Briquetting with Roller Presses

Specialists in Hot and Cold Briquetting

Köppern

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Köppern – Specialists in engineering, manufacturing and technical services for briquetting with roller presses worldwide.

Specialists in Briquetting with Roller Presses

Founded in 1898 in Hattingen, Germany, Köppern remains a family-run enterprise reflecting its traditional values of technology leadership and highly dependable manufacturing quality, coupled with a unique regard for the individual needs of its customers. Köppern's worldwide network of subsidiaries provides customized services on all continents. With the sale of our first roller press in 1901 for the briquetting of coal, Köppern can look back on a long tradition of technological development for the briquetting industry.

The roller press is a well-established piece of equipment for agglomeration in large quantities. The working principle is simple: raw materials are fed between two counter-rotating rollers, which are furnished with synchronized moulds that define the product shape. The material to be briquetted is introduced into the nip between the two rollers by means of a feeder system. On passing through the roller gap, the material is compacted and formed into briquettes of uniform size and shape, enabling its inherent resources to be utilized in subsequent production cycles.

The design of our machinery and equipment is highly flexible and can be tailored to customers' specific requirements. Our range of services in this segment is supplemented by specially developed, comprehensive testing programs. For this purpose, Köppern maintains and operates an industrial-scale pilot plant fitted out with the equipment needed to design the machines and systems.

Köppern roller presses are designed for heavy duty applications and for easy maintenance, and are in operation throughout the world in the toughest conditions. To cope with the most demanding feed materials, we offer a large variety of pressing tools ranging from standard tool steel via hard castings to our RESIDUR® powder-metallurgical solution.

We differentiate between three different process routes:

Cold briquetting without binder

The feed material possesses inherent binding properties and can be briquetted directly. Typical applications are burnt lime CaO, caustic magnesia MgO, sodium cyanide NaCN and polymers.

Cold briquetting with binder

The feed material does not possess inherent binding properties and a binder, or a combination of binders, needs to be added to provide the necessary product properties. Typical applications are chrome ore, sponge iron fines, steel mill residues and raw materials for direct reduction.

Hot briquetting

Here the binding properties of the feed materials are activated at elevated temperatures. To cope with temperatures of up to 750 °C, roller presses can be furnished with water cooling and inertization. Highly temperature-resistant steel is used in their construction, whereby thermal expansion is taken into consideration. Typical applications are hot briquetting of DRI, converter dust and Waelz oxide.

If you feel that this can be of interest to your company, we would invite you to read on in order to gain more insight into our specialist roller press and briquetting technology.

The Köppern Chronicle – Focusing on Briquetting

1898
Wilhelm Köppern acquires the "Berninghaus-Hütte" in Hattingen, Germany

1901
First roller press for briquetting of coal

1903
First coal briquetting plant (85,000 t/year)

1934
Introduction of double shaft drive

1938
Briquetting plant for zinc oxide

1973
Introduction of hinged frame design, over 350 roller presses supplied to date

1974
First plant for hot briquetting of direct reduced iron (HBI)

1993
Introduction of simplified standard frame, over 520 roller presses supplied to date

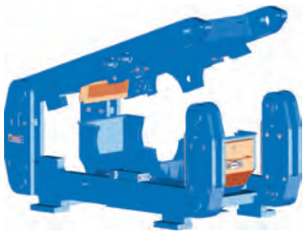
2006
Introduction of C-Frame design

2012
Introduction of Multi-Hinged Frame

up to 2016
So far more than 700 briquetting roller presses supplied to more than 240 customers in 55 countries – 566 roller presses for cold briquetting and 139 for hot briquetting applications

Design Features

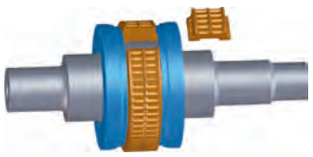
Hinged press frame

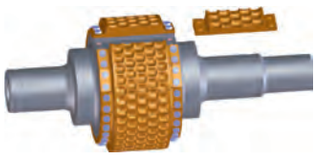


Standard press frame

Roller shaft including bearing

Modular Construction for Customized Flexibility





Pressing tools

Briquetting with roller presses follows a simple principle: a fine raw material is fed into the space between two counter-rotating rollers, where it is then compressed and formed into briquettes. The main functional assemblies provided for this purpose are:

- press frame
- pressing rollers with bearings and bearing housings
- main drive with reduction gear
- material feeder
- hydraulic pressurizing system
- grease lubrication
- roller housing

The press frame accommodates the fixed roller and a floating roller as well as the hydraulic pressurizing system and the roller housing. In contrast to our standard frame, the hinged frame design allows a roller set to be exchanged by removing and replacing the rollers via the frame ends. Thus, a roller set can be changed in a short time without dismantling any of the upper parts of the machine.

The fixed roller is supported directly in the press frame, while the so-called floating roller is supported in the frame by a hydro-pneumatic spring. The movement of the floating roller constitutes the basic principle of a roller press. The rollers are driven by an electric motor in combination with a double-shaft gear box and tooth couplings. This system synchronizes the rollers and allows for the movement of the floating roller.

Controlling the material feed into the roller nip is of paramount importance, whereby a gravity feeder can be used for materials with sufficient flow properties. To adjust the flow, a tongue is provided that can be varied in length and angle. Other materials may require a screw feeder that forces the material into the nip between the rollers.

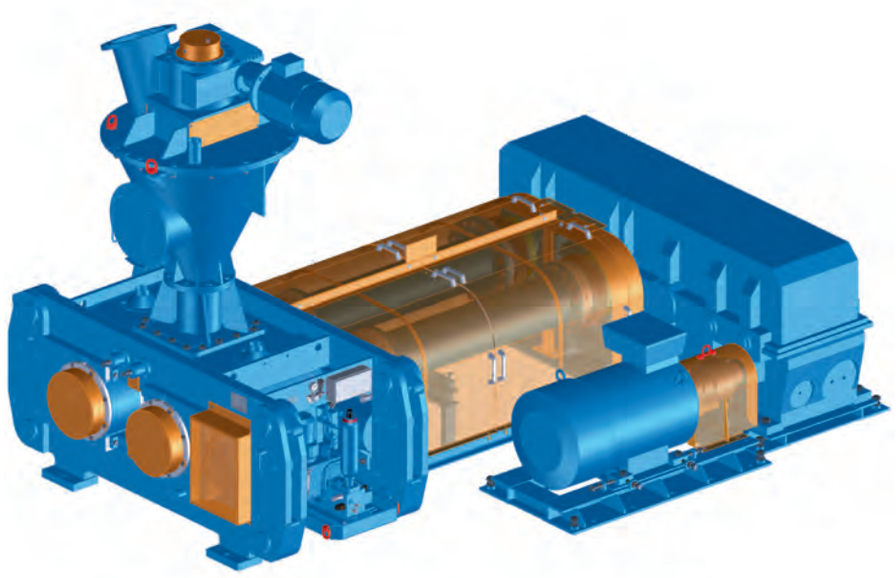
The pressing tools are designed as press rings, or bolted or clamped segments, and are fitted with pockets of the desired size and shape. Köppern pressing tools are sturdy and wear-resistant, thus ensuring maximum service life and minimum expense. Refurbished pressing tools with a smaller than nominal diameter can also be used.

