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VORTRAGSTITEL

Schlüsselkomponenten für Performance und Effizienz im e-Antriebsstrang

Key components for performance and efficiency in the electrified drivetrain

Abstract

In the long term, the number of drive solutions in the field of electric mobility will decrease compared to combustion engines and hybrids, with the electric axle playing a special role in the integration of functions. Friction systems for torque management to stabilise, agility and emotionalise vehicles will play an important role. New technologies and innovative approaches are needed to meet performance and comfort (noise, vibration, harshness) requirements. The characteristics of the power output of electric motors and the ambient media, which place a large number of new demands on neighbouring components such as the power electronics of pulse inverters and the cooling of winding heads, pose particular challenges for the friction systems in an electric axle. The components of the e-axis also play a key role in increasing efficiency/range. Decoupling units are used to engage or disengage a drive axle or individual wheels. Using new, even more resource-efficient processes, sintering technology offers solutions for high-strength assemblies combined with the lowest possible CO_2 footprint during production.

Kurzfassung

Die Anzahl der Antriebslösungen im Bereich der Elektromobilität wird sich im Vergleich zu Verbrennungsmotoren und Hybriden auf lange Sicht reduzieren, wobei der E-Achse eine besondere Rolle hinsichtlich der Integration von Funktionen zukommt. Reibsysteme für das Drehmomentmanagement zur Stabilisierung, Agilisierung und Emotionalisierung von Fahrzeugen spielen dabei eine wichtige Rolle. Um den Anforderungen an Performance und Komfort (Noise Vibration Harshness) gerecht zu werden, sind neue Technologien und innovative Ansätze notwendig. Die Charakteristik der Leistungsabgabe von Elektromotoren sowie die Umgebungsmedien, die eine Vielzahl bisher neuartiger Anforderungen benachbarter Bauteile, wie etwa die Leistungselektronik von Pulswechselrichtern und die Kühlung von Wickelköpfen, bedienen, stellen besondere Herausforderungen für die Reibsysteme in einer E-Achse dar. Den Komponenten der E-Achse kommt auch bei der Erhöhung der Effizienz/Reichweite eine Schlüsselrolle zu. Hier werden Abkoppeleinheiten genutzt, um eine Antriebsachse oder einzelne Räder zu- bzw. abzuschalten. Mit Hilfe neuer, noch ressourceneffizienterer Verfahren bietet die Sintertechnologie Lösungen für hochfeste Baugruppen in Kombination mit geringstem CO_2-Fußabdruck während der Fertigung.

1. About Miba

Miba AG

Miba AG is an internationally renowned technology company that has grown into a global player since it was founded by Franz Mitterbauer in Austria in 1927. As a family-owned company, Miba can look back on almost 100 years of experience and innovation. The group specialises in the development and production of high-precision, high-performance components for optimising efficiency and reducing emissions in various industries.

Miba operates in several key business areas that are known worldwide for their outstanding technologies: from powder metal components to bearings, friction materials, and coatings, to applications in power electronics and green energy. In the automotive and industrial sectors, Miba has established itself as a reliable partner, offering advanced solutions for increasing efficiency and reducing emissions. Miba is also setting new standards in the fields of electromobility and renewable energies, thus making an active contribution to the global energy revolution.

An important part of the company's strategy is the "local to local" approach, which places production sites and research centers close to customer markets around the world. This not only enables faster and more flexible responses to customer needs, but also helps to reduce CO2 emissions through shorter transport routes.

In line with its corporate mission "Technologies for a cleaner planet", Miba continuously invests in the research and development of innovative products that help protect the environment. With state-of-the-art production technologies and a global network of sites and research centers, Miba is actively shaping the future of sustainable mobility and industry. As a company with a rich tradition, a forward-looking mindset and a commitment to excellence, Miba remains a pioneer in the development of advanced technologies that make our world cleaner and more efficient.

Miba Friction

Miba Friction is an important division within the Miba Group, specialising in the development and production of high-performance friction materials. These materials play a decisive role in improving the performance and reliability of brake and clutch systems in industries such as automotive, industrial and heavy machinery.

Miba Friction has the broadest technology portfolio in the market, offering all technically demanding solutions. This diversity enables tailor-made products for a wide range of applications. The product range includes high-quality brake pads, clutch facings and special friction materials that significantly improve safety, durability and efficiency. These products are designed to deliver consistent performance under extreme conditions, making them essential for demanding applications.

In addition to friction materials, Miba Friction also develops and manufactures counter plates and their surface finishes. With a variety of coatings and surface treatments, Miba Friction offers comprehensive tribological solutions to ensure that all components are perfectly matched for maximum performance and durability.

Miba Friction is characterised by a high degree of vertical integration and extensive process know-how, from the fibre concept to the finished disc. This holistic approach guarantees the optimum quality and performance of each product and enables us to meet specific customer requirements. State-of-the-art testing facilities allow for application-oriented development and thorough testing of products under real-world conditions. This ensures that friction materials meet the highest standards and perform reliably in demanding use cases.

Aligning with the corporate mission "Technologies for a cleaner planet", Miba Friction is continuously investing in the research and development of new friction technologies. Modern manufacturing processes and a global network of production and development sites enable Miba Friction to offer tailor-made solutions for the specific needs of various industries.

With a strong commitment to innovation and quality, Miba Friction holds a leading position in friction technology. The continuous pursuit of optimisation and sustainable practices secures Miba Friction as a reliable partner in developing advanced braking and clutch systems, contributing to a cleaner and safer world.

