New Technology for Stronger Plastic Gears

GLEASON-K2 PLASTICS ELIMINATES WELD LINES WITH NO MACHINING

With the acquisition of K2 Plastics, Gleason is now a source for strong, quiet thermoplastic gears containing no weld-lines, with a thru-hole and no secondary machining.

"Coupling Gleason's arsenal of non-linear contact FEA and advanced gear design software, with the latest engineered thermoplastics, Gleason-K2 Plastics' gears are a top choice for all demanding plastic gearing applications," says Klaus Kremmin, general manager of the Gleason-K2 Plastics division of The Gleason Works.

Weld, meld or knit lines in a molded gear are where two or more material flow fronts meet. Weld lines create a weak point in the gear, where material strength can be just a fraction of the normal material strength, particularly in fiber- or glass-filled resins. The result is that the typical 2–4 X safety factor isn't sufficient for gears with weld lines.

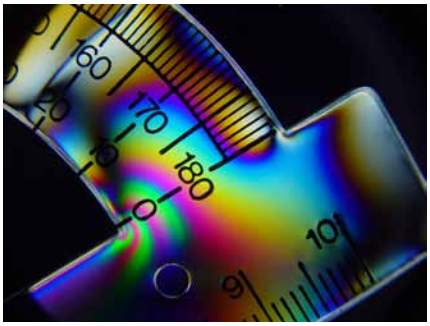
"This is also why we continually see frustrated customers who had gears designed and manufactured elsewhere upset with their cracked gears," Kremmin says. "The gears cracked at the weld line due to thermal and contact load cycling beyond the weld-line limits. As the gearing engineer, you are forced to test for weld-line strength yourself to properly select an appropriate safety factor for your design since material data sheets do not provide this information."

Gleason-K2 plastic gears can provide optimized gear designs, verified by FEA analysis. In some cases, depending on the material, an additional 1,000 percent improvement in strength can be achieved by the elimination of the weld lines. "That is an order of magnitude improvement in plastic gear strength, which is a very significant advancement in plastic gearing," says Kremmin. With Gleason gear design software, an experienced gear designer can also optimize gear profiles for increased contact ratio, reduced sliding ratio and reduced bearing loads, providing strong, silent, low-wear plastic gears.

Accuracy drops one to three AGMA levels comparing gears manufactured without weld lines to gears made with them. A weld-line-free Gleason-K2 gear can measure less than 0.0010" for TCE (total composite error) and under 0.0003" for TTE (tooth to tooth error) while the ID is kept to ±0.0005".

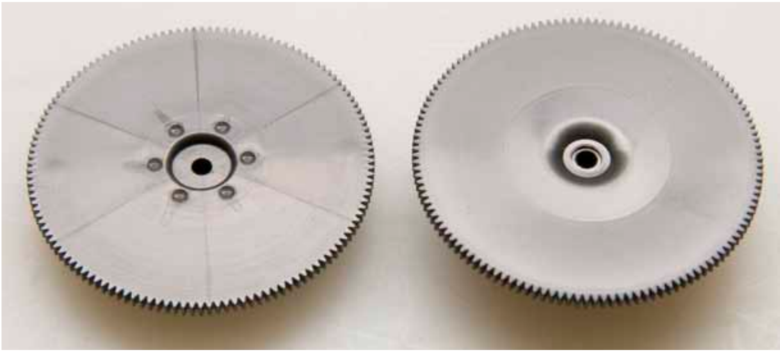
"Gleason-K2 has taken an art, reinvented the science and finally turned it into a robust, highly repeatable proprietary process vastly superior to the two approaches typically taken to address the weld-line issue," Kremmin says.

One standard "best practice" solution to the weld-line issue is to first mold the gear with a test tool of a gear containing multiple gates centered close to the ID, while maintaining strict control of the appropriate pressure and temperatures. Then, the error of the resultant gear containing weld lines is accurately measured in order to construct a second tool with the negative of the first tool's error in hopes of cancelling it out. The second tool now has negative error built into it, but still produces gears with a weld line. A second, better standard option is to disc gate the gear with a blind hole and then machine the disc gate off to achieve a thru-hole. This process, however, requires transporting the molded gear to its machining operation, precisely chucking it up to machine away the disc gate, and then de-burring it without getting any machining fines onto the electrostatically charged gear flanks.