A roller housing is provided for safety reasons and to minimize dust emission.

Factors determining the selection of machine type are:

» required application
» attainable peripheral speed
» specific pressing force requirements
» product shape and size
» design of pressing tools and material feeders

Press types	40	52	60	72	92	500	630
Max. press force	1,430 kN	2,330 kN	2,910 kN	4,970 kN	7,350 kN	8,700 kN	12,950 kN



Main drive with reduction gear

Screw feeder

Gravity feeder

Hydraulic pressurizing system

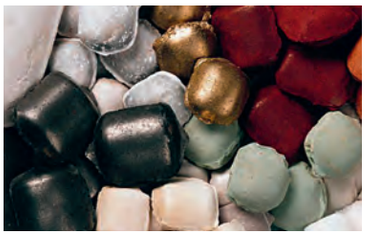
Grease lubrication

Roller housing

Process Technology

Briquetting without Binder – typical raw materials

- Aluminum
- Bentonite
- Burnt lime CaO
- Caustic dolomite
- Caustic magnesia MgO
- Clay
- Dimethylterephthalate DMT
- Flue dust
- Fluorspar
- Gypsum
- Lateritic iron ore
- Lignite
- Maleic anhydride MA
- Salt NaCl
- Sewage sludge
- Sodium cyanide NaCN
- Wood chips



Briquetting without Binder

A number of substances can be converted into product of adequate strength without the addition of a binding agent. The material must of course possess inherent binding properties, whereby the bonding can be achieved in a number of different ways:

Plastification under pressure

Structures (crystalline or non-crystalline) are forced into each other and when the pressure is then reduced, the structures rearrange themselves and form an almost natural bond. This effect can for example be observed in various salts (NaCl, KCl) or metals.

Binder "on board"

One example is the lignin contained in biomass. On being subjected to pressure, the inherent lignin is squeezed out of the original structure into the voids between the particles.

Mechanical linkage

The particles interlink on account of their shape (e. g. metal turnings).

Capillary forces

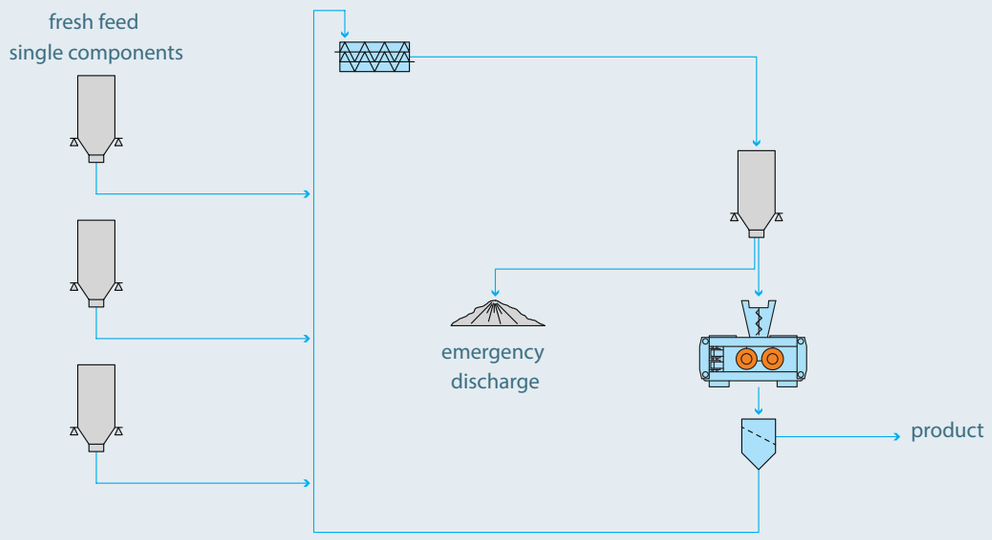
Small water bridges form the bond between the particles. This requires a fine particle size distribution along with the correct proportion of water. The briquettes are soft and their physical properties are not suited to severe handling or transportation situations.

The briquetting process as such is quite simple. Raw materials are metered out and homogenized before being fed to the roller press. Köppern tailors the roller press to the customer's requirements in terms of the:

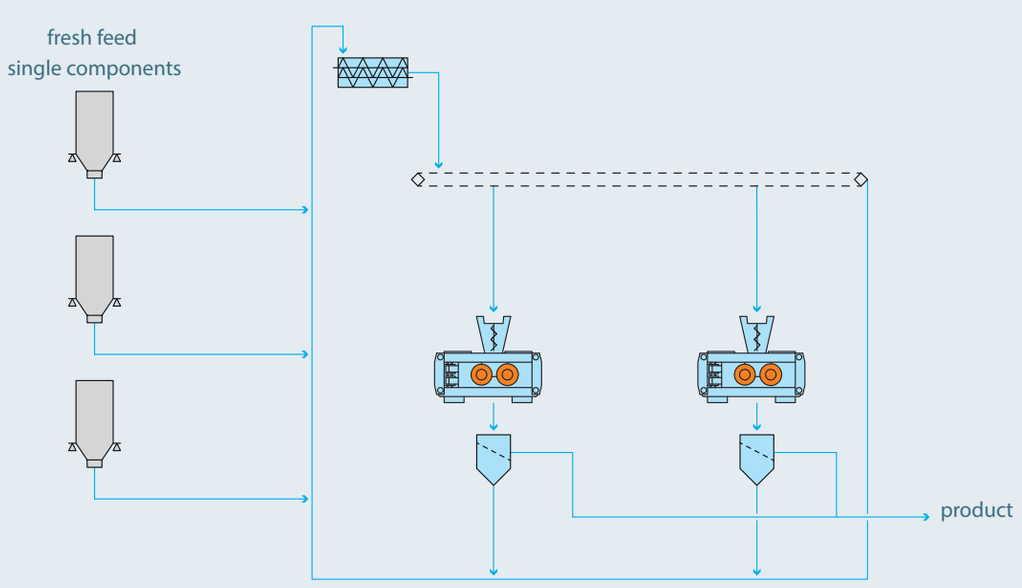
- gravity feeder/screw feeder
- roller speed
- (specific) press force
- torque of the main drive
- briquette size and shape
- number of roller presses
- etc.

