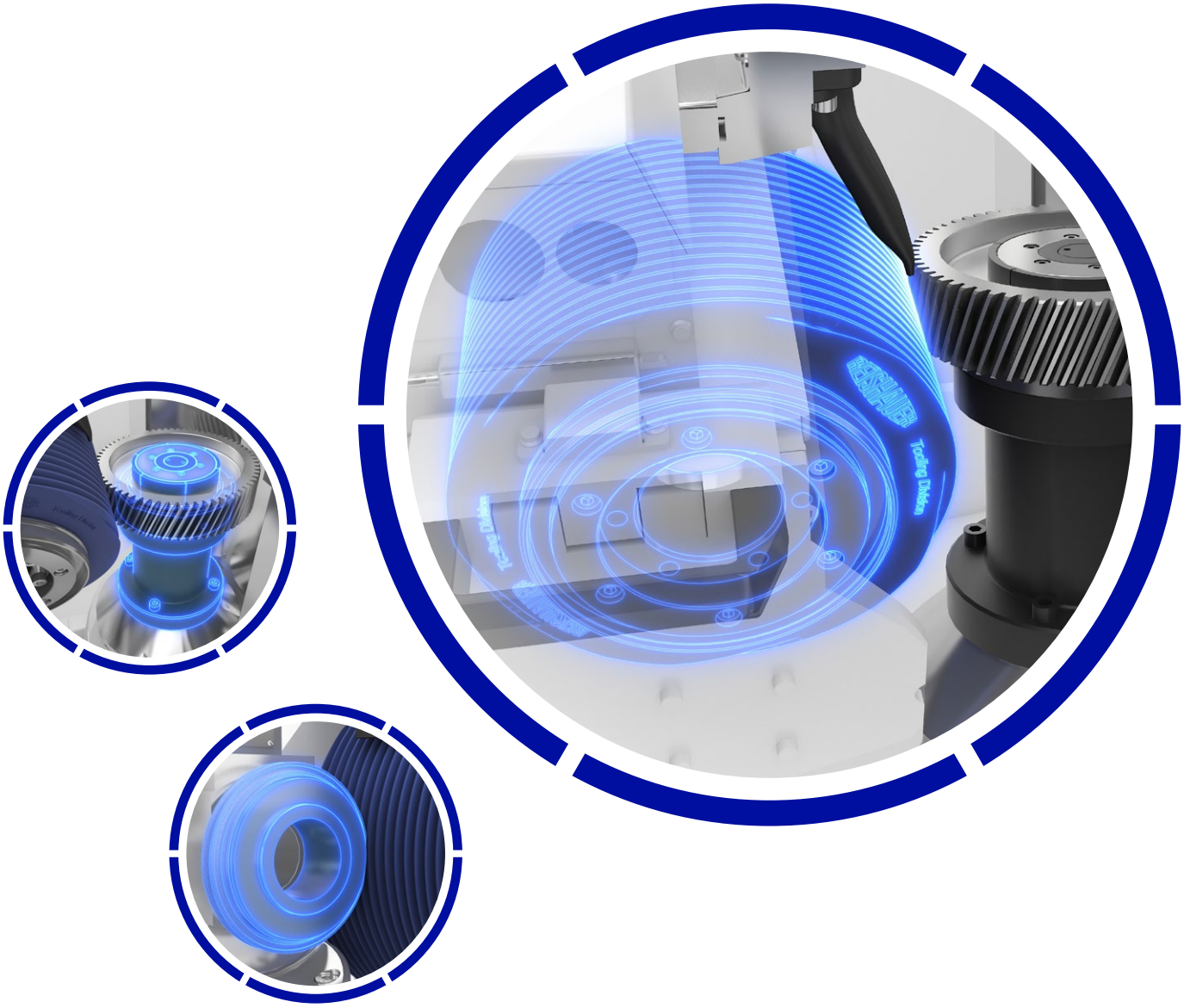
REISHAUER

Gear Grinding Technology

Threaded Grinding Wheels



MACHINE | AUTOMATION | **TOOLING** | TECHNOLOGY | DIGITAL | SERVICES

For optimum grinding results

Swiss precision.
Made by Reishauer.

As far back as developing the world's first generating grinding machine, Reishauer has greatly impacted modern transmission production through its innovative developments in machine and process technologies. Our high-tech gear grinding machines, pioneering digital applications, efficient tools, and proven clamping fixture concepts enable durable, efficient, and quiet transmissions to be produced.

