International Jour. Chem.
Vol. 20, No.4, (2010) 259-263

COMPARATIVE STUDIES ON DENSITY, HARDNESS AND POROSITY INDEX EFFECTS OF FLEXIBLE POLYETHER FOAM FILLED WITH COW AND CHICKEN BONES

T. U. ONUEGBU, I. O. C. EKEJIUBA, U. E. EKPUNOBI, C. EJIKEME and **J. N. OBI**
Department of Pure and Industrial Chemistry, Nnamdi Azikiwe University, Awka, Nigeria

Abstract : This work studies the comparative analysis effects of density, hardness and porosity index of flexible polyether foam filled with cow and chicken bones. The size distributions of the two bone samples were determined and 63μm of each of the filler samples were incorporated in the foam recipes. The densities, hardness and porosity indexes of the foam samples were studied using standard methods. Results showed that the densities of 5% foamj samples filled with cow and chicken bones, 2.86×10^{-5} and 2.65×10^{-5} respectively were better than that of the foam samples filled with 10% $CaCO_3$ used in industries whose density is 2.56×10^{-5}. The porosity index of the foam samples increase with increase in filler load. The parameters studied showed that cow bone performed better than chicken bone filler.

Introduction

Over the past few years, there have been increases in the prices of flexible foam as a result of vast applications of this product. These increases necessitated to the incorporation of varieties of fillers in the foam samples. Filler is an inert material added to a polymer composite to improve its properties and to reduce its cost [1]. Fillers cause stiffening of polymer. The degree of stiffening is a direct functional surface area of the filler. The surface area can be determined by the particle size and the porosity of the particles. The three types of fillers are: reinforcing fillers which are glass, graphite, alumina, carbon boron and beryta and these are capable of 'enhancing strength properties of a polymer [2]. Fillers that increase the mechanical strength are called active fillers. While inactive fillers are those, that bring down the cost of materials as well as improve the finishes of the moulded products, these include wood and other similar materials in different shapes and sizes. Inactive fillers may be organic or inorganic [3]. Physico-mechanical properties of flexible polyether foam filled with fibrous and animal wastes have been studies extensively [4-6]. Fibrous and 'particulate materials have been found useful as fillers in natural rubber for reinforcement [7]. Natural fibres are found to have extensive applications in building and civil engineering fields [8].

The raw materials for the production of flexible polyether foam are polypi, polyisocyanate, blowing agent, catalysts, surfactant and additives. Flexible polyether foams products which are made from liquid substances are available in a wide range of types and forms designed for specific applications based on the density [9]. Based on these criteria, flexible polyether foam can be classified as: low density 16-24kg/m³, medium density; 32-48kg/m³ while high density;

Keywords : Comparative, density, porosity index, polyether, filler

48 kg/m^3 and above. Low density types are mainly used for low and poor quality mattresses and packaging operations, medium density types are used for upholstery such as cushions and mattresses while the high density flexible polyether foams are used for wrestlers and athletic underlay [10].

The present study is an attempt to provide additional information on the effects of animal bones on the density, hardness and porosity index of the flexible polyether foams samples.

Experimental

Materials

Raw materials were collected from Winco Foam Nigeria Ltd, Awka, Anambra Stat e, Nigeria, the cow bone was obtained from Abatoir, while the chicken bone was sourced from Citi exotic Fast Food Company, No. 39 Afikpo Road, Abakiliki, Ebonyi State.

Methods

10kg of the cow bone samples were oven dried at 110°C for 48hrs in order! to remove the water content. 7.15kg of the bone of the bone recovered was crushed in mortar and milled with a manually operated corona lever machine model YCIA S.A. and sieved. 8.55kg of the oven dried chicken bone was also milled using the same procedure.

Characterizations of the bone samples

(a) Sieve analysis

The particle size distributions of the two bone samples were determined by the Gilson Automatic Sieve Tester, SS-15 model attached to the following mesh sizes, 320 µm, 180 µm, 87 µm and 63 µm.

(b) Specific gravity

The specific gravity was measured by the air comparison pyconometer technique using ASTM D2840 standard method.

Foam formulation

The foam formulation is shown in Table-1.

Table-1 : Formulation of foam samples

Raw material	Pph	$CaCO_3$ (g)	FAB_0 (g)	FAB_1 (g)	FAB_2 (g)	FAB_3 (g)	FAB_4 (g)	FAB_5 (g)
Polyol	100	200	200	200	200	200	200	200
TDI (index 108)	54.4	108.8	108.8	108.8	108.8	108.8	108.8	108.8
Water	4	8	8	8	8	8	8	8
DMEA	0.14	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Silicone	0.8	1.6	1.6	1.6	1.6	1.6	1.6	1.6
Stannous	0.15	0.30	0.30	10.30	0.30	0.30	0.30	0.30
Metliylene chloride	3.6	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Cow or Chicken bone	% varied	10%	0%	5%	10%	15%	20%	25%

Note: Pph=Part per hundred, FAB_0 = foam with 0% Animal Bone etc.