The roller press output can be screened so that undersize material is recycled back to the roller press.

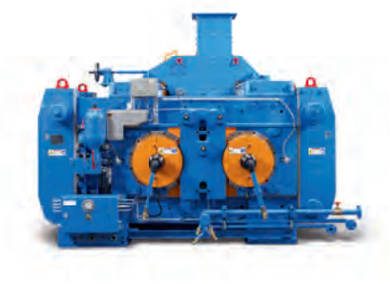
Single Roller Press



Multiple Roller Presses



Process Technology



Briquetting with Binder – typical mixes

- Chrome ore with molasses / hydrated lime
- Coal with bitumen
- Coke fines with starch
- Copper-nickel concentrate with lignosulfonate
- DR / HBI plant residues with bentonite
- DRI fines with molasses / hydrated lime or sodium silicate / hydrated lime
- Feed for RHF-based DR process with starch
- Molybdenum oxide with ammonia solution
- Nickel powder with PVA
- Steel plant residues with molasses / hydrated lime

Briquetting with Binder

For cold briquetting at feed material temperatures of up to 100 °C, it may be necessary to add binders to improve the briquette-forming characteristics.

Binders are primarily used for the briquetting of substances that have inadequate adhesive properties and are thus otherwise unsuitable for the production of firm briquettes. An example is the ubiquitous egg-shaped coal briquette, which has been produced from coal fines for well over 100 years. Today, briquettes are usually pillow-shaped, with sizes ranging from 1.5 to 60 cm^3. However, depending on the material to be briquetted and the customers' specific requirements, other forms and sizes of briquette are possible.

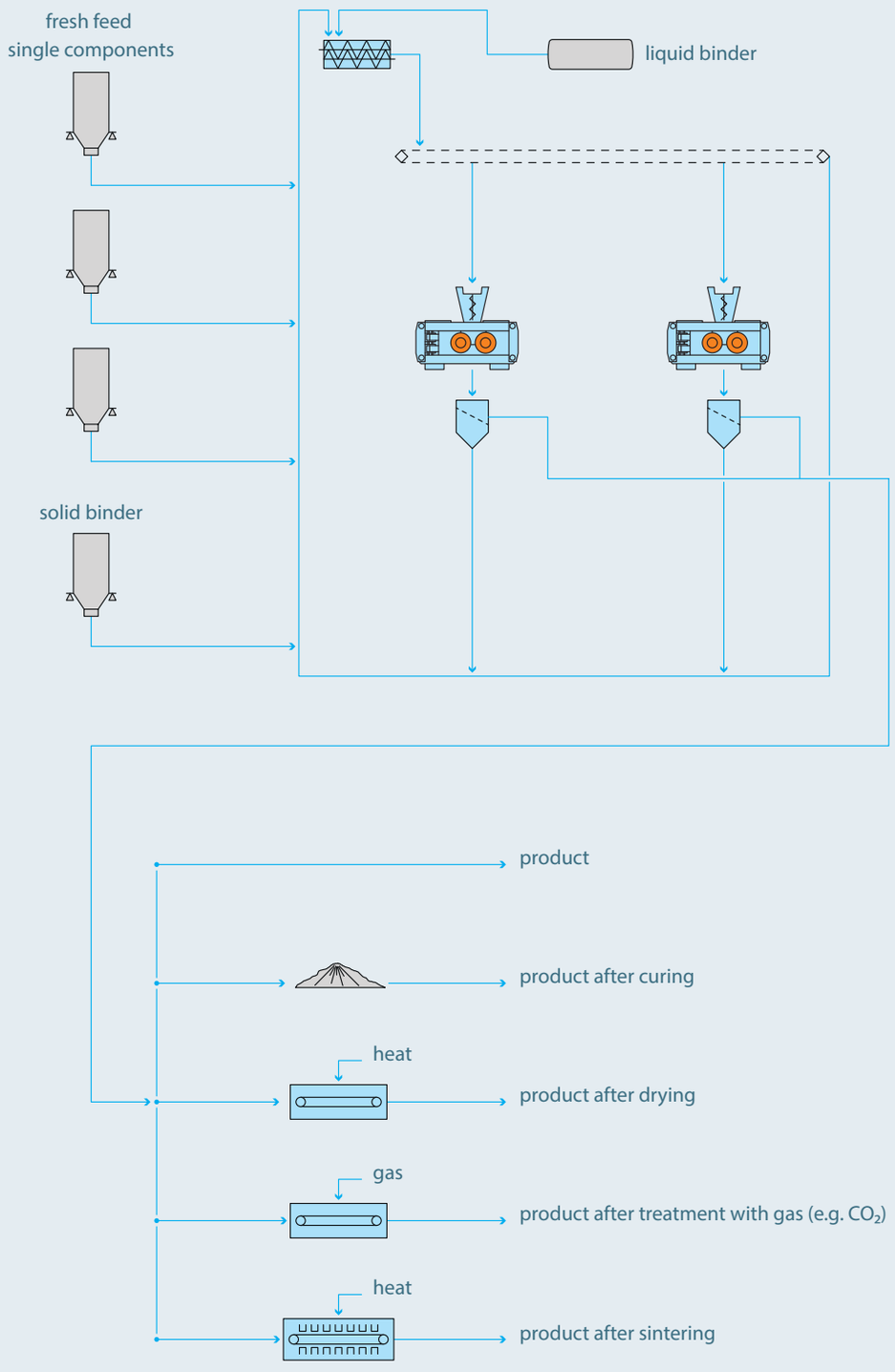
A variety of binding agents is available, but certain criteria need to be met for the right choice of binder. Clearly, the binder must function properly and the briquettes need to be robust enough to withstand handling on the way from the roller press to their usage destination. The subsequent processing also has its specific requirements; for example, a binder that corrodes the lining of a metallurgical vessel will not be suitable, no matter how good its physical properties may be. And from an economic point of view, the binder must be available in sufficient quantities and at an acceptable price per ton of product.

Binders can be classified as:

- glucosidic (e. g. molasses, starch)
- inorganic solutions (e. g. sodium silicate)
- clays (e. g. bentonite)
- thermoplastic (e. g. bitumen, pitch)
- mortar-type (e. g. cement, hydrated lime)
- non-glucosidic organic solutions (e. g. resins)
- fibers (e. g. paper fluff).

