Deep rolling and finishing machine
Typ 7624/7624 H

HEGENSCHEIDT MFD

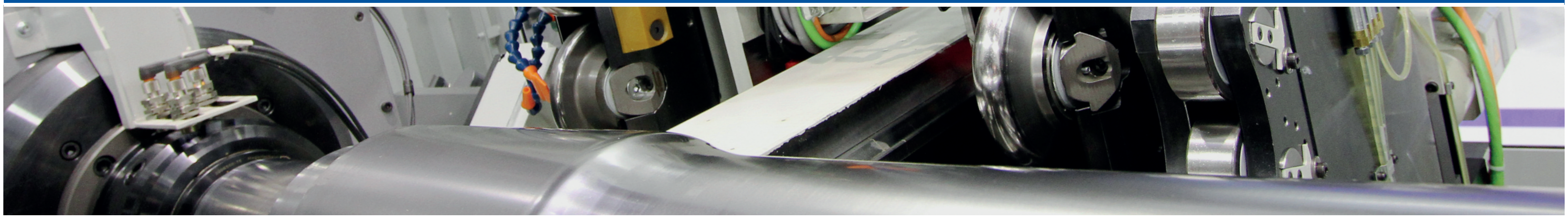
for machining wheelset axles and shafts

The operational strength of wheelset shafts is critical for safety. However, technical suitable measures for improving them must also be economically feasible.

One highly effective method for improving operational strength is by deep rolling - a method that has been used very successfully for many years in the automotive and aerospace industries. Deep rolling can provide favourable material and component states. Through deep rolling, suitable rolling elements are guided over the component surface under pressure:

- Depending on the contact ratios, the surface is smoothened (small notches are levelled out).
- The plasticity deformed volume of the material is strengthened.
- Any damaging internal stresses present in the surface layer of the workpiece due to pre-machining are eliminated.
- The combination of elastic and plastic deformation during rolling imposes highly favourable residual stress behaviour in relation to stability. After rolling, useful residual compressive stress is present in the outer surface layer.
- The deep rolled wheelset shafts resist numerous stresses acting on them much better than unrolled shafts.
- The tensile stress present due to purely mechanical bending stress are reduced in the surface layer. In combination with the increased material strength and the elimination of machining notches, the service life is increased considerably. The formation and progression of cracks are therefore hindered.
- In small notches between the wheel and bearing seats, the effect of the residual compressive stress is extremely favourable, as is well known from crankshaft applications.
- Residual compressive stress and material hardening make the deep rolled wheelset shaft significantly more robust and able to withstand handling errors and impacts (FOD).
- Although corrosion cannot be prevented by rolling, the residual compressive stress prevents cracks from spreading as a result of corrosion; the cracks are "held together".
- The same mechanism also has an effect while fretting the edges of pressed connections. Relative movements in the micro range and their direct consequences cannot be eliminated, but the cracks caused by these can be reliably prevented from growing.

An increase in strength resulting from deep rolling was proven again in recent dynamic tests. The positive results confirm the relationship identified in the past that led to the deep rolling of wheelset shafts being prescribed in the GOST (Russian technical standard). Suitable tried and tested deep rolling specifications have been drawn up, the implementation of which increases the service strength of wheelset shafts.



Information on Workpiece Machining

Workpiece data

Characteristic [1)]	Value
Axle length, max.	2800 mm
Axle diameter Minimum fixed and finishing rolling Maximum fixed and finishing rolling Maximum interfering contour	 100 mm 250 mm 350 mm
Workpiece material	Steel
Prick punch point angles	75°; 60°; 90° or according to customer requirements
Front-side positive drive element	Groove or drill hole

Accuracies of the Workpiece

Manufacturing tolerances [1)]	before rolling	after rolling
Usual surface quality: Axle zone 1 (bearing area) Axle zone 2 (pre-bearing area) Axle zone 3 (wheel seat area) Axle zone 4 (intermediate area)	 Rz *40 µm Rz *40 µm Rz *20 µm Rz *40 µm	 Ra *1.25 µm Ra *1.25 µm Ra *1.25 µm Ra *2.50 µm
Radial runout from the centring to the adjacent bearing diameter	*0.2	*0.2
Residual compressive stresses at depths of up to		5.0 mm [2)]
Increase in strength on the surface up to		25% [2)]
Penetration depth		5 -8 mm [2)]

[1)] Values in mm, shape and position tolerances according to DIN EN ISO 1101
[2)] Depending on the material, design of the axle and deep rolling parameters.

The purely mechanical surface treatment is a

- very effective,
- environmentally friendly and
- resource efficient method.

Research is currently being carried out regarding the positive influence deep rolling has on delaying crack initiation and crack progression, using the latest methods and approaches. The goal is to clarify the interrelationships and determine the optimal rolling parameters.

The amount of energy used is negligible. No additional materials are required from the local non-cutting machining of wheelset axles or shafts. The process is carried out at room temperature. The cycle time is limited to a few minutes. The relationship between cost and benefit is therefore extremely favourable.

Hegenscheidt-MFD has developed an automatic, CNC-driven deep rolling and finishing machine for railway axles and shafts based on a proven machine concept. The machine features the latest machine tool technology and is fitted with two separate tool posts, each of which carry three pairs of deep rollers that are able to perform various rolling tasks. For maximum machining capacity, the two tool posts can be operated simultaneously with two roller pairs on each, so that the entire surface of the wheelset shafts can be rolled. Since the machine is designed for both the high-feed and plunge cut methods and is equipped with swivel axes normal to the rotation axis, all standard wheelset shaft geometries can be deep rolled and/or finished.

Applying the surface roller holds a high potential for increasing the service life and operational strength of wheelset axles and shafts. The already very cost-effective method can be seen extremely well through Hegenscheidt-MFD's new deep rolling and finishing 7624 machine.