HAMMELMANN®

High pressure water jetting in the Oil & gas Petrochemical industry

What needs to be cleaned

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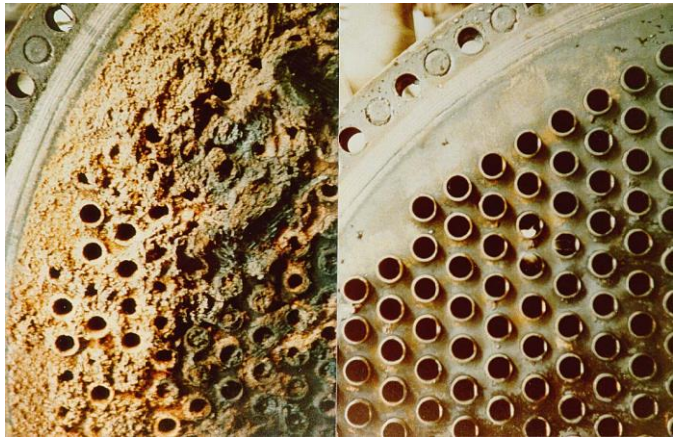
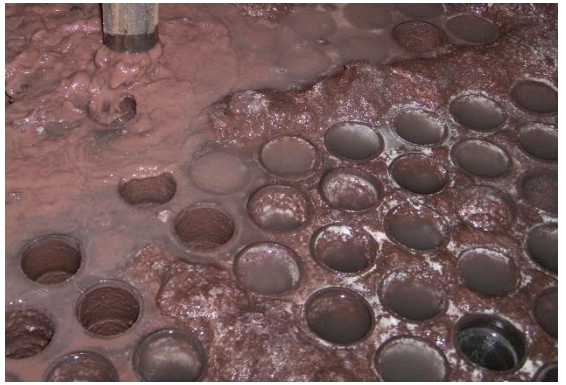
Heat exchanger bundles - tubes inside





What needs to be cleaned

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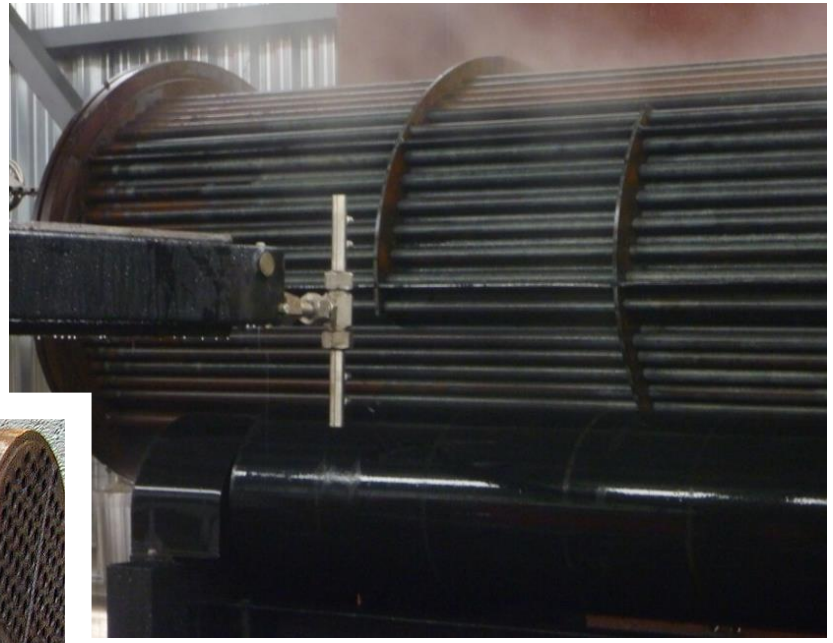
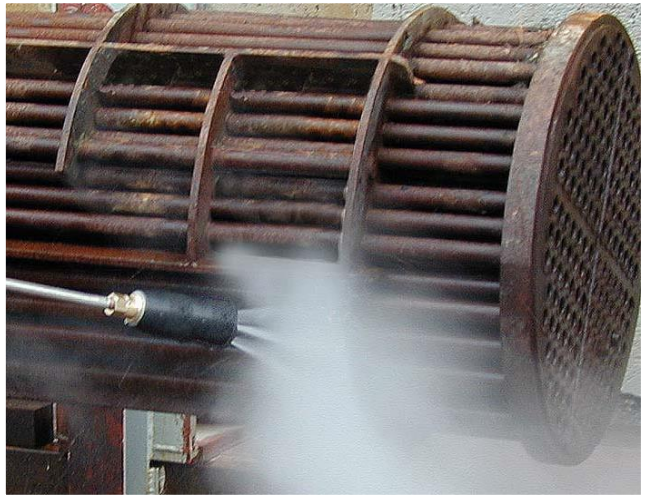
Heat exchanger bundles - shellside

Photo Peinemann





What needs to be cleaned

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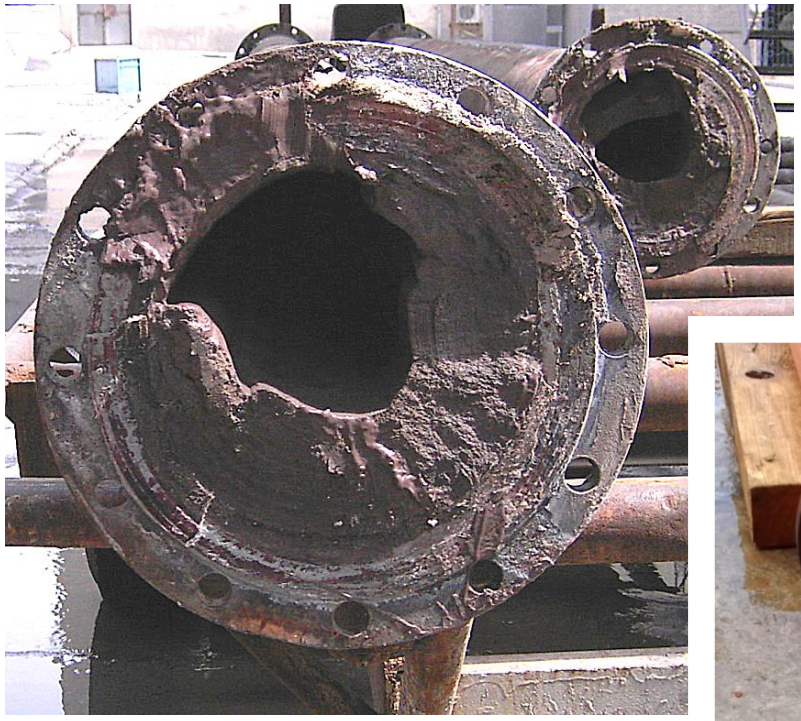
Pipes and pipelines – internal