The briquetting process must take into consideration the handling of the binder including its storage and dosing. Furthermore, a mixer will be required to ensure sufficient penetration of the binder, and the feed mix needs to be free-flowing in order to avoid the formation of binder nests. Optimizing the distribution of the binder will also have a positive effect on operating costs.

Briquetting with Binder and Various Post-Treatments



Process Technology

Design Features of a Roller Press for Hot Briquetting

- Feed temperatures up to 750 °C
- Specific press forces up to 180 kN/cm
- Heat resistant steel
- Heat extension
- Insulation
- Inert gas distribution
- Cooling water distribution
- Venting
- Dedusting
- Ease of maintenance
- Availability
- Heavy duty application
- Separation of briquette string
- Capacities beyond 100 t/h

Hot Briquetting

The term 'hot briquetting' is used when the temperature of the feed material requires the use of highly heat-resistant roller presses that incorporate special arrangements for cooling.

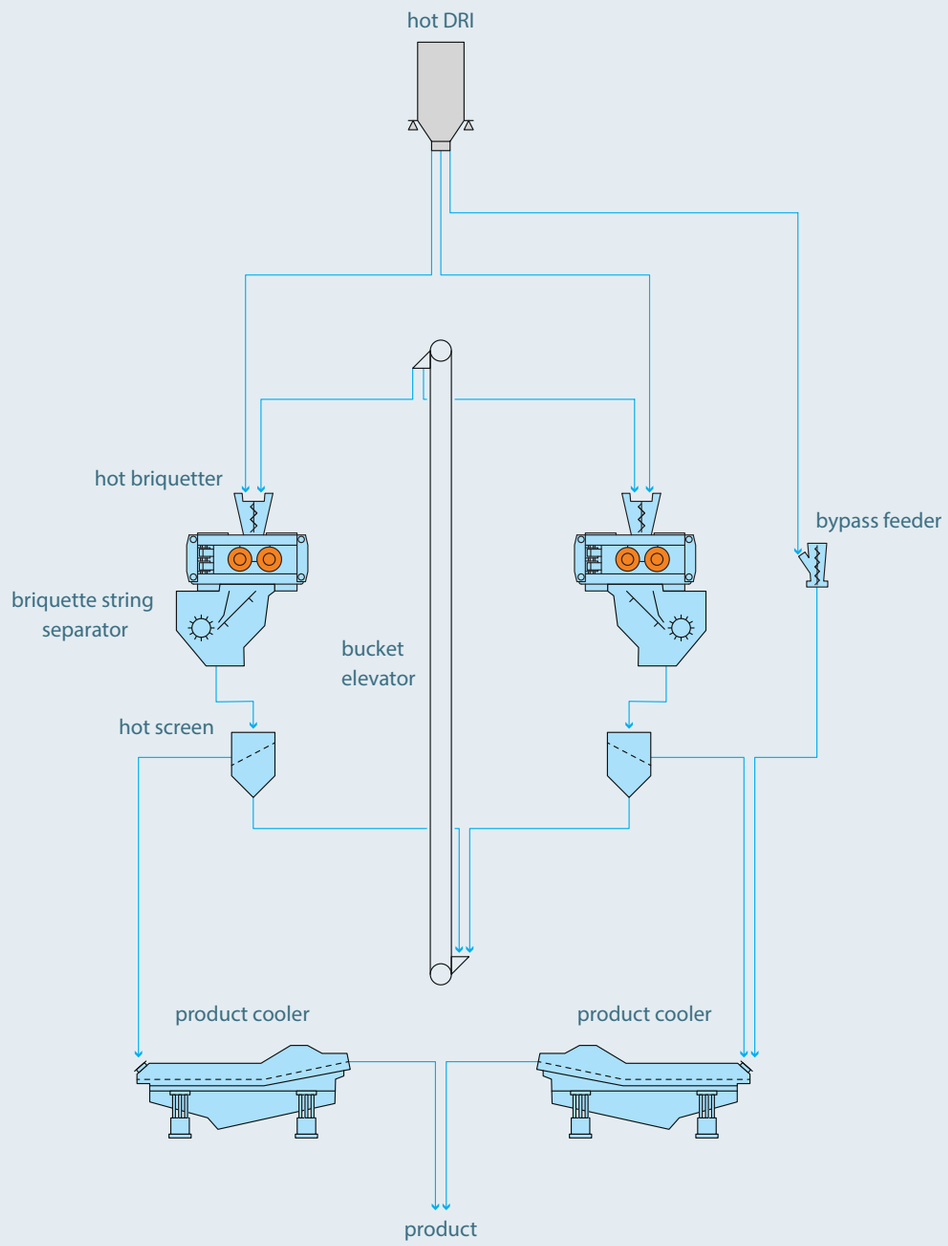
Materials are briquetted under hot conditions in such cases where binding characteristics are activated at high temperatures.

Köppern continues to play a pioneering role in the development of the hot briquetting process. Backed by our extensive experience, we are now the world's leading manufacturer of hot briquetting machinery and related systems.