Miba Sinter

Miba Sinter is the largest division within the Miba Group and specialises in the development and production of high-precision sintered components. These components are critical to improving the performance and efficiency of applications in the automotive and industrial sectors. Miba Sinter combines extensive knowledge and innovation with advanced powder metal technology to deliver top-quality products to customers worldwide.

Miba Sinter's product portfolio includes reliable engine components, transmission parts and other sintered products that help reduce emissions and improve fuel efficiency. Thanks to advanced sintering processes, Miba Sinter can produce parts with complex geometries that offer excellent performance and cost efficiency. Sintered products are characterised by economic manufacturability, high material utilisation, low weight and precise production, making them particularly attractive for the requirements of electromobility.

In line with its corporate mission "Technologies for a cleaner planet", Miba Sinter continuously invests in the research and development of innovative sintering technologies. The division relies on state-of-the-art production technologies and an extensive network of production and development sites around the world. With these advanced approaches, Miba Sinter offers tailor-made solutions for sustainable mobility and industry.

With a strong tradition of excellence and a forward-looking approach, Miba Sinter remains a leading player in sintering technology, driving progress towards a cleaner and more efficient world.

2. Definition of performance and efficiency

In this presentation, performance is understood as the optimal distribution of torque in the drivetrain to enable maximum utilisation of the Kamm's circle. Optimal torque distribution allows maximum traction and contributes significantly to stability and thus to the safety of the vehicle occupants and other road users. The aim of Miba Friction components is to ensure that the transmitted forces remain controllable in different driving situations in order to guarantee a safe driving experience.

High performance also means focusing on the car's agility. This is achieved by making the most of the power available, significantly improving the car's responsiveness and dynamics. The driver benefits from more precise and quicker feedback, making the car more agile and sporty.

Another important aspect of performance is emotionality. The aim is to enable the driver to adjust the driving performance to suit different needs and preferences. This adaptability ensures that the driving experience is personalised and driving pleasure is maximised.

In terms of components, this means that aspects such as power density in terms of package space, weight reduction and optimum and efficient manufacturing processes, coupled with high economic efficiency, are development goals. The advanced friction systems and sintered components provide the necessary safety reserves and help to maximise the transferable torque. This results in greater overall efficiency and significantly improved utilisation of drive power.

Overall, performance at Miba Friction stands for comprehensive driving dynamics that combine stability, efficiency, and driving pleasure, thus contributing to an outstanding driving experience.

In this presentation, efficiency will be understood in terms of two main areas:

On the one hand, efficiency refers to the use of disconnect systems in electric vehicles to reduce energy consumption. These systems disconnect the drivetrain elements when torque transfer is not required, thereby helping to increase range and optimise vehicle performance. By using energy only when it is actually needed, the use of resources is maximised.

On the other hand, efficiency also includes the production of these components. Here, efficiency is demonstrated by Miba's use of the best possible manufacturing processes. Powder metallurgy (PM) makes it possible to produce high-strength parts with lower energy consumption and a smaller CO_2 footprint. Innovative technologies, such as die-wall lubrication, increase material efficiency by achieving higher strength and longer part life while reducing the number of processing steps required. This reduces both production costs and environmental impact.

In summary, efficiency in the presentation should be understood as the intelligent use of energy-saving technologies in vehicles and the optimised, sustainable production of these technologies.

3. Performance Applications for friction systems

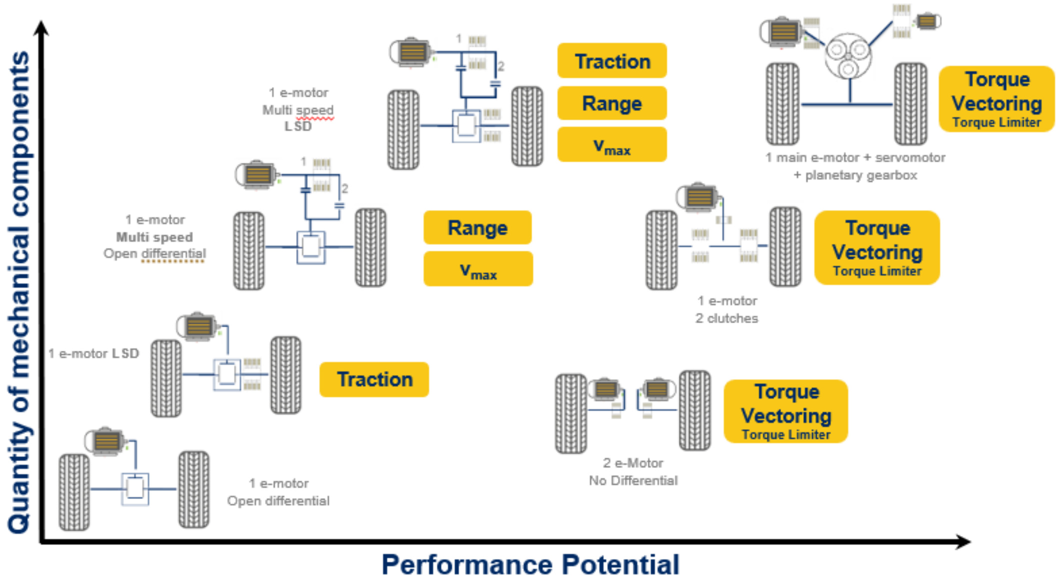

Figure 1: Applications for friction elements to increase performance

As the weight of electric vehicles increases, so does the demand for driving dynamics that were previously only possible with internal combustion engines. The main influencing factor is the weight of the vehicles. To achieve this performance, the number of components used and their requirements increase significantly. (Figure 1)
Electric powertrains require precise tuning of the powertrain components to ensure the desired driving dynamics and safety. This includes the optimisation of torque distribution, traction control and the integration of multi-speed transmissions in super sports cars. The development of tailor-made friction materials and advanced technological solutions plays a key role in meeting the high demands for performance and reliability. By increasing power density and improving friction properties, electric vehicles can be made not only more efficient, but also more dynamic and safer. The continuous development and adaptation of these systems is essential to meet the increasing performance expectations of electric vehicles.

