Abstract - The versatility of polyurethane flexible foam has made it an indispensable material in furnishing, transportation and packaging. Castor oil was extracted from the seeds using hydraulic press and characterized in terms of moisture content, volatile content, acid value, free fatty acid and saponification value. It was made to react with toluene di-isocyanate and other material to obtain the polyurethane foam, also the polyether polyol was used with other materials to obtain the conventional foam. Incorporating castor oil showed significantly increased density, hardness and compression. While tensile strength and elongation decreased with increased in the castor oil. The use of castor oil showed a significant decrease in the cost of production of foam as compared to polyol. The cost benefit analysis conducted on samples of flexible polyurethane foam produced showed a significant decrease (about 10%) in the cost of production when compared with foam produced with 100% polyol.

Keywords - Castor Oil, Polyurethane, Polyether Polyol and Flexible foam.

I. INTRODUCTION

The polymer known as polyurethane includes materials that incorporates the carbamate (urethane) functional group as well as the other functional group, such as ester, ether, amide and urea. They are usually produced by reaction of polyfunctional isocyanate, the most often hydroxyl. The hydroxyl containing component covers a wide range of molecular weight and the type including polyether, polyester polyol. The polyfunctional isocyanate can be aromatic, aliphatic, aliphatic, in structure and can be used directly or in modified form. This flexibility in selection of the reactant leads to a wide range of physical properties that allows polyurethanes to play an important role in the world market for quality product from synthetic polymers[1]. Foam is form when gas is blown through solidifying plastic. Depending upon it ability to retain original shape after compression foam can be classified as either flexible or rigid foam. Polyurethane is most widely used for thermal insulation and packaging materials, cushion and floor covering[2]. Improving the quality and cost effectiveness of polyurethane foam demands a constant search for new and renewable active monomer in the foam production.

The use of non-conventional chemicals like castor oil as monomer in the production of polyurethane foam is been proposed. Foam manufacture is a combination of Science and Technology which is an integral part of everyday life. The commercial products known as polyurethane are complex polymeric materials usually formed by the reaction of liquid isocyanate component. The greatest advantage offered by polyurethane foam is their versatility in applications.

Castor oil, a renewable material is known to have some properties in common with polyether polyol and this therefore necessitated this research in search for replacement or blending polyether polyol with locally sourced castor oil. In this work production of flexible polyurethane foams using locally sourced castor oil in place of imported polyether polyol blend in different ratio, physico-mechanical and various mechanical tests analysis on the samples of flexible polyurethane foams produced were undertaken and compared with the polyurethane foam produced from 100% polyether[3].

II. OBJECTIVE OF THE WORK

A. Objectives

1. To synthesis of polyurethane foam using castor oil and diisocyanate.
2. To optimize the percentage loading of castor oil with petroleum polyol.
3. To compare the properties of polyurethane foam made from pure castor oil based polyol, pure petroleum based polyol and combination of castor oil with petroleum polyol in different composition.
5. To characterize product for thermal mechanical and morphological properties.

III. SCOPE AND JUSTIFICATION

A. Scope of the Work

The main scope of polyurethane foam in industrial application includes automotive, building, footwear, furniture, insulation etc. It is naturally occurring and biodegradable polymer so the scope of polyurethane foam and its derivatives is increasing.
Depending on the need and requirement of the industry, polyurethane has different industrial grades suitable for entirely every manufacturing and production scope. Flexible PU foam cushioning and other upholstery material, Car-door, roof-trim, quilting, shoulder pads and coat interlining, Paint rollers, sponges and packaging, Automobile industry for chair seats. Rigid PU foam are used such as Car-crash pads and packaging equipments, Construction when sandwiched between metals, paper, plastic, wood, and PU rigid foam plays an important role in construction industry, rigid foam offer advantages in thermal insulation of building refrigerator and domestic appliances and Shoe shole.

B. Justification

Polyurethane foams are used widely in many fields as heat-insulating, packaging, structural, flotation and load bearing materials, due to their ease processing and unique combination of excellent thermal insulation and mechanical properties. Polyurethanes are one of the most useful three-dimensional polymers because they can be used in various forms of materials such as sheets, foams, elastomers, adhesives and paints, etc. About 80% of all polyurethanes are used in the form of foams, 20% in the form of non-cellular products. Because they give various advantages such as flexibility, lightweight, excellent cushioning properties, available in anti-static, Good die cutting capability, Easily laminated to corrugated surface, Multiple colours available, Caster oil based biopolyol provided the foam with significant biodegradation, The biodegradation by thebiopolyol compromises the decreases of mechanical properties (density and compression strength) etc.

IV. CHEMISTRY OF REACTION

A. The generalized polyurethane reaction is:

\[ R_{NCO} + HOR' = RNHCOOR' \]

Example- (When 1,4 butanediol and hexamethylene diisocyanate react to give fiber forming material called perlon U is polyurethane).

B. The reaction is exothermic, the rate of polymerization reaction depends upon the structure of both isocyanate and the polyols. Aliphatic polyls with primary hydroxyl end groups are more reactive. They react with isocyanate about 10 times faster than similar polyols with secondary hydroxyl groups phenol react with isocyanate more slowly and the resulting urethane groups are easily broken on heating to yield the original isocyanate and the phenol.

The structure has same resemblance to polyamides because both of them contain -CONH- groups. The principle linkage in polyurethane however is -NCOO-. The presence of additional oxygen in the chain increases the flexibility. This is the reson why the mealing point of polyurethane is 150c[4].

V. TESTING OF POLYURETHANE FOAM

1. Density test
2. Tensile test
3. Compressive test
4. Flexural test
5. Water absorption test
6. Differential scanning calorimetry (DSC)
7. Dynamic mechanical analysis (DMA)
8. Fourier-transform infrared spectroscopy (FTIR)
9. Scanning electron micrographs (SEM)

A. IR spectrum analysis

The IR spectral analysis indicates well defined peaks for hydroxyl, carbonyl, olefinic and CH(stretching vibration) absorptions bands for CO. The OH for CO absorption band is broad indicating the presence of hydrogen bonded OH groups and the large band area suggests high concentration of OH groups.

Infra-red spectroscopy is of particular value in the recognition of usual functional groups and in the study of fatty acids with trans double bonds. This method has been used to recognize certain functional groups in most oils containing usual mixtures of saturated and unsaturated acids. Such functional groups includes: OH, C = C, -COOH, NH2, CONH2 etc.
However, the absorption frequencies for these groups are not absolute as they are affected by other parameters such as H–bonding, neighboring groups, vibrational couplings, molecular associations, conjugation of multiple bonds, and the solvents in which these samples are dissolved. For instance, H–bonding and other molecular association, conjugation tend to lower vibrational frequencies especially for alcohols, carboxylic acids and diene, triene conjugated acids in that order.

Acknowledgement

The thank Dr. P. V. Thorat sir for his motivation and support.

REFERENCES