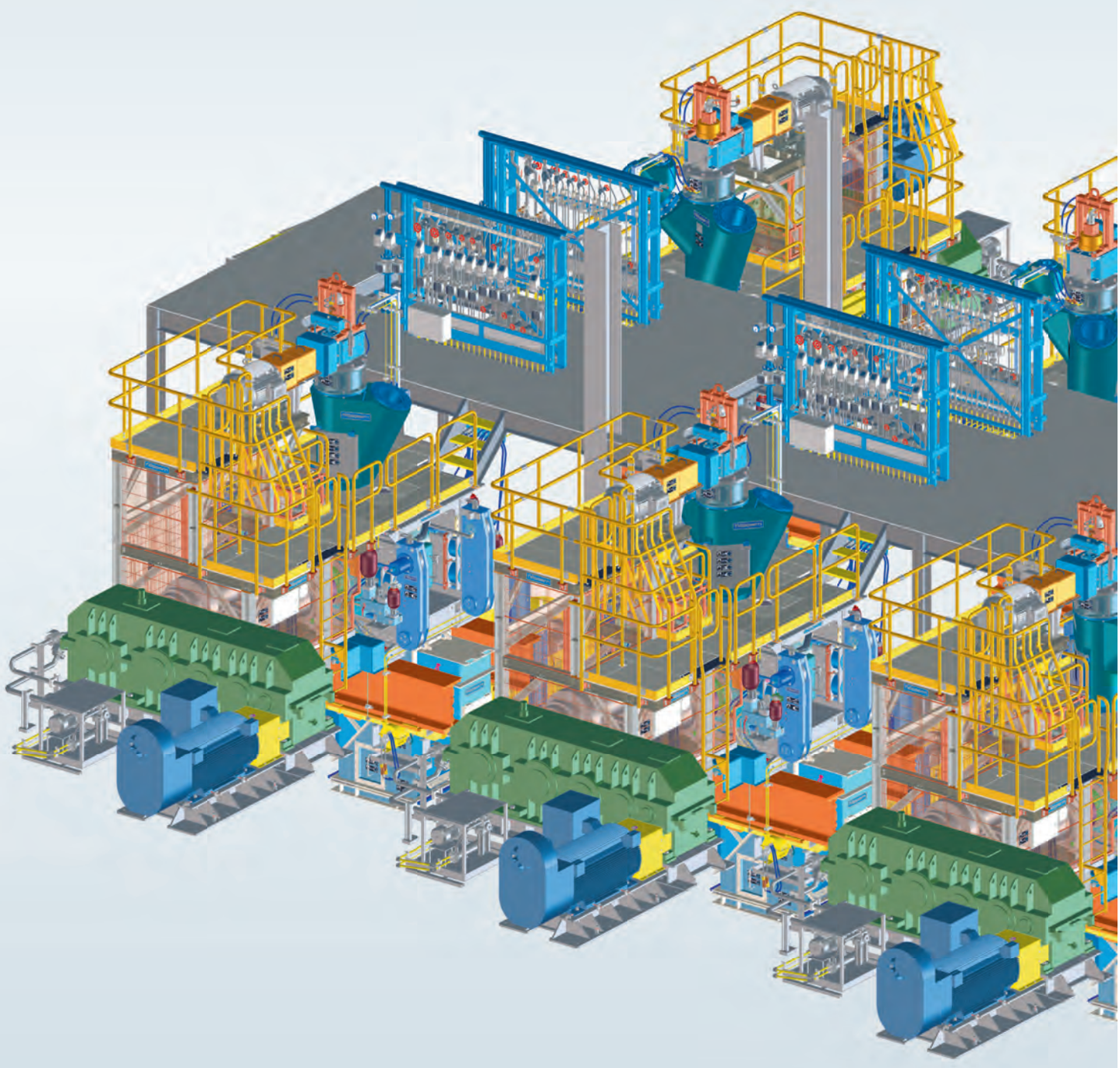
Following its industrial development in the 70s and 80s, hot briquetting of direct reduced iron (DRI or sponge iron) is the only passivation method that complies with IMO regulations. Due to its porous structure, DRI reacts easily with air and water, and especially with seawater. These reactions result in the generation of heat and/or hydrogen, which is especially critical during shipment by sea. Hot briquetting is the only fully-accepted, reliable technology for the passivation of pyrophoric direct-reduced iron (DRI) to convert it to the more convenient form of hot-briquetted iron (HBI). Following its discharge from the reduction facility at temperatures of around 700 °C, the DRI is channeled to the hot briquetting system, where specific press forces of up to 180 kN/cm are applied. This typically produces a continuous briquette string, which is generally separated into largely single briquettes while still in hot condition. The resulting fines can be recycled to the roller press via hot screen and bucket elevator. The product can be either air-cooled or water-cooled.

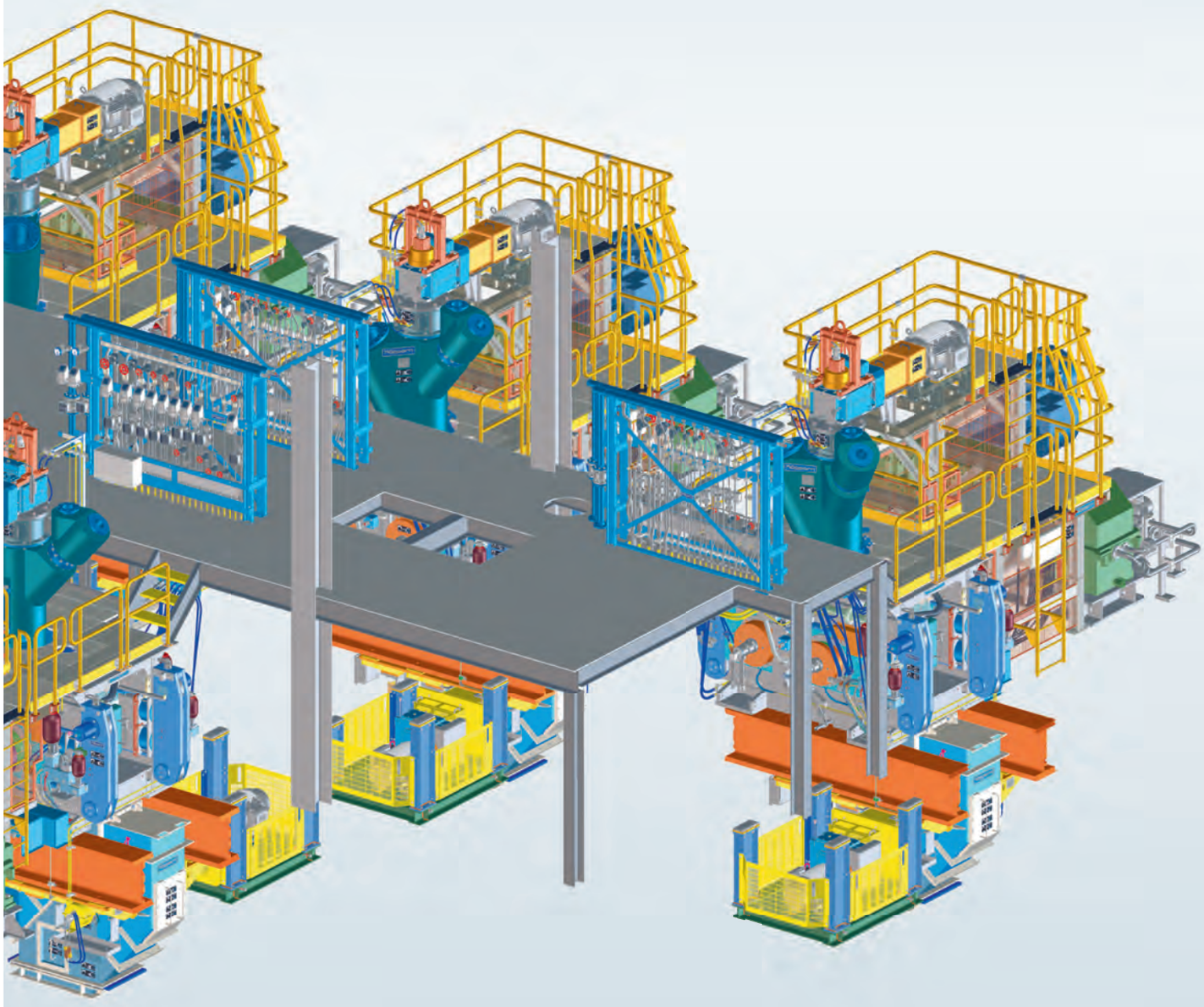
Further examples of hot briquetting applications are converter dust and Waelz oxide.

