The right choice for reliable drive systems

Plasma spraying protects gears in the wet end of papermaking machines against corrosion.

In production plants where torque needs to be transmitted or transformed, cost-effectiveness depends on the availability and efficiency of the machinery. Even under extreme operating conditions, drive systems are subject to an increasing demand for longer service life, higher speed and greater efficiency. Downtimes must be avoided under all circumstances. This is a challenge which, with its state-of-the-art production facilities, the company Wolfgang Preinfalk GmbH, a leading manufacturer of custom gearboxes and drive systems headquartered in St. Ingbert in Germany's Saar region, has been meeting successfully for over 40 years. In underground or surface mining, in industry or the environmental technology sector – this drive system specialist offers custom solutions to meet every requirement. For example, large gearboxes for deployment in the wet end of papermaking machines. Here, the sealing seats of the gears are thermally coated with refractory ceramics to protect them against corrosion and wear. At the customer's request, Preinfalk entrusts this process to the company Pallas GmbH & Co. KG, an established expert in the field of sophisticated surface engineering located in Würselen near Aachen.

Founded in 1976 as a component production and repair centre for the coal mining industry in the Saar region, Preinfalk today has 200 employees working in three business units and is an established fixture in the field of high-quality gear manufacturing. In 2011, the company became a member

of the Schottel Group, a leading manufacturer of propulsion and steering systems for ships. In its gearbox manufacturing business unit, Preinfalk develops and constructs custom gearboxes for the underground and surface mining sector as well as for numerous industrial sectors, for example the paper industry. But the primary corporate focus is on contract production of precision gear components. These are used, for example, in underground mining in drives and gearboxes for face and drift conveyors or belt conveyors, in surface mining in shredder and crusher machinery, in road headers up to the 400kW performance class for tunnelling, or in machinery for industrial cranes and continuous casting plants. The third business unit specialises in gearbox components for energy conversion systems in wind turbines. With this portfolio, Preinfalk is active in all the leading world markets.

Impressive precision

Whether the order is for universal standard gearboxes or custom gearbox solutions with unit weights of up to 25 tons – Preinfalk's high degree of operational reliability and output density are a guarantee for consistent component quality. This is due to state-of-the-art production on a floor area of 1,800 square metres in St. Ingbert which facilitates a large vertical range of integration and exceptionally high production standards. For example, gears up to module 32 with an external diameter of 1.6 metres and a unit weight of five tons are manufactured here, with the temperature-controlled production hall ensuring consistently high quality of the components. This is the only way to meet the special toothing precision requirements without which ship or wind turbine transmissions would not be permanently able to handle the challenging environments in which they are deployed. The precondition for such high-precision products is high-quality raw material, usually forged T&Q steels, nitriding steels or case-hardening steels. In the

pre-production stage, the gear components made of these steels are given their basic form by means of CNC turning. In the next stage, in the gear-cutting shop, the components are machined to tolerances in the order of tenths of a millimetre. Then, in the company's own heat treatment shop, any warpage from the previous stage is minimised through stress-relieving annealing and case-hardening. After subsequent metallurgic quality control and descaling through shot blasting, the components are then processed mechanically to finishing in one of the most modern cylindrical and tooth flank grinding shops in the world. After the finishing treatment, the component surfaces now comply with tolerances in the order of thousandths of a millimetre. Extensive quality controls mark the final stage of production at Preinfalk before the gears are put together in the company's own assembly shop into complete gearboxes. The process, from material sourcing to finishing, takes four to five months. Objectively speaking, this is a relatively short time frame – thanks to Preinfalk's huge machinery park, with which large numbers of components can be processed parallel to each other. However, in the event of a gear failure in a customer's machinery, replacement parts must be immediately available. For this reason, especially in the case of continuously operating, fast running equipment like papermaking machines, industrial processors always keep a stock of spare parts at the ready.