Grinding wheels optimally adapted to suit your needs

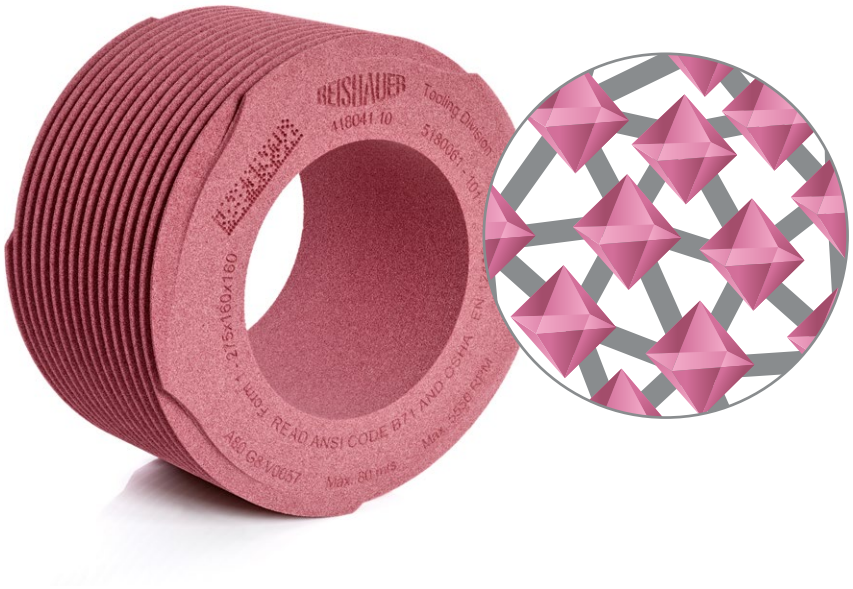
The Reishauer performance portfolio—the Circle of Competence—covers all aspects of the hard fine machining of gears. In order to master the entire process chain of the continuous generating grinding process, Reishauer manufactures not only the highly sophisticated gear grinding machines but also the clamping devices, dressing tools and grinding wheels.

Why our grinding wheels deliver optimum results

Threaded grinding wheels are at the core of continuous generating grinding and play a fundamental role in mastering the machining process. For this reason, Reishauer carries out production in-house in the world's most modern grinding wheel factory to offer a complete tooling system and to be independent of third-party suppliers. Our focus is to set the industry benchmark for threaded grinding wheels in terms of reproducibility, homogeneity, and the low hardness differential across the full wheel width using mainly automated manufacturing methods.

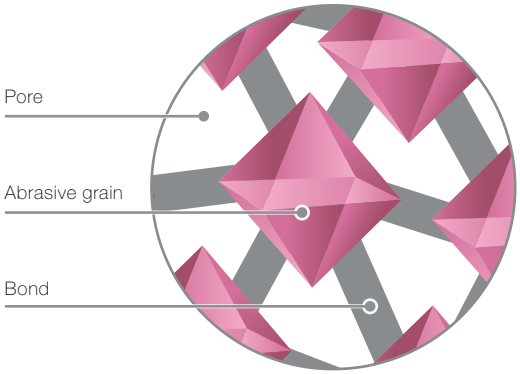
The structure of our grinding wheels

Typical grinding wheel structure



Grinding wheels, also called grinding worms due to their pre-profiling, consist of three elements, all of which fulfill a specific purpose. These elements are the grit (abrasive grains), the bond, and the pores. In short, the grit's task is to perform the cutting of hardened steel at a high material removal rate, to be self sharpening, to achieve a surface finish within a desired range, and make sure that there is no grinding burn during the process.

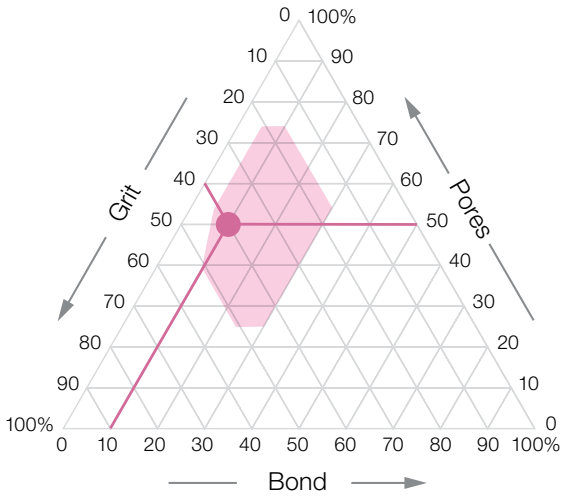
Elements of the grinding wheel structure



The bond acts like an adhesive, holding the grit in place in such a way that individual grits will not break out under heavy cutting loads in the roughing passes. Even though the bond itself does not aid the cutting process, and is often wrongly seen as a necessary evil, it is of the utmost importance as it determines the quality of the grinding wheel. Furthermore, the bond also determines the possible operating speed and must ensure a high level of safety for the grinding process. This corresponds to international standards and is in keeping with the trend toward higher cutting speeds, which in the case of Reishauer machines, may reach up to 100 m/s.