Hot Briquetting with Hot Fines Recycle and Cooling



Hot Briquetting Plant Arrangement





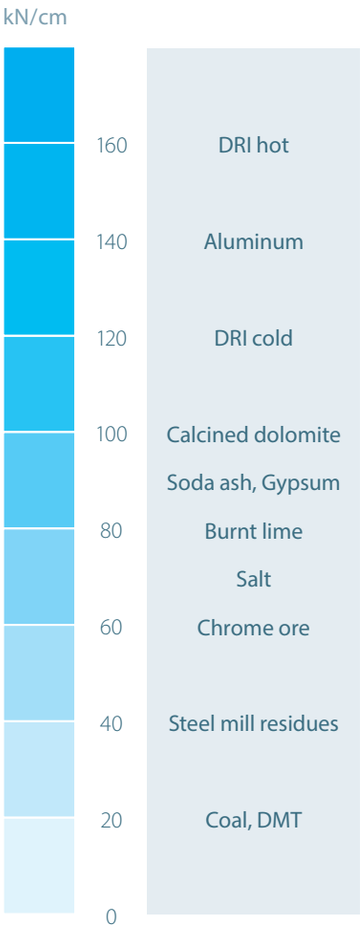
A 3D-view of an operative hot briquetting plant is shown here. Seven hot briquetting machines with briquette string separators are located directly below the discharge of a direct reduction furnace. Pellet-based DRI – Direct Reduced Iron – is fed at temperatures of approx. 700 °C and formed into briquettes while still in hot condition. The product is called HBI – Hot Briquetted Iron – and is used in steel mills worldwide as an iron source with a low content of tramp materials.

Pilot Plant – Test Work

It is always advisable to conduct test work with representative materials in order to assess their relevant properties prior to processing. Optimized plant layout and settings right from the start will boost efficiency and keep operating costs to a minimum.

Our pilot plant facilities not only support our customers in choosing the right process parameters and roller surfaces, but also by defining the correct technical process chain. Years of process-related know-how are concentrated in our pilot plants, so that all the relevant process data concerning the utilization of a roller press can be established in semi-industrial conditions.

Specific Pressing Force Requirement of Feed Materials



Customer Requirements

- Product tonnage
- Product size range
- Product properties
- Representative material(s)

Test Parameters

- Specific pressing force
- rpm rollers
- Feed recipe
- Binder
- Temperature
- Moisture
- etc.

Systematic optimization

Test Work Results

- Material properties
- Circumferential speed
- Specific pressing force
- Product density
- Shatter-, tumble-, compression-, abrasion-strength
- Yield

Roller Press & Process Design

- Bearing size
- Roller diameter
- Working width
- Feeder
- Circumferential speed
- Drive capacity
- Sizing of peripheral equipment

In order to simulate the processes required before and after roller press operation, the pilot plant is also equipped with mixers, crushers, screens, ovens and laboratory tools. The process data collected can be used to plan either individual units or complete briquetting or compaction plants. If required, the results can be included in a basic engineering document to define the plant components.

Overview of pilot plant

Köppern's main pilot plant is located at the Bergakademie Freiberg Technical University in Germany, providing optimum conditions for process-related research and development. Results collected over many years provide data for evaluating the suitability of materials for processing.

Trials need to be carried out to establish the final design and layout of an operating system. For this purpose, two industrial-scale briquetting / compaction machines (1,000 and 650 mm diameters) and two roller presses for grinding tests are available at Köppern's pilot plant in Freiberg.

Depending on the test material, these pilot presses can be equipped with different feeding systems and pressing tools. The presses have variable speed drives and are connected to the central operating data collection system to facilitate the analysis of results.

The industrial-scale trials aim to:

» optimize feed characteristics
» determine process parameters
» select suitable equipment
» evaluate product parameters
» examine recycling potentials.

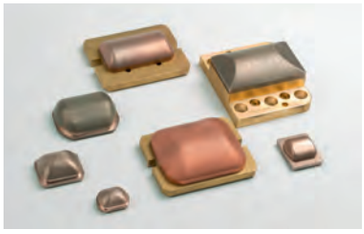
For the benefit of our customers, laboratory and pilot plant data are continually updated in line with our field experience. With its pilot plant facilities and specialist staff, Köppern is in a unique position to help you find the best solution for your specific requirements.

Köppern pilot plant, in cooperation with the Technical University of Freiberg

Roller press type 52/10

Roller press type 52/6.5

ECM – Electrochemical Machining



Different electrodes

A specialized process with many applications

A significant in-house application relates to one of Köppern's leading products, namely roller presses for briquetting. The briquette pockets recessed into the pressing tools have been machined using ECM technology since 1965.

Since the sixties, Köppern has been a full-service contract manufacturer for ECM-processed workpieces, from unmachined parts to finished products. We are equipped with modern ECM die-sinking machines that can process workpieces each weighing from 20 g to 15,000 kg. With its many applications, such as machine and plant engineering, gas turbine or aerospace technology, ECM has become a well-established manufacturing process.

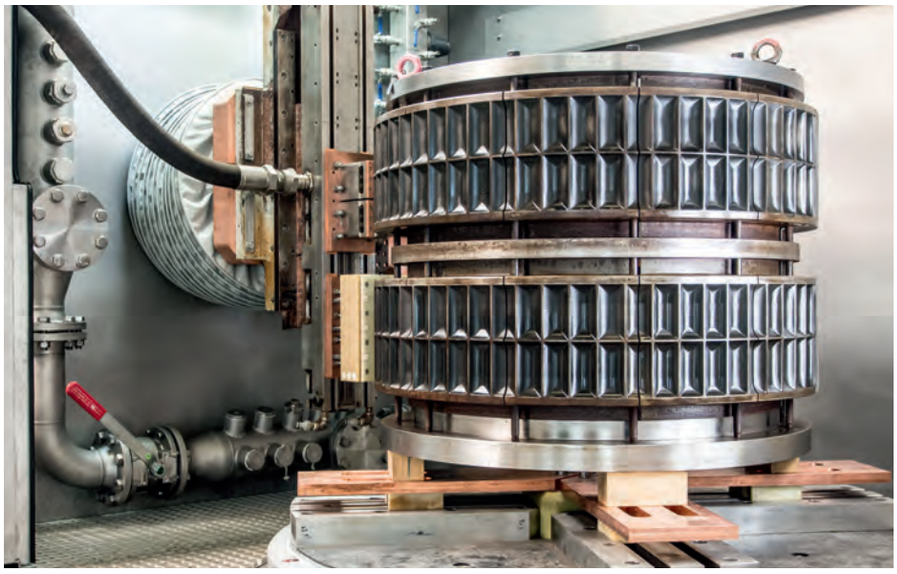
Electrochemical machining has proved to be superior to other forms of processing, especially when it comes to materials with very high hardness and abrasion resistance, where cracks must be avoided and a high surface quality is required, as for example in the aerospace industry.

