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Cutting our teeth on 5-axle milling

Heavy industry requires heavy duty equipment. But simply making your equipment tougher doesn't always mean you'll get the accuracy required to make it work properly and endure the demanding conditions of the mining industry.



PRODUCTION OF A BEVEL PINION USING THE HOBGING METHOD

Take gears for example. To crush, grind, agitate, mix and convey, you need some sort of drive unit to keep things moving. On sophisticated equipment, bevel gears are often utilized to transfer power and determine direction, rotation and speed. If gear teeth aren't accurately aligned, unnecessary wear may be the least of your problems. Comminution equipment requires long-lasting, heavy-duty gears that perform to keep the whole plant up and running.

Built for crushing

Gyratory and cone crushers are widely used in the comminution process within the minerals industry. The working principles of gyratory and cone crushers are almost the same. The feed is guided from the top into the crusher and moved by gravitational force through it. An eccentric shaft with vertical orientation and conical shape is rotating inside the stator cone. The air gap between the shaft and stator cone vary with the rotational



PRODUCTION OF A BEVEL PINION BY FIVE-AXLE MILLING MACHINE

movement of the central shaft. The feed is clamped and crushed between rotor and stator cone.

The movement of the rotor is provided by a stand-alone electrical motor with horizontal orientation and is transferred into its vertical direction by a bevel gear stage inside the crusher. This bevel gear is a highly stressed component and the pinion is especially subjected to wear caused by the smaller number of teeth compared to that of the bevel wheel. The exchange of the bevel pinion over the lifetime of a cone ore gyratory crusher is not exceptional.

Conventional manufacturing of bevel gears

Conventionally, cyclo-palloid bevel gears are produced by a machining process known as the hobbing method, which is still the most commonly used for this type of gearing. Cyclo-palloid toothings is normally used for large size and high power application because of their running smoothness and the motion transmission uniformity.

In the hobbing method, a special cutting tool with normally five cutting blades progressively cuts the gap between the teeth one

after another performing a well-defined, simultaneous rotation and swinging movement. The developed longitudinal tooth shape, an extended epicycloid, is purely formed by the simultaneous motion of the cutter and the bevel gear.

Reproducing spare pinions matching the existing bevel wheels is possible if the exact geometry of the pinions is known either by having the geometrical definition of the toothings or by measuring the existing pinion.

State-of-the-art hobbing machines are multi-axis CNC machines providing high flexibility and accuracy for the production of cyclo-palloid bevel gears. However they are not suitable to manufacture any other type of gearing and need special cutters.

Innovative multi-axis milling

With the development of highly accurate, multi-axis milling machines it's possible to manufacture any type of gearing. The simultaneous movement of five or more axis drives of a modern multitasking machine allows a high-precision machining of complex geometries. The highly accurate positioning and trajectory guarantee precision and impeccable surface quality.



With the aid of sophisticated engineering software, the complex tooth surface is developed in a multitude of points with unique x, y and z coordinates which allows the modeling of the tooth surfaces in a 3D-CAD system. With the CAM process (computer aided manufacturing) tools, tool passes and cutting conditions are defined. The high-performance cutter transfers the calculated surface geometry onto the workpiece point by point. With this method, it is possible to manufacture nearly every kind of tooth geometry. In addition, tooth corrections in both profile and longitudinal direction can be implemented directly.

With professional measuring machines and advanced engineering software, reverse engineering of existing pinion or gear is possible and manufacturing of critical spare parts is even easier on multi-axis milling machines because of its flexibility.

Finally, based on engineering analysis and many years of experience, design improvements can be proposed to increase reliability of parts, whereas high-performance manufacturing secures fast availability of components for customers.

Consider the advantages

High-performance manufacturing of high-quality bevel gears is now even more attainable thanks to modern multi-axis milling machines combined with computer-aided accuracy. The tooth surface is calculated point by point and the milling tool transfers this geometry to the workpiece by the aid of highly sophisticated engineering software. With this process, nearly every tooth form can be manufactured.

With modern CNC-controlled machine tools, sophisticated engineering software, highly skilled engineers and machine operators, and the knowledge of the exact geometry, it's possible to manufacture spare pinions for crusher bevel sets without having the bevel wheel, which would usually be required for matching the probes, in-house.

For many years, FLSmidth MAAG Gear has been delivering bevel gears for heavy-load applications, including crushers. We are operating the most modern, state-of-the-art, multi-tasking machines to support our customers with fastest delivery and highest quality of bevel gears. The achieved results have been so promising that further investments have been made to bring on additional machines for more capacity. ▀



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