Liebherr

LFG GRINDING MACHINE OFFERS PRECISION AND PRODUCTIVITY

This machine concept facilitates highly productive profile grinding for large workpieces. The range for external and internal gears comprises models for manufacturing workpieces up to 2,000 millimeters – for industrial gear units, wind power, and marine propulsion applications. Specific and controlled handling of twist in profile grinding solves production-related problems, and simultaneously opens new gear manufacturing doors. Various other solutions are available on the market for dealing with twist problems. Liebherr now introduces the five-axis LFG series profile grinding machines, with a novel machine design approach for twist-free profile grinding (or, if needed, the manufacture of specific twist designs) for single- and double-flank grinding.

Five Axes for Ultimate Precision

The machining concept works with five axes. LFG does not require a dressing axis, which rules out one potential source of inaccuracy. Another difference to comparable machines is the inversion of the shift and swivel axes. The mechanical limitation that results from the process of "first swivel, then shift" is overcome as a result. This special arrangement allows for the dimensioning of shift travel to be much larger than usual.

The machine's directly-driven table, featuring a highly dynamic wear-free torque motor, also delivers high precision throughout the machine's lifetime. It is a key component in allowing the machine to single- or double-flank grind precision- and custom-topographic tooth flanks.

Simultaneous Dressing Shortens Cycle Times

Because the machine also uses the shift and swivel axes to dress the grinding disks, the dressing axis can be eliminated. The basic LFG model's grinding disk is dressed by a single dresser in combination with the shift and swivel axes. The Syncdress design provides two dressing rolls that dress simultaneously left and right and greatly reduce dressing time. As a result of its increased importance, the LFG relies greatly on the permanently active swivel axis for profile grinding. Traditionally, the swivel axis was a set-up axis that was pivoted and clamped for grinding purposes. The grinding head for producing internal gears is mounted over the outer grinding head. No contact is made with the outer grinding head. Only the grinding disk must be removed. The dressing process for the internal grinding disks is consecutive, with the aid of the shift axis.

Twist Problems under Control

Crowning could only be performed via the X-axis in conventional grinding machines. Twist, however, occurs when this type of crowning is employed in profile-grinding. The result is an altered profile angle over the entire face width. The problem of twist due to this crowning method has played a rather minor role in gear manufacturing development for quite some time.

"Minimizing twist is one thing, incorporating specific twist designs is yet another. LFG series machines can grind anything required," explains Dr. Hansjörg Geiser, manager de-velopment and design gear cutting machines at Liebherr-Verzahntechnik.

The axes of the LFG facilitate additional movements and generate the opportunity to create the desired degree of crowning and prevent twists, even if double-flank grinding is involved, by overlapping the axis movements. By using the V, C and A-axes in addition to the × and Y-axes, the profile angle can be modified and the twist problem can be solved for both single- and double-flank grinding. In this way the operator can completely avoid tooth flank twist or intentionally produce it in compliance with the narrowest of tolerances.

Topological Modifications

Certainly the opportunities that the 5-axes create with respect to twist are limited by mathematics. Additional clearance allows for precision topological grinding. The division of the topography into multiple strip-shaped areas and corresponding processing with multiple strokes provide a multitude of specific options, for example, for prototype development or academic applications. The operator no longer has to concentrate on $f_{H\alpha}$ and C_α corrections, but rather can target individual points for processing.

Removal-Optimized Grinding through 5-Axis Infeeding

The figure shows how, during radial infeeding, the removed material near the tooth head is greatest at three infeeds during the final strokes. The workpiece is subjected to unnecessarily high loads as a result of variable grinding steps. Micro-structure damage occurs frequently.

Five-axis infeeding produces a (as far as possible) constant allowance distribution over the course of the strokes. The principal

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material for this wear-optimized grinding is no longer left to wear-out on the tip; as a result the risk of grinder-burn is minimized, and the workpiece is protected. Number of strokes and production time can be reduced as a result, depending on application.

The different involute gear profiles (pinion/planet/cylindrical) show the distinction between the three tested gears, which lies primarily in the curvature in the involute gear profiles. Thus in the case of a pinion with maximum curvature the maximum benefit can be derived by using the 5-axis infeed method.

The number of infeed steps is reduced from 15 to 9 as a result of the 5-axis infeed. The curvature of the spur gear is small (due to the number of teeth, among other things) and, therefore, the savings in infeed steps is smaller (9 to 8).

Production Controls Profit from Large Shift Travel

The measuring sensor swivels laterally along the grinding disk. It uses the large shift travel (±300 millimeters) and, like a dedicated measuring machine, measures the gear. This leads to an additional acceleration of the process. Table rotation and radial infeed are not required for measuring, which contributes to additional precision of the measurement results.