The forming of high-alloy materials, such as nickel-based or titanium alloys, or powder-metallurgical / hardened materials, is also unproblematic. The machining process produces a burr-free, high-grade surface quality, without thermal stress as the processing temperature is below 90 °C.

In the course of the ECM process, metal is removed by way of electrolytic dissolution until the workpiece has reached its specified form. The workpiece to be machined is connected to a positive pole (anode) and the tool electrode to the negative pole of an external direct-current voltage source. The tool electrode possesses the form of the required workpiece contour. An aqueous electrolyte solution in the gap between anode and cathode closes the electrical circuit. The electrolyte carries the ions needed for the process, dissipating the generated heat and discharging the dissolved material. The workpiece contour is created through the guided motion of the tool. The process-related continuous flow of the electrolyte solution between the tool electrode and the workpiece ensures that the components are not in contact with each other, so that neither the electrode nor the machining process itself are impaired by wear.

Advantages of ECM

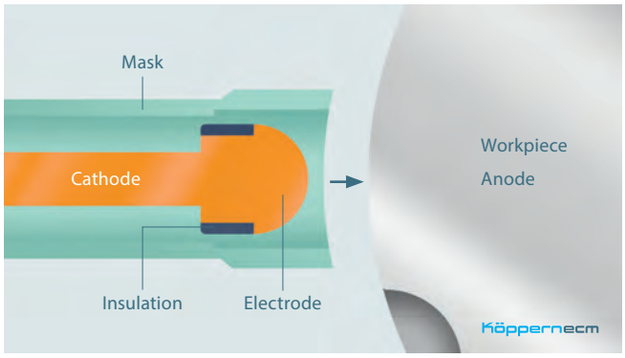
- Machining of hard materials
- No structural alteration
- Freeform surfaces
- Burr-free
- Surface quality Rz <10 µm
- Short processing times



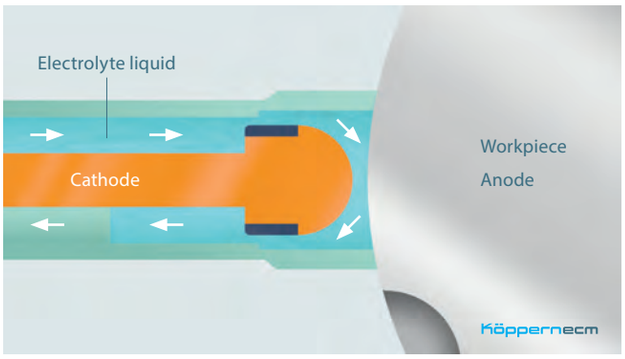
ECM-processing of HBI rings with multiple tools – around 133 kg of material removed

Electrode – detailed view

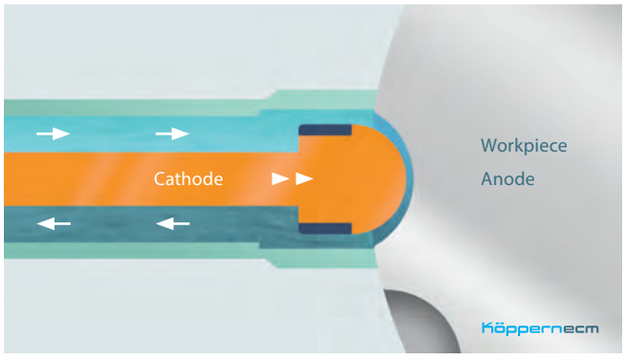
ECM Working Principle



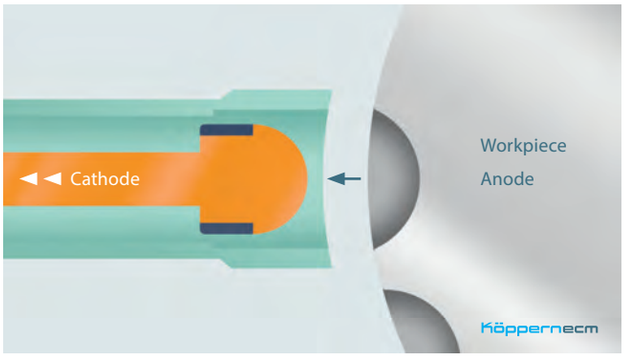
Step 1: Electrode approaches the workpiece



Step 2: Electrolyte liquid surrounds the electrode, processing begins

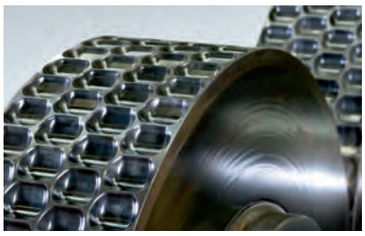


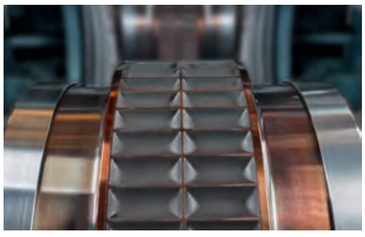
Step 3: Final machining depth attained, possible polishing requirement



Step 4: Withdrawal of the electrode, ready for next form

Advanced Wear Protection





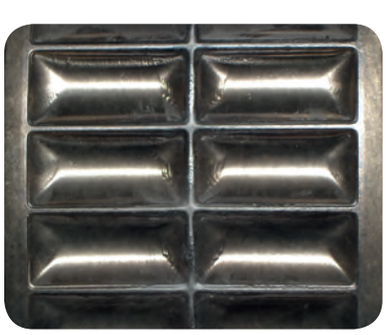
RESIDUR® – powder-metallurgical solution for especially demanding feed materials

Derived from Köppern´s unique HEXADUR® wear protection system, these powder-metallurgical surfaces are also available for applications in briquetting and compaction. A base ring provides the ductility for a secure shrink-fit to the roller core. The base ring is positioned in a capsule and the gap between outer shell and base ring is filled with powder, which is tailored to its tribological partner to optimize wear resistance and cost efficiency. The capsule is then closed, evacuated and sealed. The assembly is sintered at a minimum of 1,000 °C and 1,000 bar, resulting in a pore-free layer completely welded to the base ring. The capsule is then removed and the pressing tool undergoes heat treatment to reach the required level of hardness and ductility. Finally, the RESIDUR® rings are machined to the desired shape and, as with the standard pressing tools, the pockets are formed into the surface using ECM technology.