The third element, the pores, gives the grinding wheel an open structure to reduce friction in the contact zone. The pores also ensure that the coolant is transported to the contact area during grinding, that the chips generated during the process do not adhere to the abrasive grit, and they generate chip space so that the chips can be transported away from the grinding zone. Furthermore, if the percentage of pore volume is insufficient, the grinding wheel clogs up and thermal damage might result.

Three-phase diagram for grinding wheels



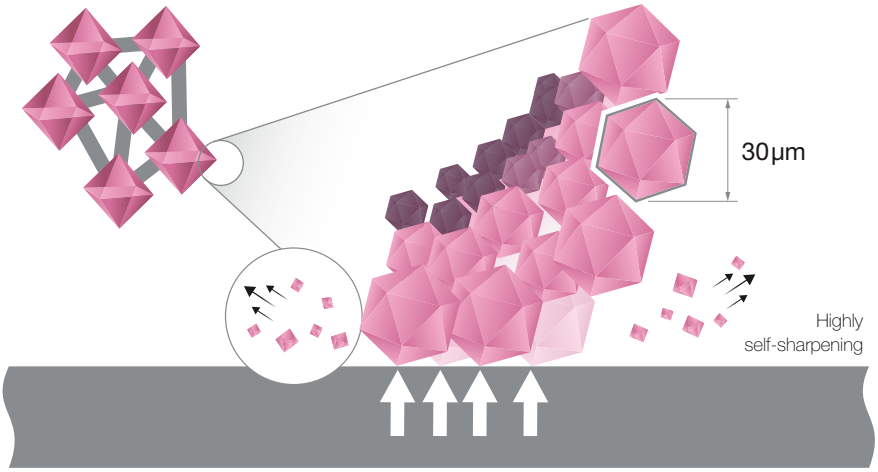
40 % grit
50 % pores
10 % bond

In an ideal world, one would aim for a threaded grinding wheel with as low a percentage of bond as possible, with as many pores as possible. Realistically, this is not technically possible. Grinding wheels have a specific "window of feasibility" as illustrated in a three-phase diagram. The colored section within the diagram's triangle represents the possible combinations of percentages of abrasive grit, pores, and bond. The diagram shows a combination of 40 % abrasive grit, 50 % pores, and 10 % bond, which would be typical for threaded grinding wheels for continuous generating grinding.

Abrasive specifications

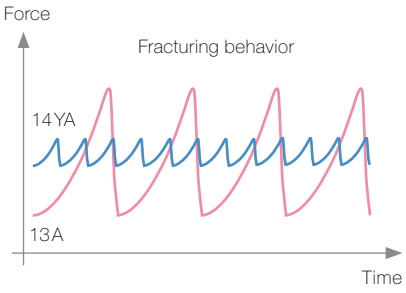
With very few exceptions, threaded wheels for generating grinding have some form of aluminum oxide (Al_2O_3), known as corundum, as their abrasive. White or red aluminum oxide, single crystal corundum, and ceramic aluminum oxide are all part of the family of aluminum oxides, which are used at Reishauer in a wide range of blends and concentrations.

Stable grinding properties through permanent self-sharpening

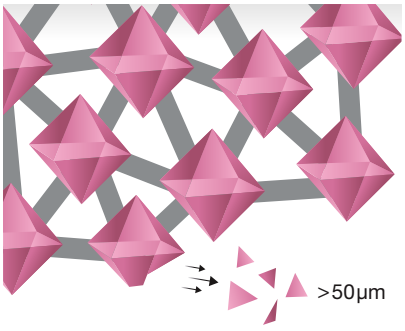


Many cutting edges

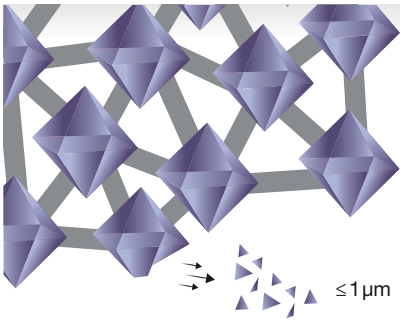
Self-sharpening mechanism (illustrative)



