

EXECUTIVE SUMMARY

Polyols are used to manufacture polyurethane, which find extensive use in the automotive, construction, refrigeration and other industrial sectors.

0.1 NATIONAL SCENE

The polyols produced in India are glycols of high molecular weight of polyether, polyester and hydrocarbon types. Polyethene glycol is primarily produced to meet the demand of emulsifiers and surfactants and hardly any of it is used in the manufacture of polyurethane. But, 98% of the other polyethene polyols like polypropylene glycol are used in the production of flexible or rigid foams. Polybutadiene based polyols are made mainly for use as solid rocket propellant binders.

Before 1950, Dai-Ichi Karkaria and Castrol (I) Ltd., were producing urethane grade polyols. Now, there are some more industries which have commenced manufacture of polyols for polyurethane. These industries are Manali Petrochemicals Ltd, UB Petroproducts Ltd., Shivathene Linopack Ltd., NOCIL, Malabar Polyols and Expanded Incorporation. Manali Petrochemicals and UB Petroproducts have started production of polyether polyol in 1990. Manali Petrochemicals Ltd. has technical collaboration with M/s ARCO, USA, while UB Petroproducts has one with M/s Pressindustria A.G., Switzerland.

There are the only two units in the country manufacturing polyols from the grass root level, using propylene as the raw material. Propylene is converted to propylene oxide and then into polyols, whereas all the other units are vegetable oil based or else they start with propylene oxide.

The polyols are blended with necessary catalysts, surfactants and blowing agents and mixed in the right proportion with isocyanates to yield foam of predictable quality.

Conventional slab stock foam manufacturers have sufficient expertise to blend the necessary catalysts and chemicals. Such customers purchase polyols directly. However, for the market, blended polyols and rigid grades alone are sold in the suggested mix ratio of isocyanates, together with typical data of machine properties like cream time, gel time and properties of the foam thus generated.

MPL and UB, reportedly have sufficient expertise to make the systems and necessary test equipment, equivalent to that of any international company.

0.2 MANUFACTURE

0.2.1. Polyether Polyol

Commercially, polyether polyol is manufactured by ethoxylation/propoxylation of a polyhydric alcohol in the presence of a catalyst. The polyhydric alcohols used are ethylene glycol, Dipropylene glycol, diethylene glycol, glycerol. Carbohydrates such as Sorbitol, Mannitol, triethanol amine, sucrose are also used as polyhydric alcohol in the preparation of polyether polyols for making polyurethane foam.

0.2.2 Polyester Polyol

The polyester polyols used in the manufacture of polyurethane are required to be hydroxyl terminated. Polyester polyol is prepared by reacting an excess of the stoichiometric amount of difunctional glycol with dibasic acid. The manufacture is usually carried out through a batch process. The most widely used polyester polyol is polyethylene adipate.

0.2.3 Castor Oil Based Polyol

Castor oil is the most widely used polyol in the manufacture of rigid one shot polyurethane foam. Castor oil is a triglyceride of ricinoleic acid

which contains hydroxyl group at its 12th carbon position. There is one disadvantage in using castor oil based polyols in the manufacture of rigid foam, because of poor reactivity of the secondary hydroxyl group. The foam produced from castor oil has poor compressive strength. For making castor oil polyols suitable for polyurethane foam, it is often treated with polyhydroxy compounds such as ethanol amine, glycerin etc. by way of alcoholysis.

0.2.4 Hydrocarbon Polyols (Hydroxy Terminated Polybutadiene)

Polyols having hydrocarbon backbone (HTPB) are mainly required for use in solid propellant binders. These are made by free radical polymerisation of butadiene gas using hydrogen peroxide as initiator or by anionic polymerisation of butadiene. The major manufacturers of HTPB are M/s ARCO, USA and Japan Synthetic Rubber, Japan. In addition, hydroxyl terminated natural rubber (HTNR) has also been developed for use in fuel rich propellants, starting from natural rubber and hydrogen peroxide.

0.3 INTERNATIONAL SCENE

A major part of the world's polyols production is shared by the two polyols namely Polyether and Polyester polyol. The production capacity stands at 3.5 million tonnes and a growth rate of 4% per annum is forecast. There are no serious health hazards associated with polyols and their raw materials. Dow Chemicals, Bayer, BASF, Union Carbide are some of the major producers of Polyols. Dow Chemicals claims more than 20% of the world's manufacturing capacity for polyols. Main producers of polymer polyols are Union Carbide Corporation, Bayer AG and Mitsui Nisso Corporation. Polymer polyol is preferred by many polyurethane foamers due to its lower viscosity, light colour and high load bearing characteristics.

