

Microgeometry Increases Opportunities

LIEBHERR DEVELOPS DISTORTION-FREE GENERATING GRINDING METHOD FOR TOOTH-LEAD MODIFICATIONS

Twist-free generating grinding is a proven industrial production method, first registered by Liebherr-Verzahntechnik GmbH as a patent for Dr. Gerd Sulzer's invention in 1987. Since then, grinding worms featuring length-modified profile angles have been used to correct the natural twisting that occurs during generating grinding of gear teeth featuring tooth-lead modifications. During the diagonal generating grinding process, the grinding worm is guided past the workpiece in an axial motion, enabling each section of the grinding worm to come into contact with the workpiece successively. This eliminates twisting.

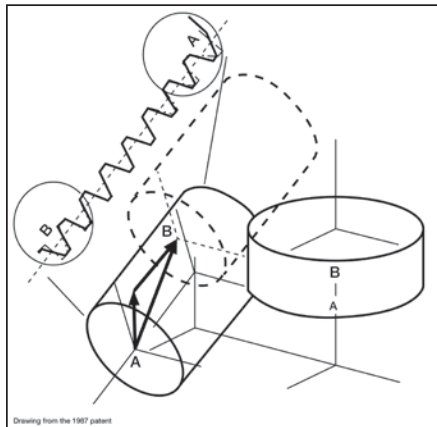
"But what this method does not eliminate are geometrical errors," said Dr. Robert Würfel, technical mathematics at Liebherr-Verzahntechnik. In Figure 3, the twisting has been corrected, but an unwanted concave crowning occurs in the profile (Figures 1 to 3).

Dr. Hansjörg Geiser, head of product development and design engineering, illustrates the helical gearing distortion issue using a practical example featuring a rounded end-relief detail (Figures 5 to 7).

The modification can only be accurately achieved by the pitch circle diameter. "Topological gear measurement shows significant distortions — too much material is ground off in two corners, and too little in two other corners. This impacts the load capacity and noise generated by the gears," Dr. Geiser said.

Low-twist grinding alone does not solve the problem

Simple, low-twist generating grinding only partially solves the problem. Geometrical variations continue to exist (see Figure 8), and the modification is ultimately only achieved correctly at the pitch circle diameter. One option of correcting such distortions would be to topologically dress the grinding worm. It would be dressed line by line, but dressing time would be considerably extend-



Drawing from the 1987 patent.

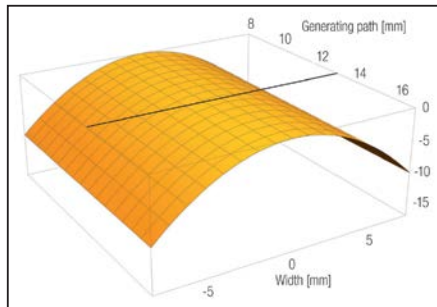


Figure 1 Twist-free tooth-lead crowning specification.

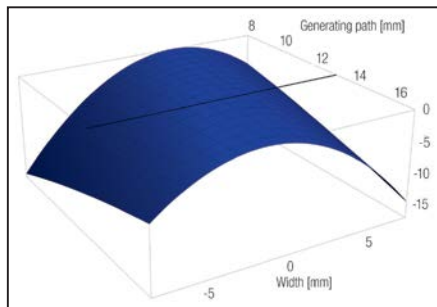


Figure 2 Naturally twisted.

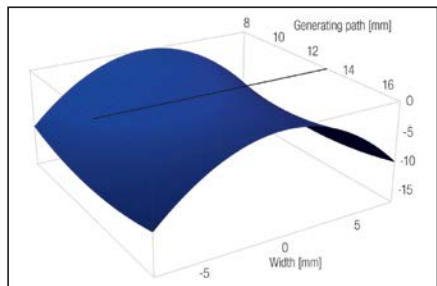


Figure 3 Twist-reduced.



Figure 4 Distortion-free generating grinding is feasible on all Liebherr generating grinding machines.

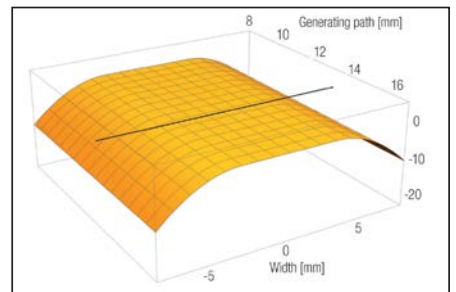


Figure 5 Rounded end-relief detail specification.

