Latest Generation of Quieter Plastic Gears CAN TAKE THE HEAT

Robin Wright, Assistant Editor

DSM's Stanyl lawn mower starter gears, actuator gears and other products allow for higher torques through a wider temperature range.

Ten years ago, most mainstream gear manufacturers didn't even consider plastics as an option, especially in higher power applications. While metal is still the most popular choice, the plastic gear community is working to raise its visibility.

And the auto industry, at least, appears to be noticing. The increase in fuel costs has led many to consider lighter weight materials as car components, which translates to greater fuel economy.

A variety of other automotive trends is driving the increased attention on plastics, says Steve Wasson, application development engineer at DSM.

"What we're seeing, which plays well with Stanyl (the latest grade of plastic from DSM), is a trend toward more power. The automotive industry has greater requirements, as window glasses get bigger, seats get more stringent so recliners need more strength." Also, Wasson says, "All the 'under the hood' requirements lead to increased heat performance, as does turbo control."

To meet those strength and heat requirements, DSM has developed Stanyl PA46, a thermoplastic resin for molded gears featuring higher endurance and reduced dimensional change for use in high temperature environments and for high torque transmitting situations. According to the company literature, Stanyl can retain mechanical properties between 100–170°C and offers endurance and fatigue resistance at 100°C.

"Where Stanyl is important for gears is that it offers very linear material properties through a wide temperature range, from 85–260°C," says Wasson. "Most other material will go through a blast transition and the slope of the line drops off."

GE-Plastics, a division of GE, manufactures specialty thermoplastic compounds for automotive gears as well as those for business equipment and fluid handling equipment. GE-Plastics also sees the importance of temperature. James Fagan, product manager for Lubricomp and Stat-Kon products, sees the future of plastic gearing divided into two areas.

"There's two trends going on right now," he explains. "Many traditional business equipment gearing applications are now manufactured overseas. On the other end, we have customers who've seen a great need for our plastics to go in gears operating in high temperature environments. In these more demanding applications, customers gravitate towards GE-Plastics' glass or carbon fiber-reinforced materials that go hand-in-hand with high temperature base resins to deliver materials with the thermal and fatigue resistance needed to perform in these

demanding applications. Additionally we are seeing a need for some gears which need to be made with flame retardant compounds."

For GE-Plastics, most of the demand for flame retardant plastics comes from business equipment manufacturers whose designs place the gears near a power supply.

Ticona Technical Polymers is also catering to the special high temperature needs of the automotive industry. Its latest material, Fortron linear polyphenylene sulfide (PPS), has been used for actuator housings and gears. Each PPS actuator is comprised of an injection molded body and cover, which are ultrasonically welded to create the final assembly. Importantly, PPS was used in the actuator because of its ability to remain dimensionally stable at temperatures from well below 0° to 180°C.

New Materials Require New Understanding

This continued emphasis on highly engineered plastic materials has led GE-Plastics to more thoroughly characterize materials for easier specification into gearing applications. GE-Plastics is planning an e-seminar to discuss the company's findings, which are also available online at *www.lnp.com*.

"Traditionally, only single point data has been available, which doesn't do a complete job of describing material suitability for use in gear applications. We've developed multi-point data that is much more thorough in describing our materials performance capabilities to a gear designer," says Fagan.

Winzeler Gear, a company that designs and manufactures plastic gears, is also taking proactive steps to teach the gearing community more about the field of engineering material selection for high strength, low cost gears.

To that end, John Winzeler, president of Winzeler Gear, has commissioned a research project with Bradley University in Peoria, IL. Over the past five to six years, 600 graduate students and two professors have analyzed the success of plastic gearing.