What needs to be cleaned

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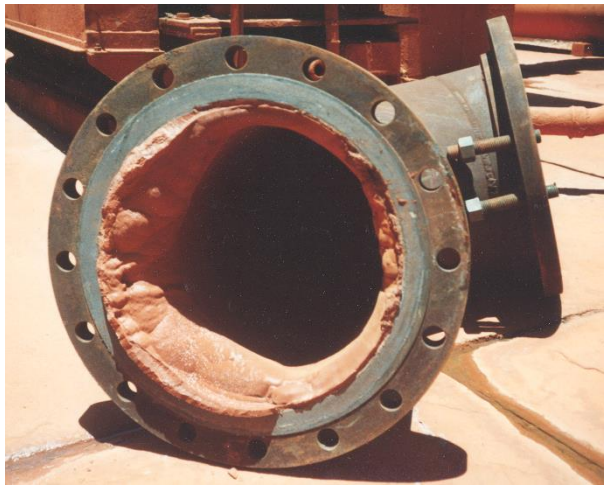
Pipes and pipelines – internal

pipe elbows, shutt-off valves, housings, etc…



What needs to be cleaned

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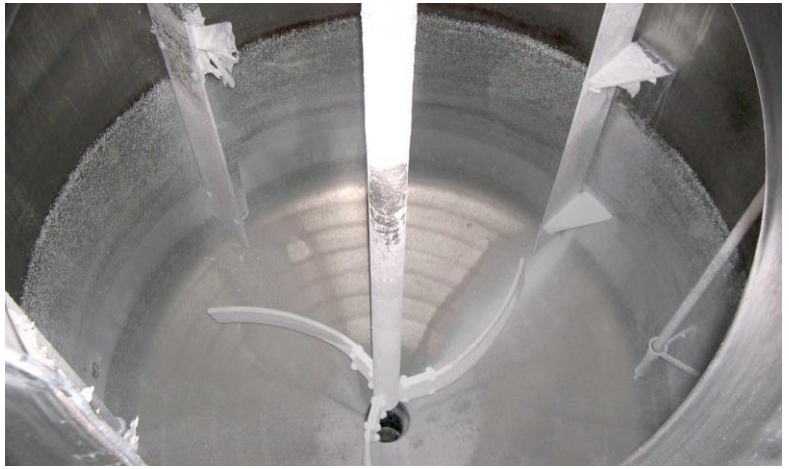
Tanks, vessels, reactors, autoclavs



What needs to be cleaned

Storage tanks – coating removal

Heat exchanger cleaning – tubes internal

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Most common method:
manually operated flexible lance with a pipe cleaning nozzle

Working pressure in oil & gas and petrochemical industy
up to *1200 bar*

Advantages

- Highly flexible deployment
- Minimum space requirements
- Quick setup time
- Relatively low investment costs

Disadvantges

- Low performance
- No push forces possible at the nozzle
- Safety is not up to date

Heat exchanger cleaning – tubes internal

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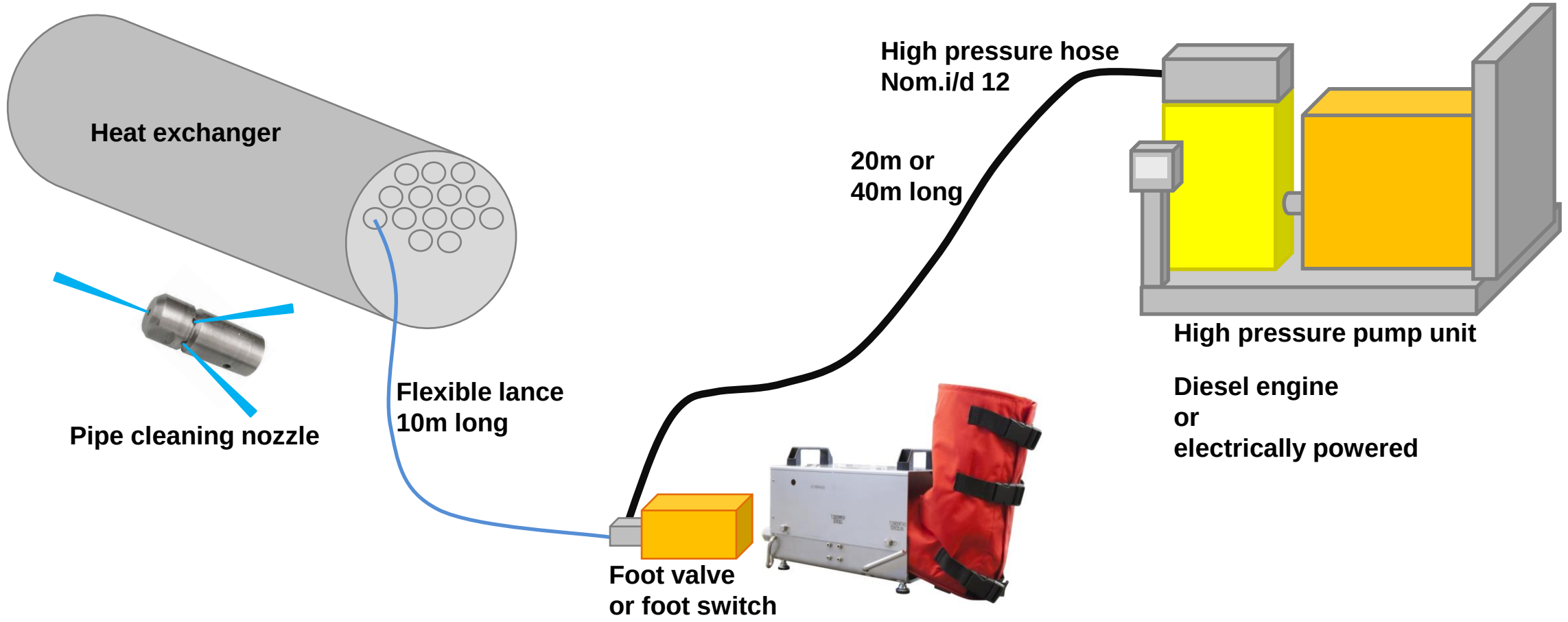
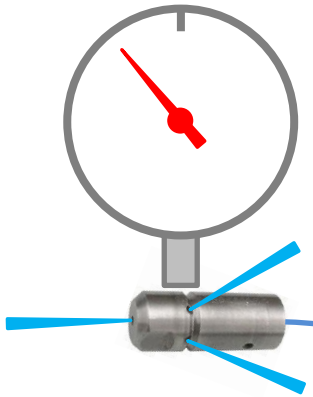
Typical setup for manual heat exchanger bundle cleaning by using flexible lances



