Fewer oil changes for gear wheels with Pulse Finish surfaces

Optimizing the surface quality of contact components is a key aspect of tribological studies. A uniform, smooth surface profile and suitable lubrication reduce wear and increase product life this is especially important for gear wheels for example.

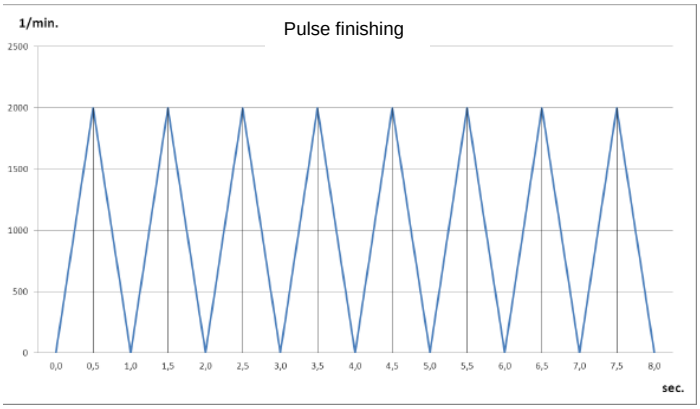
A range of different finishing processes, such as mass finishing, can reduce the amount of running-in needed. With mass finishing, the roughness peaks are removed and there is less metal abrasion. For example, if oil lubrication is used, the reduction in metal abrasion has a positive effect on oil fouling. This enables the oil change interval to be increased considerably.

Mass finishing is a proven process for smoothing, polishing or grinding surfaces. Because of the relatively low stock removal rate, however, it is unsuitable for many processes. In addition, the complex component geometry of gear wheels means that they must be ground with abrasive media in the micro range (size: 0.5 – 1 mm), which reduces the stock removal rate even further.

New “pulse finishing” mass finishing process with higher stock removal rate

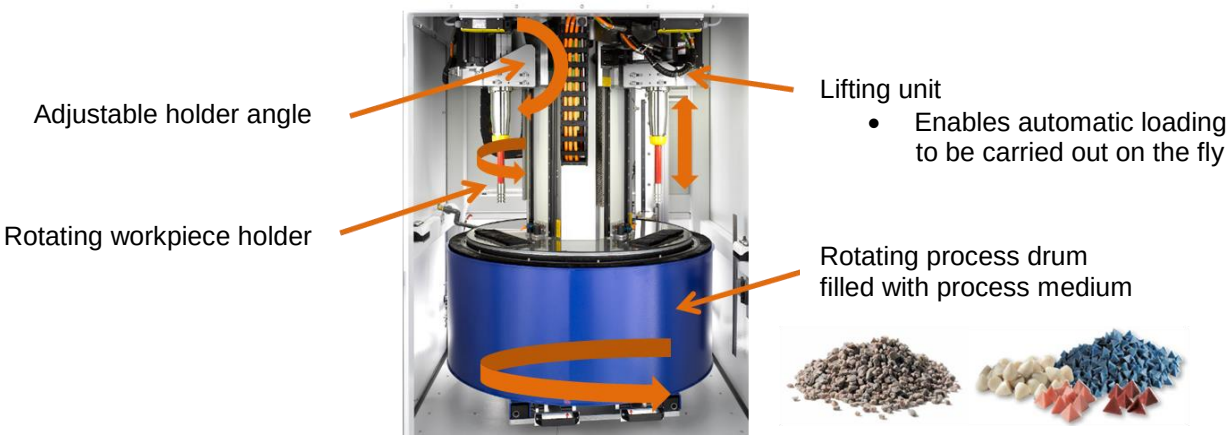
The new mass finishing process from the equipment manufacturer OTEC Präzisionsfinish GmbH exerts high forces on the workpiece during surface finishing and thereby achieves a higher stock removal rate in processing times of 1 – 2 min.

During “pulse finishing”, the workpieces (e.g. gear wheels) are individually clamped in holders and processed in a stream of grinding or polishing medium rotating in the alternating directions. Repeatedly decelerating and then accelerating again to 2,000 rpm takes a mere 0.5 s. This process creates relative velocities of up to 30 m/s and accelerations of up to 40 G. With this system, a machine with 4 workpiece holders can fully finish a workpiece every 15 – 20 s.



