New Jet Pump Technology for HDD & Long-distance Pipe Jacking in small diameters

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How to use a Jet Pump?

Pumping principles.

- **Rotary Pump**
  - Working Principle
  - Execution example
  - Characteristics:
    - Design size
    - Separate power unit
    - Moving/rotating parts

- **Jet Pump**
  - Working Principle
  - Execution example
  - Characteristics:
    - Small compact size
    - No power unit
    - No moving/rotating parts

Highlights:

- How to use a Jet Pump?
- Jet pump for HDD
  - Full-Face Hole opener & Downhole Jet Pump System
  - Variations
- Jet Pump for small diameter Pipe jacking (long distances)
  - Standard Pipe jacking
  - E-Power Pipe®
- Outlook for Jet Pump and Direct Pipe®

Jet Pump development in Herrenknecht AG.

- 2010: First test with jet pumps (student study)
- 2012: Further test with high pressure jet pumps on Herrenknecht plant
- 2014: Test plant for HDD down hole jet pump
- 2016: First pilot in HDD down hole tool
- 2016: First pilot test in AVN machine
- 2017: First AVNS machine for E-PowerPipe
- 2018: Jet pump standard tool for HDD and microtunnelling
Jet Pump for HDD

HDD limitations in permeable soils.

- Principle HDD arrangement of the borehole and drill string
- Return flow through borehole
- either to rig-site or to pipe-site

Jet Pump for HDD

HDD limitations in permeable soils - Conventional HDD vs. HDD with Jet Pump.

Jet Pump for HDD

Requirements for the Downhole Jet Pump.

- Min. Borehole diameter 20" (508 mm)
- Mud-Flow 400 gal/min – 530 gal/min (1500-2000 l/min)
- Mud-Pressure 725 psi – 870 psi (50-60 bar)
- Recycling capacity 792 – 924 gal/min (3000-3500 l/min)
- Recommended Drill Pipes 6 5/8"
- Flowmeter and swivel on Pipe-site
- Mud return-line from Pipe-site to Rig-site

Jet Pump for HDD

New: drill pipe used as discharge line.
Jet Pump for HDD

Applications for the Downhole Jet Pump.

Tandem mode: with Full Face hole opener for hard rock conditions

Single mode: with soft ground tool for reaming in soft ground conditions

Pipe pull mode during pipe pullback

Cleaning run before pipe pullback

Jet Pump for HDD

Benefits overview.

- Minimum frac-out risk during reaming.
- Possibility to use a simple and cost saving mud program.
- Clean borehole (98%).
- Immediate formation feedback on the separation plant (1,000m = 3,280ft = 7 min.)
- Transportation of larger cutting sizes
- Min. wear on the tools (service life high)
- 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 HDD

Requirements for the Downhole Jet Pump.

- 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, flintstone
- Contractor: BAB Rörtryckning AB

Jet Pump for HDD

Slurry circuit in Pipe Jacking.
Jet Pump for Pipe Jacking
State-of-the-art rotary slurry pumps.

Jet Pump for Pipe Jacking
Alternative to centrifugal slurry pumps.

Characteristics
- Compact design size + drill diameter > 500mm
- No separate power unit in machine
- No moving/rotating parts ➔ less service & maintenance
- Conveying length >1.000m with one jet pump in machine

First 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

E-POWER PIPE
New development E-PowerPipe®
High Voltage Power Grid in Germany.

- Intention to replace nuclear power plants by renewable energy until 2025.
- North – South connections (New DC lines) with underground cables
- 1.500 to 2,250km (900 – 1,600 mi.)
- Protests against overhead lines lead to trenchless technology.
- Commissioning of North-South connections in 2025

New development E-PowerPipe®
Requirements by Transition System Operators (TSOs).

- 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: 1.000-1.500m (3,300ft – 4,000ft)
  - Depth: 2-4m (5ft to 13ft) constant
  - Diameter casing: 250-400mm (DN10” – 16”)
  - Casing material: plastic, non-conductive, e.g. PEHD
  - Distance between lines: 1m (3ft), constant
- Available on market: 2017

Comparison trenchless installation methods - Limitations.
New development E-PowerPipe®
New AVNS-Machine.

Installation process.

Step 1
Pilot Bore to target point with preliminary casing pipes

Step 2
Disassembly of pipe jacking machine

Step 3
Mounting of pullhead and product pipe and pullback

New development E-PowerPipe®
New steel jacking pipes.

Characteristics
- Smart coupling system
- All pipes and cables integrated
- Less couplings
- Life time

Pipe length 9m

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 340t
- All coupling steps in one operation
New development E-PowerPipe®
First project in Germany.
- 3 x 300m (1,000ft)
- Mostly silt, sand, marl
- Constant depth of 1m (3ft)
- Spacing of approx. 1m

New development E-PowerPipe®
Second project in Germany.
- 6 x 300m (1,000ft)
- Mostly silt, sand, marl, boulders
- Curved drive, radius 500m
- Constant depth of 1m (3ft)
- Spacing of approx. 1m
Outlook for Jet Pump and Direct Pipe®

- 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.

Outlook for Jet Pump and Direct Pipe®

- Jet pump for Direct Pipe®
  - Beneficial for long distance crossings and small diameters <36".

Together we build our future.