With calibration in mind, conventional methods of measurements usually focus on a very sensitive $f_{H\alpha}$ profile angle. There is additional potential for inaccuracy when a machine radially retracts and extends its stylus. The sensitivity is considerably lower and, accordingly, the results more accurate when retracting laterally (shifting). There is a lot to be said for the precise measuring methods that can be achieved right on the production machine, and specifically this 5-axis LFG.

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KISSsoft

RELEASES 03/2013 SOFTWARE

KISSsoft is a modular calculation system for the verification, optimization and sizing of machine elements. The scope of the application ranges from a single machine element up to the automatic sizing of complete gearboxes. *KISSsoft Release 03/2013* once again contains a wide range of new functions, including the following highlights:

The contact analysis has been greatly extended for planetary gear units. It is now possible to take into account the exact deflections of the shafts on the sun wheel, planet gear and internal gear. The planet carrier position is also determined during a shaft calculation, or can alternatively be specified as a displacement. The results are finally displayed in the 3-D system, ensuring maximum clarity. This provides a powerful analysis tool for the planet system.

New dimensioning suggestions are now calculated for modifications, especially for planetary gear units. This ensures that tooth trace modifications can be specified accurately, on the basis of the planet carrier torsion and sun wheel deformation.

The contact analysis for cylindrical gears has also been extended and improved. Experience gained following a comparison between various different commercial contact analysis programs, carried out in fall 2012, has also left its mark on the calculation. For example, additional correction factors (including one for Hertzian flattening) have been implemented, providing the user with even more detailed setting options. Of course, as you would expect, appropriate standard values are also set where suitable.

Thanks to improvements in calculation algorithms, the cylindrical gear contact analysis is now faster and more robust, and so enables the contact pattern for cylindrical gears to be analyzed more accurately.

Another highlight is the extended setting and evaluation options for optimizing modifications for cylindrical and planet gears. A new feature is that the face load factor $K_{H\beta}$ can now also be calculated. This therefore reveals the direct influence of the tooth trace modification on the safeties of the classic tooth root and flank load capacities.Some new features have also been added to the plas-

tics calculations. The draft of the new VDI guideline 2736 is especially worthy of mention. After many years work, with contributions from KISSsoft, this guideline has now been released in draft form and so is also available in *KISSsoft*.

Freely configurable manufacturing drawings have now also been made available for all cylindrical gears. The toothing data and a range of different graphics — such as flank modifications, etc. — can now be displayed as graphics, output to screen or paper, and sent to the gear manufacturer.

Fine sizing functions have been added to the worm gear and spiral toothed gear wheel calculations. You can now vary the macro geometry within specific ranges and select the best possible solution. These modules, along with the cylindrical and bevel gears, now cover the sizing options for any tooth type. This latest functionality can be viewed in the shaft editor: Shafts and bearings are now displayed with shadowing (optional). Bearings are displayed according to their attainable service life. The new versions of the DIN 743 shaft calculation analyses and the FKM Guideline (6th edition) are also implemented in the *03/2013 KISSsoft* release.

As before, the CAD interfaces are designed to reflect the very latest version of each particular CAD system. In addition to the calculations for machine elements, there are now additional software features which make *KISSsoft* even more powerful and effective in handling real life situations. For example, you can create rules which check specified parameters before and after the calculation and output messages if required. 3-D models can now also be generated via a COM interface.

Finally, the current release includes a completely restructured user interface for *KISSsys*: the most commonly used elements are now available as icons. To generate a model, a user can simply drag and drop icons to add elements directly to the diagram window and link them up. The new *KISSsys Gear Unit Assistant* guides users through the process for generating models of planetary gears step by step. After the relevant kinematics have been defined, the bevel gear and worm wheel stages can now be rough sized directly in *KISSsys*.

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EMAG

OFFERS HARD TURNING AND GRINDING ADVANTAGES

The advantages of the process combination hard turning + grinding lie in process stream consolidation, improved component quality and greater flexibility. But process combinations can also be used to great effect for the shortening of cycle times. Where all the hard fine-machining operations can be carried out on a single machine, throughput, transport times and storage periods can be drastically reduced. There are also benefits to be had in the reduction of time and effort spent on setting up the machine.