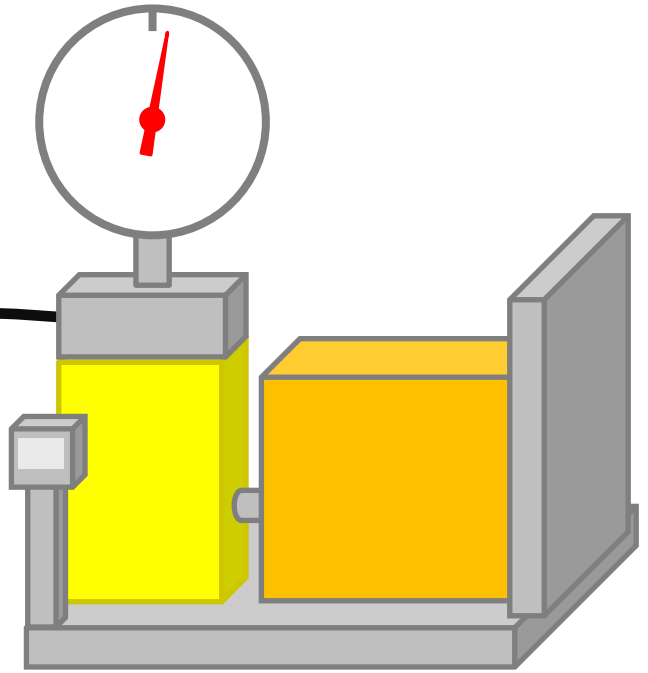
Heat exchanger cleaning – tubes internal

Recommended flow rates dependent upon inside diameter of flexible lance:

Nom. i/d 4 mm ➔ max. approx. 30 l/min
Nom. i/d 5 mm ➔ max. approx. 50 l/min
Nom. i/d 6 mm ➔ max. approx. 75 l/min



Wall and fluid friction results in pressure loss between the pump and the nozzle.



High pressure pump unit

The extent of pressure loss is dependant in the main on the velocity of the medium and the length of the hose line.

Foot valve

Heat exchanger cleaning – tubes internal

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Pressure loss from pump unit to nozzle tip – approximate calculation

Nom. i/d 4

Flow rate & pressure loss

UNIT

Unit: Please select

Flowrate: 31 l/min (31 l/min)

HOSE CONFIGURATION

AMOUNT	LENGTH	TYPE
2	20 m	DN 12
1	10 m	DN 4

+ Add another hose

NOZZLE CONFIGURATION

NOZZLE TYPE	AMOUNT	NOZZLE-Ø	ANGLE
Direkt gebohrte Düse	1	0.5 mm	0 °
Direkt gebohrte Düse	3	0.9 mm	120 °

+ Add another nozzle

1 046 bar Overall Pressure

330 bar 330 bar Pressure Loss

-70 N Reaction Force

Nom. i/d 5

Flow rate & pressure loss

UNIT

Unit: Please select

Flowrate: 50 l/min (50 l/min)

HOSE CONFIGURATION

AMOUNT	LENGTH	TYPE
2	20 m	DN 12
1	10 m	DN 5

+ Add another hose

NOZZLE CONFIGURATION

NOZZLE TYPE	AMOUNT	NOZZLE-Ø	ANGLE
Direkt gebohrte Düse	1	0.7 mm	0 °
Direkt gebohrte Düse	5	0.85 mm	120 °

1 067 bar Overall Pressure

275 bar 275 bar Pressure Loss

-106 N Reaction Force

Nom. i/d 6

Flow rate & pressure loss

UNIT

Unit: Please select

Flowrate: 75 l/min (75 l/min)

HOSE CONFIGURATION

AMOUNT	LENGTH	TYPE
2	20 m	DN 12
1	10 m	DN 6

+ Add another hose

NOZZLE CONFIGURATION

NOZZLE TYPE	AMOUNT	NOZZLE-Ø	ANGLE
Direkt gebohrte Düse	1	1 mm	0 °
Direkt gebohrte Düse	5	1 mm	120 °

