

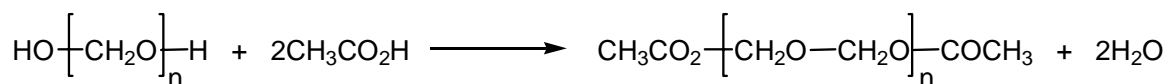
## PERP Program – New Report Alert

October 2002

Chem Systems' Process Evaluation/Research Planning program has published a new report, **Polyacetal (01/02S12)**.

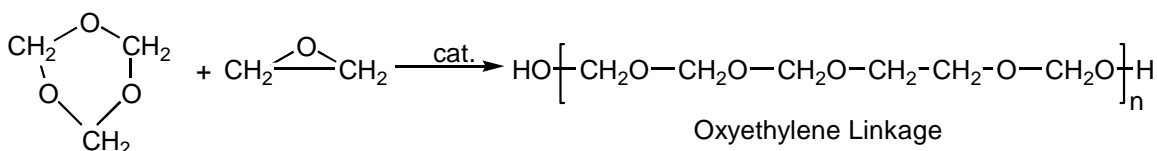
Acetal polymers, also known as polyoxymethylene (POM) or polyacetal, are formaldehyde-based thermoplastics that have been commercially available for over 40 years. Polyformaldehyde is a thermally unstable material that decomposes on heating to yield formaldehyde gas. Two methods of stabilizing polyformaldehyde for use as an engineering polymer were developed and introduced by DuPont, in 1959, and Celanese in 1962.

DuPont's route for polyacetal yields a homopolymer through the condensation reaction of polyformaldehyde and acetic acid (or acetic anhydride):



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The Celanese route for the production of polyacetal yields a more stable copolymer product via the reaction of trioxane, a cyclic trimer of formaldehyde, and a cyclic ether (e.g., ethylene oxide or 1,3 dioxalane):



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The improved thermal and chemical stability of the copolymer versus the homopolymer is a result of randomly distributed oxyethylene groups. These groups offer stability to oxidative, thermal, acidic and alkaline attack. The raw copolymer is hydrolyzed to an oxyethylene end cap to provide thermally stable polyacetal copolymer.

The stabilization of acetal polymers includes the addition of antioxidants and acid scavengers. Polyacetals are subject to oxidative and acidic degradation, which leads to molecular weight deterioration. Once the chain of the homopolymer is ruptured by such an attack, the exposed polyformaldehyde ends decompose to formaldehyde and acetic acid. Deterioration in the copolymer ceases, however, when one of the randomly distributed oxyethylene linkages is reached.

The copolymer is also more stable than the homopolymer in an alkaline environment. Its oxyethylene end cap is stable in the presence of strong bases. The acetate end cap of the homopolymer, however, is readily hydrolyzed in the presence of alkalis, causing significant polymer degradation.

Acetal homopolymer is more crystalline than acetal copolymer. The homopolymer, therefore, provides better mechanical properties, except for elongation. The oxyethylene groups of the copolymer provide improved long-term chemical and environmental stability. The copolymer's chemical stability results in better retention of mechanical properties over an extended product life.

Acetal polymers have been particularly successful in replacing cast and stamped metal parts due to their toughness, abrasion resistance, and ability to withstand prolonged stresses with minimal creep. Polyacetals are inherently self-lubricating. Their lubricity allows the incorporation of polyacetal in a variety of metal-to-polymer and polymer-to-polymer interface applications such as bearings, gears, and switch plungers. These properties have permitted the material to meet a wide range of market requirements. The strengths and weaknesses of polyacetal are given in the figure on the next page.

This new report by Nexant Chem Systems outlines the process technology and compares production economics for both polyacetal homopolymer and copolymer using solution and bulk processes. The supply/demand outlook for polyacetals to 2007 is also presented.

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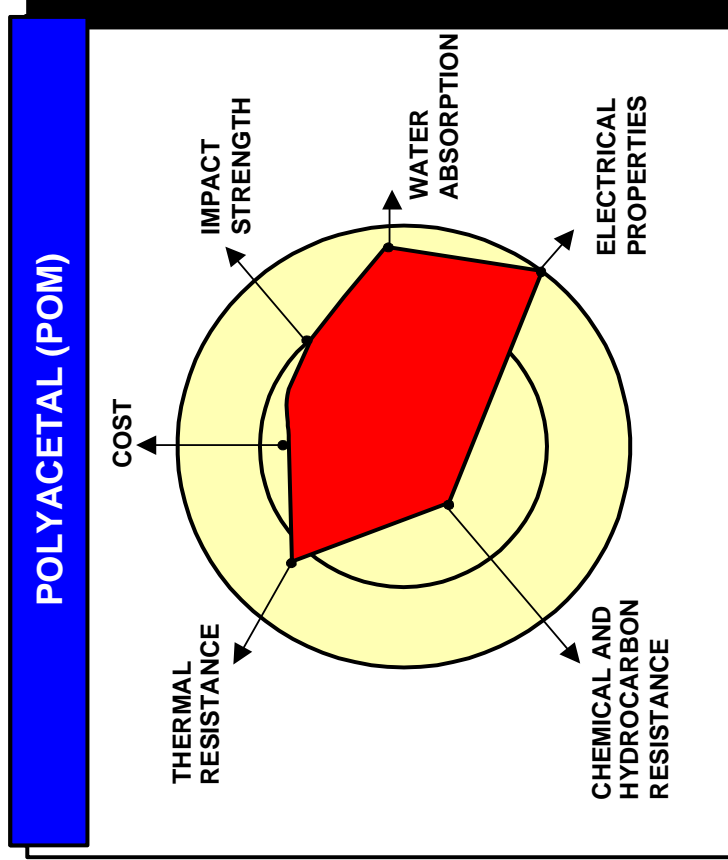
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## STRENGTHS/WEAKNESSES OF POLYACETAL

### Major Strengths

- Stiffness
- Creep resistance
- Moisture absorption
- Electrical properties
- Abrasion resistance
- Chemical resistance
- Coefficient of friction



### Major Weaknesses

- Impact strength
- Shrinkage/warpage
- Flammability

Competition: nylon

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