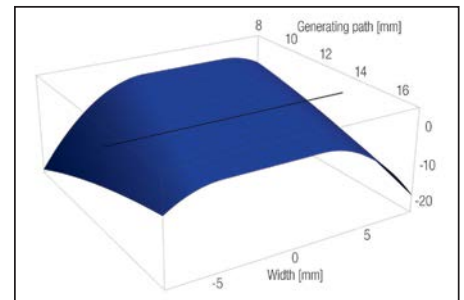


Figure 6 Results following standard generating grinding.

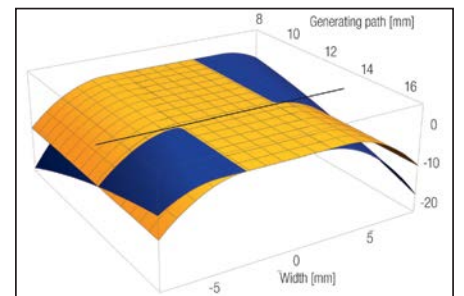


Figure 7 Illustration of end relief that's too small/distortion.

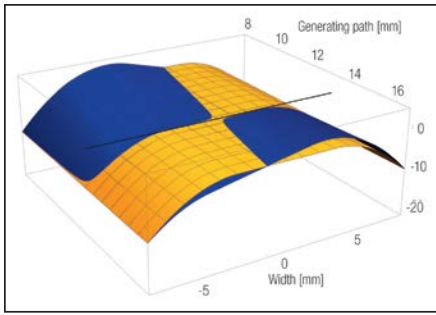


Figure 8 Discrepancies can also occur in simple low-twist generating grinding.

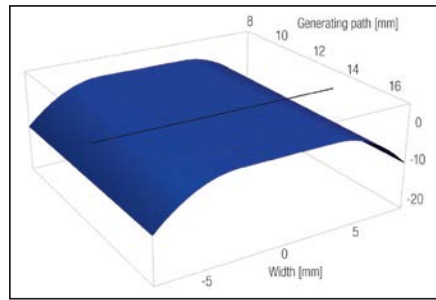


Figure 9 Results delivered by Liebherr's distortion-free generating grinding method.

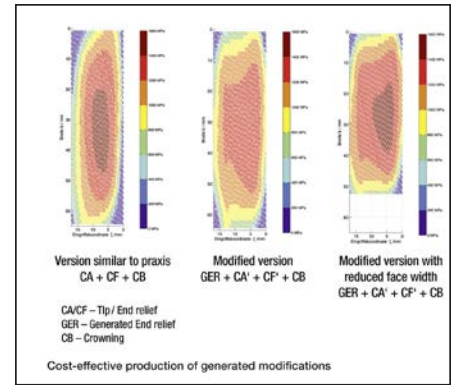


Figure 10 Cost-effective production of generated modifications.

ed. This would make a cost-effective process impossible. "Liebherr has developed a new grinding method, which prevents this predicament," Würfel said.

Liebherr's distortion-free generating grinding method

Liebherr's new method enables absolutely distortion-free generating grinding tooth-lead modifications. "We haven't exactly reinvented generating grinding, but we are well aware of what it involves," Geiser said. The results delivered by the new method correspond one-to-one with specifications (Figure 9).

"The new mathematical method enables modifications to be accurately achieved of all measuring diameters," Würfel explained. At the same time, grind and dress times correspond to those of low-distortion grinding. No special tools are required to achieve this; the standard dressing unit is all that's needed to do the job. "We have developed a cost-effective method for serial production. Our method can be used for all free-form tooth-lead modifications," Würfel added.

For load-capacity reasons, this patent-pending method is of major interest for gearbox applications.

Generated modifications (GER)

In addition to grinding free-form tooth lead modifications, the method described above can be adapted to enable generated modifications as well. The benefits of such triangular end-relief details (generated end relief) in terms of load capacity have been debated in the gearing industry for many years. Practical application has not been feasible to date because no cost-effective production method was available. Liebherr has therefore cleared one of the last

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remaining hurdles (Figures 11 and 12).

