Dry Hobbing Saves Automaker Money, Improves Gear Quality

Dry hobbing delivers a breakthrough in productivity, economy, cycle times, tool life and part quality.

David Arnesen

It takes confidence to be the first to invest in new manufacturing technology. But the payback can be significant. That has been the experience at the Ford Motor Company's Transmission & Chassis Division plant at Indianapolis, IN, which boasts the world's first production application of dry hobbing.

Beginning in July 1994, Ford began installing Liebherr LC 82 CNC hobbing machines to hob steering pinions (SAE 1045, 22 Rc). According to Ford manufacturing engineers, dry hobbing with carbide cutters has reduced machining costs by 44%, shortened cycle time by 48% and increased tool life by a factor of 6. So far.

Goal No. 1: Improve Pinion Quality

The task at Ford's Indianapolis plant was to improve gear quality—surface finish and pitch diameter runout—and meet increased production demands. After determining that existing hobbing machines using standard coated HSS hobs with coolant were incapable of meeting the plant's targets, the engineers investigated new technology.

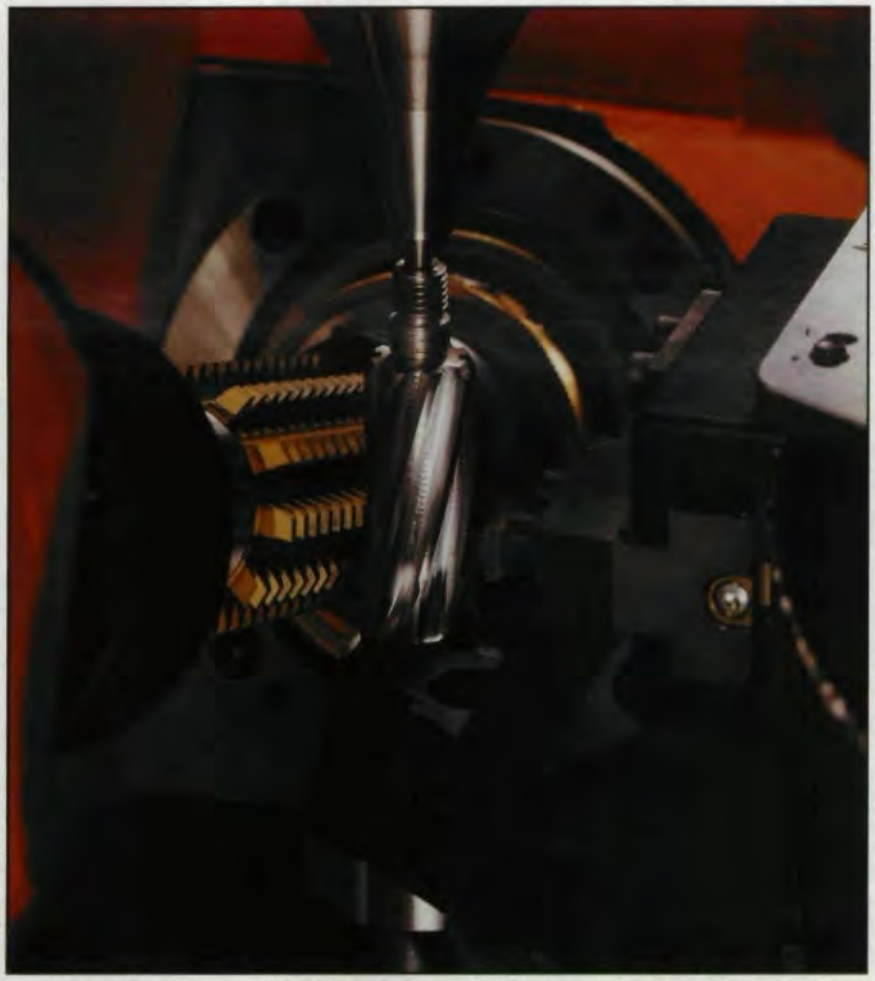
After extensive research and subsequent testing at Ford, carbide hobbing without coolant showed the most promise in meeting quality goals and offered the additional potential of greatly extended tool life and lower maintenance costs. During test cutting of the steel pinions, the process demonstrated a Cpk of 3.0, and tool life was far longer than was achieved with any steel hob. The process testing was completed using carbide hobs on a Liebherr CNC hobbing machine specifically designed for carbide dry hobbing.