Preparation of flexible polyether foam

Flexible polyether foam samples were produced by batch process as described in a number of articles [9, 11]. 10% $CaCO_3$ used in industry was used as control, while the animal bone powders used in the production of the bone samples varied from 0%, 5%, 10%, 15%, 20% and 20%. The foam samples were removed and kept at a temperature of 25°C for 72hrs.

Characterization of foam samples

The following mechanical properties of the foam samples were determined using standard methods: density, hardness and porosity index [12].

Results and Discussion

The results of the particle size determination of the bone samples indicated that the mesh sizes are 320μm, 180μm, 87μm and 63μm while the 63μm was used for the production of the foam samples. The particle size of filler 'has a dominating effect on tensile strength and other properties. The smaller the particle size the larger the surface area and the more the filler polymer interaction. The size distribution of fillers whose particles are larger than 40μm and which have at least moderate sphericity can be conveniently measured by sieved method. Those, whose size range from 4-40μm are measured by microscopy, sedimentation, permeametry or radiation scattering methods. The finer the particle sizes the higher the tensile 'strength, modulus and hardness. Coarser particles give weak product than the materials without fillers, but if the particle size is fine there is an enhancement of the mechanical properties. Coarse particles lead to points of weakness in polymer and will therefore fail under stresses. Filler surface area determines the ease of dispersion in the foam recipes, the flow properties and optimum loading of filled polyether foam. This indicates that the particle size of the filler sample is of fine particle grade, which are suitable for use as filler in polymer. Fillers become increasingly reinforcing ,as their particle size decreases. The particle 63μm was used in the production and the smallness of the particle size provides a larger surface area and hence a large filler- polymer- interaction. The particle size of filler samples are shown in Table-2.

Table-2 : Particle sizes of the filler samples

Filler type	Mesh No. Particle size (μm)	N50 320	N100 180	N150 87	N200 63	Total
Chicken bone filler	Weight retained(g)	234.51	61.94	85.70	63	423.15
Cow bone filler	Weight retained(g)	379.82	91.50	39.47	69.20	579.99

From the results shown in Fig-1, it is clear that the cow and chicken bons have moderate densities, SG=0.88 and 0.79 respectively. The specific) gravity of filler that composed of relatively large, non-porous spherical particles is usually determined with air pyconometer. The SG of cow bone was higher than that of chicken bone.

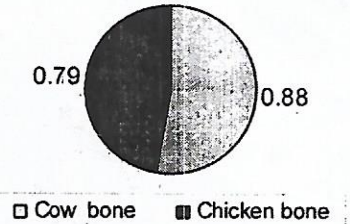

Fig-1 : The specific gravities of cow and chicken bone fillers

As can be seen in Fig-2, the results of the densities of the foam samples indicate that the cow bone filler gave foam samples with higher densities than the chicken bone filer. At 0% a high density value was attained probably because the foam samples were air tight. As the percentage of the filler load increases, the density decreases. This may be because, as more filler is added, the cell opening of the foam sample increases leading to the foam with light weight. At 10% filler load, the $CaCO_3$ gave the foam with highest density followed by cow bone filler and then the chicken bone fillers.

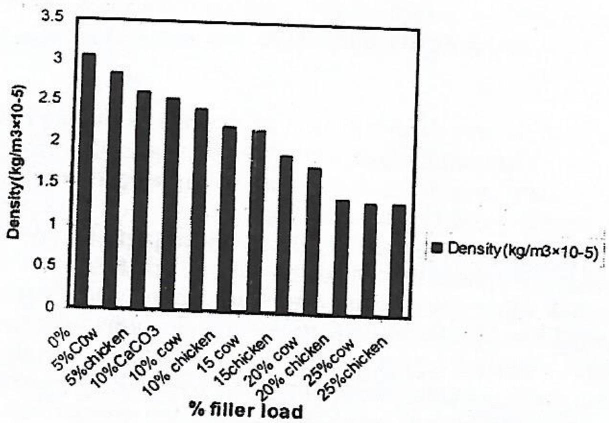

Fig-2 : Density (kg/m3 × 10 – 5) of the foam samples

From the results of the hardness test in Fig-3, it can be deduced that the incorporation of fillers into the foam samples enhanced the hardness of the foam samples. At 10% filler load, cow bone filler gave the highest value, followed by chicken bone filler and the $CaCO_3$ The hardness value decreases with increase in filler load. This indicates that the filler load that gives the hardest foam sample is 10% and the cow bone filler gave the best results.