4. Challenges for eFluids

The development of e-fluids for advanced e-axis architectures presents many challenges, as these speciality fluids must offer both improved thermal and dielectric properties. These properties are essential for cooling and lubricating the electric motors and power electronics. The often used parallel axis arrangement of the drive machine reduces the load on the gearwheels, which in turn reduces the demands on the lubricants.

Modern eFluids should have a low viscosity in order to guarantee efficient energy transfer. At the same time, they improve heat dissipation and contribute to the thermal stability of the systems. Special attention is paid to environmental compatibility during development, with biodegradable or more environmentally friendly fluids being favoured.

There are also considerable opportunities in the field of friction system additives. Specific properties such as wear protection, friction reduction and ageing resistance can be improved by optimising the additives in the eFluids. This leads to increased efficiency and service life of the friction systems and enables tailor-made solutions for various applications.

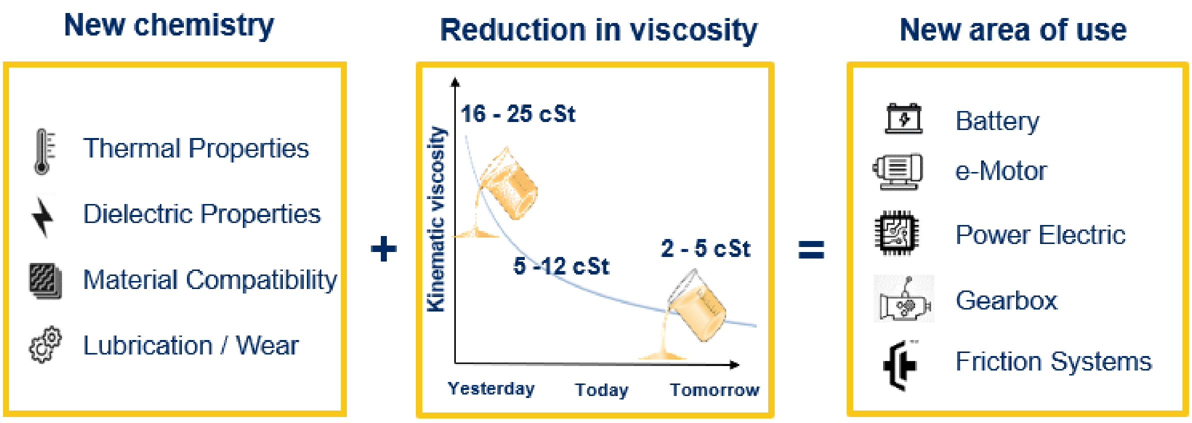

Figure 2: Challenges for eFluids

5. Development possibilities of friction systems

In order to best meet the new operating conditions and special requirements of the operating, two main areas of development can be defined to ensure that the requirements of the friction system are met.

Friction lining requirements

The mechanical requirements for friction materials are varied and complex:

- Mechanical load: the material must be able to withstand high absolute pressures under a variety of dynamic and pulsating loads.
- Wear resistance: High resistance to mechanical abrasion is essential for consistent performance over a long period of time.
- Rigidity: The elasticity of the material should enable excellent control quality with minimum lining thickness so that the overall system remains compact and lightweight.
- High thermal resistance: The material must be able to withstand high temperatures without losing its mechanical properties.
- Oil compatibility: The material must be compatible with the lubricants used in order to avoid chemical reactions that could affect the material or the lubricant.

Counter disc requirements

- The counter disc plays a decisive role in the friction system:
- Wear resistance: It must be particularly wear-resistant, which is achieved through special surface treatments to ensure constant physical and chemical properties over the entire service life.
- Dimensional accuracy and shape tolerances: Precise dimensional accuracy and low shape tolerances in terms of flatness are required to ensure stable and uniform force transmission.
- Thermal function: As the counter blade acts as a thermal accumulator, it must be able to efficiently absorb and dissipate localised thermal peaks.
- Resource-saving handling and CO2 footprint: Sustainable materials and optimised manufacturing processes are crucial to minimise resource consumption and significantly reduce CO2 emissions.

Requirements for the entire friction system:

The requirements for the entire friction system include both the properties of the individual components and the interaction between these components:

- Coefficient of Friction and Gradient: The level and type of friction coefficient and a positive friction coefficient gradient over the service life minimise frictional vibration and ensure consistent performance.
- Friction material thickness: The thinnest friction material thicknesses are required to optimise power density in relation to installation space requirements.
- Thermal load capacity: High thermal load capacity of the entire system s required to achieve the required power density.

These demanding development priorities require a high degree of vertical integration and extensive process expertise. This includes the in-depth analysis and design of individual fibre materials in order to provide tailor-made solutions that meet both the high demands of the friction system and the sustainability targets.

6. Example: Impact on a electrical limited slip differential

To illustrate the impact of these developments, the design of an electronic limited-slip differential is described in detail.

By precisely adapting the lining composition and its formulation in coordination with the oil chemistry, coupled with targeted modifications to the chemical reactivity of the mating discs, the design-critical coefficient of friction was significantly increased. In this particular case, this resulted in a 50% increase in the coefficient of friction, which has a strong direct impact on the torque capacity.