More Speed, Greater Horsepower

To properly utilize the advantages of carbide, a hobbing machine must be capable of increased speeds and greater horsepower than is typical of conventional machines. The Liebherr machine table can achieve speeds up to 450 rpm; the hob head is equipped with a heavy duty drive that permits speeds up to 3,000 rpm with drive power to 18 kW (25 hp), several times that of the conventional hobbing machines at Ford.

The combination of carbide hobs with maximum diameter of 90 mm (3.6") and the new machines, which have cutter spindle speeds of 2,000 rpm, enabled hobbing at 850 sfpm, much greater than the capability of conventional production machines.

The higher cutting speed reduced machining times to approximately 22 seconds from 42 seconds previously with HSS. A workpiece load/unload mechanism built into the hobber and closely coordinated with workpiece



Courtesy of Liebherr-America

View of the pinion, hob and tailstock in the Liebherr LC 82. The workpiece load/unload mechanism built into the hobber, closely coordinated with workpiece clamping, reduced Ford's chip-to-chip time to about 4 seconds.

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Because the pinions are held rigidly in place during machining by hydraulic gateways driven by cams, part movement or deflection is prevented, and the potential for runout, feed scalloping and chatter marks is reduced. The result is that surface finish improved to between .5 and .75 Ra from 1.1 to 1.5 Ra.

In the first year of production, Ford Indianapolis immediately achieved significant gains in tool life, more than offsetting the higher initial cost for carbide cutters. Because heat is the main factor affecting tool life, the engineers made several further changes to allow the cutter to run even cooler. These included different coatings, recently developed carbide materials and hob geometry.

To reduce heat build-up at the edge of the cutter and increase the shearing action, the rake angle was increased to 5°. The number of gashes was reduced to 12 from 15, allowing more room for chip evacuation.

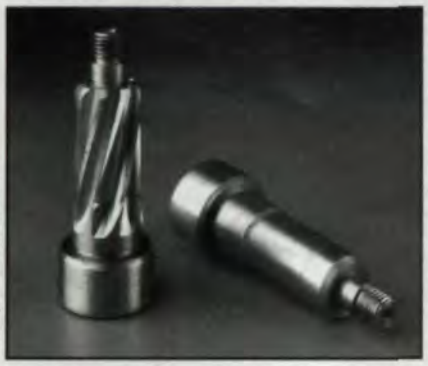
Documented Benefits

Data from the Ford experience clearly points to the benefits of dry hobbing. According to Ford manufacturing engineers, tool life improved to 252,000 pinions per hob (14 regrinds) using dry carbide from 39,000 pinions per HSS hob (12 regrinds) on existing wet cutting machines. Machining cost fell by 44%. In addition, Ford found that the process is very stable, maintaining exceptional consistency well within the process capability specifications.

Increasing the cutting edge rake angle and changing the coating to TiAlN is now being tested, and Ford is now achieving up to 33,000 pinions per regrind, with the potential of getting nearly 300,000 pinions per cutter.

The primary goal was to improve quality and production economy, but the plant also achieved a Ford 2000 environmental goal by eliminating the use of cutting oils and coolants. Operators like the rapid, coolant-free cycling. It's environmentally safer and cleaner with no cutting oils and mist.

A search for a better quality pinion at Ford Motor Company yielded a process that not only produced a better surface finish, but reduced piece cost and cycle time. It also provided the additional advantage of coolant-free operation, saving costs and improving operator morale. ○



Courtesy of Liebherr-America

Dry hobbing produces Ford steering pinions in 48% less time, at 44% less cost and improved gear quality.

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