No chance for corrosion

One of Preinfalk's customers, a major paper manufacturer, regularly orders small batches of gears for the forming section or "wet end" of its papermaking machines. The demands that this particular deployment scenario places on the surface quality and the tightness of the gears are extremely high. The base material at the sealing seat is vulnerable to abrasion of the fibre-reinforced seal and thus, in the prevailing wet

conditions, offers a potential target for corrosion. In the worst case, this could result in water penetrating the gears and doing permanent damage to them. In order to reliably exclude this risk, the sealing seats are treated with a thermal coating by means of atmospheric plasma spraying (APS) – a high-tech surface engineering procedure which Preinfalk entrusts to the specialist company Pallas. In the APS process, an extremely abrasion- and corrosion-proof customised protective coating is applied without effecting any changes to the base material of the sealing seat which is at risk of corrosion. This is achieved by injecting a refractory ceramic compound in powder form into the plasma flame – burning at a temperature of approx. 18,000°C – where this feedstock melts in microseconds and is propelled by the kinetic energy generated in the process against the surface of the workpiece. There, the particles form a dense, highly adhesive layer on the substrate to be coated. The high dimensional precision and reliable reproducibility of this protective layer are among the particular advantages of this procedure. In addition to the size of components that can be handled, the extremely limited focus of the energy feed – the spot measures just eight millimetres – and the precise controllability of the thermal strain on the component are further arguments for choosing plasma spraying as the optimal method for coating heavy-duty sealing seats. The specifications Pallas receives from Preinfalk are certainly stringent. The coating of the large 700 kilogram components must be absolutely pore-free, have a surface roughness of R_a 0.4 µm and, after finishing, be ground perfectly smooth. The sealing seats must be coated internally and externally while maintaining concentricity tolerances of one thousandth of a millimetre, so that the complete system has the required tightness.

Measurable quality at every stage

On receiving the gears, Pallas first checks their dimensional accuracy per calliper on a vertical turning lathe. Should any deviations of more than a hundredth of a millimetre be found here, a precision measurement per laser would then be performed in order to exclude the possibility that a radial run-out between the sealing seats may have occurred in the factory. Purely a precautionary measure, as Pallas managing director Alexander Kalawrytinos points out, because Preinfalk dependably delivers consistently high-precision components. After this check, the gears are thoroughly degreased by Pallas technicians. Depending on how soiled they are, this is first done using electrolysis in the electroplating shop, then manually with solvents. The complete component must be absolutely clean and free of grease before the coating process can begin. The next stage is to apply cover strips. In order to ensure that these adheres optimally, the gears are heated to a temperature of 20 – 30°C in order to remove any last traces of moisture from them. Because Pallas is not permitted to grind or in any way process the edge zones of the gear – which have been precision ground ready for installation by Preinfalk – these areas of the gear are masked with three to four layers of cover strips. Before shot blasting, the precision-ground gear teeth are covered with a protective metal sleeve. The next step is, using white aluminium oxide, to blast the areas of the gear which are to be coated internally and externally. Precise adjustment of grain size, blasting angle and pressure allow the required degree of surface roughness – R_a between 45 and 55 µm – to be attained and documented. "At Pallas, quality is measurable in every stage of the process," says Alexander Kalawrytinos. This roughening activates the surface of the component so that the protective coating layers will adhere well. The actual coating itself is performed robotically on a coating turntable. Both the external and internal seats on the gear are coated in one clamping. To ensure consistent temperature distribution, Pallas alternates between coating the inside and

the outside of the sealing seats – 40 to 50 times – until the 250 µm thick coating has been completely applied. The feedstock used is chromium oxide (Cr_2O_3). This extremely hard (~1300 $HV_{0,3}$) and abrasion-proof oxide ceramic has a very low porosity of 3 to 5%, which is negligible considering the thickness of the coating. For this reason, chromia counts as standard in the papermaking industry. And in this specific deployment scenario, too, the ultra-hard, dense and smooth layer of chromium oxide proves to be ideal for protecting the sealing seats against corrosion in the aggressive wet-end atmosphere. In the final stage of processing, both sealing seats – again in a single clamping – are machined and polished to their target dimensions. After exhaustive final checks of dimensional accuracy, concentricity, roughness depth and coating thickness, the finished coated gears are returned to Preinfalk. Rafael Müller, Preinfalk's design manager for gearboxes and gear components is certainly satisfied with the collaboration with the surface treatment specialists in Germany's Rhineland region: "Pallas provides the right quality! They give us exactly what we ask for."

