

Frenco—Inspecting All Flanks in Minutes

GIVE US TWO MINUTES,
AND WE'LL GIVE YOU 370 CONTACT POINTS PER FLANK.

The above sentence might be the best way for Frenco GmbH to describe what its RollScan gear inspection machine can do.

In less than two minutes, the RollScan machine can inspect all of a helical gear's flanks and provide complete topographical information on them. It can inspect a small helical gear in about one minute.

Rapid is the reason for the RollScan's invention.

"Rapid by the measuring time," Andreas Pommer says. "Rapid by its availability because it's designed to be used directly on the shop floor."

A senior design engineer with Frenco, Pommer oversees research and development of the machine.

The RollScan, though, is best suited for inspecting large numbers of identical helical gears, like automotive gears.

That's not surprising given its corporate inventors: Ford AG and Ford Global Technologies. Although patented by them, the machine has been licensed since '01 to Frenco, which is responsible for developing, designing and producing the machine.

The RollScan can inspect helix/lead, profile, runout and pitch deviations. It

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can provide theoretical calculations for several types of composite deviations, such as total single-flank, tooth-to-tooth tangential and total tangential, including the short-period and long-period components of total tangential. It can calculate theoretical double-flank contact results, too.

The RollScan also can measure tooth thickness and, based on the thickness, can calculate span size and size over balls.

The machine takes these measurements using a method like single-flank gear rolling inspection.

A gear to be inspected is clamped on the RollScan's arbor, between the machine's two master gears.

Each master gear has measuring tracks placed on certain flanks. Each measuring flank has either a lead track or a profile track. Each master gear can have up to eight lead tracks, covering major diameter to form diameter, and typically can have up to three profile tracks to check involute profile.

The result: a grid of about 370 points for each measuring flank.

For inspection, the gear rolls simultaneously with the master gears, one master gear inspecting all the gear's left flanks, the other all the right flanks. The



A helical gear is ready to have its involute profiles inspected by two "hedgehog master gears" on a RollScan machine. Licensed to Frenco GmbH, the RollScan can also use conventional master gears with whole teeth. The RollScan can inspect all of a helical gear's flanks and provide complete topographical information on them in less than two minutes.

three gears are kept in direct contact at all times by brakes.

To inspect all of a gear's flanks, the RollScan operator figures the number of rotations needed for the tracks to mesh with all the gear's flanks.

RollScan's method, though, was created to check deviations that couldn't be checked with normal single-flank roll testing. Such testing measures devia-

tions as angular errors between the axes of the driving and driven gears. Also, in such testing, helical gears can have contact ratios of up to three.

As Pommer explains, such contact ratios prevent precise locating of detected deviations.

RollScan avoids this ratio problem with its lead and profile tracks, which reduce the contact ratio. It also avoids

the interference problem because the tracks are separated by a number of intervening teeth.

The separation reduces each tooth's contact line to more of a contact point. But the point's exact position can be calculated because its track location is known. Consequently, all detected deviations can be located, so a scan of the gear flank can be obtained.

The machine's basic model costs €120,000, about \$144,000. The cost includes two master gears for inspecting a gear with specific measurements and one clamping tool.

Pommer, though, recommends a possible customer first rent a model and buy two master gears to test the system. Also, the customer can have Frenco position the tracks to collect more or less data depending on which tooth aspects the customer most wants to know about.

The customer can then use the system in his factory to gain practical experience collecting data, choosing which inspection reports he wants, deciding if he's satisfied with the gear aspects being inspected.

"It helps that the customer has more practical experience," Pommer says.

After testing, the customer can have Frenco redesign the master gears, moving their tracks again.

A pair of master gears has an estimated lifetime of 200,000 measurements. Due to wear, the pair will need regrounding after that many measurements. The pair can be reground twice.

Frenco also has a second type of master gear in the final stages of development. This second type was designed to have two advantages over the first: 1.) be less expensive to produce and 2.) have a longer life.

Frenco expects this new type of master gear to be fully ready and available for commercial purchase in the second half of '04.

This new type is called a "hedgehog master gear." Instead of whole teeth, a hedgehog master gear consists of tooth segments.

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These segments reminded Frenco employees of a hedgehog. A European animal, the hedgehog has pointed spines on its back. The resemblance between segments and spines was sufficient; the new type of master gear had its name.

Each segment is a profile track, so it scans a part of every tooth on a gear being inspected. The partial scans of each tooth are then combined to create a full scan. A hedgehog can have many profile tracks, depending on its size. Pommer estimates that a realistic limit on the number of tracks would be 15.

Frenco added a ceramic coating on the hedgehog to extend its lifetime.

Frenco, though, is still testing the hedgehog to determine its lifetime. The company is also field testing two pairs of hedgehogs with two potential customers.

The RollScan offers several report options. An operator can see all profile graphs or all lead graphs, so he can find the most important flanks as fast as possible. He can also see lead and involute graphs. Moreover, these reports are in the format of normal CMM inspection reports.

He can see single-flank test results, too. The RollScan can perform single-flank inspection if the operator reverses the machine's spindle rotation.

To manage all this data, the operator can use statistical methods to obtain distributions, so he can concentrate on mean and maximum values.

He can also see theoretical double-flank contact results, calculated by RollScan, and see graphs of them.

Then there's the topography report, which shows all inspection data. On a computer screen, this report appears as a 3-D grid of the flank. Topographical measurement of all teeth requires use of statistical methods for evaluating deviations.

"The main objective was to bring more information to the user," Pommer says. ☀

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