Stable grinding results can only be achieved with sharp cutting edges. Corundum is therefore highly suitable as an abrasive due to properties such as its hardness. As soon as the grinding pressure increases above a certain level, the abrasive grits will fracture to some extent at their worn points in order to produce new and sharp cutting edges. This fracturing is called self-sharpening. The size of the sharp-edged microparticles and the amount of cutting edges that are produced are specific properties of each type of corundum. These properties determine its suitability for the customer's requirements.



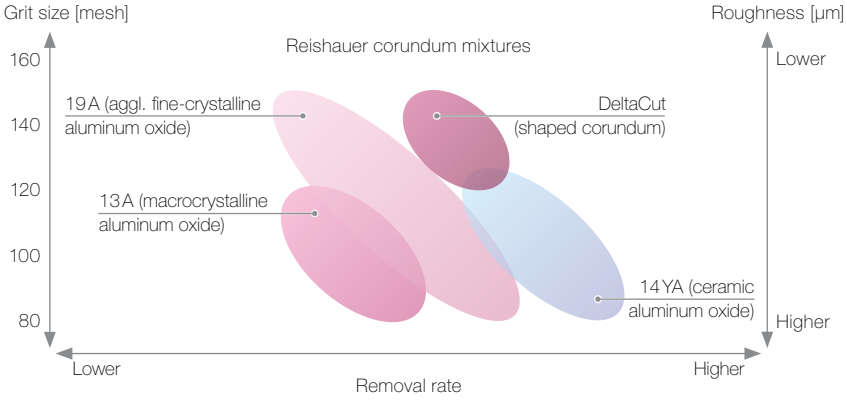
Self-sharpening mechanisms of macrocrystalline grit, aluminum oxide



Self-sharpening mechanisms of microcrystalline grit, ceramic aluminum oxide

Reishauer uses four different types of abrasive specifications, all of which are blends of different aluminum oxides. Each type of corundum delivers different results—including in regard to the removal rate and the surface finish. A targeted blend can be used to achieve the desired effects.

Choice of abrasive (illustrative)



Aluminum oxide grinding wheels (13A / 19A)

A blend of macrocrystalline white and red aluminum oxide (mixture 13A) can be used for the majority of standard applications. This has a particle size of >50µm during self-sharpening.

Reishauer also has fine-crystalline, agglomerated aluminum oxide grinding wheels in its portfolio. This is Al_2O_3 grit with a particle size of approximately 30µm blended with white aluminum oxide (mixture 19A). This specification is ideal when high removal rates and thus short cycle times are required.

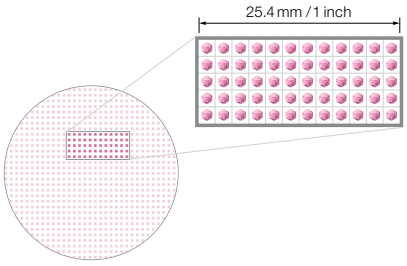
Ceramic aluminum oxide grinding wheels (14YA)

Ceramic aluminum oxide grinding wheels consist of aluminum oxide with a particle size of ≤1µm blended with white aluminum oxide (mixture 14YA). Since the abrasive grit fractures into microcrystalline particles during the self-sharpening process, this is a high-performance wheel which exhibits particularly high dimensional stability while delivering high removal rates. This specification is therefore best suited when there is limited machine tool availability, if there are fluctuations in the hardness of the workpieces, if there is a high level of retained austenite in the steel, or if there is a lot of stock allowance to be removed.

Shaped corundum grinding wheels (DeltaCut)

To meet rising requirements in relation to the quality and surface finish of new components, Reishauer has developed the Performance-Line with shaped corundum grinding wheels These consist of a blend of sol-gel shaped corundum with white and red aluminum oxide (DeltaCut mixture). This specification is required in applications that call for a constant surface finish with high removal rates. Furthermore, shaped corundum grinding wheels also have a significantly lower risk of grinding burn compared to conventional abrasives due to their cool grinding.

Grit size, hardness, and structure



"Mesh" refers to the number of sieve openings per linear inch. Here: 12 openings per inch, thus a grit size "12".