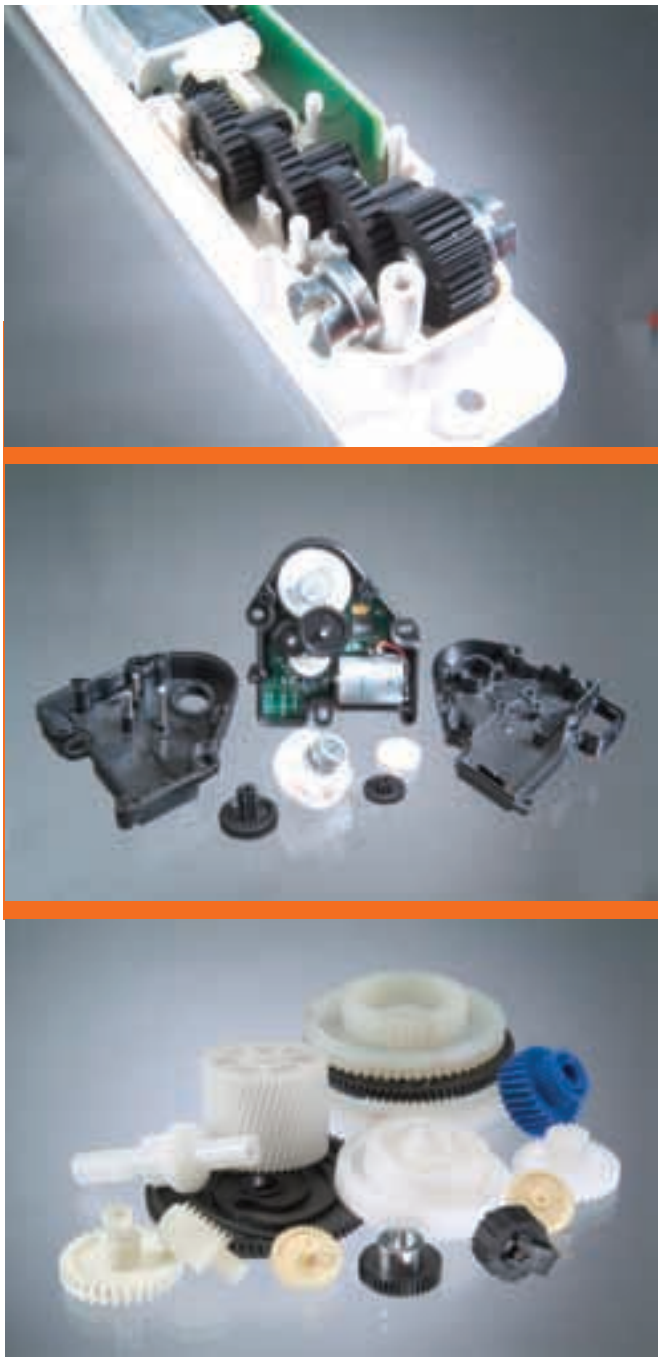
"We're confirming what we've always known. The industry-accepted software for designing plastic gears today creates conservative results that leads the decision makers to select metal over exotic plastic every time," Winzeler says.

New Materials Allow for Stronger, Smaller Gears

Larger gears are used for low volume applications, yet require the same amount of work as a high volume application, says Winzeler. All of this tends to be cost-prohibitive and ultimately makes larger plastic gears less appealing to the customer.

The gears Winzeler supplies are consistently getting smaller. The work typically falls in the range of microsizes up to 3–4" in diameter. Among the company's most notable products are gears tiny enough to be in a watch or a very small motor.

Smaller gears seem to be abounding in the market. Fagan explains one reason for this popularity: "Most gear applications necessitate smaller size gears. Since there's more receptivity to reinforced material design, smaller gears are the obvious material choice for carrying more loads or doing more work."



Seitz Corp. offers a gear train developed to open and close interior plantation shutters for the window fashion industry (top), actuators for HVAC applications (middle), and plastic gears with a variety of resins.

Pushing the Envelope for Low Noise and High Quality

For plastic gear manufacturers, a priority equal to the gear size is the gear's noise. The Seitz Corp. of Torrington, CT, is a full-service plastic gear operation with many of its customers in the medical and specialty auto fields demanding quieter operation.

Karl Seitz, vice president of sales for Seitz Corp., says the company's designs always include customization for less noise. "It's so subjective when people request a noise specification. Everything starts with how quiet the motor is. Finer pitch gears

have more tooth engagement and, therefore, less noise. They include less of a gap between the teeth so you get less noise, but not as much torque."

Winzeler Gear is also devoting resources to the noise issue. Specifically, the company is working extensively with single-flank testing as well as looking into metrology methods with sound chambers, Winzeler says.

Plastic gears have also gained in quality. It's now possible for injected molded plastic gears to attain AGMA 11–12 in mass production, but the journey can be a long one, says Richard Kuhr, a member of AGMA's plastic gearing committee and global gear design manager for Enplas Inc.

"For instance, we [Enplas] manufacture to AGMA 12, but the analytical inspection requirements are much more difficult for plastics than for metal gears," Kuhr says. "The quality standard was written for metal gears. One of the things we'd like to do is develop a plastic gear quality standard. There's a lot more education needed on the topic."

Plastics Allow for Unique Designs

Crown gearing adds another dimension to the emergence of plastic gearing, and Enplas has researched this niche of the market.

"Crown gearing is nothing new," Kuhr says. "It just hasn't been widely applied in plastics. In the plastics market, it offers certain advantages inherent in its design to compensate for shaft misalignment. The testing we've done shows more uniform motion transmission results and reduce noise levels."

According to Enplas Corp., plastics can follow any tooth form, so the design technology proven by testing can dictate the profile modifications required to enhance the profile and change the tooth form.

The most recent form of Enplas' work is the backlashless gear, which was displayed at Gear Expo in October. With high positional accuracy, the design reduces contact stresses of impact loading and the problems of noise generation and transmission errors associated with gear slap—a major noisemaker. The backlashless gear keeps both sides of the gear engaged without requiring additional torque.

Because of all these options, along with enhancing material properties and quality capabilities, plastics are becoming more common in more applications. Seitz says they're the preferred material in the ever-growing medical field for disposable prod-

GE-Plastics gearing research focuses on fillers and base polymers.

ucts, due to their light weight and lower cost. Will they ever replace metal gears entirely?

"Never say never," he says.

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