+ Add another nozzle

1 083 bar Overall Pressure

250 bar 250 bar Pressure Loss

-127 N Reaction Force

Note! Pressure losses

Calculations done by using the Hammelmann APP

Get it on

iOS App-store

Android Play-store

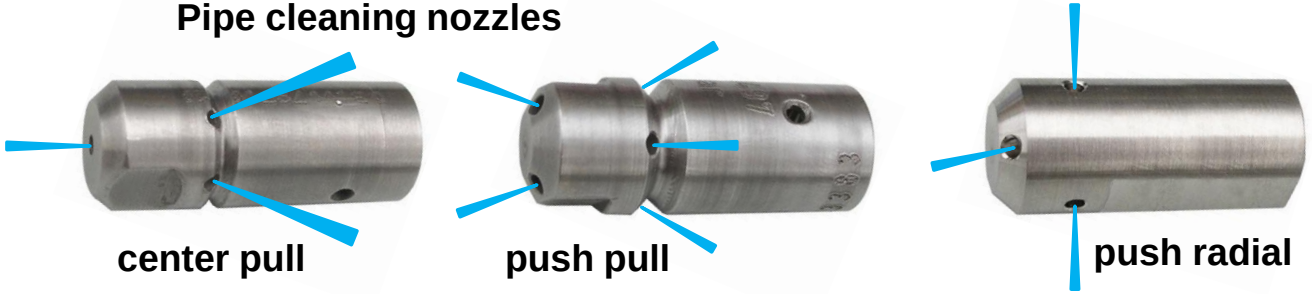
or use online in your web-browser

www.hammelmann.de

Heat exchanger cleaning – tubes internal

Equipment

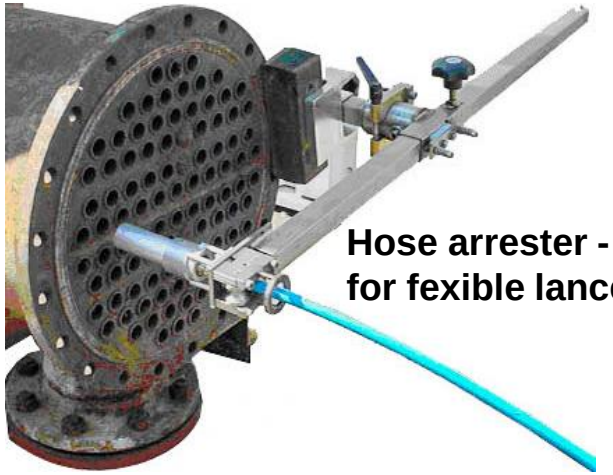
Pipe cleaning nozzles



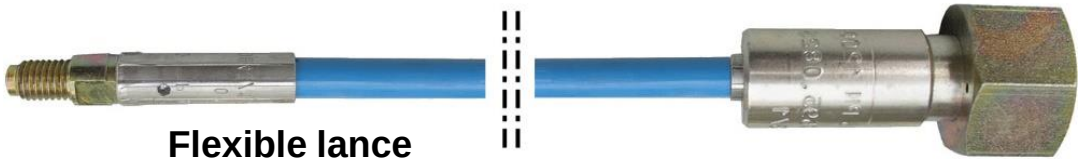
center pull

push pull

push radial



Hose arrester - safety catch
for fexible lance



Flexible lance
available in different lengths and inside diameter

Stinger (up to 500mm) or rigid lances (up to 6,0m)

Foot valve
up to 1000 bar

Foot switch

Heat exchanger cleaning – tubes internal

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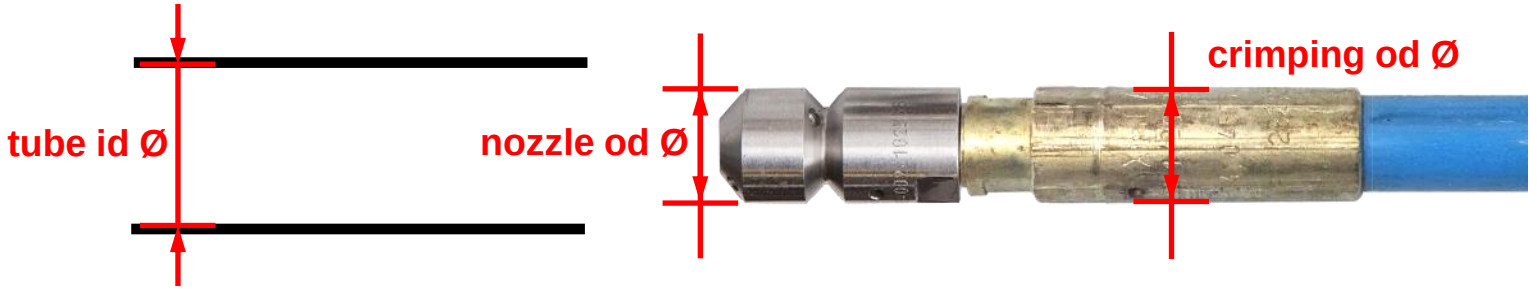
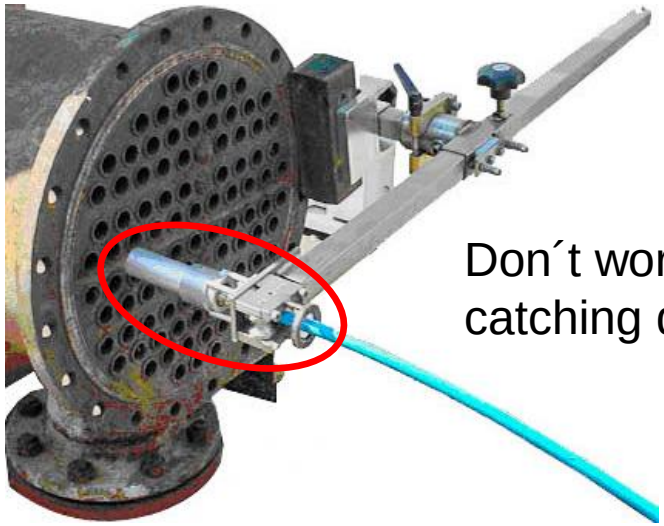
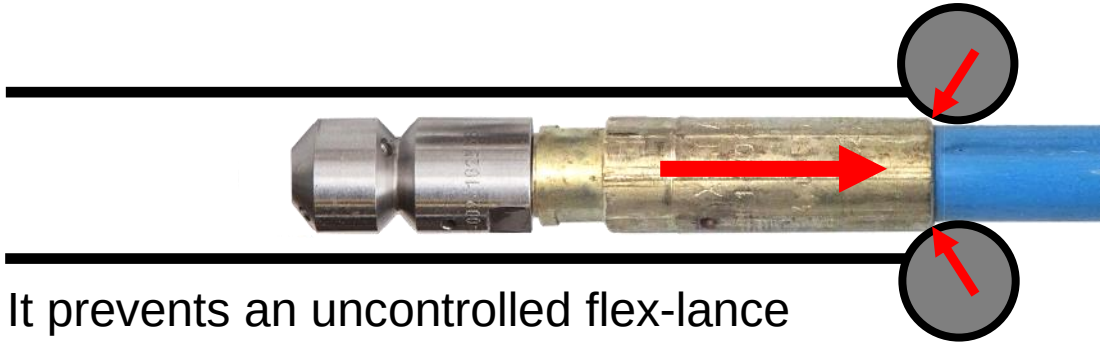
Safety note!



⚠ Tube inside diameter must be at least 2 mm greater than nozzle outside diameter or crimping diameter



Don´t work without hose catching device!