Excitation-enhanced modifications

Another application is excitation-enhanced modifications. Time-variable gear tooth rigidity causes a periodic transmission error with amplitudes between two paired gears, which has a major impact on noise levels. During the last few years research into the use of sine-shaped modifications to reduce these errors has been successfully con-

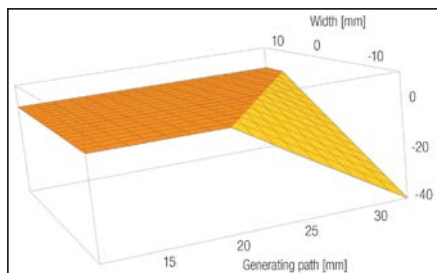


Figure 11 Triangular end-relief specification.

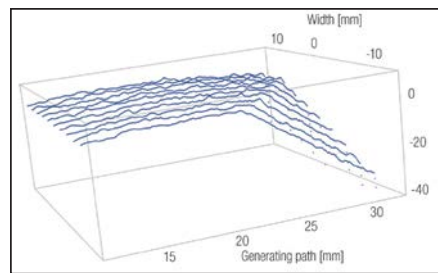


Figure 12 Triangular end-relief readings.

ducted by the Gear Research Centre (FZG) at Munich Technical University's Institute for Machine Elements. This tar-

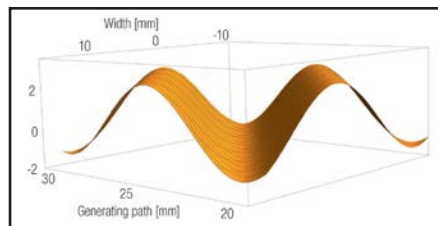


Figure 13 Targeted undulation specification.

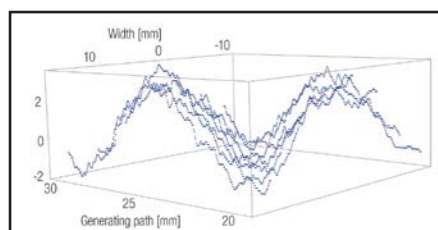


Figure 14 Targeted undulation readings.

geted degree of undulation, which typically has a μm -range amplitude, has no impact on load distribution (Figure 13 and 14).

Conclusion

Liebherr's distortion-free generating grinding method can also be used to produce tooth-lead modifications with relatively large adjustments and short gear-tooth widths — free of errors and distortions. Here, grind and dress times correspond to those of low-twist grinding. Liebherr grinding machines facilitate cost-effective, large-scale production of generated modifications; the same applies to excitation-enhanced modifications. Other applications are already being developed.

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MS3D Gear Inspection

CREATES 3D SCAN OF GEARS IN UNDER 10 SECONDS

French manufacturer Mesure-Systems-3D (MS3D) has developed a contactless inline testing system for gears. With GearInspection, a gear with 23 gear teeth can be fully measured in 3D in less than 10 seconds. With 3D inline testing, the manufacturer obtains real-time information about the effects any changes to the production parameters will have.

MS3D's 10 second inspection makes sure that no faulty part gets through to final assembly and offers information about defects in the process parameterization. Cylindrical straight, helical and bevel gears can be checked and measured using five sensors, which may be positioned differently depending on the diameter, module and helix angle of the gear. Each of the sensors digitizes part of the tooth flank surface, generating a dense cloud of points at the rhythm of 700 data points per four thousandths of a second.

One sensor measures the gear axis while the other four generate the points, which are then stitched together to get the complete surface data of all teeth flanks. Within a second, millions of data points are generated, from which a 3D model can be calculated. This point cloud is then used to identify the profile of the gear teeth, helix angle, helix curvature, diameter on flank, thickness of teeth and the pitch between the gear teeth.

The challenge of the geometry calculation using a cloud of points generated by lasers is that the raw data is very "noisy" due to reflections of the laser on other areas (e.g. the opposite flank) or the high gloss of the surface (e.g. honed surfaces). If not eliminated, this noise leads to measuring imprecision and poor repeatability. This issue has been successfully overcome by specific algorithms developed by MS3D thanks to its 10 years' experience in dealing with the inline non-contact inspection of complex metallic parts.

Saving the time spent to assemble a faulty gearbox, testing it, dismounting it, checking every gear individually to identify the faulty one and mounting the gearbox anew is one of the major benefits of using MS3D GearInspection inline.