An important requirement for combination machines is the unhindered fall of the turning and grinding chips. The VLC 250 DS with its vertical work spindle and its tools positioned below the workpiece offers the best possible chip flow conditions. All machine modules are mechanically sturdy and particularly vibration resistant. This is augmented by the machine base in Mineralit polymer concrete, with its great vibration damping properties, and by the design of the work spindle, which forms an integral part of a sturdy quill that carries out its Z-axis movement in a high-precision, hydrostatic guideway — also a design particularity that has a highly effective vibration damping effect.

The tooling systems are firmly anchored in the machine base and provide a stable basis for demanding turning and grinding operations — an important precondition for time-saving hard pre-turning work and for achieving the best surface finish with a hard finish-turning or grinding operation. Number and design of the stationary tooling systems can be chosen to suit the individual machining requirement. Continuous monitoring of the machine temperature ensures a high degree of thermal stability. The operating temperature is quickly reached and maintained within tight limits of the ambient temperature by a powerful cooling unit. The pick-up technique employed on the VLC 250 DS Turning and Grinding Center ensures that the machine loads itself. Gantry loaders — or other cost-intensive, space-devouring loading devices that involve time-consuming resetting work — can be eliminated.

The VLC 250 DS can handle complex manufacturing processes. Whether there is a call for turning work at high chip removal rates or for the somewhat gentler grinding operation — the machine covers a wide range of applications. The

advantage is obvious: complete-machining in a single setup, and thus the elimination of reclamping errors. Measuring operations too can be included. This would ensure optimal integration of a quality control function into the overall process. The measuring probe is located between machining area and pick-up station, where it is safe from the ingress of chips and coolant. As the workpiece remains clamped during the gauging process, intermediate measurements can also be taken.

A typical example of successful combination machining is the manufacture of gearwheels. The end face is hard finish-turned, whilst bore and cone are pre-turned and then finish-ground to ensure that the high quality requirements are met. For this purpose the machine is equipped with two grinding spindles, whereby one spindle machines the bores and the other carries out the external grinding work. As the amount to be ground is only a few hundredths of a millimeter, the grinding wheels need only be designed for finishing operations.

The advantages offered by the VLC 250 DS:

- Vertical hard turning and finish-grinding on a single machine and in one setup
- All sectors of the workpiece that can be turned with process integrity are hard finish-turned, and only those are ground (after hard pre-turning) where quality requirements and process integrity demand it.
- Improved workpiece quality and higher productivity rates, as the workpiece is complete-machined in a single setup, whereby the hard pre-turning process leaves an allowance of just a few microns for the subsequent grinding process.
- The grinding process needs to remove only very little material. The wear and tear on the grinding wheel is therefore minimal and it needs to be dressed only infrequently, and only by a fraction. This is of considerable advantage where cycle times are a concern.
- The grinding wheel specification can be fixed as "finishing quality," as only a very small allowance needs to be removed. This produces process-capable surface finishes in the Rz < 1.2 µm range.
- Unlike hard turning processes, the grinding operation will, on the same machine, generate absolutely scroll-free surfaces.
- Rear end faces are difficult to reach with a grinding wheel — a problem that is easily solved with hard turning.

The cross-operational machine design provides exceptionally easy access.

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Sandvik Coromant

OFFERS COOLING TECHNOLOGY SOLUTIONS

Accurate targeting of coolant during machining provides maximum effectiveness in chip evacuation. However, precision and pressure are two equally important aspects of coolant. A high precision coolant requires lower pressure. The higher the pressure, the more demanding applications can be machined with excellent results.

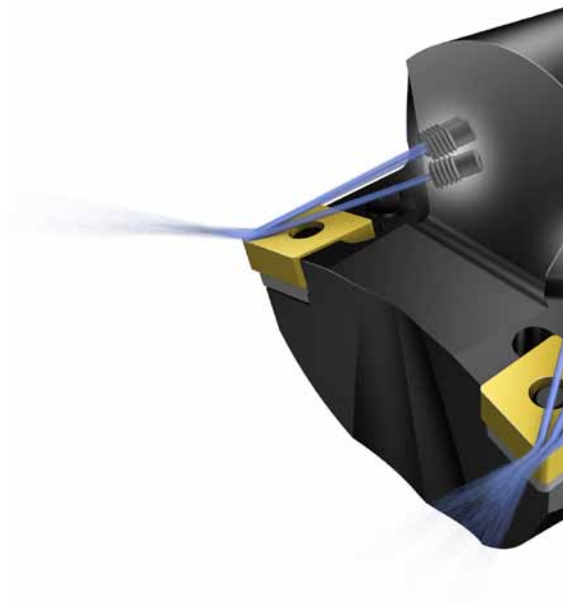
Sandvik Coromant offers cooling technology solutions through advanced nozzle technology and dedicated insert geometries for steel, stainless steel and HRSA material for all machining applications. The company recently announced additions to the growing range of options to apply coolant in the machining process. The range of new insert geometries and customized tool holders feature fixed nozzles that guarantee a precise coolant jet flow accurately hitting the center of the cutting zone target.

