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A Short Review on Polyurethanes

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Abstract – In this review paper an overview of the literature is presented from the papers published in last few years. As there is scarcity of petroleum products these days, so the use of vegetable oils in manufacture of polyurethane foam (PU) is increasing day by day. Here, the use of vegetable oils by different researchers in formation of PU foam and characteristics of the foam obtained are highlighted.

Keywords: Vegetable Oil, Polyurethane Foam, Petroleum Products.

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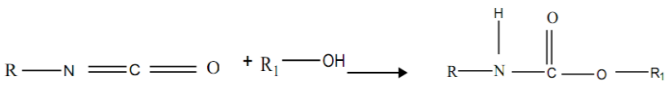
INTRODUCTION

Foam may be defined as a mass of gas bubbles dispersed in a solid or liquid (or glassy) matrix or these are dispersions of gases in liquids or solids. There are several types of foams which are formed by different polymers like Polystyrene foam, Polyurethane foam, Polyolefin foam, PVC foam, Phenolic foam, Urea formaldehyde foam, Epoxy foam, Synthetic rubber and silicon foam, Inorganic foam etc. The polyurethane (PU) is one of the most developing branches of polymer technology having applications in various fields including coatings, resins, medicines, furniture, packaging materials, leather, fibers, storage tanks etc. The pioneer work on PU foam was done by Otto Bayer and his team in 1937 and got patented the work on PU foam (Bayer, et. al., 1937).

Reaction of PU foam formation

The general reaction used for polyurethane foam production is:



Urethane linkage is produced by reaction of isocyanate with hydroxyl group and polyurethane is produced by reaction of polyisocyanates with polyols in presence of a catalyst.

DISCUSSION

Plastic/Polyurethanes foams are generally of two types: Rigid foam and Flexible foam, besides these two, one more form is there, which is semi-rigid. Rigid foams are polystyrene foams which have low cost and thermal insulation properties. Polyurethanes are best flexible foams used for making mattresses, packing materials, insulating materials and structural materials (Szycher, 1999). Formation of PU foam needs polyols which are obtained from coal or petroleum, which are non-renewable sources.

These days attention has been given towards use of vegetable oils in manufacture of PU foams for sustainability and to avoid environmental pollution. The structure of the polyols plays an important role in the type of PU foam obtained. The polyols of small chain length produce rigid foams whereas those of longer chain produce comparatively flexible foams (Uhlig, 1999). Polyols can be obtained from various vegetable oils like castor oil, canola oil, soybean oil, palm oil etc. Except castor oil, other vegetable oils don't have hydroxyl groups naturally and these are introduced by various methods including ozonolysis, epoxidation, hydroformylation *etc*. (Lysenko, et. al., 2006. Petrovic, et. al., 2002. Petrovic, et. al., 2005).

As catalyst is used during preparing of PU foam and the type of catalyst used affects the type of foam obtained. The comparison between properties of PU foams prepared by using different metal catalysts *i.e.* Rhodium and Cobalt was studied (Guo, et. al., 2002) and it was found that rhodium is expensive whereas cobalt is cheaper. Moreover the PU obtained from rhodium catalyst is rigid and that from cobalt is hard rubber. During synthesis of PU, chain extenders can also be used, the example of such chain extended PU foams synthesized using butanediol and hexanediol chain extender in castor oil and their properties were also studied (Swamy, et. al., 2003). PU can be synthesized using castor oil, on which lot of researchers have done their studies. A PU adhesive based on castor oil and nonaggressive to environment having good gluing capacity was prepared (Azambuja and Dias, 2006). Besides using castor oil, Rigid PU foams using modified polyols from canola oil and palm oil were also synthesized and their properties were studied (Narine, et. al., 2007. Chuayjuljit, et. al., 2007).

Flexible PU foams synthesized using cross linker polyol and co-polymer polyol in polyol of Soyabean oil observed good compression and mechanical properties (Zhang, et. al,. 2007). Flexible PU foams can also be synthesized using polyol from palm oil and its influence on various properties of foam was studied (Chian and Gan, 2008. Maznee, et. al., 2009) and it was found that there is considerable increase in compressive strength, tensile strength (Pawlik and Prociak, 2012). A comparison of PU obtained from petroleum products and vegetable oils is also noticed by taking the help of micro-organisms. Vegetable oil based polymer is prone to attack by microorganisms and are degraded by specific strains of microorganisms (Cangemi, et. al., 2008). The results of biodegradation were indicated by TG curve and FTIR spectra.

Lot of work has been done on PU foams synthesized by using castor oil but interpenetrating networks of PU prepared by using pentaerythritol modified castor oil and polystyrene has been studied and change in mechanical properties observed were explained on the basis of crosslinks formed (Valero, et. al., 2009). The interpenetrating polymer networks (IPNs) are obtained by the reaction between components in which one is polymerized or cross-linked (Sperling, 1981). Further IPNs were synthesized using modified castor oil and poly(2-hydroxyethylmethacrylate) [PHEMA] which showed reasonably high hardness, resistance, tensile strength etc. (Prashantha, et. al., 2001). Effects of different proportion of silicon oil on the properties of PU foam prepared by using castor oil were significant on various properties including flexural and compressive strength (Kaur and Kumar, 2013). The influence of lignin on different properties of PU foam was studied and it was found that there is no effect upto 10% content of lignin but at 15% lignin content, cell size increased (Huang, et. al., 2017). Waste cooking oil and non-edible oils can also be used for synthesis of PU foam which can be used for insulation purpose and as structural materials (Enderus and Tahir, 2017), (Palanisamy, et. al., 2011). Karanja oil is extracted from seeds of *Pongamia glabra* found in India, which has oleic and linoleic acid as its chemical constituents (Palanisamy, et. al., 2011). PU foam prepared from karanja oil is found to possess good mechanical properties and density was comparable to semi-rigid form of PU.

CONCLUSION

After going through research work done by various researchers and institutions, it was found that PU foams prepared by using polyols or modified polyols from vegetable oils are low cost, ecofriendly, biodegradable materials having improved mechanical and structural properties.

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