Polyoxymethylene (POM), Acetal

Introduction to Polymer Presentation
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Presentation Outline:

- **Introduction:**
  * What is polyoxymethylene?

- **Formation:**
  * How it is formed?

- **Properties and applications.**
  * Acetal Homopolymer (properties and applications)
  * Acetal Copolymer (properties and applications)

- **How are they processed?**
Introduction:

- Polyoxymethylene is a functional group or molecule containing the functional group of a carbon bonded to two -OR groups. It can be also refer to "Acetal".

![Chemical Structure of Polyoxymethylene]

- Introduced to industry in 1956 as a potential replacement for die-cast metals.

- Polymer Type (Thermoplastic)

- It is a colorless liquid with a strong odor.

- Used as in solvent in perfumes and as synthetic flavoring ingredient.

- It is a flammable liquid and dangerous fire hazard.
Introduction Continuation:

- **Advantages**
  - Highly crystalline
  - More creep resistant than Nylon.
  - Good resistance to solvents (except phenols).
  - Low smoke emission.
  - High gloss surfaces.

- **Disadvantages**
  - Poor resistance to acids/alkalies.
  - Burns easily, (not available with flame retardants).
  - Limited processing temperature range.
  - High mould shrinkage.

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**Key Properties**

- Resistance to chemicals
- Dimensional stability
- High strength and stiffness
- Machinability

**Acetal Fabrication**

- Highly machinable
- Excellent for mechanical parts or electrical insulators
- Wear resistant surfaces
- Excellent rigidity
Formation:

- An acetal is the product of the acid catalyzed reaction between an alcohol and a ketone or aldehyde. In order to achieve effective acetal formation two additional features must be implemented.
  - Acid catalyst must be used
  - The water produced with the acetal must be removed from the reaction.
Formation:

-Hemiacetal is formed through a NACC attack by the alcohol oxygen.

-Hemiacetal can react further in the presence of acid and more alcohol to generate an acetal.

-Acetal resins are produced by the polymerization of purified formaldehyde [CH2O] into both homopolymer and copolymer types with slightly different advantages for each.
**Properties:**

- Available in several viscosity ranges
  - higher viscosity materials are generally used for extrusions and for molded parts requiring maximum toughness;
  - lower viscosity grades are used for injection molding

- It resins have high tensile strength, stiffness, resilience, fatigue endurance, and moderate toughness under repeated impact.

- Have high resistance to organic solvents, excellent dimensional stability, a low coefficient of friction, and outstanding abrasion resistance among thermoplastics.

- Resistance to creep is excellent.
Acetal Homopolymer

Applications:

- **Automotive applications**
  - include fuel-system and seat-belt components, steering columns, window-support brackets, and handles.

- **Plumbing applications**
  - shower heads, ballcocks, faucet cartridges, and various fittings.

- **Consumer items**
  - quality toys, garden sprayers, stereo cassette parts, butane lighter bodies, zippers, and telephone components

- **Industrial applications**
  - couplings, pump impellers, conveyor plates, gears, sprockets, and springs.
Acetal Copolymer

Properties:

- High tensile and flexural strength, fatigue resistance, and hardness. Lubricity is excellent.

- Moisture absorption is low.
  - permitting molded parts to serve reliably in environments involving humidity changes.

- Good electrical properties, combined with high mechanical strength.
  - qualify these materials for electrical applications requiring long-term stability.

- Excellent resistance to chemicals and solvents and resistance to strong alkalies is exceptionally good.
Acetal Copolymer

Applications:

- **Industrial and automotive**
  - copolymer include gears, cams, bushings, clips, lugs, door handles, window, cranks, housings, and seat-belt components.

- **Plumbing applications**
  - valves, valve stems, pumps, faucets, and impellers

- **Applications for the FDA-approved grades**
  - include milk pumps, coffee spigots, filter housings, and food conveyors.
How are they Processed?

- Acetals may be processed by 
  - extrusion techniques.
  - conventional injection molding

- Polymer extrusion

  - Extrusion is the most used, and perhaps the most important method of plastic fabrication today.
  - It is the conversion of a raw material into a finished product or part by forcing it through an opening.
How are they Processed?

- **Injection Molding**
  - It is the most widely used polymeric fabrication process.
  - Polymer melts have a high viscosity and cannot simply be poured into a mold.
  - Large force must be used to inject the polymer into the hollow mold cavity.
  - Identical parts are produced through a cyclic process.
How are they processed?

- **Injection molding**
  - It is accomplished by large machines called injection molding machines.
Conclusion:

- The acetal resins are among the strongest and stiffest of all thermoplastics, so it is used where requirements for good moldability, fatigue resistance and stiffness justify its high price.

- Characterized by good fatigue life, low moisture sensitivity, high resistance to solvents and chemicals, and good electrical properties.

- Because of these properties, acetals often compete with nylons for many of the same applications.

- It can be extruded to produce shapes of constant cross section such as fibers and pipes.

- It must be processed in the temperature range 190 – 230 C and may required drying before forming because it is hygroscopic.

- Without co-polymerization or the addition of blocking groups it degrades easily.