Grit size

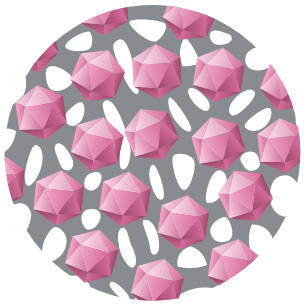
The grit size distribution for bonded abrasives is governed by the DIN ISO standard 8486-2 with which Reishauer fully complies. The grit size designation has its origin in the USA and is given in mesh, i.e., sieve mesh sizes. Mesh refers to the number of openings in a sieve per linear inch (25.4 mm), whereby the wire diameter takes up 30 % of the linear distance. For an 80 grit, theoretically this means:

- 1 inch (25.4 mm) minus wire diameter (30 % of 25.4 mm) divided by the nominal grit value (here 80)
- (25.4 mm × 0.7) / 80 = 0.22 mm, whereas the mean value is given as approximately 0.185 mm.

The finer the chosen grit size, the better the surface finish and the better the form holding will be. However, at the same time, too fine a grit increases the risk of grinding burn and reduces the removal rate potential.

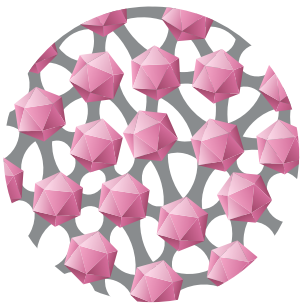
Hardness and structure

Closed structure



The letters of the alphabet denote the wheel's hardness, where "A" represents the theoretically lowest hardness and "Z" denotes the theoretically highest hardness. Reishauer wheels range between "F to J" as these hardnesses have proven themselves as the best balance between self-sharpening and form holding for generating grinding. The softer the wheel's structure, the cooler the grinding wheel will act. However, form holding will decrease with increased softness. The inverse holds true, too: The harder the wheel structure, the better the form holding will be. However, this also increases the risk of burning. This shows how important it is to observe the aforementioned criteria carefully and to design the appropriate structure. In general, the wheel's hardness is controlled by the amount of bond added to the mix and by the pressure applied to the mixture in the mold during pressing.

Open structure



All grinding wheels feature some natural porosity, as the pressing process cannot push the grits together such that there are no gaps between them. As mentioned before, porosity aids in getting the coolant into the grinding zone and helps to remove the chips from that zone. More importantly, porosity reduces the contact area between the grinding worm and the workpiece. In this manner, there is more pressure on an individual grit, and this makes for better self-sharpening and, therefore, for a cooler cutting process. The natural porosity is insufficient for high-performance grinding processes and must be increased artificially by means of adding pore inducing agents into the press mixture. The structure of the grinding worm can be precisely controlled through the size and number of the individual pore inducing agents. The pore inducing agents will decompose completely during the burning process, leaving voids. Grinding wheels are categorized into closed (natural) and open (pore induced) structures.

Our compositions

A grinding wheel with the specification
A 80 G 8 V 0057

Reishauer's different abrasive grit mixtures represent technical solutions to customer requirements in regard to economics, performance, surface finishes, dressing tools, the retained austenite in the workpieces, and the hardness of the steel to be ground. A typical Reishauer grinding wheel specification can be broken down as follows:

A	80	G	8	V	0057
Abrasive grit	Grit size	Hardness	Structure	Bond	Types of bond
Aluminum oxide	80 = coarser	F = softer	7 = denser	B = resin bonded	
Ceramic aluminum oxide	100	G	8	V = vitrified	
	120	H	9		
Shaped corundum	150	I	10 = more porous		
	180 = finer	J = harder			

Our wealth of experience in grinding wheel manufacturing encompasses several hundred compositions, which means that, in the majority of cases, we already know the most suitable mixture for the customer's requirements. To give you an overview of the type of grit on the individual types of grinding wheels, we have drawn up the following summary of our most sought-after items:

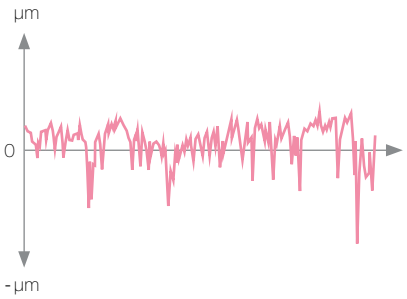
Grain mixtures	Grit size	Hardness	Structure	Types of bond
13 A (macrocrystalline aluminum oxide)	80	G	8	V0057
	100	G	8	V0108
	80	H	8	V0058
19 A (agglomerated fine-crystalline aluminum oxide)	80	G	8	V0167
	120	G	8	V0176
	150	G	8	V0237
14 YA (ceramic aluminum oxide)	80	G	8	V0166
	80	H	8	V0233
	80	H	8	V0252
	120	H	8	V0247
	120	H	8	V0254
	180	H	8	V0249
DeltaCut (shaped corundum)	120	F	8	V0264
	150	F	8	V0262

