



**HERRENKNECHT SEPARATION PLANTS –  
KEEP IT FLOWING.**



## RAPID TUNNELLING THANKS TO EFFICIENT SEPARATION.

**Low-impact mechanized tunnelling:** The way ahead for new infrastructure must necessarily lead underground: road, metro and railway tunnels are creating new room for maneuver underground. While a tunnel is being excavated underground, life on the surface must go on undisturbed. Every city has its own pace of life, its own flow. If this is halted, it can result in economic losses.

Success in tunnel construction depends on the smooth cooperation of many different actors: contractors, planners and all commissioned companies. That is why Herrenknecht aims to contribute its many years of experience as early as the project planning phase to bring together the technical concepts of all those involved and to keep the project forging ahead. Herrenknecht sees itself as a partner in Teamwork Tunnelling throughout the entire project.

**Integrated solutions.** As a technology and market leader, Herrenknecht offers efficient and reliable tunnel boring machines for any geological conditions for over 30 years. Herrenknecht has developed a new generation of separation systems for shields with slurry-supported tunnel face; the multi-step processes are optimally designed for the requirements of mechanized tunnelling. With its Full Service Tunnelling, Herrenknecht supports rapid construction work progress and creates project-specific packages that include all services required on site. From spare parts management, cutter shops and lining segment factories to separation plants. We provide our customers with tailor-made and perfectly coordinated service packages. A network of 49 subsidiaries, affiliated and associated companies working in related fields, allows us to provide advice and comprehensive services around the world. Always, everywhere.

**Maximum safety in heterogeneous ground conditions.** Mixshield technology is based on supporting an unstable tunnel face using a bentonite suspension – a mixture of clay and water. With this Herrenknecht system, soils with high water permeability, mostly sand and gravel, can be tunnelled through quickly and safely without the tunnelling activities causing aboveground subsidence or heave.



**A closed circuit.** Herrenknecht separation systems are an important, central and integrative component of mechanized tunnelling. In a Mixshield, the bentonite suspension serves as both a stabilization and a transport medium. The excavated soil material is pumped via the slurry line to the separation plant. Efficient and sequential processes separate and remove the excavated soil material from the bentonite suspension; the clarified flushing medium is returned to the slurry circuit.

The separation of ultrafine particles is a vital capacity, because the bentonite suspension will otherwise become denser and the transport medium will thicken. Only efficient separation can guarantee high performance tunnelling. Separation in a Herrenknecht separation plant takes place in several steps – depending on the geology and the grain size. Modern screening technology, hydro vacuum cyclones, vertical clarifiers and centrifuges form an innovative, integrated recycling concept which is ideally suited for mechanized tunnelling for both Traffic Tunnelling and Utility Tunnelling.



Small footprint required for the Herrenknecht HSP900 separation plant in Cologne, Germany.





The Herrenknecht HSP2800 separation plant for the Herrenknecht S-381 Mixshield (Ø 13m) in Jenbach, Austria.

## SEQUENTIAL SEPARATION COMPLETELY REMOVES ALL SOLID PARTICLES.

An efficient and effective separation plant forms the basis for the successful operation of Mixshields. The complete removal of excavated solids from the slurry and the addition of bentonite and other additives to the slurry circuit are determined according to the geological conditions; this is the defining feature of an efficient separation process. The solids content of the slurry and the density of the solids in a given order of grain size, impact on the excavation speed in mechanized tunnelling. The size of solid particles in the excavated material ranges from less than a micrometer to greater than 160 millimeters and they can be categorized as gravel, sand, silt or clay particles. Herrenknecht separation plant systems completely remove particles of different grain sizes using sequential separation steps.