It prevents an uncontrolled flex-lance leave out of the tube

Heat exchanger cleaning – tubes internal

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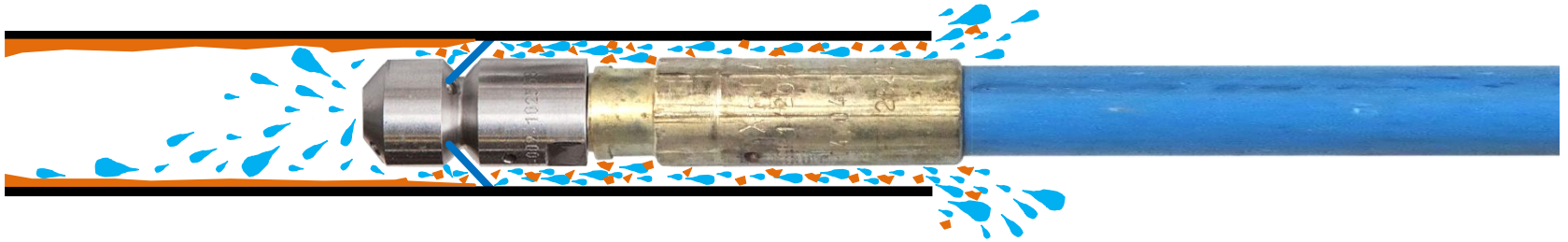
Light scale, nozzle can allways pass the tube



Heavy scale, nozzle can not pass the tube – not fully clogged

Fully clogged tube

Heat exchanger cleaning – tubes internal

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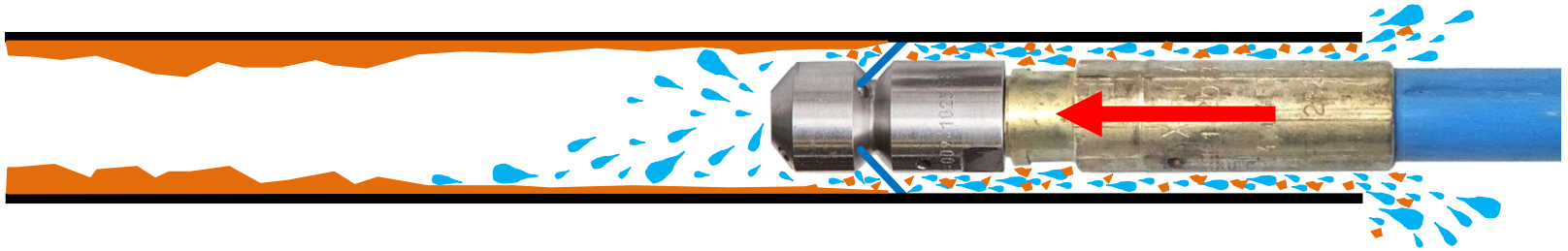
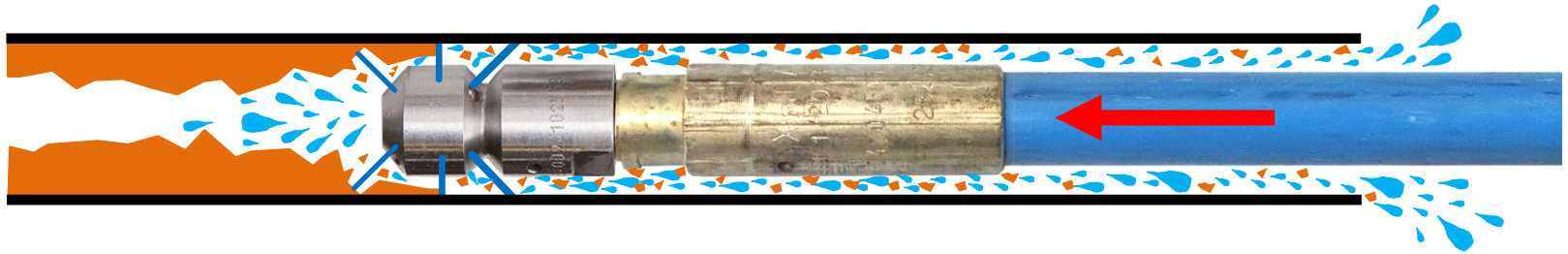
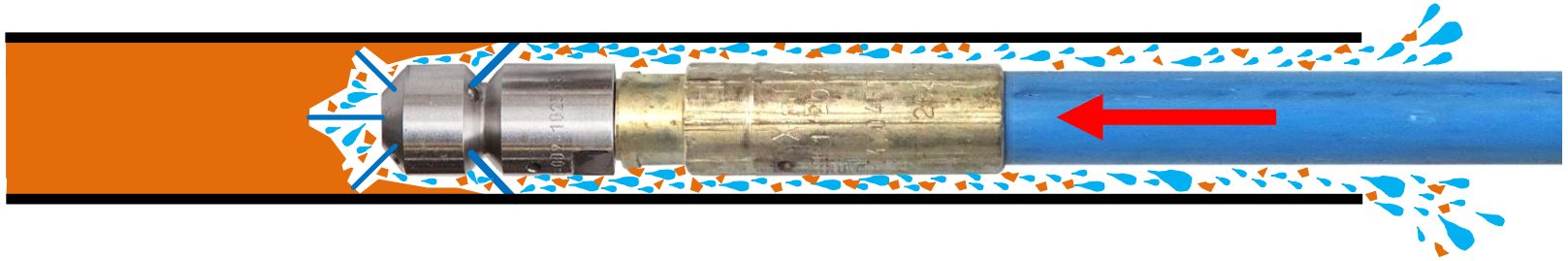
Light scale: PULL or PULL - RADIAL nozzle



