PU 101: Polyurethane Chemistry

Course Description:

This course provides a focused introduction to the chemistry of polyurethanes, covering key raw materials, reaction types, and formulation components. Participants will explore isocyanates, polyols, and coreactants, along with different polyurethane systems such as rigid, flexible, coatings, and elastomers. The course also highlights common testing methods, applications across major industries, and basic processing equipment, while emphasizing safe handling practices. Ideal for those seeking a deeper technical understanding of polyurethane chemistry and its real-world use.

Background of Polyurethane Technology

- History of the development
- Basic polyurethane chemistry overview
- Review of typical definitions and terms
- Thermoset vs thermoplastic

Polyurethane Chemistry

- Aromatic and aliphatic reaction chemistry
- Monomeric and polyisocyanates
- Differentiation of chemistry and reaction: MDI, TDI, HDI, H12MDI, IPDI
- Types of chemistries involved
  - Rigid vs flexible
  - 1K vs 2K
  - Moisture cure
  - Waterborne, PUDs
  - UV
  - Powder

Coreactants – Brief overview of chemical structure and reaction

- Polyether
- Polyester
- Acrylic
- Polyamines

Formulating Components and Chemistry – what they are and why they are used

- Blowing Agents
- Fire retardants
- Mold release

- Additives to polyurethane coatings: Catalysts, solvents/VOC, chain extenders, surfactants, others

Typical Testing Parameters

- Rigid: compression, density, exposure to heat and water, open vs closed cell
- Flexible: flex, accelerated aging, flame resistance
- Coatings: hardness, accelerated weathering, appearance/gloss, chemical resistance
- Adhesives: green strength, shear strength, and shear modulus, bond strength, fracture,
- Elastomers: compression, hardness, modulus, chemical resistance
- TPU: hardness, tensile strength, compression, abrasion

Polyurethane Market Applications – overview of breadth of applications and reasons for use

- Automotive: OEM and refinish
- Building and Construction
  - Insulation – rigid and spray
  - Polyiso board
  - Adhesives and sealants
  - Floor coatings
- Furniture
  - Comfort furniture and mattress
  - Foam to foam bonding adhesives
  - Wood Coatings
- Appliances
- Packaging: foam and flexpac adhesives
- Composites
- Protective metal coatings
- Marine
- Textiles
- Sporting equipment
- Encapsulants and potting compounds
- Elastomers

Application Equipment – review the types of equipment used for using polyurethanes

- Foam: High-pressure impingement Metering Equipment
- Foam: Loa pressure metering
- Composites: Pultrusion
- Composites: Infusion
- Coatings and adhesives: Brush, roll, spray (plural component spray gun)

- TPU: Injection molding
- Elastomer machinery

Safe use and handling of isocyanates

Summary and Questions