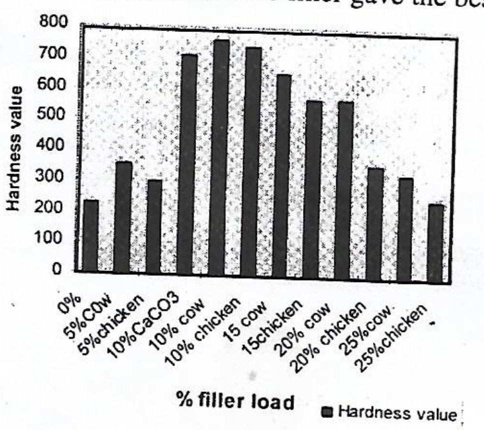

Fig-3 : Hardness value of the foam samples

It is apparent in Fig-3 that as the percentage of the filler load increases the porosity index of the foam samples also increases. Ta 0%, the foam was averagely porous because the foam sample is air tight while at 10% filler load $CaCO_3$ filler giv£s a moderate value followed by cow bone filler and finally the chicken bone filler. From 15-25%, the foam samples were observed to be more porous although, the chicken bone foam samples were) very porous when compared to cow bone foam samples. It may be deduced that the incorporation o°'this filler in the foam samples enhances its porosity index.

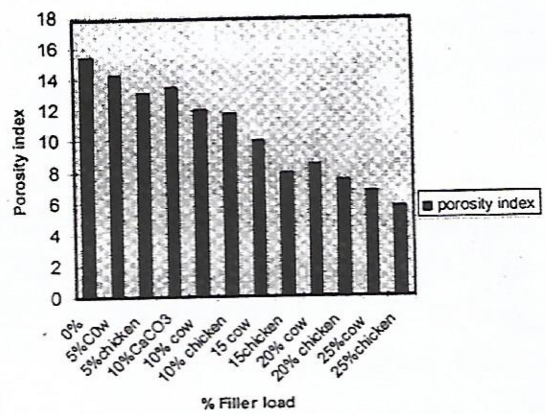

Fig-4 : Porosity index of the foam samples

Conclusions

A number of conclusions is evident from the results of the analyses. The animal bones enhance the mechanical properties of the foam samples. The specific gravities of the bone samples were moderately high. Cow bone gave the foam samples with the highest densities. 10% cow and chicken bone fillers are comparable to the 10%$CaCO_3$.

Acknowledgments

The authors are grateful to Winco Foam Nig. LTD, Awka, Anambra State, Nigeria for providing the raw materials used in this investigation.

REFERENCES

M. S. Bhatnagar, (2004) : A Textbook of polymers, Chemistry and Technology of Polymers, Condensation Polymers Vol. 11, S Chand & Company LTD, New Delhi, p 61-67.

E. Osabohien, O. Anomohanran and S.H.O. Egboh (2007) : Thermal Conductivity and Equilibrium Swelling Properties of Natural Rubber Filled with Welders used Carbide Waste, J. Chem. Soc. Nigeria, Vol. 32, (2) pp 234-239.

B. K. Sharma (2006) Industrial Chemistry Including Chemistry of Engineering, Goel Publishing House, Meerut, pp 353-354

T. U. Onuegbu, O. Ogunfemitimi and V.I.E. Ajiwe (2007): Local raw Material as Filler in Flexible Polyether Foam. Anachem J. Chem. Soc. Nigeria, Vol 1 (1&2)pp 1-7.

T.U. Onuegbu, P.N. Ekemezie and N.C. Okoro (2008), Effetct of Filler on production of Flexible polyether Foam. Anachem J. Chem. Soc. Nigeria, Vol 2 (1) pp 262-267.

T. U. Onuegbu, I.O.C Ekejiuba P.N. Ekemezie and C.C.Ogbonna (2009): The use of Proteinous Material as Filler in Flexible polyether Foam. 34(1), pp 193-197.

Adeosun B. F.(2000): Mechanical and Rheological Properties of Natural Rubber Composites Reinforced with Agricultural Wastes, Nig. Journ of Polym. Sci. and Techn. 1(1), pp 58-68.

Susheel Kalia, B.S.Kaith and Inderjeet Kaur (2009): Pretreatment of Natural Fibres and their Application as Reinforcing Material in Polymer Composites- A Review, Polym. Engineering and Sci., DOI 10.1002/pen, ppl254-1272.

Ajiwe V.I.E., Ulakpa C.M.and Onuegbu T.U., (2005): Additive Effects on Production of Polyurethane Flexible Foams. World Journ. Of Biotechnology, 6; 957-967.

Concise Encyclopaedia of polymer Science and Engineering.

Kroschwizt, IJ Petry Poni Institute of Macromolecular Chemistry, Jassy Romania pp 890-892.

V.I.E. Ajiwe, T.U. Onuegbu and M.C. Ozumba (2007): Manufacture and Analysis of Co-polymerized Rigid Polyurethane Foam Products, J.Sci Engr Tech. 14(1):7298-7310.

Nigerian Industrial Standard (1979): Method Testing Porosity of Flexible Polyurethane Foam, SON, Enugu p 8. 53, Lagos, p 3-8.