Heavy scale: PULL – PUSH or PULL – RADIAL – PUSH nozzle



Fully clogged tube: PULL – PUSH – CENTER nozzle

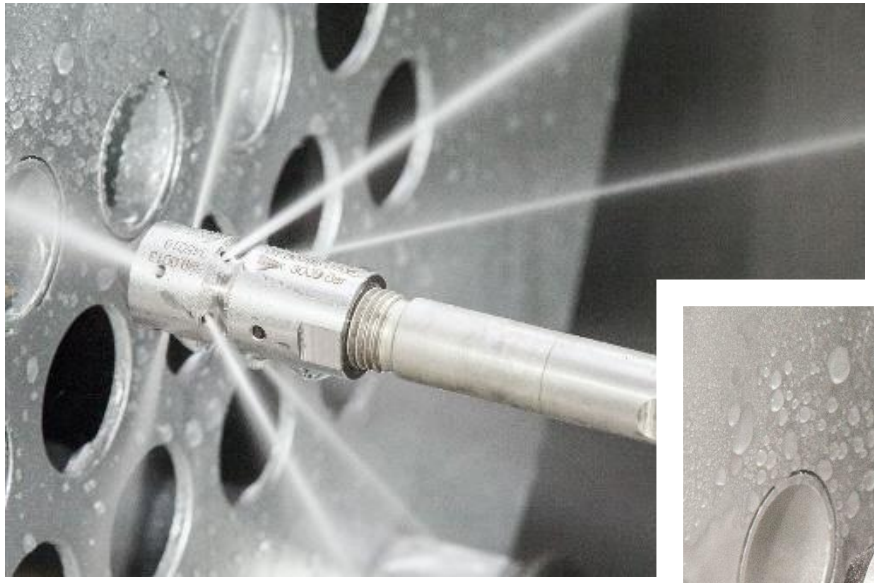


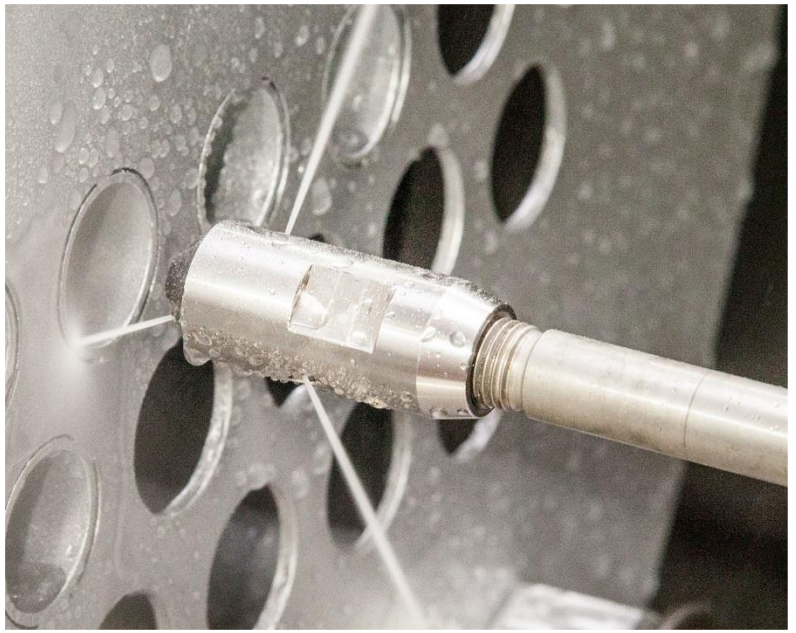
Make sure that the resultant reaction force of the nozzle is allways directed into the tube.

Pipe cleaning nozzles used at flex-lances have to have PULL reaction forces

Heat exchanger cleaning – tubes internal

Static pipe cleaning nozzles





Heat exchanger cleaning – tubes internal

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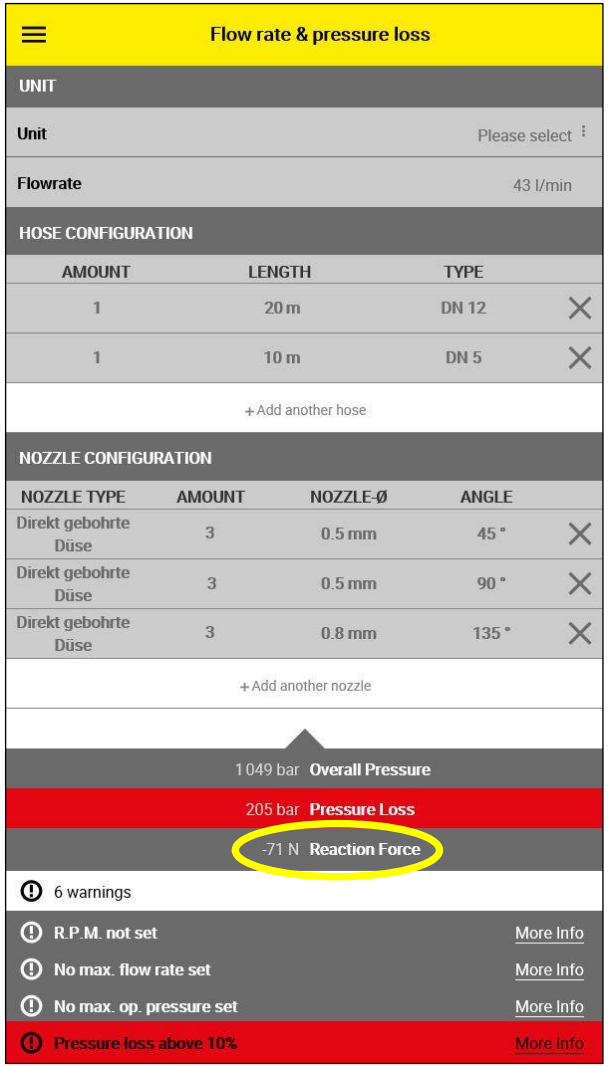
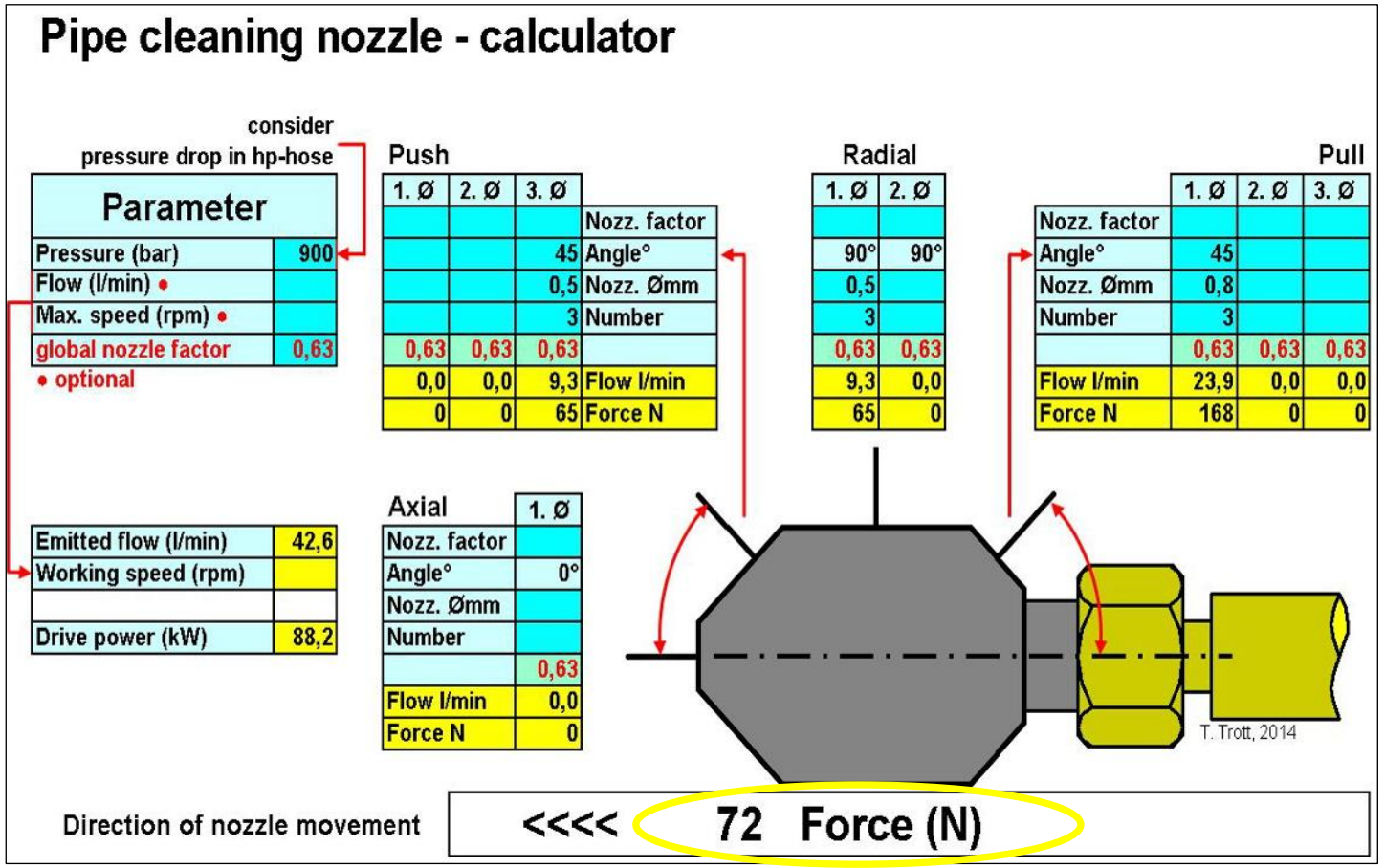
Use HAMMELMANN App or nozzle calculator to determine the reaction force of a pipe cleaning nozzle





