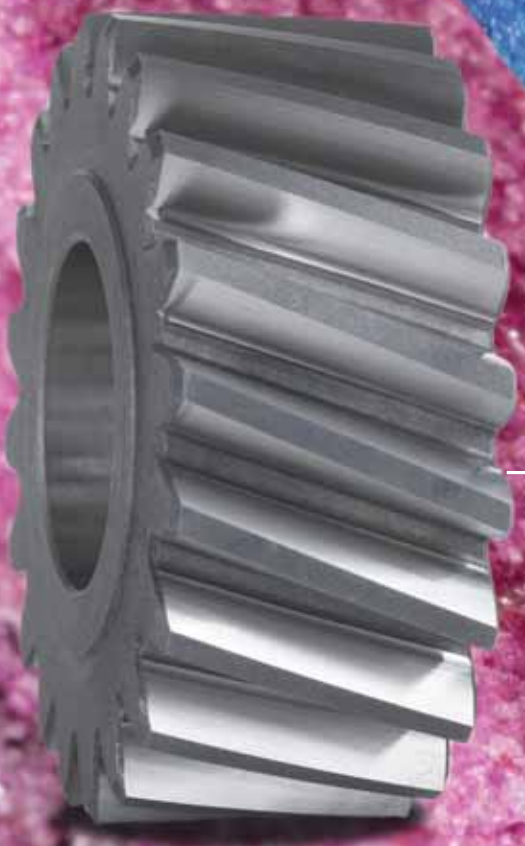
REISHAUER

Polish Grinding of Gears

Polished



Ground

www.reishauer.com

Gear polish grinding

More efficient and quieter gearboxes

by Dr Maximilian Zimmer

Fig 1: Direct comparison between the ground (left) and the polished ground (right) gear.

With the switch from combustion engines to high-speed electric drives, the automotive industry aims for particularly efficient and quiet transmissions. Once again, precision plays a decisive role in achieving success. Transmissions are one of the drive systems' most inconspicuous parts. The many innovations in transmission design over the last few decades have made vehicle transmissions work ever more efficiently, and, in the best case, they remain completely unnoticed by the vehicles' occupants. The installed gears have ever-lower power losses and ever-better noise excitation behaviour (NVH - Noise, Vibration, Harshness), ensuring lower fuel consumption and improved running smoothness.

In 2012, Reishauer introduced a technology suitable for large-scale production: polish grinding. This process smoothes the surface of the tooth flanks in an additional machining step after the conventional hard fine machining of the gear flanks, without interrupting the machining process.

Conventional hard fine machining with highly productive continuous generating grinding aims to achieve a gear geometry with as little deviation as possible in short cycle times. The subsequent machining step of polish grinding does not alter the ground gear geometry. Polishing only removes the roughness peaks (see Fig. 2). The remaining valley roughness traces serve the purpose of distributing the transmission oil between the meshing gears.

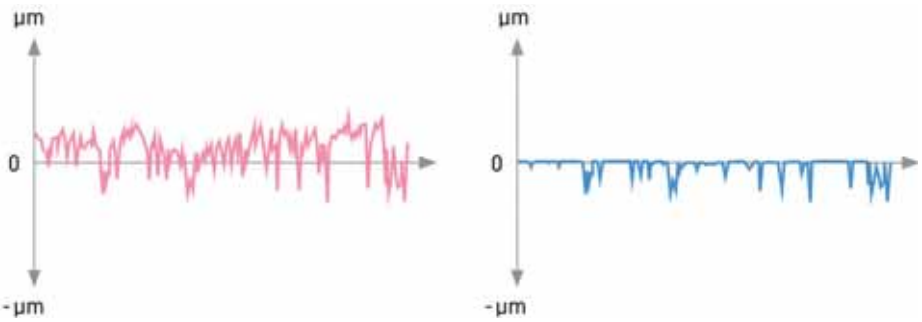


Fig. 2: The surface profile of a standard grinding worm (left) and the smoothed surface profile after polishing (right) with unmachined surface valleys to hold the lubricant. Illustrative representation.

Smoother surfaces equal lower friction

The concept behind polishing is straightforward. Polished tooth flanks reduce friction in the tooth contact, allowing for the use of low-viscosity gear oils. This, in turn, reduces power loss in the gearbox and extends the service life of the gears, a significant technical advancement in gear manufacturing.

Polishing also increases the load-bearing capacity of the tooth flanks. This increases the power density of the gears, allowing for the use of more compact and lighter gears.

The gear grinding process

First introduced by Reishauer in 1945, continuous generating grinding stands as a testament to our industry's commitment to innovation and productivity. It remains the most productive machining process for the hard fine machining of high-precision gears, grinding the tooth flanks using the kinematics of a helical gear pairing.

Current developments in gear hard finishing focus on transferring special functional properties to the tooth flanks during the finishing process. This includes, for example, changing the surface roughness function, influencing the NVH behaviour, or modifying the tooth flank topography.

Reishauer developed the polish grinding as an extension of continuous generating grinding and requires minimal investment. The grinding machine, the clamping tools and the diamond dressing tools remain unchanged. In contrast to conventional gear grinding, polish grinding requires specific and newly developed grinding tools: The threaded grinding wheels are divided into two zones (see Fig. 3). The zone for conventional generating grinding using a roughing and a finishing pass, consists of an aluminium oxide section in a vitrified bond,

whereas the polishing zone uses fine-grit aluminium oxide in an elastic bond. During machining, the machine axis moves the threaded grinding wheel axially to bring the different areas of the grinding wheel into mesh. The functional advantages of polish grinding offset the reduced output due to using an additional zone with one or more additional polishing passes.

Fig. 3: 2-zone threaded grinding wheel.

Significantly tighter requirements for E-Mobility

The Polish grinding of gears developed by Reishauer has quickly established itself in gear manufacturing. In particular, the significantly higher quality requirements for gearboxes used in e-mobility, which have much higher input speeds, have led to the widespread application of the process. With these requirements at the forefront, the advantages of polish-ground gears are particularly effective.

For polished gears, the possible reduction in the gearbox's overall weight due to the higher load-bearing capacity, the reduced power loss due to the lower roughness in the tooth contact and the possible use of low-viscosity gear oils, all significantly contribute to extending the range of electric vehicles.

Due to the high input speeds of e-transmissions, gear noises tend to occur at high frequencies, which people perceive as unpleasant due to the combustion engine's lack of noise masking. Therefore, the noise behaviour of ground gears has become increasingly important. Polished tooth flanks have been shown to reduce noise excitation in the transmission.

The results

The significantly higher quality requirements for gearboxes for use in e-mobility require all components involved in the manufacturing process to be optimally harmonised. With its "Circle of Competence" performance system, Reishauer can harmonise all components, such as grinding machines, clamping devices and grinding and dressing tools, for specific machining tasks. As part of the control system, Reishauer's application engineering supports users in optimising the machining technology, as does the AI-supported Argus monitoring system developed by Reishauer, which, following its introduction into series production, already comprises a data set of over forty million ground gears. This interaction is the key to ensuring the reliable production of high-precision gears.

Author: Dr Maximilian Zimmer, CTO at Reishauer AG, Switzerland

Reishauer AG
Tel: 0041 448 32 2211
Email: info@reishauer.com
www.reishauer.com