This increase in torque capacity with the same axial force results in a 50% improvement in the performance of the transverse lock. This offers several potential advantages:

- Reduction in axial force: Due to the increased torque capacity, the axial force required can be reduced by the same factor. This results in a significant reduction in the load on the actuator mechanism. The lower mechanical requirements are reflected in reduced wear and longer component service life. here are also significant economic benefits, as less robust and therefore less expensive actuator modules can be used.
- Optimisation of the installation space: Keeping the axial force at the original level, the increased torque capacity allows a significant reduction in the installation space - at least 33%. This space saving opens up new design possibilities and can contribute to integration in more compact assemblies.
- Thermal load capacity: The improved thermal load capacity of both the friction material and the mating disc makes it possible to further reduce the thickness of the mating disc. This optimisation has the added benefit of reducing the amount of material used, which not only saves costs but also helps to reduce the carbon footprint.
- Improved efficiency: The reduction in axial force also reduces the energy consumption of the entire system. This is particularly important in applications where efficiency and energy savings are critical factors.
- Improved driving comfort and safety: In the automotive sector, a more efficient and compact electronic differential lock can increase driving comfort and improve safety through more precise control of driving dynamics.

In summary, these advanced developments not only improve technical performance, but also bring significant practical and economic benefits.

7. Disconnect – Torque Limiter Clutch

The technological advances achieved can also be utilised very effectively in other areas. A separable multi-plate clutch, which slips in the event of overload and enables a disconnect function, offers significant advantages here.

Features of a separable multi-plate clutch in the electrified powertrain

- Overload protection due to slipping
  - The multi-plate clutch protects against mechanical overload by slipping when a certain torque is reached. This feature protects critical components such as the engine and gearbox from damage without completely disconnecting the drivetrain.
- Disconnect function
  - If required, the multi-plate clutch can be fully opened to disconnect the powertrain. This allows flexible adaptation to different driving modes, such as switching between pure electric and hybrid modes.
- Synchronisation
  - After a disconnection, the clutch can be seamlessly re-engaged to resume normal powertrain operation.
  - Benefits in the electrified automotive powertrain
- Increased protection and durability
  - By slipping in the event of an overload, the multi-plate clutch protects key components from damaging overloads and increases their service life.

- Efficiency in driving operation
    - Disconnecting the powertrain when required allows the most efficient operating mode can be selected, maximising energy efficiency and optimising vehicle performance.
- Reduced energy consumption
    - The disconnect function makes it possible to completely decouple the e-axle in the configuration of a hybrid drivetrain during pure combustion engine operation, thereby reducing mechanical losses and lowering energy consumption.
- Increased driving safety and comfort
    - Automatic clutch slipping prevents abrupt changes in the powertrain, resulting in a smoother ride and increased safety.
- Cost savings and ease of maintenance
    - Overload protection minimises damage and wear, reducing maintenance and repair costs.

In summary, a separable multi-plate clutch in the electrified automotive powertrain offers an excellent combination of protection, flexibility and efficiency.

8. Drag Torque investigations of a disconnect clutch

Drag torque is the unwanted resistance that occurs when lubricating fluid remains between moving components in a mechanical system, creating a viscous coupling. This additional friction can reduce the efficiency of the system by impeding the free movement of the components and requiring additional energy input.

Drag torques pose a major challenge for wet multi-plate clutches, especially in disconnect mode. In this mode, the clutches are designed to disconnect the mechanical connection in order to switch off the drivetrain and thus saving energy and increasing efficiency.
Miba Friction has carried out extensive tests on specially developed drag torque test rigs. These have shown that the effective groove design of the friction lining segments in combination with separating springs means that the existing oil is ejected very quickly and the drag torque is reduced immediately as a result. This proves that the design of the clutch components has an important influence on the behaviour in disconnect mode.

Special grooves in the friction lining and the use of separating springs enable the lubricant to be removed efficiently and quickly. This minimises the unwanted viscous coupling between the discs. This technology allows faster and more effective separation of the discs and contributes to a reduction in drag torque, increasing the efficiency of the powertrain.
In addition, the logic is that oil only enters the clutch when it is needed. Precise control of the fluid supply ensures that the lubricant is only present when the clutch is actually engaged and that there are no unnecessary losses due to viscous coupling during disengagement. This further improves energy efficiency and minimizes fuel consumption. Figure 3 shows a WLTP cycle of a wet multi-plate clutch with different groove designs and a air gap between the friction and the counter disc of 1 ‰ of the diameter of the friction partner in mm. The clutch, shown as an example, can transmit up to 4000 Nm in the closed arrangement.

In summary, Miba Friction's research shows that the combination of an efficient groove design, the use of release springs and a demand-driven fluid supply can significantly reduce the drag torque. This leads to a significant improvement in the efficiency and performance of wet multi-plate clutches in disconnect mode.