Alternating direction of rotation

The parameters which have the greatest tribological effect are speed of rotation and swivel angle of the workpieces, pulse time, immersion depth and the process medium.

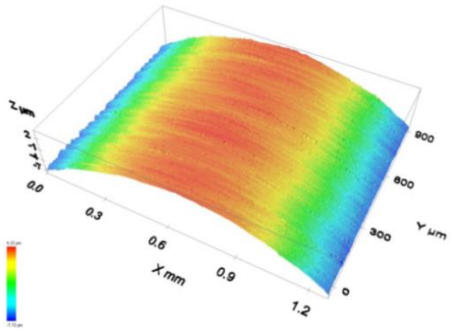


What does the surface profile of the gear wheels look like after pulse finishing?

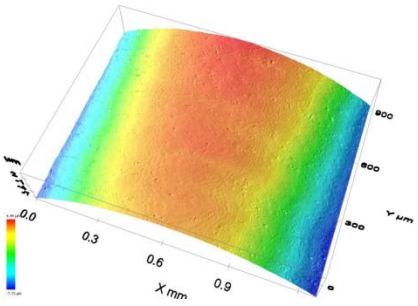
Tribological studies carried out on two-disc rolling contact tests with pulse finished surfaces have shown that uniform, smooth surfaces with micro cavities and low R_{pk} values cause the least amount of wear and material loss through abrasion. The lubricating oil can collect in the micro cavities, creating “oil valleys” and is not displaced upon contact as is the case with grooves resulting from conventional grinding processes.

Mass finishing using the pulse finishing process removes grooves caused by the grinding process, reduces roughness parameters and generates micro cavities.

Surface comparison before and after mass finishing:



Before

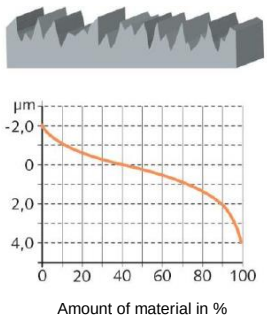


After

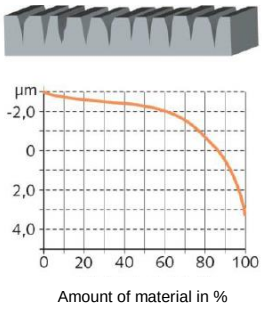
The coefficient of friction in a rolling contact, which is characteristically subject to the parameters R_k and R_{pk}, has been demonstrably reduced by up to 30 % in the case of mass finished discs. The fact that the roughness depth R_k and the peak height R_{pk} are the most significant parameters is probably because R_{kp} is initially relevant during running-in and R_k during subsequent operation. A reduced peak height R_k improves the contact surface area for the same R_a value.

Even a minimal change in the roughness values measured by a tactile sensor produces a considerable improvement in surface characteristics. With the pulse finishing process, roughness values of R_a = 0.1 µm and R_{pk} < 0.1 µm were achieved.

With cam shafts, too, the pulse finishing process halved the Ra values and R_{pk} values:



Conventional grinding process
R_a = 0.2 µm and R_{pk} < 0.2 µm



Mass finishing using the pulse finishing process: R_a = 0.1 µm and R_{pk} < 0.1 µm

Further benefits of pulse finish surfaces

The lower coefficient of friction has many positive effects: It reduces heat generation and thereby increases the performance and the energy conversion efficiency of the tribological system concerned. In addition, it reduces noise generation by up to 50 % compared to conventionally ground parts. Furthermore, it helps to prevent fatigue damage caused by excessive increases in compression.

Using the pulse finishing process to finish parts therefore results in an overall improvement of component properties and ultimately to a longer service life of the parts.

The company

OTEC is a medium-sized manufacturer of drag finishing, disc finishing and stream finishing machines. Founded by Helmut Gegenheimer in 1996, the company has steadily established itself on the market by developing innovative new machine concepts and numerous patented processes.

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