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Pallas GmbH & Co. KG

The company Pallas GmbH & Co. KG, headquartered in Würselen near Aachen, is a technological leader in the field of surface engineering that offers a complete range of surface treatment processes from a single source: electroplating, thermal coating, non-stick and plastic coating as well as laser treatment. By combining the advantages of thermal, mechanical and electromagnetic procedures and working materials, Pallas develops application-specifically optimised surfaces for heavy-duty components or tools. For over 50 years now, this owner-managed family business with its circa 35 employees has regularly set new standards in the field of technical

and decorative surfaces. In key industrial applications like tool- and mould-making, for sealing and bearing seats, rollers or drill pipes, Pallas offers the attractive option of rapid repair as an alternative to time- and cost-intensive replacement with brand new components.

For further information, please contact:
Pallas GmbH & Co. KG
Adenauerstraße 17
D-52146 Würselen
Telefon: +49 (0) 2405/4625-0
Telefax: +49 (0) 2405/4625-111
E-Mail: info@pallaskg.de
www.pallaskg.de

Copyright free. Please send a copy to:
impetus.PR
Ursula Herrling-Tusch
Charlottenburger Allee 27-29
D-52068 Aachen
Telefon: +49 (0) 241/189 25-10
Telefax: +49 (0) 241/189 25-29
E-Mail: herrling-tusch@impetus-pr.de

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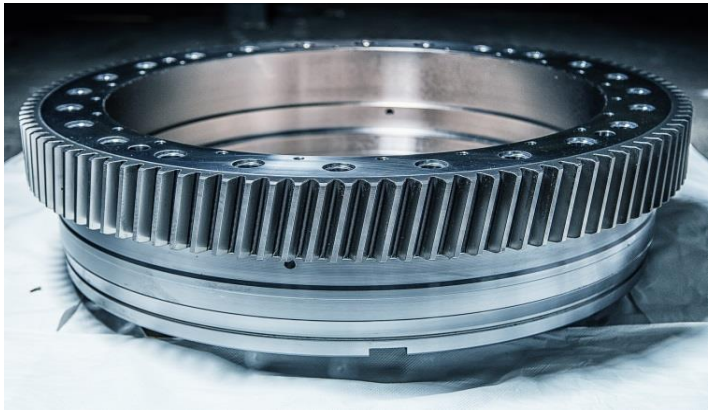
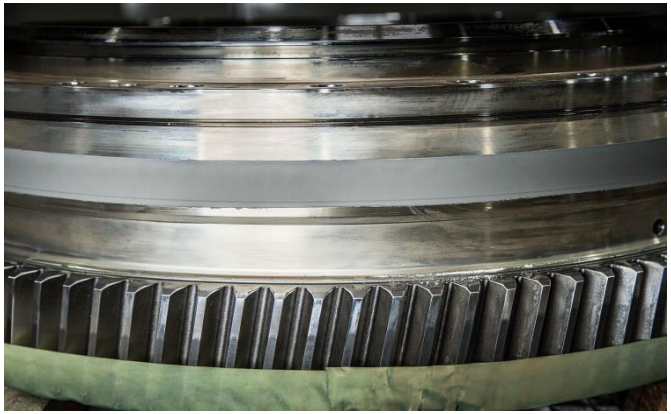
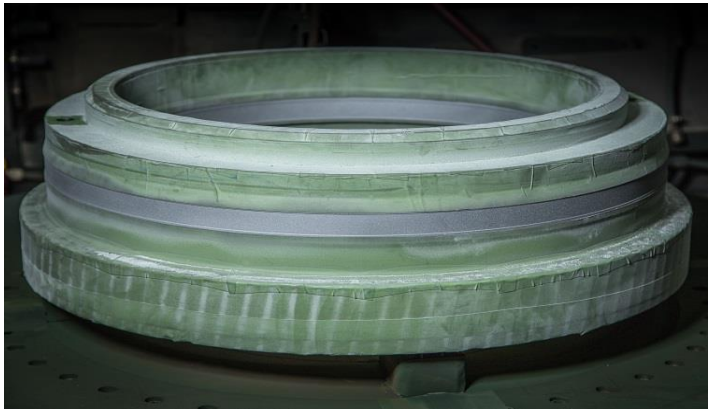