The residual stress, caused by a poor molding process, can be seen by the colored fringes inside the part.

Example of plastic gear with cracks at the weld line due to thermal and contact load cycling beyond the weld-line limits (left) and no weld lines on the right (all photos courtesy of Gleason-K2).



A complete line of strong, quiet thermoplastic gears containing no weld-lines, with a thru-hole and no secondary machining (pictured right), is offered by Gleason-K2.

"Producing perfectly clean, 'ding free' and accurate gears, all at an economical price, from this process is very difficult," according to Kremmin. "We've found both of these solutions to be highly inferior to Gleason's no-weld-line solution. Gleason-K2's solution builds only one tool which molds plastic gears from any thermoplastic resin with a wide processing window without weld lines or any secondary machining. It does this while providing a gear with the least amount of residual stress of any competing gear molder."

Reducing the impact of residual stress. Take a polarized lens and look at a molded part made of a clear resin. The residual stress can be seen by the colored fringes inside the part. The stress is caused by a poor molding process. Cooling the molded gear too soon or constraining it in the mold because of poorly calculated part shrinkage will induce residual stress. Residual stress is also caused by poor part geometry, gating and ejection. Kremmin says that residual stress becomes particularly apparent when a gear undergoes thermal cycling either by transport to the end user or by load cycling. The stress will want to relax, resulting in gear warpage. "I have found most molders do not consider the impact of residual stress in their parts," Kremmin says. "They are having a hard enough time predicting shrink and achieving a part to print, let alone dealing with another layer of complexity to reduce the residual stress in their moldings. As long as their parts meet the print, they are OK to ship. I'm sure residual stress will be talked about now."

The no-weld-line process works for all thermoplastic resins including unfilled elastomers, acetal, nylon, urethane and filled polycarbonate, PPS, PEEK and ultra-exotic high temperature materials with melt temperatures above 800°F and heat deflection temperatures greater than 600°F. "We can even insert-mold our gears onto metal bushings, tooth plates and hubs, still producing a gear with no weld lines and no secondary machining," Kremmin adds.

Besides gears, pulleys, encoder wheels, tooth plates, bushings, sleeves, nozzles and tubes, any molded part with a hole through it that would normally be produced with weld lines can now be made weld-line free with the proprietary Gleason-K2 process.

For more information:
Gleason-K2 Plastics Division
The Gleason Works
8210 Buffalo Road
Bergen, NY 14416
Phone: (585) 494-2470
www.k2plasticsinc.com

Large-Gear Grinding and Gear Hobbing Machines

PROVIDE HIGH-EFFICIENCY PRODUCTION FOR LARGE-PART MANUFACTURERS

There has recently been an increased demand for machining large gears for use in wind turbine gearboxes, mining equipment, and so on. And although the world economy continues to struggle, that demand is expected to continue as wind turbine generators and construction equipment recover. While most gear machines manufactured by Mitsubishi Heavy Industries Ltd. (MHI) have been used for automotive products, the company intends to actively pursue the market for larger-gear machines in order to win more orders. Witness the large-gear grinding machine ZGA2000 and large-gear hobbing machine GEA1200 as products that provide highly efficient, highly accurate machining.

ZGA2000 Large-Gear Grinding Machine

The ZGA2000 is a gear grinding machine capable of handling workpiece diameters up to 2,000 mm. A high machining accuracy is required during the gear grinding process. In

this process, the tooth surfaces of a gear are ground after heat treatment. For highly accurate and efficient machining, the ZGA2000 uses built-in motors for the wheel and dress spindles, and a direct-drive motor and high-stiffness hydrostatic bearing for the worktable spindle. As a result, it can reduce machining time by 20 percent, compared to the existing ZG1000 model, and it has achieved a machining accuracy compliant with