Fine and polishing grinding wheels

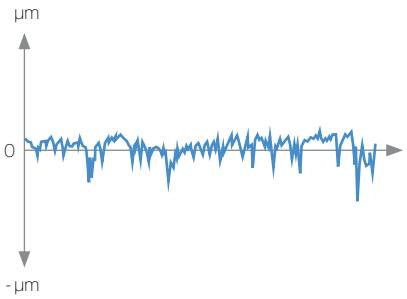
Reishauer machines enable grinding and subsequent fine finish grinding or polishing to be carried out in one clamping operation to achieve the required or optimized surface finish for the application in question. Grinding worm sets with two areas, a grinding zone and a finishing zone, are used for these processes.

The roughness profiles of the gear flanks shown here document the surface structure of conventional gear teeth subjected to a generating grinding process, a fine finishing grinding process, and a polishing grinding process (illustrative).

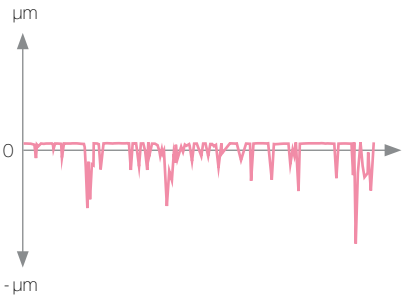
Standard grinding wheel



Fine grinding wheel



Polishing grinding wheel



Targeted optimization of the surface structure of hard-finished gear flanks leads to an increase in the load-bearing capacity of the gear teeth and to a reduction in the power loss in the transmission. This effect is due to the reduction in friction between teeth as well as the possible use of lower-viscosity gear oils. Optimization of the surface structure can also lead to lower noise excitation in the transmission.

Combined rough and fine grinding wheel

Fine grinding wheels

Fine grinding wheels, which consist of two vitrified bonded grinding zones, are used to improve the surface structure. The first zone is for rough grinding with a coarser grit to achieve high stock removal and the second zone has a fine grit for refining the surface. A grain size of up to 320 is used for this.

Combined grinding and polishing wheel

Polishing grinding wheels

Threaded polishing grinding wheels are also composed of two grinding zones with different grinding wheel specifications, which essentially differ in the type of bonding and the grit size of the abrasive. Vitrified bonded corundum is used for the roughing and finishing. The polishing zone consists of resin bonded aluminum oxide with fine grits of up to 800.

The grinding zone is used to grind the workpieces to their final dimension. These are then subsequently moved into the polishing zone by a shift jump, where the parts are polished in one or several strokes. Only the uppermost roughness peaks are removed, without changing the precision-ground macrogeometry.

Available in all common dimensions

A typical grinding wheel dimension for our RZ x60 4.0 series

Reishauer offers grinding wheels in all the necessary dimensions for equipping Reishauer generating grinding machines:

Outside diameter x width x clamping diameter	Machine type
300 × 125 × 160 mm 300 × 145 × 160 mm 300 × 160 × 160 mm	RZ 410 RZ 550 RZ 1000
275 × 160 × 160 mm	RZ x60 RZ x60 4.0
275 × 125 × 160 mm	RZ 150
140 x 140 x 46 mm 160 x 140 x 53 mm	RZ 126 / 160 KWS 4.0 KWS attachment spindle

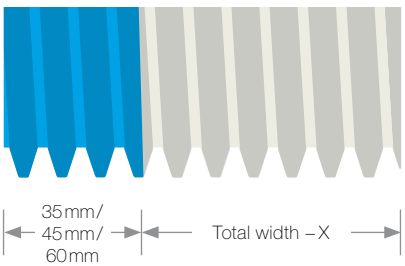
Reishauer also offers its customers grinding wheels in other standard market dimensions.

Zone division for fine and polish grinding

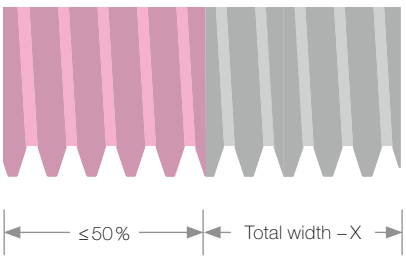
For fine grinding or polish grinding, a conventional grinding wheel is modified and combined with a fine- or threaded polishing grinding wheel. In doing so, the additional finishing stroke is performed quickly in the same clamping operation.