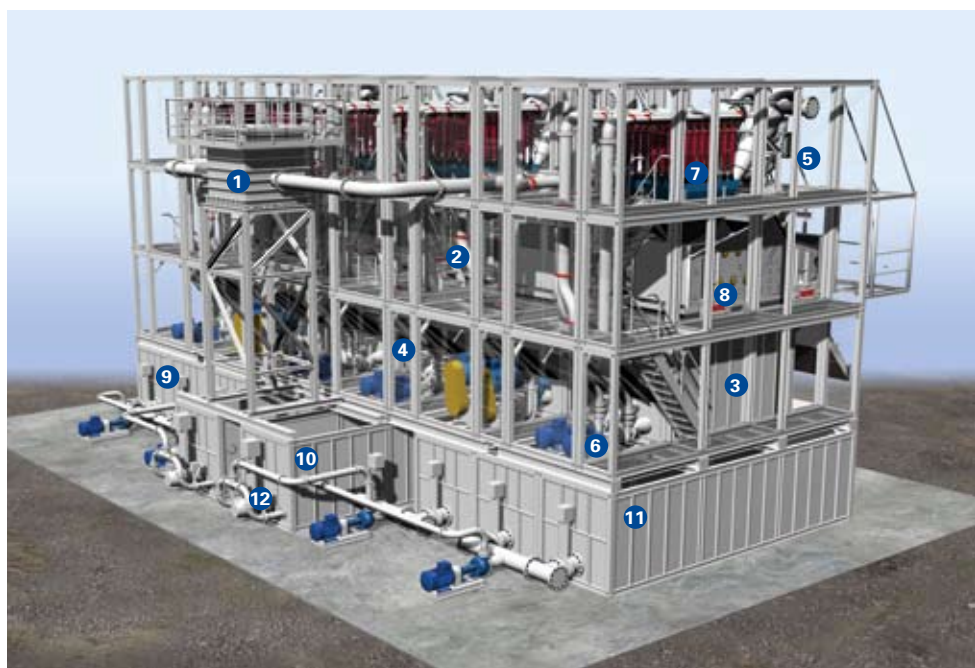
**1<sup>st</sup> step:** Separation of gravel using coarse screens. Particle size > 4 millimeters.

**2<sup>nd</sup> step:** Separation of sand and silt with hydro vacuum cyclones and downstream dewatering through fine screens. Particle size > 20 micrometers.

**3<sup>rd</sup> step:** Separation of silt and clay with centrifuges, vertical clarifiers and filter presses. Particle size > 1 micrometer.

The Herrenknecht separation process

- Slurry distribution ①
- Coarse screens ②
- Underflow collector ③
- Feed pump coarse cyclones ④
- Coarse cyclones ⑤
- Feed pump fine cyclones ⑥
- Fine cyclones ⑦
- Fine screen ⑧
- Overflow tank ⑨
- Driving tank ⑩
- Fresh bentonite tank ⑪
- Transfer pump ⑫





Tunnelling jobsite with Herrenknecht tunnelling machine and separation plant.

### Advantages of Herrenknecht separation plants.

- Optimal adaptation of the separation system to the TBM and the construction ground.
- Efficient processing and reutilization of bentonite suspensions with very low material loss.
- High G-forces guarantee high work performances and the separation of solid particles with a small screen footprint.
- Efficient screen performance through the use of up to four shaker motors per screen machine.
- Large and variable screen sizes allow rapid adaptation of the plant to changing geologies during tunnelling thanks to a special exchange system.
- Twin deck screen units with a significant increase in screen performance with the same footprint requirement.
- Cyclones and screen systems for the effective removal of solid particles, optimized against wear and tear.
- Adjustable hydro vacuum cyclones for effective removal.
- Great capacity of the cyclones due to large intake and overflow.
- Container-based design ensures mobility, flexibility and rapid assembly/dismantling of the plant.
- Low-noise design.
- Monitoring of the relevant separation plant parameters via computer-supported control system.
- Online data transfer and visualization of the most important performance parameters between tunnelling system and separation plant.