Advanced Nozzle Technology

The coolant flows from the pump to the tool through nozzles directed exactly at the cutting zone. This produces a wedge of coolant that efficiently removes the heat from the cutting zone and forms the chip. Improved chip control and longer tool life are just two of the benefits that contribute to secure and predictable machining, preventing unplanned machine stoppages. Increased productivity can even be achieved in tricky applications, and in difficult to machine materials, regardless of the pressure you use.

Low pressure 7–10 bar (100–150 psi)

When using low pressure, the new Sandvik Coromant CoroTurn HP holders, with high precision nozzles, outperform regular tool holders that can have a tendency to flood coolant. This makes for improved chip control and better process security in steel and other common materials. Substantially higher cutting data can also be applied, as well.



70–80 bar (1,000–1,200 psi)

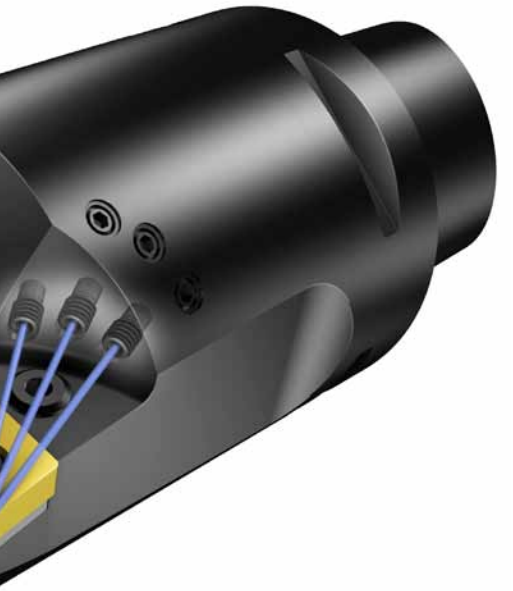
For demanding materials, such as duplex stainless steel and HRSA material, higher coolant pressures are needed. The unique CoroTurn HP nozzle technology in combination with the new-SMC, -MMC, -PMC insert geometries provides greater productivity.

150–200 bar (2,200–2,900 psi)

Few machines provide solutions for these pressures, however Sandvik Coromant offers standard holders and inserts that allow for up to 275 bar (3,900 psi) of coolant pressure. Coromant Capto clamping units for high-pressure coolant with 200 bar (2,900 psi) coolant pressure capability provide unrivalled performance ensuring that machine utilization is optimized through reduced set-up and production time.

Tool holders

The Sandvik Coromant advanced cooling technology has been a solution primarily for customers using quick change with Coromant Capto, SL- and QS holding system. Now, the same premium technology can be applied with general shank tools, making it possible for everyone working with wet machining to utilize this highly productive coolant solution, even in small lathes.



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Gleason Corporation

INSTALLS 10 METER CAPACITY GEAR HOBBER IN CHINA

Gleason Corporation recently announced the successful installation of a P 8000/10000 Gear Hobber at Changzhou Tianshan Heavy Industry Machinery Co. Ltd., in Changzhou, China. The machine has the capacity to produce spur and helical gears up to 10 meters in outside diameter, and has been fully demonstrated to consistently produce large gears at DIN 7 quality or better, reducing cutting times from as much as a week on older machines to as little as 10 hours. Founded in 2002, Changzhou Tianshan is a producer of approximately 35,000 gears per year ranging in size from 100 mm to 10,000 mm in diameter. Through investment in the most advanced gear production machines, Changzhou Tianshan has expanded rapidly and is today a factory of nearly 87,000 m^2, with 300 employees. The acquisition of the Gleason-Pfauter P 8000/10000 hobber has opened the doors for new projects in mining equipment, port mechanical equipment and large industrial applications, as well as with several of the world's leading wind turbine manufacturers, producing planetary gears, sun gears and eccentric gears for wind turbine gearboxes. When asked "Why Gleason" Jiang Wenge, chairman of Changzou Tianshan said, "The efficiency and accuracy of similar equipment on the market is low, but customer expectations are increasingly high, and the trend is to higher and higher accuracies and reduced lead times. Gleason-Pfauter has the experience in gear technology, service and support, so a high-quality production machine is assured. Among the manufacturers of high-accuracy large gear equipment, Gleason-Pfauter is the industry leader. There really is no competitor."

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