Return on Investment is estimated to be only a few months. Therefore, not only can manufacturers generate considerable savings, they can also give their customers a zero-defect guarantee. As the specifications of gears can differ according to applications, the machine has been designed with automobile manufacturer suppliers requirements. GearInspection is



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currently suitable for gear diameters between 30 and 90 mm. Besides this, further development for inline testing of gear axles is planned for 2016.

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Exsys Tool Swissclamp

ALLOWS MOUNTING OF MULTIPLE WORKPIECES

Exsys Tool Inc. has expanded its offering of ultra-high precision products to include the pL Lehmann SwissClamp modular clamping system. This new system allows operators to mount multiple workpieces on machine tool tables for uninterrupted production and unmanned operations.

For use with rotary and standard

ing machines, the Swiss-manufactured SwissClamp modules mount on face plates or directly on worktables. The system extends a shop's potential part-clamping range from 90 mm to 200 mm—a 40 percent increase in workpiece capacity within the same clamping length.

SwissClamp's four basic modules enable more than 240 possible configurations, including both mono clamping, requiring only one basic body, and duo clamping, where two mono clamps are mounted opposite one another. Configuration options include creating a clamping tower/tombstone on a fourth axis, a horizontal clamping cone that is overhung or with counter bearing, or a clamping bridge on a trunnion table set up where both sides require a different design with mono and duo systems. Operators can also create clamping



modules on the fourth or fifth axis.

Suitable for a variety of mass production applications in automotive, aerospace, medical/dental and micro technology industries, SwissClamp can be utilized for either strong gripping or light finish clamping applications. For strong gripping, the system achieves rigid, pull down clamping to depths of 3 mm or 6 mm via a mechanical grid on its jaws.

When used for finish clamping, SwissClamp's finish jaws achieve non-rotating, precise parallel clamping with a clamping stroke of approximately 1 mm that prevents indentations and ensures high surface quality. The system enables finish clamping to a depth of 6 mm.

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Seco Tools T-Style Inserts

EXPAND ROUGHING AND SEMI-FINISHING PERFORMANCE

Seco has expanded the roughing and semi-finishing performance capabilities of its Secomax CS100 sialon ceramic grade by adding inserts with T-style edge preparation to the line. Featuring a free-cutting, extremely sharp geometry, the new inserts bring strength, stability and performance longevity to the machining of nickel-based superalloys in unstable conditions.

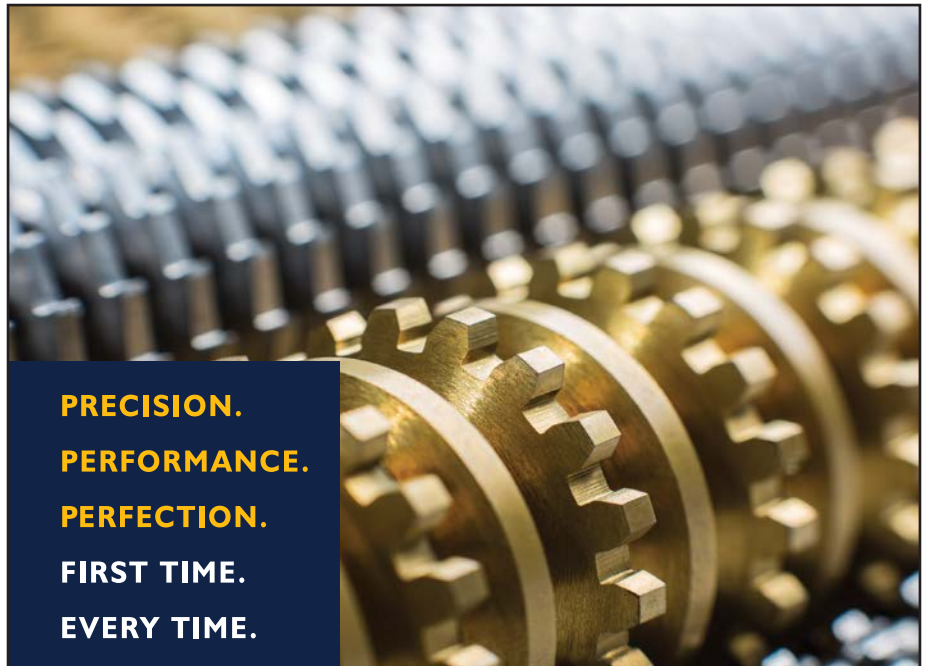
Well suited for turning applications that require tight tolerances and low cutting forces, the T-style (chamfered) CS100 inserts are available in 20-degree chamfers that range from .002" – .004" (0.05 mm to 0.1 mm) in width. The sharp, negative reinforced cutting edges on these inserts absorb some of the high cutting force and pressure that would otherwise be placed on the machine setups and workpieces. As a result, these inserts eliminate the risk of workpiece deformation, especially in thin-walled components, as well as reduce excessive vibrations that shorten tool life and negatively impact surface finish.