0.4 LATEST TECHNOLOGY

Polymer polyols are a completely new type of polyol made by graft polymerization of monomers having a vinyl group on to polyether

polyols. By using this polymer polyol, it is possible to obtain features which can not be obtained by polyether polyol alone such as high load-bearing properties, excellent strength and high resilience. Polymer polyols are largely used in manufacturing flexible slab-stock foams and semirigid foams such as bumpers and also to improve mouldability of foams. Now acrylonitrile based third generation polymers are being used in these polymer polyols. Of course, high resilience slab stock is yet to find acceptance in the primary market because of its high cost. Rigid foams like bumpers, are also made entirely using reactive polyols.

0.5 DEMAND AND GROWTH

In India, polyols are consumed along with isocyanates by polyurethane (PU) foam manufacturers. Polyether polyol is the most widely used polyol to manufacture both rigid and flexible polyurethane foam. The total demand of polyols in India is approximately 12,000 TPA. Unlike in the western countries where rigid PUs have a larger share of market, flexible PUs have better market in India. In India, mattress manufacturers are the major consumers of these polyols. Apart from flexible PUs, other major sectors of consumption of polyols are shoe soles, coating insulation etc.

Before 1990, the total demand of polyols was met through import. Some companies have come in the field of manufacture of polyols and some companies like UB Petroproducts Ltd., Manali Petrochemicals Ltd., have already commenced production of polyols.

Rigid polyurethane foam is also used in India for refrigerator insulation, interior panelling, wing tips, fuse large insulation, radar covers etc. of air crafts, car bumpers, instrument panels, steering wheels, roof insulation of automobiles etc.

Recently, Urethane India Ltd. (UIL) a subsidiary of Chemicals and Plastics India Ltd. have started providing thermoplastic polyurethane resins (TPUs) in collaboration with M/s B.F. Goodrich Chemical Group. For making TPUs, they use imported polyols and isocyanate.

0.6 HEALTH & SAFETY FACTORS

Polyols used in manufacture of polyurethane have very low toxicity. High molecular weight polyether polyols derived from propylene oxide and copolymers of propylene oxide and ethylene oxide have a low oral toxicity. Polyols are not irritating to the eyes & skin. Similarly, polyester polyols also have low toxicity. Although polyols have low toxicity, the raw material from which they are manufactured e.g. ethylene oxide, propylene oxide are highly toxic. Ethylene oxide is toxic both in gaseous and liquid form. The current TWA is 1 ppm. Like EO, Propylene oxide is also a toxic material. The AGGIH recommends an 8h-TWA limit of 20 ppm.

0.7 SPECIFICATIONS

There are no Indian standards/specifications available for testing of polyols. However, there are specifications available for polyurethane foams.

0.8 RESEARCH AND DEVELOPMENT

R&D Work is going on for development of technologies for polyols in very few National Institutes and Laboratories in India. Vikram Sarabhai Space Centre (VSSC) has developed technologies for castor oil based polyols & hydroxy terminated polybutadiene (HTPB) polyols and have transferred the technology to three companies. VSSC also has developed a technology for the manufacture of hydroxyl terminated natural rubber (HTNR) and epoxidized HTPB for use in solid propellants and adhesives respectively. IICT, Hyderabad is going to start research work on development of substitute for CFCs. Polyol producing industries have elaborate in-house R & D facilities, Manali Petrochemicals Ltd, UB Petroproducts have fully equipped laboratories for carrying out research in Polyols & Polyurethane systems. They are paying their collaborators for technical and R&D support.

Polyols are required in the manufacture of polyurethanes which find wide applications in the manufacture of flexible, semi rigid, moulded and rigid foams. Other important applications are in the manufacture of thermoplastic elastomers, coatings, adhesives, artificial leather and medical devices.

Manali Petrochemicals and UB Petroproducts Ltd. are the two major units involved in the manufacture of polyols. Shivathene Linopack Ltd. makes vegetable oil based polyols. Vikram Sarabhai Space Centre (VSSC), Trivandrum has developed the process for hydroxy terminated polybutadiene and a castor oil based polyester type of polyol.

Moulded grade polyols, soft polyols and polyol based polyurethane systems need to be developed in the country.

The manufacturing units have active R&D programmes under various stages of progress. The national laboratories have not taken up any serious work in this area. Only VSSC has undertaken work in this area.

All the raw materials required in the manufacture of polyols are not available in sufficient quantities indigenously. Besides, TDI and MDI, which are also primary raw materials required for the manufacture of polyurethane together with polyols, are not manufactured indigenously. Several grades of polyols are also yet to be manufactured indigenously. These are some of the gaps identified.

RECOMMENDATIONS

The following recommendations emerge :

- As isocyanates are largely required in the manufacture of foams, together with polyols, and are not currently being manufactured in the country, priority need be given to initiate manufacture of the same.

- All required grades of polyols need be manufactured in the country. Manufacturers need take necessary action.
- Growth areas and export potential need be tapped by the manufacturers.
- Ethylene oxide is required in the manufacture of polyols. As there is a demand supply gap in ethylene oxide, steps need be taken to step up its production.
- Effects need be stepped up for development of soft polyols to be used in CFC free polyurethane foams.