For the surface finish, we manufacture threaded polishing grinding wheels with a polish-grinding zone of 35, 45, or 60 mm. For fine grinding wheels, the fine grinding zone accounts for up to 50 % of the total width.

Combined grinding and polishing wheel



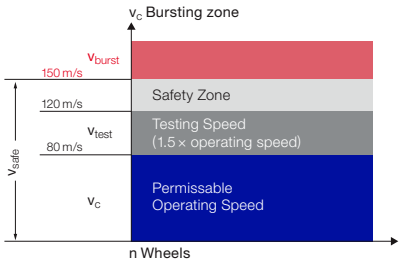
Combined rough and fine grinding wheel



Grinding wheel safety

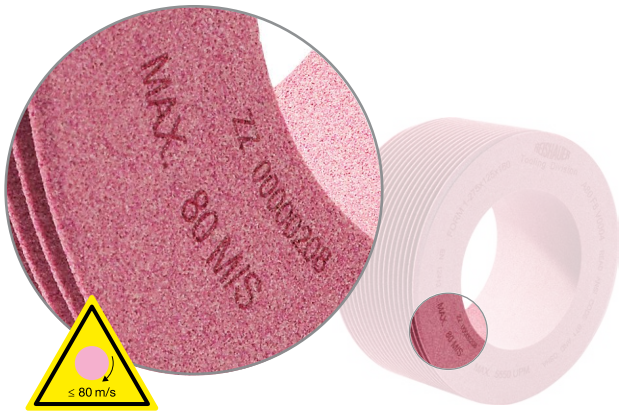
Reishauer strictly adheres to all country-specific safety rules and regulations and supplies the grinding wheels tested and marked in accordance with these rules and regulations. This encompasses safety standards according to FEPA, the European standard EN 12413 for bonded abrasives, the US standard pertaining to bonded abrasives, ANSI B7.1, "Safety Code for the Use, Care, and Protection of Abrasive Wheels", and the Chinese standard GB 2494 "Bonded Abrasive Products – Safety Requirements". Reishauer also offers grinding wheels which meet the even stricter Japanese standards JIS D 6210 and JIS R 6242.

Safety: Operating and testing speed



For the European and the US market, each Reishauer grinding wheel is speed tested at a factor of 1.5 x the permissible operating speed. In the case of a wheel approved for a maximum operating speed of 80 m/s, this translates into a speed test at 120 m/s. Each wheel features a laser marked and electronically readable code. Thus, each wheel is traceable across its complete manufacturing chain (exact position in the kiln, safety-related production steps, and speed testing). Furthermore, Reishauer grinding wheels are systematically subjected to a bursting test at a prescribed frequency. Additionally, wheels are checked for their constant homogeneity on the circumference and across the wheel width in terms of density and modulus of elasticity. These tests ensure that all batches stay within a narrow range of manufacturing tolerance. The process for the speed and bursting tests are shown here.

Never exceed the specified operating speed!
Here: 80 m/s



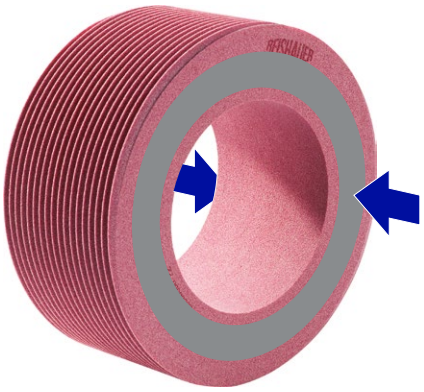
The operating speed marked on the grinding body must never be exceeded. Ignoring this instruction may lead to the grinding body bursting, and may cause damage to property. The illustration shows the laser-marked maximum permissible cutting speed which is engraved on all grinding worms made by Reishauer.

