Outline

- Background
- Introduction
- Basic Chemistry
- Raw material
- Advantages and Disadvantages
- Applications

Background

- PU is obtained by mixing ingredient chemical (isocyanate and polyols), in predetermined proportion, which further react to form the polymer.
- The consistencies of the end product depends on mixing, in previous ration of ingredient chemicals and maintenance of process temperature.
- These is a exothermic reaction, as liquid isocyanate and polyol react to form PU, the mixture becomes increasingly viscous eventually forming a solid mass.
- There are no hard and fast rules for obtaining the optimum PU end product, success is due to good formulation selection with well chosen and appropriate processing parameters
- The important processing characteristics of the system will include viscosity, pot life, reactive mix ratio control, time and process temperature.

POLYURETHANE

- Define: Polyurethane is any polymer consisting of chains of organic units joined by urethanes links
- Polyurethane can be made in a variety of textures and hardness by varying the particular monomer used and adding other substances.
- Otto Bayer discovered and patented the chemistry of polyurethane in 1937.
- They are best know to us in the form of flexible foams, mattresses, earplugs, chemical resistant coating, specialty adhesives and sealants.

Basic Chemistry

- The simplest PU is linear in which the hydroxyl compound and the nitrogen compound each have a functionality of two. This can be represented by the following
- Isocyanate + Polyol = Polyurethane
- PU polymer are typically made by the reaction of diisocyanate with a molecule containing at least two hydrogen
- The reaction is self sustaining and is relatively easily controlled. The mechanism is know as polyaddition

Basic Chemistry (cont)

- <u>Polyaddition Polymerization</u>
- OCN-R-NCO+HO-R'-OH---->-(O-OC-HN-R-NH-CO-O-R')n"

  Diisocyanate Diol Polyurethane
- When a isocyanate reacts with a alcohol a urethane is formed
- R-NCO + R'-OH----> R-NH-CO-OR'

  Isocaynate alcohol Urethane
- The isocyanate can react with different chemical groups, so the final properties of the polymer will vary according to the reaction route taken.
- Therefore the formulation of a PU must take into account every possible reactive constituent. PUs may have a very widely varying structure depending on the type of isocyanate and the type of reactive hydrogen components present in the formulation.

Raw Materials

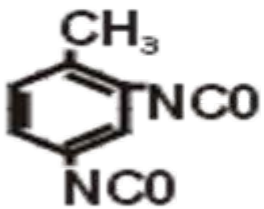
- Isocyanate: Many commercial grades of isocyanates used for making PUs are aromatic in nature.
- Each isocyanate will give different properties to the end product, in most cases, different processing systems.
- An important property of an isocyanate is its functionality, i.e. the number of isocyanate groups (-NCO) per molecule.
- For cross linked PU applications the average functionality of the isocyanate is usually a little over two. The higher functionality isocyanates are used for special applications.
- When a di-functional isocyanate is used with a di-functional polyol a long linear PU molecule for elastomeric applications is formed.

Raw Materials Isocyanates (cont)

- The common isocyanates used to make PUs are

MDI (diphenylmethane 4,4 - diisocyanate)

NDI (naphthalene 1,5 - diisocyanate)



TDI (tolune diisocyanate)

$OCN(CH_2)_6NCO$

HDI (hexamethylene diisocyanate)

Raw Materials

- Polyols: There are two main types of polyols used in the PU industry, polyethers and polyesters. Typical polyols used are shown below

Polyethylene adipate (a polyester)

Poly(tetramethylene ether) glycol (a polyether)

Raw Materials Polyols

- Polyethers: Widely used polyethers have a relatively low molecular weight in the range of 500 to 3000 and are manufactured from propylene oxide (PO) and ethylene oxide (EO).
- PO is the major constituent of the polyol, whereas EO is only included in small amounts to modify the properties of the polyol.
- The functionality of the polyether polyol (number of active hydroxyl groups per molecule) can be varied and is normally 2 for elastomers, approximately 3 for flexible foams and up to 6 or more for rigid foams

Raw Materials Polyols

- Polyesters: The polyester polyols are typically produced by the condensation reaction of a diol such as ethylene glycol with a dicarboxylic acid.
- Polyester polyols tend to be more expensive, are usually more viscous and difficult to handle but develop PUs with superior tensile, abrasion, flexing and oil resistance properties.
- They are used to make PUs for more demanding applications. A disadvantage of polyester based PUs is their lower hydrolysis resistance.

Advantage

- High strength to weight ratio.
- Resistance to flame spread.
- Excellent thermal insulation.
- Low coast.
- Easily processed.
- Cheaper than Epoxy and Polyester.

Disadvantages

- Moisture absorption tendency
- Toxicity: Potential health hazards of Isocyanates as isocyanates are generally toxic chemicals.
- Non recyclable

Application

- Flexible Foams: The largest markets for flexible PUs foam are in furniture (cushioning), transportation, bedding industries (mattresses), as well as automotive seating, semi-flexible foam are used for sound and vibrationa control in automotive application.
- Specialty applications include reticulated foam for filtration and consumer products such as sponges, scrubbers, and paint application.
- Rigid Foam: These are board or laminates, which are used in residential sheathing (building and construction) for commercial roofing, refrigeration.

Application

- They are typically integrated in large-scale assembly operations, such as Aircraft carriers, insulation of truck trailers, truck bodies, cargo containers, tank and pipe insulation.
- Liquid natural gas is usually insulated with rigid PUIR foam laminates.
- Polyurethane Coating: All application that require abrasion resistance, skin flexibility, fast curing, good adhesion and chemical resistance.
- Polyurethane Elastromers: Used in application where toughness, flexibility, strength, abrasion resistance and shock absorbing qualities are required.