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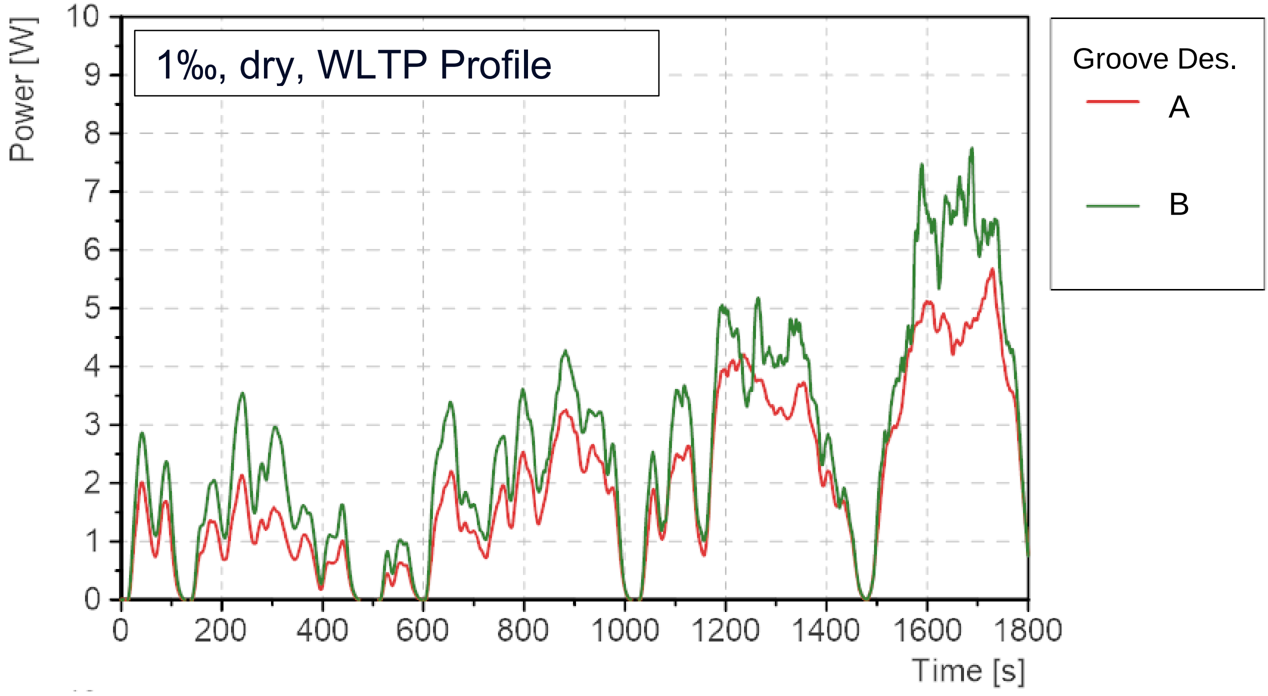


Figure 3: WLTP Power Loss for 2 Groove Designs

9. High-Strength Sinter Parts for Decoupling units in e-Axles

Powder metal technology is well known for products used in the automotive industry. With the shift to electric powertrains, key requirements such as component strength had to be adapted. This has been successfully achieved by developing and implementing new innovative processes to withstand the loads required in electric axles. Powder metal parts such as planetary gears or disconnect systems can even combine these properties with a significantly lower product carbon footprint compared to conventional steel.

The disconnect system

The primary function of an e-axle disconnecting system is to improve the efficiency and performance of battery electric vehicles by automatically decoupling the transmission shaft from the wheels when no power is required from the electric motor. As soon as power is required, the connection is closed again. Various concepts for disconnect units are available on the market, utilizing shifting components such as dog clutches or sliding sleeves to achieve the mechanical disconnecting function.

Figure 4: Examples of Shifting elements for Disconnecting systems in BEVs

The key functions of a disconnecting system are:

- Energy Efficiency: By disconnecting the e-axle when it is not needed (e.g., during highway cruising when only one axle is sufficient), the system reduces power consumption, which in turn can extend the vehicle's range.
- Performance Optimisation: It allows the vehicle to perform optimally by engaging or disengaging the e-axle according to driving conditions, ensuring that the required power available when needed.
- Component Wear Reduction: Disconnecting the e-axle when not in use can reduce wear and tear on the drivetrain components, resulting in longer component life and lower maintenance costs.
- Driving Dynamics: Improves driving dynamics by providing better traction and stability control. For example, it can disconnect at high speeds to improve fuel efficiency and re-engage at low speeds or off-road conditions to improve traction.
- Temperature Management: Helps manage the thermal load on the powertrain by disconnecting during periods when high performance is not required, preventing overheating and improving component life.

10. The Powder Metal Process Route – High strength and Energy efficient

The powder metallurgy process is known for its ability to efficiently produce high volume parts with comparatively low energy consumption. The following chart (Fig.2) gives an overview of all possible process steps. Low loaded parts can have a process route that ends directly after sintering, whereas highly loaded parts such as disconnect sleeves require additional operations like sizing or heat treatment.

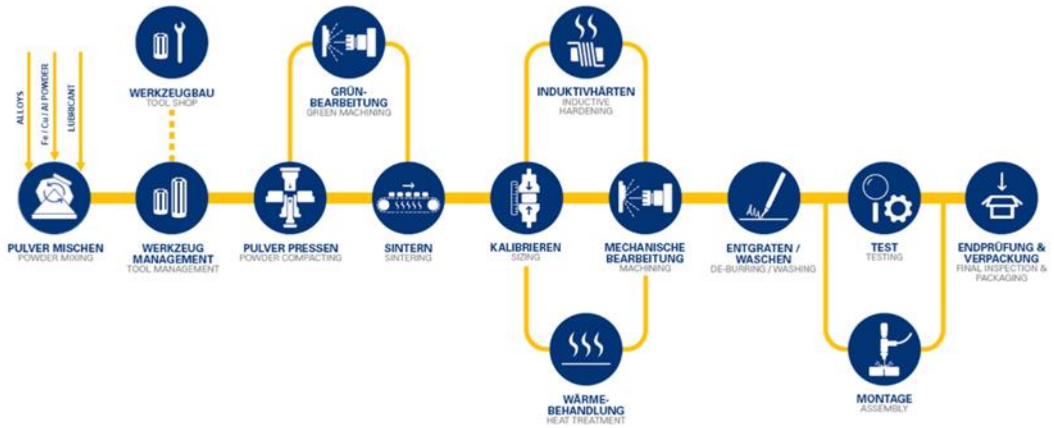


Figure 5: The Powder Metal Process Overview

High Strength Process Innovation

Powder metal products such as mass balancer or crankshaft gears are known for their high strength, low weight and additional benefit in NVH performance [1,2]. This is achieved by combining a standard part density in the core area (~7,0g/cm³), with a near full density area where the gears are loaded (left, Fig.3). The high-density area can be achieved by rolling or sizing the sintered part. For even higher loaded components such as disconnect systems, the density in the core area of the part needs to be further increased (right, Fig. 6).