Heat exchanger cleaning – polishing tubes internal

Common method

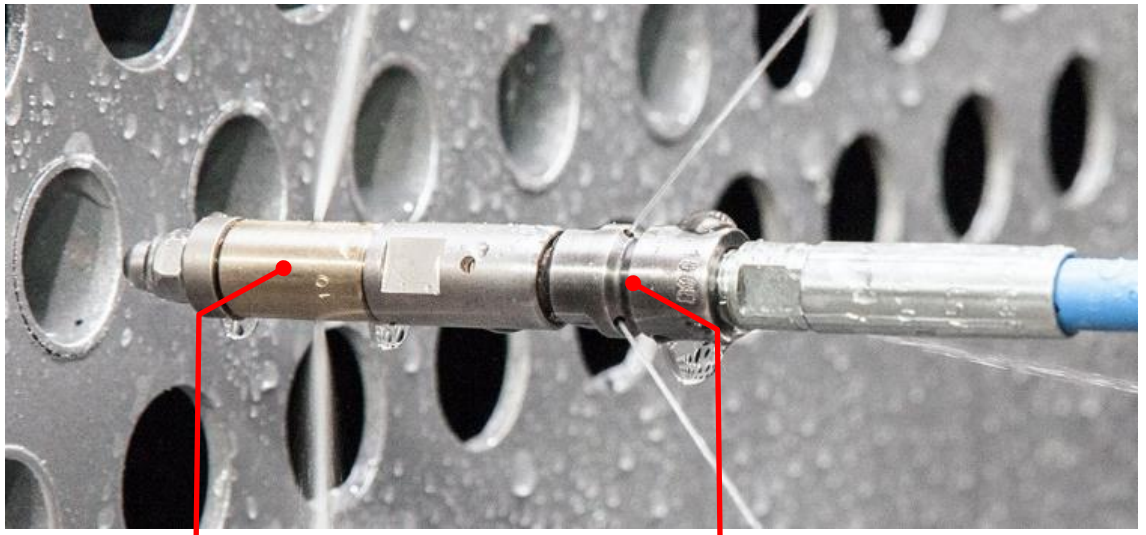
1 Step: fixed (static) nozzle for descaling, unplugging or rough cleaning

2 Step: Turbojet to polish the tube

Turbojet is a fast spinning nozzle to remove remaining spots of scale – final cleaning step

