), Polypropylene raffia (PP Raffia). These are purchased from petrochemical companies.

## 3. A Review of the Use of Locally Sourced Raw Material in Terms of Filler- Snailshell and Eggshell in Polypropylene Plastic Formulation

Considering the number of pp plastic products companies in Nigeria which include companies that are into the production of plastic chairs, bottle crates, waste bins, and others, if filler additive such as snailshell and eggshell which are abundant in the country and

considered as waste are used in these companies, it will boost the country's resources, create massive employment, reduce the cost of the product. Table 1 below shows a list pp plastic products companies in Nigeria.

S/N	Name of Plastic Manufacturing Company
1	Ace toys and plastics Nigeria ltd
2	Belhope plastics industries ltd
3	New china rubber and plastic footwear industry Nigeria ltd
4	Aquapac limited
5	Shongai packaging industries
6	Leoplast industry
7	Reliance plastic industries
8	Explosives and plastic company
9	Zenith plastic industries
10	United plastics industries
11	General plastics Nigeria limited
12	Basabia plastics industries
13	Asia plastics industries (Nig) limited
14	Innoson Group of companies

*Table 1: Some plastic Companies in Nigeria*

If these plastics industries make use of filler additives such as egg shell, snail shell, seashell. It will create more wealth for the nation and make the environment cleaner as well as provide massive employment for the people.

#### 4. Conclusion

The locally sourced additives when blended in the right proportion with the pp resin are expected to improve the mechanical properties of the pp matrix composites as well as pp plastic products depending on the application of the end products in terms of strength and ductility. This is also expected to find applications in other areas where enhanced and better mechanical properties of polypropylene are needed which include automotive construction like in car bumpers, accelerator pedal, dashboard/instrument panel, door panels and a host of other applications.

#### 5. References

1. Herman V. Boeing, "Structure and Properties of Polymers". John Wiley and sons, New York 1973.
2. A.S.Ahmed, M.A.Alam, A. Piee, M.R.Rahman, S.Hamdan. "Study of Physical and Mechanical Properties of Oil Palm Empty Fruit Bunch Fibre Reinforced Polypropylene Composites". Journal of Energy and Environment 2010
3. T.D.Tran, M.D.Nguyen, C.N.H.Thuc, H.H.Thuc. T.D.Tan. "Study of Mechanical Properties of Composite Materials Based on Polypropylene and Vietnamese Rice Husk Filler". Journal of chemistry volume 2013(2013), article 1D 752924, 6pages.
4. A.El-Midany, S.S.Ibrahim. "Interfacial Role of Compatibilizers to Improve Mechanical Properties of Silica-Propylene Composites". Physicochem. Probl.Miner. Process 46(2011) 295-305
5. M. Baker, "Engineering plastics". 1980
6. A,W.Barley and M.J.Scout, "Plastic Materials Properties and Applications", Leonard hall Glasgow 1982
7. V. Krevelan, " Properties of Polymers" 2<sup>nd</sup> edition, Elsevier, Amsterdam 1976
8. J.P.Lipez, J.Girones, J.A.Mendez, N.Mausouri, M.Liop, P.Mutje, F.Vlasecs. "Stone Ground Wood Pulp-reinforced Polypropylene Composites: Water Uptake and Thermal Properties"
9. A.R.Sanadi, D.F.Caulifield,R.E. Jacobson, R.M.Rowell. "Renewable Agricultural fibres as Reinforcing Fillers in Plastics". Industrial and Engineering Chemistry Research 34(5), 1889-1896.
10. Ruler and Francis International Journal 2006
11. Fred W Billmeyer, Jr. and Renee Ford "The Anatomy of Plastics", science technology 1968.