

# Celcon® Acetal Copolymer Grades GC25A and M90™

## Washing Machine Transmission

**Typical Related Applications Requiring High Flexural Fatigue Strength, Low Moisture Absorption, Dimensional Stability, Chemical Resistance, Wear Resistance and Spring Resilience:**

- Industrial Transmissions
- Office Equipment
- Appliances
- Power Tools
- HVAC Equipment

### Requirements

Washing machine transmissions with steel gears have traditionally been noisy and heavy. An innovative dual drive washer transmission developed by the Maytag Herrin Manufacturing Facility in Herrin, IL was designed from the outset to use plastic gears to reduce operating noise and simplify assembly.

Stacked in a diecast metal housing above the 3/4 horsepower motor, the split power drive has two sets of gears driving a common output. A plastic input pinion turns two cluster gears with each turning a second-stage crank gear driving two rack gears. These drive the output pinion on the agitator shaft. Care taken with the design insured that the load was equalized through the two power paths.

The Maytag drive team specified gears molded to American Gear Manufacturers' Association (AGMA) Q7 quality standards. AGMA Q7 denotes tooth-to-tooth composite tolerances of 0.0018 in. and total composite tolerances of 0.0046 in. for the 17 diametral pitch, 52 tooth gear with a reference pitch diameter of 3.059 in. The molded gears had to



*Celcon® GC25A and M90™ used in multiple gears in this Maytag transmission, met all engineering requirements and simplified assembly. The resins also reduced the noise, wear, number of components, weight, and heat generated.*

maintain their strength and dimensions despite operating temperatures reaching 190°F. They also had to withstand the chemical environment of the oil-lubricated transmission. Maytag's requirements called for the transmission to last at least 15 years in residential service.

### Selection Criteria

Maytag evaluated several candidate resins and conducted extensive lubrication studies to select materials for the gears and pinion. Any resin chosen for the gears needed sustained strength and creep resistance to prevent excessive tooth deflection. It also had to hold tight dimensional tolerances in a hot, oily environment.

Nylon was ruled out due to moisture absorption and swelling, Celcon® GC25A 25% glass-coupled acetal copolymer provided the necessary strength and fatigue resistance, and met all other engineering requirements.

At the base of the dual drive, the less heavily loaded input pinion has two tangential leaf springs molded into its sides. The integral springs compress and slip

when the wash basket oscillates but spread and lock when the motor reverses for spin. General purpose, unreinforced Celcon M90™ provided sufficient strength and the necessary resilience for this part.

## Results

Maytag selected Celcon® GC25A and Celcon® M90™ acetal copolymer resins for the gears used in the split power drive, the input pinion and its cluster gears, as well as the second-stage crank gears. These resins provided:

- Sustained strength and dimensional stability at test temperatures reaching 190°F
- Long-term resistance to lubricating oils
- Easy, consistent molding properties to repeatedly produce gears to AGMA Q7 tolerances
- Resilience and creep resistance for a long-life spring action pinion

The new drive with its plastic gears made transmission noise almost inaudible to observers. It reduced heat rise 10 to 15% compared to the old metal transmission – a clear indication of improved efficiency. Accelerated life testing revealed far less wear on the plastic gears than

on the steel gears in the earlier transmission. Use of Celcon resins also reduced weight by 13 pounds and eliminated 42 parts compared to the old metal drive. (The typical oscillating/spinning washer drive weighs around 35 pounds, and Maytag’s metal transmission added a heavy counterweight to balance the gearbox during the spin cycle.) The split-power design transmission is inherently balanced and eliminates clips, snap rings, and other fasteners customarily used for holding parts in place.

With the transmission 13 pounds lighter than its steel predecessor, the new drive can be assembled and moved by hand without mechanical lifting aids. Reducing the number of parts afforded Maytag significant assembly savings, and timing-marks molded into the plastic gears reduces the chance of assembly errors.

The Maytag Herrin transmission marks a major advance in washing machine transmissions and plastic gear technology.

*If you would like additional information on Celcon® GC25A and M90, please call Ticona Product Information Services at 1-800-833-4882 and mention “Application Sheet AP97-01”.*

### Properties of Celcon® Acetal Copolymer for Transmission Spur Gears

Property, Test Method, (Unit)	Celcon® GC25A	Celcon® M90™	Comments
Tensile Strength @ yield, 73°F		8,800	Strength to handle temporary overloads.
Tensile Strength @ break, 73°F ASTM D638, (psi)	16,000		
Flexural Modulus, ASTM D790, (psi)	1,100,000	375,000	Rigidity to keep tooth deflection within allowable limits.
Water Absorption, ASTM D570, @ 73°F, (%)	0.27	0.22	Low moisture absorption preserves gear dimensions and contact ratio.
@ equilibrium, (%)	0.8	0.8	
Heat Deflection Temperature ASTM D648 @ 264 psi (°F)	325	230	Heat resistance prevents excessive tooth deflection under load.

## World-Class Engineering Polymers

- Celanex® thermoplastic polyester (PBT)
- **Celcon® and Hostaform® acetal copolymer (POM)**
- Celstran® and Compel® long fiber reinforced thermoplastics (LFRT)
- Fortron® polyphenylene sulfide (PPS)
- GUR® ultra-high molecular weight polyethylene (UHMW-PE)
- Impet® thermoplastic polyester (PET)
- Riteflex® thermoplastic polyester elastomer (TPC-ET)
- Vandar® thermoplastic polyester alloy (PBT)
- Vectra® liquid crystal polymer (LCP)

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