The characteristics of the T-style inserts complement the existing S-style (chamfered and honed) CS100 products designed to handle high cutting forces in rigid, stable machining conditions. Collectively, the T-style and S-style inserts in the CS100 line have high abrasion resistance and superior toughness that extends tool life and allows for high cutting speeds when processing challenging materials such as Inconel, MAR, RENE and Waspaloy. The inserts are ideal for achieving high productivity, consistent quality and a low cost per part in the aerospace and power generation industries.

Furthermore, Seco has added new N-class (Quick-Line) ceramic insert holders to its comprehensive product portfolio. Available in standard shaft and Seco-Capto styles, these holders have special pocket designs and clamping systems that easily accommodate the different thicknesses and missing center-mounting holes that are common with these types of inserts.

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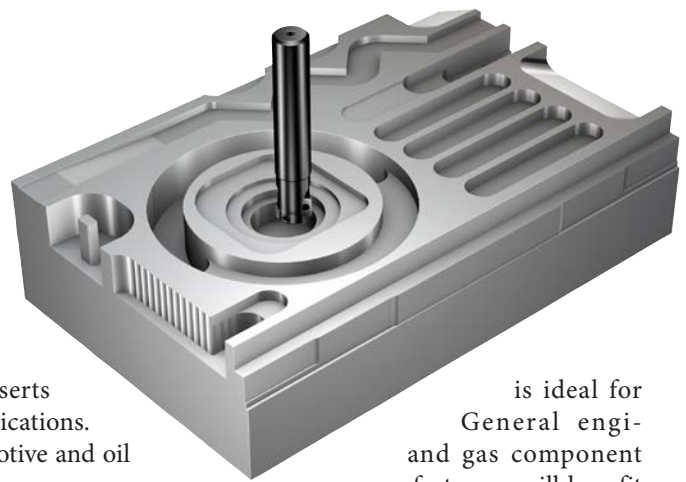
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Sandvik Coromant CoroMill 390

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Sandvik Coromant offers a new end mill for small diameters. The CoroMill 390 with size 07 inserts is a versatile cutter that is ideal for shoulder milling, deep shoulder milling, edging, linear and helical ramping, plunge milling, slot milling and face milling.

Suitable for all machine types, the CoroMill 390 with size 07 inserts mixed production and can be used with different materials and applications. neering shops, as well as specialized business segments, such as automotive and oil



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and gas component
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from its universal capabilities.

Grades for the CoroMill 390 with size 07 inserts are available for all materials. The new insert grade GC1130, produced with Zertivo technology, gives this cutter an extra dimension of security when milling steel. The smaller inserts deliver higher cutter-teeth density for superior productivity.

A unique feature of this tool is the torque key that is specifically designed for size 07 inserts. This key provides consistent clamping every time. It has built-in spring functionality that allows you to mount inserts with the correct clamping force for reliable and consistent tool life. Coolant-through technology is standard on the CoroMill 390 with size 07 inserts for additional heat and chip control.

Troy Stashi, milling product specialist for Sandvik Coromant, says, "The CoroMill 390 with size 07 inserts is the most versatile small diameter end mill on the market today. It's beneficial for anyone who machines small features in any size component including medical, automotive, and oil and gas parts."

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Mahr Federal

PLANS TO INCLUDE MARSHAFT SCOPE AND MARCATOR INDICATORS AT MFG4

Mahr Federal will feature the MarShaft Scope 250 plus and MarCator Wireless Digital Indicators at Mfg4, May 3-5, 2016, Connecticut Convention Center, Hartford, CT, Booth #1605.