#### REQUIREMENT

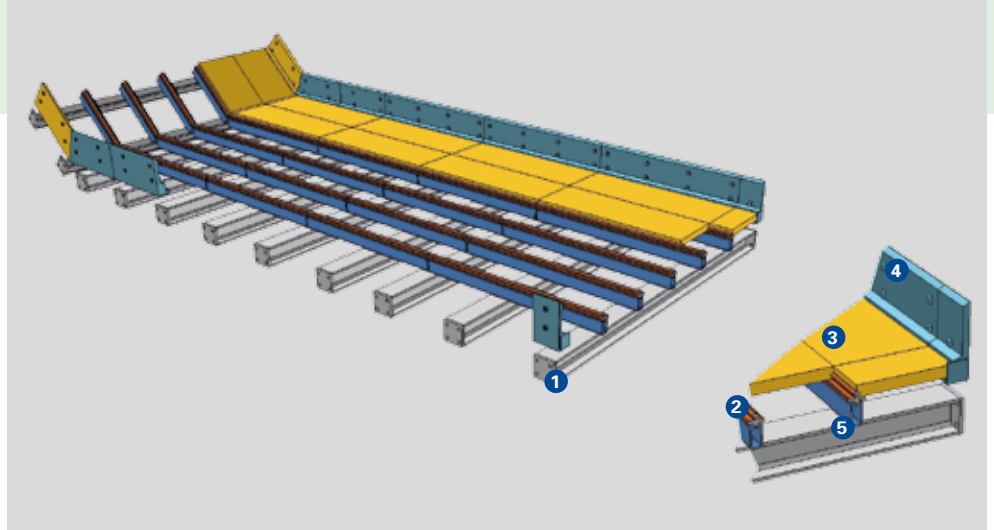
##### CONTINUOUS MECHANIZED TUNNELLING

High advance rates  
Flexible adaptation of the separation equipment to the geological conditions  
Constant slurry density  
No need for complete slurry replacement  
Maximized solids separation  
Minimized waste disposal volume  
Lower overall plant operating costs

#### SOLUTION

##### HERRENKNECHT SEPARATION PLANTS

|                                     | HSP900 | HSP1200 | HSP1400 | HSP2000 | HSP2800 | HSP3600 |
|-------------------------------------|--------|---------|---------|---------|---------|---------|
| Flow rate m <sup>3</sup> /h         | 900    | 1,200   | 1,400   | 2,000   | 2,800   | 3,600   |
| Max. tonnage, solids separation t/h | 250    | 350     | 480     | 550     | 800     | 1,100   |
| Screen areas m <sup>2</sup>         | 12     | 18      | 50      | 60      | 100     | 120     |
| Number of coarse cyclones           | 12     | 4       | 4       | 4       | 8       | 8       |
| Number of fine cyclones             | 96     | 112     | 64      | 88      | 128     | 160     |
| Grain size d <sub>50</sub> µm       | 28     | 28      | 35      | 35      | 35      | 35      |
| Footprint m <sup>2</sup>            | 10x15  | 15x15   | 15x25   | 15x25   | 35x25   | 35x25   |
| Height m                            | 12     | 12      | 12      | 12      | 12      | 12      |
| Driving tanks                       | 1      | 1       | 1       | 1       | 2       | 2       |
| G-force g                           | 6      | 6       | 6       | 6       | 6       | 6       |



Rapid replacement screens: ❶ Lateral support profile ❷ Snap-in support ❸ Screen element ❹ Side support ❺ Longitudinal support

## HIGH TUNNELLING PERFORMANCES WITH OPTIMUM PROCESS ORGANIZATION.

**Polyurethane screens with rapid replacement system.** Herrenknecht has developed an innovative screen replacement technology so that the screen elements can be replaced in a very short time. The separation process adapts quickly to changing soil conditions with a variety of screen elements. The standard material of Herrenknecht screens is polyurethane, which ensures durability and keeps replacement costs due to wear down to a minimum. If the customer requires, Herrenknecht can equip the screens with steel sieves to provide even greater open screen areas.