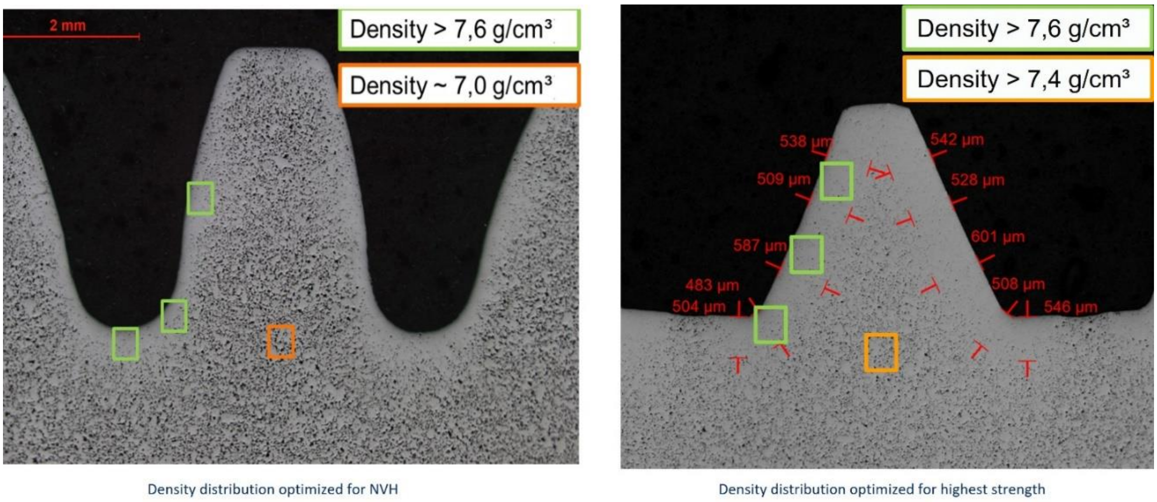


Figure 6: PM microstructure optimized for NVH (left) and high strength (right)

This requires two sizing operations: one to achieve a homogeneous core density of >7,4g/cm³ for the core area and a subsequent one for the highly loaded areas with almost full density. To avoid an additional sizing operation and thus save energy (and also cost), a new compacting technology was developed in a research project – "Die-Wall-Lubrication" (DWL).

In general, organic lubricants (e.g. amide waxes, ~0,8 w%) must be added to powder mixes to ensure lubrication between the compacted part, the die-wall and the core rod during ejection of the part. The disadvantage of adding any organic compound is that it also acquires “space” during compaction and thus works against achieving the highest densities – this makes press densities of >7,3g/cm³ infeasible for series production. With the new DWL-concept, the organic content in the mix can be reduced to levels >0,2 w%. Instead of adding to the powder mix, an oil film is applied directly to the pressing tool (see Fig. 7) and densities of ~7,4 g/cm³ can be reached directly after compacting.

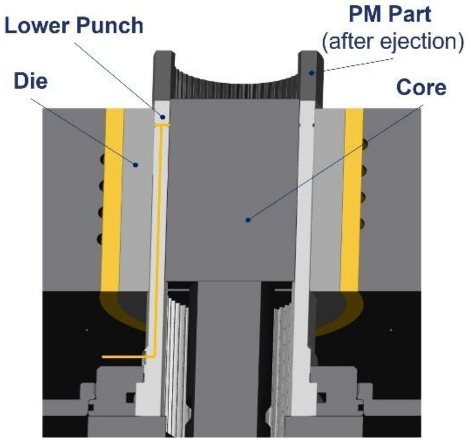


Figure 7: Tooling concept with additional lubrication of the tooling elements

The increase in strength as a function of the core density of a sintered part is shown in the graph below. The tooth root strength of sintered gears has been tested for different core densities. It can be seen, that the achievable tooth root strength is strongly influenced by the core density and can reach values of >900MPa (see Fig.8). An optimised heat treatment (dark blue line in Fig.) can further increase the achievable tooth root strength of the sintered gears compared to a standard heat treatment (light blue line in Fig.) by ~200MPa (+30%).

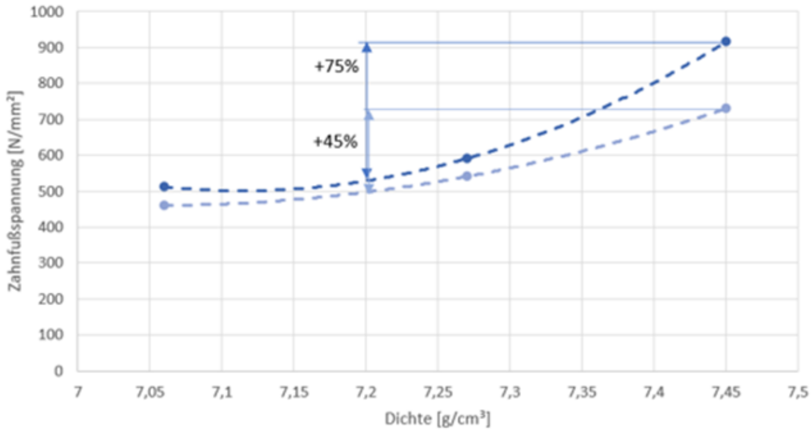


Figure 8: Obtained tooth root strength on PM gears as a function of core density

Rolling of Inner Splines

A special feature added for highly loaded disconnect components is to generate the geometric design of the coupling teeth without mechanical processing. Therefor a customised and cost-effective cold rolling process was developed. Through this rolling process, the back taper in the internal toothing of sliding sleeves, that cannot be produced by an axial compacting process and ensures the retention of the form-lock in the closed state of the disconnect system for force transmission, is formed. In Fig. 9, a cross-sectional view of the back taper area produced by the rolling process after sintering of the components is shown.