Picture 1: In order to reliably exclude the risk of corrosion and wear, the sealing seats in the wet end of papermaking machines are treated at Pallas with a ceramic coating by means of atmospheric plasma spraying.



Picture 2: In addition to the size of components that can be handled, the extremely limited focus of the energy feed is an argument for choosing plasma spraying for coating heavy-duty sealing seats.



Picture 3: Playing it safe: Because it is not permitted to grind or in any way process the edge zones of the gear – which have been precision ground ready for installation – Pallas masks these areas of the gear with cover strips.

Picture 4: Afterwards, the robot is programmed.

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Agentur für Corporate Communications GmbH

Ursula Herrling-Tusch
Charlottenburger Allee 27-29
D-52068 Aachen
Tel: +49 [0] 241 / 1 89 25 - 10
Fax: +49 [0] 241 / 1 89 25 - 29
E-Mail: herrling-tusch@impetus-pr.de

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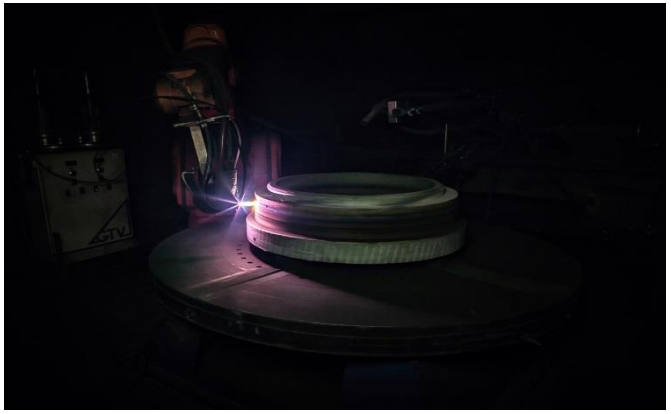

Picture 5-6: A refractory ceramic compound in powder form is injected into a plasma flame burning at a temperature of 18,000°C, where this feedstock melts in microseconds and is propelled by the kinetic energy against the surface of the workpiece.

Picture 7-8: Particles of a refractory ceramic coating – with high dimensional precision and reliable reproducibility – form a dense, highly adhesive layer on the substrate to be coated.

Picture 5-8: © Pallas GmbH & Co. KG

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Agentur für Corporate Communications GmbH

Ursula Herrling-Tusch
Charlottenburger Allee 27-29
D-52068 Aachen
Tel: +49 [0] 241 / 1 89 25 - 10
Fax: +49 [0] 241 / 1 89 25 - 29
E-Mail: herrling-tusch@impetus-pr.de

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Picture 9: Pallas coats both the external and internal seats of the gears in one clamping.

Picture 10: The coating of the large 700 kilogram components must be absolutely pore-free, have a surface roughness of R_a 0.4 µm and, after finishing, be ground perfectly smooth.

Picture 11-12: That's why the sealing seats are internally and externally machined and polished to their final dimensions in the last stage of processing, so that the complete system has the required tightness.

Picture 9-12: © Pallas GmbH & Co. KG

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Ursula Herrling-Tusch
Charlottenburger Allee 27-29
D-52068 Aachen
Tel: +49 [0] 241 / 1 89 25 - 10
Fax: +49 [0] 241 / 1 89 25 - 29
E-Mail: herrling-tusch@impetus-pr.de