Competitively priced and designed to provide fast, accurate, fully automatic measurement of smaller shafts and turned parts directly on the shop floor, the MarShaft Scope 250 plus features a highly accurate matrix camera with four million pixels. The system measures parts up to 250 mm in length and 40 mm in diameter with an MPE (Maximum Permissible Error) of less than 1.5 microns + L/40 when measuring diameter and an even more impressive 3 microns + L/125 when measuring length.

Also featured will be Mahr Federal's broad line of mechanical comparative gages which can now be configured for wireless data transmission with the addition of a MarCator 1086 or 1087 wireless digital indicator. The line includes a wide array of snap gages, ID & OD

gages, fixed and adjustable bore gages, as well as depth and comparator stands. The addition of wireless digital indicators makes these gages faster and more productive than ever before.

The combination of Mahr Federal's robust, easy-to-use, high performance comparative gages with an economical, user-transparent wireless data collection system provides the easiest way to upgrade and implement data collection for existing gages or new gaging requirements. The delays and errors associated with manually collecting and recording data are eliminated, and the measuring process can run at its maximum speed and with the most secure collection format.

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Digital Amplifier, MaraMeter mechanical comparative gages, Wireless MarCal calipers with Marcom Software, Dimensionair air gaging will also be on display. Selections from Mahr Federal's broad line of surface measuring instruments, including both portable roughness measurement devices and computer based stationary surface measuring systems will also be shown off. In addition to the new PocketSurf IV, there will be the MarSurf PS1 and a growing line of application specific surface measuring

fixtures. Mahr's stationary system line includes the MarSurf XR 1, which combines mobile surface metrology with the advantages of *MarWin* evaluation software; and the XCR 20 *MarWin*, a new generation of combined roughness and contour measurement systems. A full range of other Mahr Federal handheld gages and other dimensional metrology products will also be on display.

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German Machine Tools of America (GMTA) now offers a full line of Rasoma machining centers, including vertical turning centers, four-axis shaft turning centers, end machining, double spindle and various special purpose machining centers with full automation.

Rasoma is a large machine tool builder, founded in 1919 and based in Döbeln, Germany, who provides contract manufacturing to some of the best known brands in the global auto industry, as well as its own brands.

Gear machines for milling, hobbing and shaping are available in a variety of configurations and the GMTA application engineering team can assist interested parties to determine the best solution.

Rasoma machining centers offer high rigidity, due to separate X and Z slides plus the machine head is designed as a monoblock with polymer concrete fill. Thermal stability is enhanced by cooled motor spindles and the rapid traverse on these centers ranges up to 60 m/min at high acceleration, with feed and removal speeds to 120 m/min, less than 6 seconds from part to part and turret indexing typically under one second.

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ed metrology onboard, working inside or outside the work envelope, full tool measurement and monitoring systems and driven tool packages, all controlled by a single Siemens CNC.

GMTA President Walter Friedrich comments, "This alignment dovetails perfectly with our other lines of gear-making, laser and finishing machines and systems. It will enhance our value proposition considerably in our current market of primary automotive and will also open other market opportunities for our company. We have made substantial investments in new personnel and floor space, both here in the U.S. and at our Mexican facility, to support these new additions to our portfolio of quality German machine tools."

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Dürr Ecoclean EcoCDuty Cleaning System

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Dürr Ecoclean has developed a solvent-based cleaning system, the large-chamber EcoCDuty, for heat-treating contractors, metalforming shops and companies from the automotive and aircraft industries looking for cost-efficient part cleaning and degreasing equipment capable of handling high capacities. This machine is designed for loads measuring up to 1250 × 840 × 970 mm and weighing up to 1 ton. Operating with hydrocarbons or modified alcohols, it provides high cleaning quality and process reliability at fast cycle times. Additional benefits of this modular unit include its ease of operation and attractive design.

This large-chamber cleaning machine uses hydrocarbons or polar solvents (modified alcohols) and operates under full vacuum. Its modular design ensures adaptability to individual user needs. Configured as a steam degreaser in its standard version, the system is additionally available with one or two stainless steel flood tanks — e.g., for a process comprising steam degreasing and injection flood washing or steam degreasing, injection flood washing plus a preserving step. Vacuum drying is standard on all three versions. Chlorinated metalworking fluids can be effectively removed by means of appropriately stabilized solvents following oil compatibility testing. Moreover, the unit is suitable for cleaning off sulphur-containing oils.