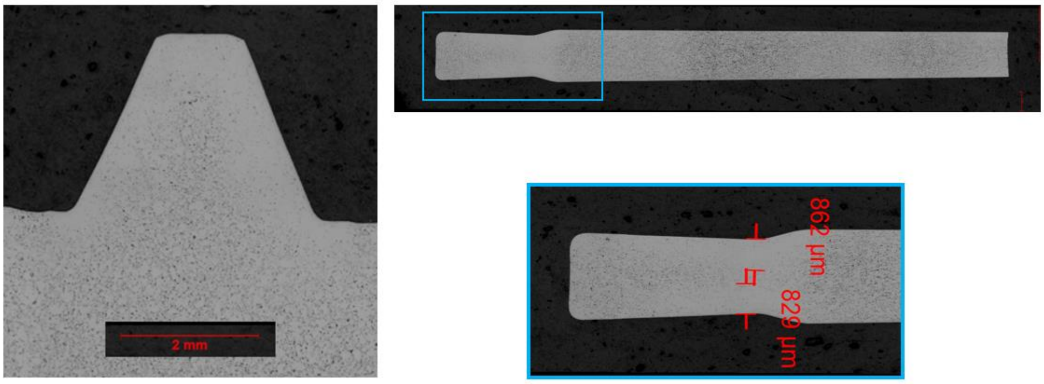


Figure 9: Cross section densified area in tooth areas of sliding sleeves for Disconnect systems

The areas of material densification generated by rolling and the resulting reduction in porosity are clearly visible. The density in the densified area is close to 7,8 g/cm³, which allows mechanical properties similar to steel after heat treatment of the component. Another advantage of this process compared to mechanical processing is the associated strength-increasing transition radii that are inherent to this process. This enables the reduction of stress peaks in the application and providing robust solutions in PM.

Energy efficient PM Route

The PM manufacturing process developed for disconnect systems is very short compared to the conventional steel route. This is underlined by the results of a joint project with iron and steel powder supplier Höganas AB. Using the LCA software SPHERA, the PCF (Product Carbon Footprint) of a powder metal disconnect sleeve was compared with the same part produced using a conventional steel process route (Fig. 10).

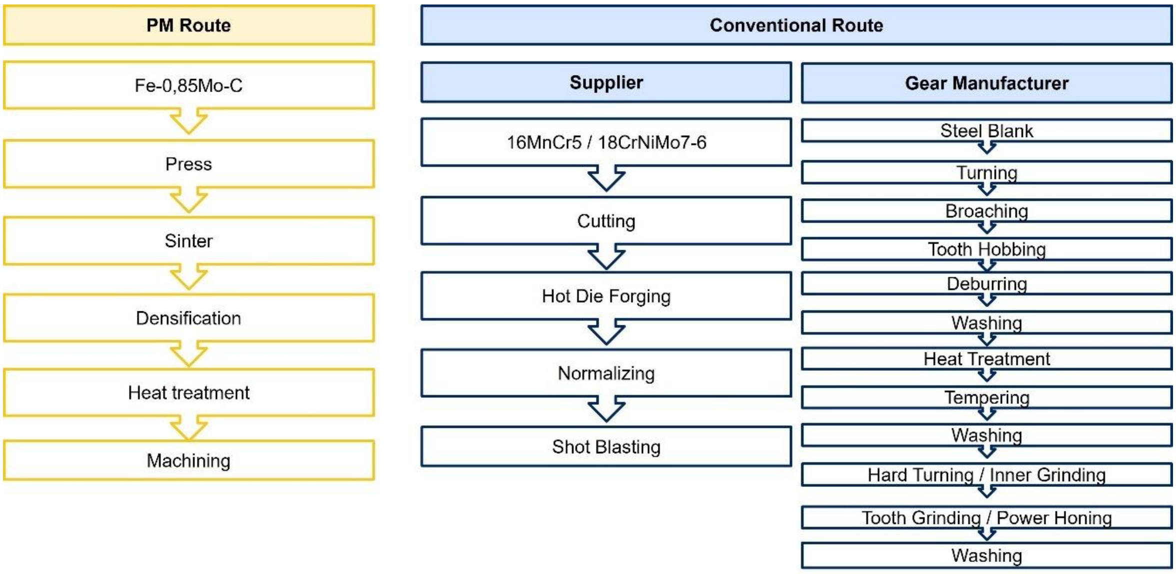
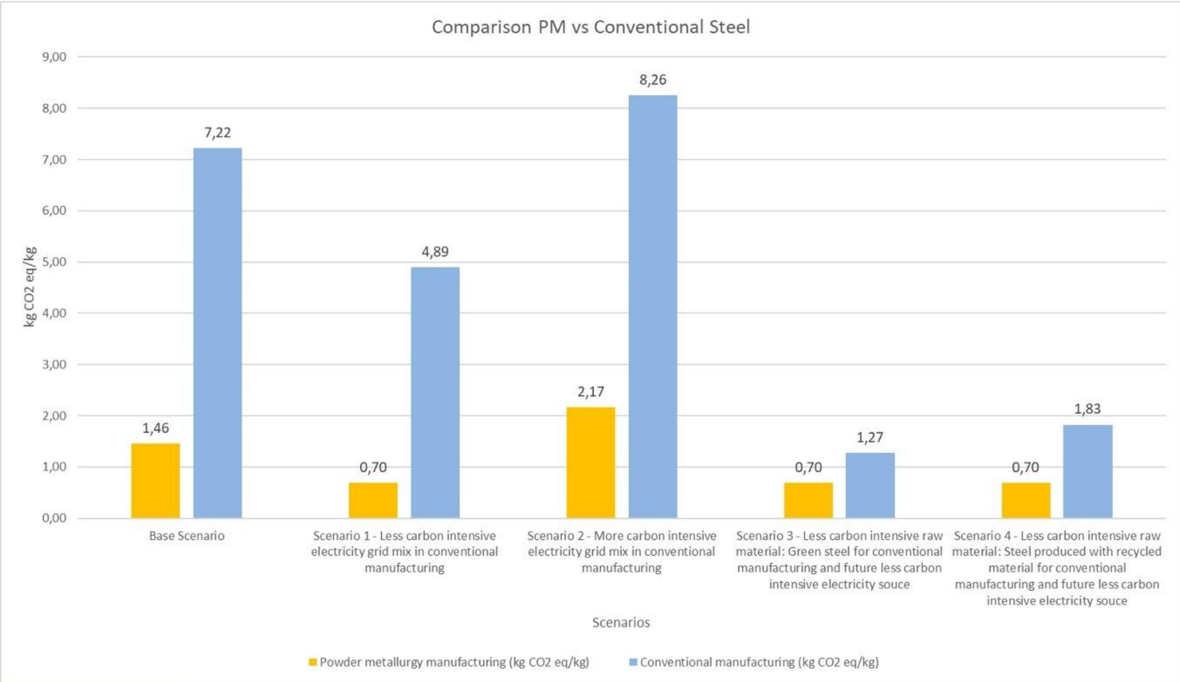


