
Dr. Gerhard Lang, Herrenknecht AG.

Fort Worth, January 2019
HDD limitations in permeable soils.

Conventional HDD.

- Principle HDD arrangement of the borehole and drill string
- Return flow through borehole
  - either to Rig side or to Pipe side
HDD limitations in permeable soils.

Conventional HDD vs. HDD with Jet Pump technology.
Jet Pump for HDD.

Principle of the system.

Nozzle:
\[ v = 100 \text{ m/s (328 ft/s)} \]
\[ p = 50 \text{ bar (725 psi)} \]

Mixing chamber

Diffuser:
\[ v = 3.5 \text{ m/s (11.5 ft/s)} \]
\[ p = 20 \text{ bar (290 psi)} \]
Jet Pump for HDD.

New: drill pipe used as discharge line.
Herrenknecht Testing Facility.
Jet Pump tests.

- High Pressure Pump
- Separation
- Test borehole (submersible)
- Unit for Rotation and Push/Pull
Herrenknecht Testing Facility.
Jet Pump tests.

1000m (3280 ft) of discharge line circuit
Jet Pump for HDD.

Reference Project: Malmö Harbor Channel Crossing.

- H-165, HK150C Crawler Rig
- Location: Malmö, Sweden
- Project: District Heating Pipeline
- Drilling length: 850ft. (263m)
- Pipeline: 40" HDPE casing pipe with inner steel pipeline for heat transport
- Geology: hard limestone, flintstones
- Contractor: BAB Rörtryckning AB
Jet Pump for HDD.
Benefits overview.

- Minimum frac-out risk during reaming
- Possibility to use a simple and cost saving mud program
- 98% clean borehole
- Immediate formation feedback on the separation plant (1000m = 3280ft = 7 min)
- Transportation of larger cutting sizes
- full-face reaming possible
- Works with non or partially filled boreholes
- Defined return flow direction
- Flow amounts (in & out the borehole) can be simply monitored and logged
- Direct connection of the mud flow to the recycling unit (No mud pit pump necessary)
Jet Pump for Pipe Jacking.
Slurry circuit in Pipe Jacking.
Jet Pump for Pipe Jacking.

State-of-the-art centrifugal slurry pumps.
Jet Pump for Pipe Jacking.
As alternative to centrifugal slurry pumps.
Jet Pump for Pipe Jacking.
Test project in Hannover, Germany.

- Machine: AVN 700 with jet pump in machine can no. 3
- Drive length: 120m (394 ft),
- Installation depth: 4.5m (15 ft)
- Geology: Sand, Clay
Jet Pump for Pipe Jacking.
Test project with AVN 700 in Hannover, Germany.

- Machine: AVN 700 with jet pump in machine can no. 3
- Geology: Clay with sand
High Voltage Power Grid in Germany.

- Intention to replace nuclear power plants with renewable energy until 2025.

- Electrical power grid extension to connect the windfarms in the North Sea with the industry in the south. (underground cable priority for DC)
  - North – South connections (New DC lines) as underground cables
    - 1.500 to 2,250km (900 – 1,600 mi.)
  - Overhead lines use AC technology under special conditions (e.g. distance protected areas), underground lines favor DC.
  - Protests against overhead lines lead to trenchless technology.
  - **Commissioning of North-South connections in 2025** (formerly 2022)
Underground cable installation.
Installation methods.

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<thead>
<tr>
<th>Application</th>
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<tbody>
<tr>
<td>Shallow installation</td>
<td>Shallow installation</td>
<td>Deep installation</td>
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<td>mostly soft ground</td>
<td>Soft &amp; mixed ground</td>
<td>All ground conditions</td>
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<tr>
<td>Rural area</td>
<td>Rural/less populated area</td>
<td>Urban area/ river crossings</td>
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Conventional Open Cut installation method.
Example Project Raesfeld.

- Soil excavation
- Soil layers stored separately
- Casing pipe installation
- Refilling of soil in separate layers
- Cable pull-in
- Cable pull-in lubrication
- Surface preparation/renaturation
- One year later
Conventional Open Cut installation method.
Not possible for crossing of waterways and protected areas
Conventional Open Cut installation method.
Not possible for crossing of waterways and protected areas
High Voltage Power Cable Installation.
by Transition System Operator (TSO).

- Limited job site, construction roads, preparation area
- No heavy equipment between launch and reception point
- Steerable installation of casing pipes for AC & DC lines

- **Length:** 3,300ft – 4,000ft
- **Depth:** 5ft m to 13ft, constant
- **Diameter casing:** ca. DN10” – 16” (250-400mm)
- **Casing material:** plastic, non-conductive, e.g. PEHD
- **Distance between lines:** 3ft constant
- **Available on market:** since 2017
Comparison trenchless installation methods.

Limitations.

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<thead>
<tr>
<th>Technology</th>
<th>Ø in mm</th>
<th>Shallow</th>
<th>Accuracy</th>
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SEPARATE INSTALLATION 250 mm

~500mm / 20"

CASING TUNNELS Ø 1,500 mm

CASING TUNNEL Ø 3,000 mm
Jet Pump for Pipe Jacking.
AVNS technology used in E-Power Pipe®.

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Jet Pump for underground cable installations. AVNS technology used in E-Power Pipe®.
New development E-PowerPipe®
New steel jacking pipes.

Characteristics
- Smart coupling system
- All pipes and cables integrated
- Less couplings
- Life time
New development E-PowerPipe®
New jacking frame.

Characteristics
- Rack & Pinion system
- 6 electric drives (total 66KW)

Advantages:
- Fast push and pull operation (max. 5m/min)
- Max. thrust and pull force 340to
- All coupling steps in one operation

Test plant.

Test criteria:

- 6 drives
- Different soil composition, distance, depth
- Construction process
- Cable pull-in + Load monitoring
- Measurement of thermal conductivity over 6 months
Test plant.
Pilot project February/March 2017.
Amprion – Project Borken.

- 3 x 1,000ft (300 m)
- Mostly silt, sand, marl
- Constant depth of 3ft
- Spacing of approx. 30”
Pilot project February/March 2017.

Performance Data.

- Drive length: 300m (1,000 ft)
- Geology: sand, little gravel, fine sand / silt on second half of the drive
- $\varnothing$ Performance: ~ 800mm/min (2.6ft/min)
- Max. Performance: > 1,200mm/min (4ft/min)
- Best daily performance: 126m (414ft)
- Pipe changing cycle: ~ 20min constant
- Jacking forces: mostly < 60ton
Pilot project February/March 2017.
Jobsite Layout.
Pilot project February/March 2017. 
Jobsite Impressions.
New development E-PowerPipe®
Second project in Conneforde, Germany.

- 6 x 300m (1,000ft)
- Mostly silt, sand, marl, boulders
- Curved drive, radius 500m
- Constant depth of 1m (3ft)
- Spacing of approx. 1m
New development E-PowerPipe®
Second project in Conneforde, Germany, January 2018.

- Project: 6 x 270m (890ft) drives
- Installation depth: 2.5-4.5m (8-15ft),
- curve radius: r=500m (1,640ft)
Conclusion | Outlook.

- Jet pump for HDD
  - Ideal for highly permeable soils.
  - Ideal for cleaning runs before the pipe pull in.
- Jet pump for small diameter **Pipe Jacking** (long distances)
  - **E-Power Pipe**® for shallow cable installations
  - New projects with long distances are already in line
Jet pump for Direct Pipe®

Beneficial for long distance crossings and small diameters <36
Together we build our future.

THINK POSITIVE!