The high dewatering capacity of Herrenknecht screens is achieved using very large screening areas. Depending on the geological conditions, the dewatering capacity can be increased by equipping the rear and side supports with additional dewatering functions. Vertical screens can be used to further increase the dewatering level for unexpected requirements.

**Modular principle.** The standard design of Herrenknecht separation plants includes a container housing and is based on a modular principle. This guarantees not only cheap and easy transport but also rapid assembly and dismantling. Containers with catwalk units between the areas of the plant make maintenance and adjustment work easy. Herrenknecht separation plants have a very small footprint and a low-noise container design which means they are perfectly suited to use in inner-city areas. Since the separation plants are covered they can be used in all climatic zones.

### Flexible and adaptable.

- Special insulation keeps energy costs and sound levels down.
- Additional application of ventilators for use under hot climate conditions.
- Explosion protection since the entire plant is designed in line with ATEX and/or UL-guidelines.

Unloading and assembly start.



Assembly start level 2.



Assembly start level 3.



Fully assembled plant.







Computer-supported control and visualization in the control cabin of the separation plant.



Herrenknecht HK84 decanter centrifuge.



Covered HK84 downstream decanter centrifuges on the H8 tunnelling jobsite in Jenbach, Austria.

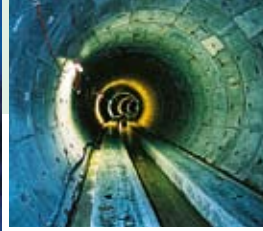
**Control during tunnelling.** Herrenknecht provides computer-supported data transfer of the important control parameters between the TBM and the separation plant. The combined overall visualization system for the TBM and separation parameters at both control stands provides the best possible tunnelling performances. Information exchange in both directions guarantees optimum availability of the tunnelling machine since downtimes for maintenance can be coordinated more efficiently.

**Herrenknecht decanter centrifuge and vertical clarifier.** Removing all ultrafine particles leads to a constant slurry density. This makes high tunnelling performances possible and reduces costs for operation and wear and tear of the slurry and transport circuit components. The removal performances of Herrenknecht separation processes can be increased to a considerable degree using additional equipment such as vertical clarifiers, decanter centrifuges and flocculant stations. User-friendly computer control and visualization of the main machine parameters mean several plants can be run by just a few operators.

**Bentonite mixing plant.** Bentonite suspensions are used to support the tunnel face and to remove excavated material hydraulically. Herrenknecht bentonite mixing plants can be adapted to the required aggregate amounts for the desired bentonite suspension. A standard unit can prepare a volume of 60m<sup>3</sup>/h with a dosage of up to 50kg/m<sup>3</sup> of bentonite, or units can be customized according to the needs of the project. Expansion times can be reduced using automatically adjustable mixing options. The construction design of Herrenknecht bentonite mixing plants means they incur very low costs for operation and wear and tear. A sophisticated procedure allows polymer-modified bentonite to be prepared.



HK60 Herrenknecht bentonite mixing plants with silos.



## **WWW.HERRENKNECHT.COM**

Herrenknecht AG is a technology and market leader in mechanized tunnelling. As the only provider of a full range of services worldwide, Herrenknecht delivers high-tech tunnel boring machines for all ground conditions and with all diameters – ranging from 0.10 to 19.0 meters.

Herrenknecht's tailor-made machines create pipeline systems for water and sewage, for gas and oil (Utility Tunnelling) as well as tunnelling systems for car, metro and railway traffic (Traffic Tunnelling) around the world. Our tunnel boring machines are forging ahead with the world's longest railway tunnel and the largest metro lines. They help to cross under water with supreme accuracy and to lay pipelines throughout continents.

Herrenknecht sees itself as a partner in teamwork tunnelling throughout the entire project. Comprehensive services for all aspects of tunnel boring activities complement our range.

The Herrenknecht Group employs almost 2,500 people and includes 49 subsidiaries and associated companies working in related fields, e.g. in logistic solutions or deep drilling systems.

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**Tunnelling Systems**