Figure 10: PM and conventional steel process route for a Disconnect sleeve

The results of the PCF calculations given in Fig.11 were obtained by using the following assumptions:

- Steel powder mix PCF of 0,48 kg CO_2e per kg material was calculated according to ISO 14067:2018
- Conventional steel (base scenario) for European primary steel of about 1,9 kg CO_2e per kg material
- Conventional steel (scenario 3 and 4): 0,3 kgCO2/kg to represent green steel and 0,55 kgCO_2/kg represent steel made of recycled material
- Simplifications for PCF on part level: consider are electricity and scrap for the processing steps of both powder metallurgy and conventional routes
- Electricity mix: For the 5 scenarios, different grid mixes were considered to cover the effect of renewable energy impact

It can be seen, that for all scenarios – even using green steel or steel made only from recycled material for the conventional route - the PM route has a significantly lower product carbon footprint. For both manufacturing routes around a third of the contribution is due to the raw material impact, giving PM a big advantage for base scenario as well as scenario 1+2. But even if only recycled steel or green steel is considered as a raw material source for the conventional route, PM still has an advantage due to the comparatively short process route.



Grid mix PM Steel	Energy	Process
Base Scenario	Electrical Energy	Austrian average electricity grid
Scenario 1	Electrical Energy	Swedish average electricity grid
Scenario 2	Electrical Energy	German average electricity grid
Scenario 3	Electrical Energy	Austrian average electricity grid
Scenario 4	Electrical Energy	Austrian average electricity grid

Grid mix Conv. Steel	Energy	Process
Base Scenario	Electrical Energy	European average electricity grid
Scenario 1	Electrical Energy	Swedish average electricity grid
Scenario 2	Electrical Energy	German average electricity grid
Scenario 3	Electrical Energy	Swedish average electricity grid
Scenario 4	Electrical Energy	Swedish average electricity grid

Figure 11: PCF of PM route compared to conventional steel incl. different used energy mixes

Summary

Friction systems for torque distribution in axles have proven themselves millions of times over in performance-oriented combustion engine drivetrains. In electromobility, characterized by increased demands for stability, dynamics, and efficiency along with high cost sensitivity, the enormous potential of these systems becomes apparent. This potential can be fully realized through targeted development of friction partners for multifunctional fluids, maximum vertical integration in manufacturing, adherence to the highest quality standards, and sustainable production processes.

Powder metal components can make a significant contribution to the transition to electric powertrains. The PM process has developed new process routes such as Die-Wall-Lubrication and Rolling of Inner splines to meet the higher demands of e-Axles. The strength levels of conventional steel can be matched and combined with the added benefit of a low carbon manufacturing route. This further supports end customers in their efforts to meet their sustainability goals.

Acknowledgement

Parts of the results presented in this paper were obtained in the framework of the research project “EUSp - Energieeffizienter und umweltfreundlicher Sinterprozess” (Grant No. FO999889415, eCall 40001901). The authors would like to thank the Austrian Research

Promotion Agency for funding this project. The authors also acknowledge all employees involved in the project at Miba.

[1] „Pulvermetallurgische Verbundzahnräder zur Optimierung von NVH Eigenschaften moderner Verbrennungskraftmaschinen in PKW Anwendungen“, A. Müller et al, 38. Internationales Wiener Motorensymposium 2017
[2] „Pulvermetallurgische Zahnradsysteme zur Optimierung von NVH-Eigenschaften in Verbrennungsmotoren“, R. Hellein, S. Zerobin, A. Müller, Hagener Symposium für Pulvermetallurgie 2019