RESIDUR® has proved its worth in many commonly experienced applications involving abrasive feed materials in the metallurgical industry, including the successful introduction of hot briquetting processes for converter dust or for direct-reduced iron.

Surface condition after similar production quantities of HBI

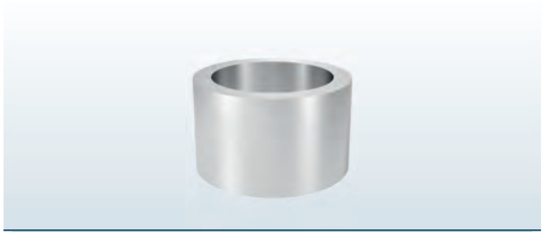
Cast segment made of tool steel



Press ring made with RESIDUR® HT

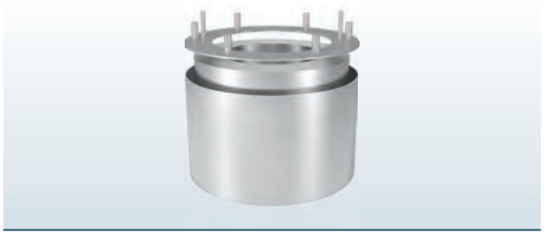
Production of RESIDUR® – Factory Tour

Base Ring



Step 1: A solid, high-strength, precision-machined steel ring provides the base for the application of the RESIDUR® layer.

Capsule Assembly

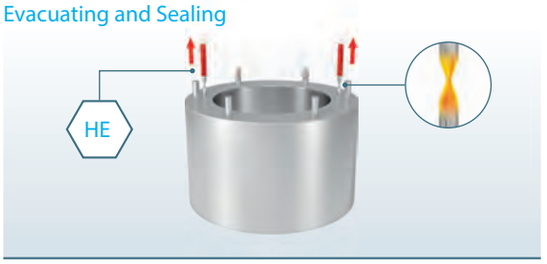


Step 2: The ring is transferred into a sheet-metal capsule. The gas-tight lid is welded onto the capsule.

Powder Filling

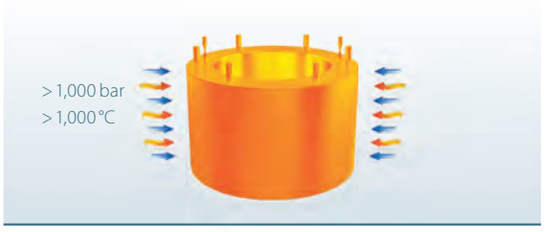
Step 3: Homogenized metal powder is filled into the capsule and densified on a vibration table. This powder will form the tough surface.

Evacuating and Sealing



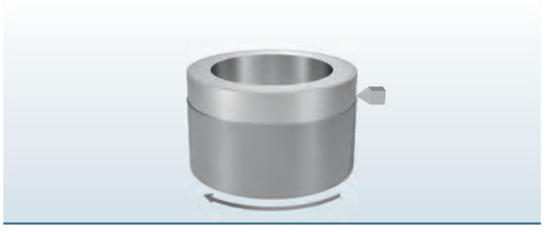
Step 4: The gas-tight capsule is evacuated. Tightness is checked using a helium leakage test.

Hot Isostatic Pressing (HIP)



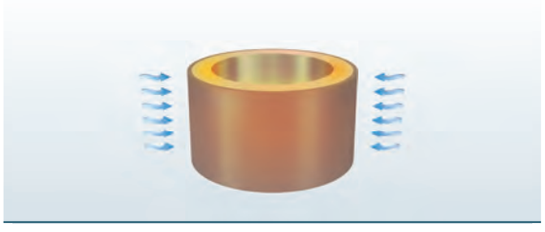
Step 5: The compound body is then exposed to high temperature and pressure (HIP technology).

Removing the Capsule



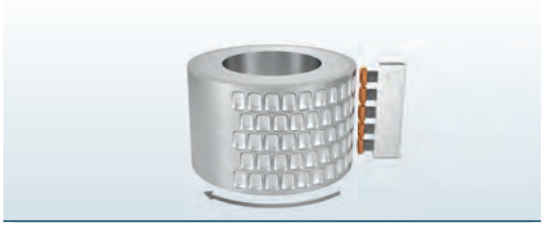
Step 6: The capsule is removed by machining on a vertical lathe.

Heat Treatment



Step 7: The required final material properties are achieved by heating the RESIDUR® tire to approx. 1,000 °C followed by controlled quenching and annealing.

Machining Pockets



Step 8: The pore-free RESIDUR® layer can only be machined with ECM technology.

Service and Support

Consulting

Backed by decades of experience, Köppern offers its customers the support of qualified engineers and technical advisers, who are able to assist in:

» analyzing process-related problems
» providing solutions to optimize your operations and increase production.

Our advisory portfolio comprises:
» Project studies
» Basic engineering
» Pilot-plant test work

Project Studies

For reliable information on the economic feasibility of major projects, Köppern can provide an initial project study including the following topics:

» Mass flow diagram
» Flow sheet – representation of the briquetting / compaction system including flow lines, quantities, physical and chemical data, operating conditions
» Equipment list and plant description
» Estimated investment costs
» Manpower estimate for the supervision of construction and commissioning
» Manpower estimate for local construction and commissioning personnel

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In addition to the information included in a project study, basic engineering covers plant layout (general arrangement) and a detailed mechanical and electrical equipment description.
This document can form the basis for the purchase of individual items of equipment as well as for the construction of the plant.

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Place your confidence in our worldwide network of service centers and engineering offices. Köppern offers a comprehensive range of customer-focused services starting with process consulting for either your greenfield project or your existing plant update.

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- Köppern Workshops
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Our specialist services cover pilot-plant test work, plant audits, process layout, engineering, supply of complete briquetting / compaction plants or key equipment, supervision of installation and commissioning as well as training.

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