The EcoCDuty is provided with a new pre-degreasing feature using steam. This technology directs the oil-laden solvent straight into the distillation circuit, thus minimizing oil enrichment of the solvent and oil deposits in the flood tank for superior cleaning performance. This is made possible by a powerful distillation system capable of handling as much as 400 or even 500 litres/hour, depending on the solvent employed. The oil collected by distillation is automatically removed via the standard oil discharge system which has a capacity of four litres per hour. Customers who encounter high oil input rates can add a second unit, thus doubling the capacity of the oil discharged system to eight litres per hour. To remove particulate contaminants from the solvent as well, the distillation system is preceded by a filter unit



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with bag or cartridge filters.

On EcoCDuty versions with a flood tank, quick flooding and draining of the work chamber and tank is ensured by powerful frequency-controlled pumps. This technology reduces non-productive times and speeds up cleaning processes, thereby reducing costs. Furthermore, these versions comprise a separate filter circuit for each tank. Full-flow filtration of the solvent is provided in the supply and return flow lines by means of three filter units per flood tank. These can be fitted with bag or cartridge filters. As a result, even exceptional cleanliness specifications can be reliably met.

When designing the EcoCDuty, Dürr Ecoclean placed great emphasis on low operating costs and high availability. This starts with the new 7 inch color display with self-explanatory pictographs. The stainless steel flood tanks have a smooth surface and come without internal heating components. This design prevents the formation of chip and dirt pockets which could re-contaminate the parts. Customers who do not yet own a steam heating source can order an optional external steam generator to heat the distillation unit. The flood tanks are heated exclusively by waste heat from the distillation system, i.e., no additional energy input is necessary.

When it comes to part feeding, the EcoCDuty again adapts flexibly to customer needs. Depending on the equipment configuration, it can be loaded manually using a pallet truck or forklift. Moreover, custom loading solutions ranging from semi-automatic single-station to fully automatic multi-station systems are supported as well.

Large maintenance openings offer an additional advantage, as they provide easy and fast access to all service-related components. This minimizes system downtime for maintenance work. To protect the system from dirt and heat in harsh production conditions, a roof with internal ventilation is available.

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Mitutoyo

RELEASES RENEWED IP67 COOLANT-PROOF CALIPERS


Mitutoyo America Corporation recently announced the renewal of the 500 Series IP67 Absolute Digimatic coolant-proof calipers. This product incorporates Mitutoyo's Absolute measurement system. The automatic power on/off shuts down the LCD after 20 minutes of inactivity, but the ABS scale origin is unaffected. Power is restored to the display when the slider is moved. In addition, it can be integrated into statistical process control and measurement systems. A 9 mm large LCD provides a 22 percent increase in height for improved visibility. The extended battery life of

five years has been achieved due to low-current integrated circuit. The calipers are easy to operate with advanced ergonomic design that uses only one button. Mitutoyo IP67 Absolute Digimatic coolant-proof calipers can be used in workshop conditions exposed to coolant, water, dust or oil. 100 percent air-leak test ensures every caliper conforms to IP67.

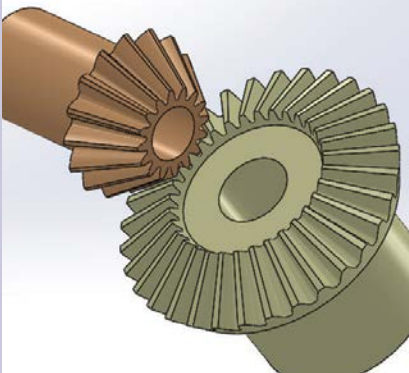
For more information:
Mitutoyo Corporation
Phone: (630) 820-2614
www.mitutoyo.com



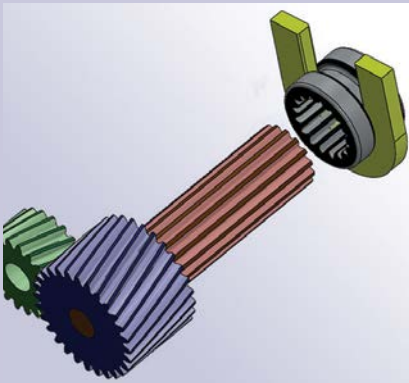
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