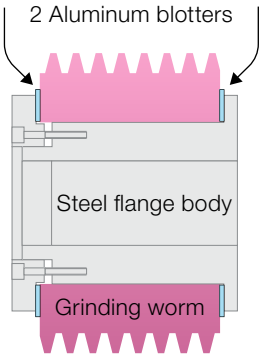
Safety-relevant installation instructions

Ring test for vitrified bonded grinding wheels and worms

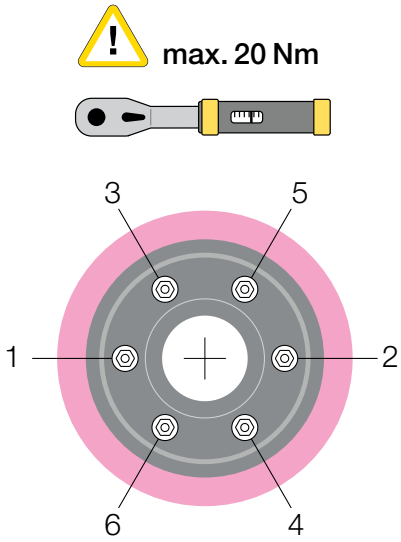
Before any grinding wheel or worm is mounted on its flange, it must be subjected to a ring test. By this simple method, the user can find out if a grinding worm is cracked or not. When tapping the grinding worm lightly with a non-metallic hammer, or a copper hammer, a clear bell-like sound should occur. If the tapped grinding worm emits a dull sound, the worm is most likely cracked. Such a grinding worm must not be used under any circumstances.

Mounting





When mounting a grinding worm on its flange, aluminum blotters must be placed on either side between the flange and the grinding body, as illustrated above. These blotters will equalize any unevenness that may be present on the grinding worm's faces. Hence, the blotters will prevent the flange from cutting into the grinding worm face and weakening it. The blotters are an important safety feature that must be adhered to.

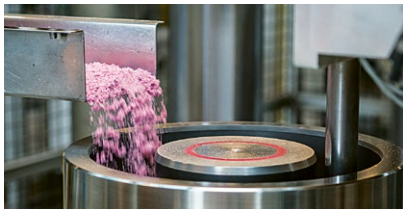


Once the grinding worm has been mounted on the flange, the flange bolts must be correctly tightened with a torque wrench. Reishauer recommends a torque of 20 Newton meters (Nm) or 15 foot-pound (ft-lb) for applications in the USA. A diametrically opposed tightening sequence should be used for the clamping screws as illustrated here.

Swiss Made at the Reishauer plant in Pfaffnau

We produce our grinding wheels in-house. This forms a key part of the Reishauer Circle of Competence and rounds off our range of gear grinding products and services.

To ensure the optimum performance of our grinding machines, we develop and produce the grinding wheels right from the loose grit through to the finished grinding worm itself. In doing so, we ensure that every single wheel that is supplied to our customers over the years has identical properties. This results in long-term stable processes and consistent results.



As a manufacturer, we work closely with our customers and become involved in their plans at an early stage. We draw upon our systems expertise to provide our customers with in-depth know-how about the grinding process and develop the most advantageous solution for them. In the event of changes at short notice, we are therefore able to respond flexibly and set many wheels in motion—such as adjusting a grinding wheel mixture in order to fine-tune the grinding process.

Every year, tens of thousands of grinding wheels leave our highly automated plant in Pfaffnau, Switzerland, where we have been based since 2008. Despite the many abrasive grit mixtures and dimensions, almost 95 % of all the grinding wheels we offer are in stock and immediately available.

The Reishauer Circle of Competence

The Reishauer Circle of Competence encompasses our complete range of products and services. By offering everything related to the grinding process from a single source, Reishauer ensures a long service life of the machine system at low life cycle costs.

Machine

A broad portfolio, future-oriented controls, and interface concepts, and state-of-the-art grinding technologies – for decades, our machines have guaranteed the highest possible output with maximum precision, consistent quality, and unmatched machine availability.

Automation

Automation "Made by Reishauer". Our automation solutions are perfectly matched to our machines and keep pace with their high output. Modular in design, they can be flexibly tailored to your production needs.

Tooling

Perfectly matched, consistent in quality, and with guaranteed availability: Together with the machine, Reishauer tooling forms the backbone of successful grinding processes.

Technology

Modern e-drives demand higher overall gear quality, clearly defined surface finishes, and highly accurate gear geometries. Reishauer grinding technologies enable you to meet your and your customer's most demanding requirements and help you remain competitive. Our technology experts are at your disposal to advise you and provide support.

Digital

System integration, in-depth process analyses, and predictive maintenance – the requirements for Industry 4.0 solutions are extremely complex and diverse. Reishauer offers a constantly growing portfolio of digital services to maximize the potential of your machines.

Services

The reliability of our machines, and thus machine availability, is of central importance for your competitiveness. Shortest reaction time, a worldwide extended network of service engineers, and decentralized spare parts stores guarantee maximum availability.

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