Sometimes combined with a driver nozzle

Custom made Turbojet with driver and static push nozzles



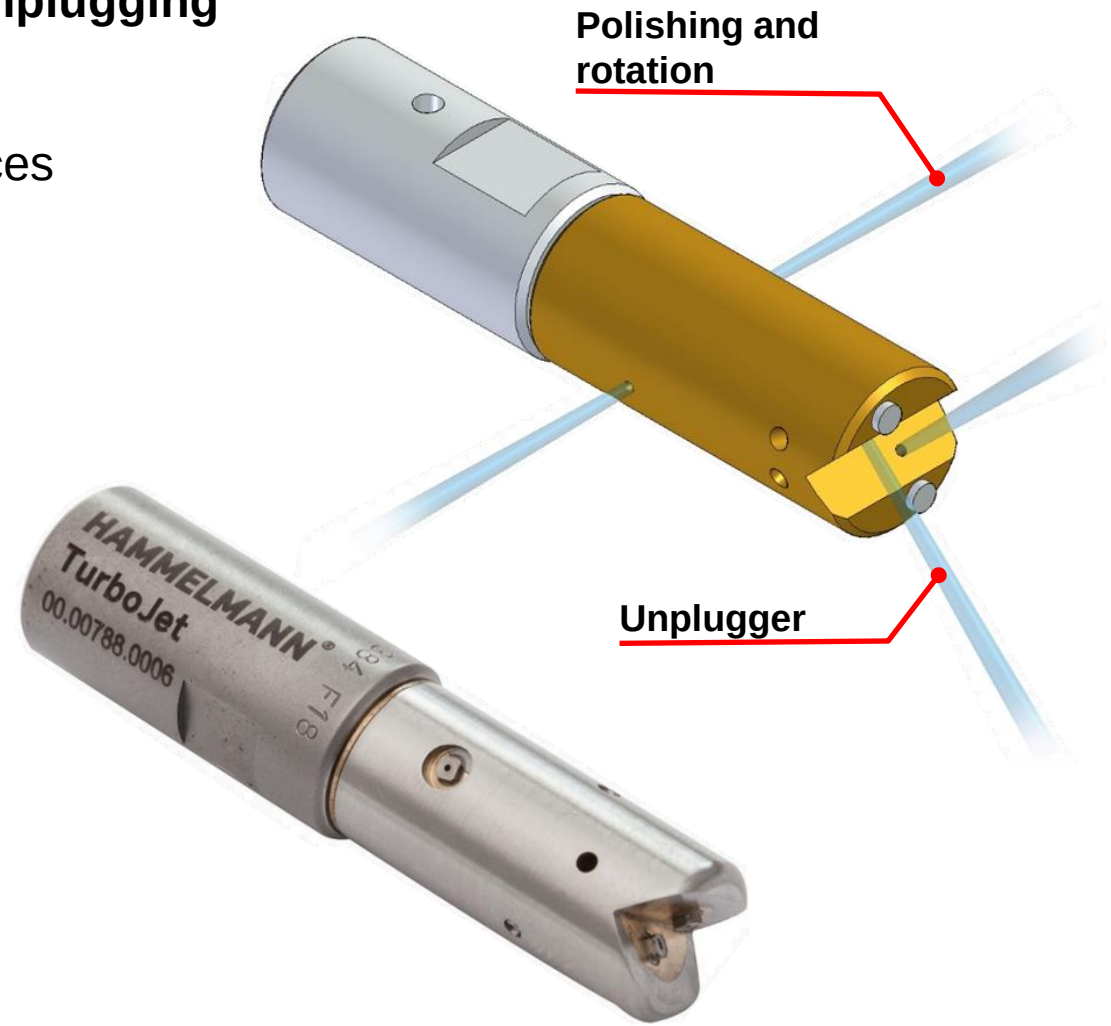
Turbojet rotating nozzles

Static driver nozzle

Heat exchanger cleaning – tubes internal

Turbojet with two forward directed cross-jets for unplugging

- Possible with soft deposits
- Has allways be combined with a driver at a flex-lances
- Two additional radial nozzles necessary for rotation
- Requires relatively high flow rates



Heat exchanger cleaning – tubes internal

HAMMELMANN®

Attention should be paid to:

- Heat exchanger bundles in U-shape
  - U-turns of inner tubes can´t be passed by the nozzle – not possible to clean
  - Nozzle comes back to operator at the outer tubes
- Crimping diameter of smallest available flex-lance is 11mm. Means smallest tube diameter is 13mm
- Consider the dramatic possible pressure loss at flex-lances with a small nominal diameter
- Use a foot valve or foot switch to controll the pump. Both hands are free to hold the flex-lance
- Hazardous area – ATEX zone? equipment has to be certified

U-shape heat exchanger bundle

Heat exchanger cleaning – tubes internal

Rigid lances – manually operated

Nozzles with PUSH forces possible

- \+ More efficient at fully clogged tubes or at tubes with massive and hard scale
- \- Long lances and in vertical position, difficult to handle. Turning more difficult
- \- Applicable at straight tubes only
- \+ Working pressure up to 3000bar possible
- ► Maximum length is about 6 m, smallest outside diameter is Ø10 mm

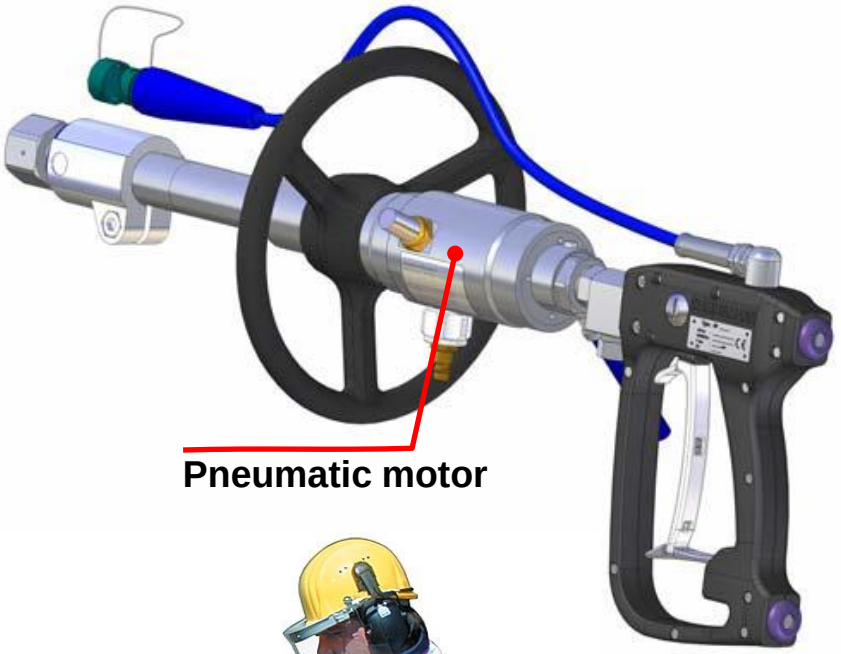
Cleaning with rigid lances

Heat exchanger cleaning – tubes internal

HAMMELMANN®

Spray gun with slowly rotating lance – SP 3000 PR ER3

- Ideal in combination with PUSH nozzles – for fully clogged tubes or hard and heavy deposits
- Pneumatic driven rotating lance
- Speed adjustable from 100 up to 600 rpm
- Max. operating pressure: 3000 bar
- Flow rate up to 30 l/min possible
- Recommened max. lance length: 4 m
- Available lance outside diameter:
  Ø14,3 mm or Ø10 mm



Heat exchanger cleaning – tubes internal

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Cleaning of spiral heat exchanger

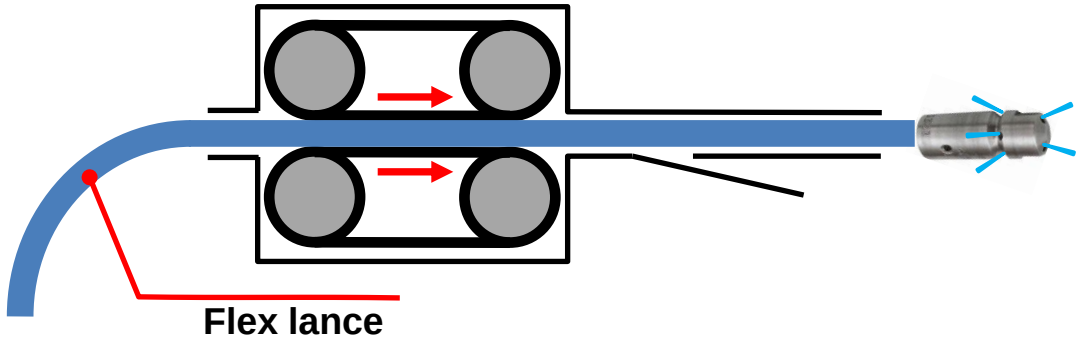
Pump performance:
24 l/min @ 2000bar

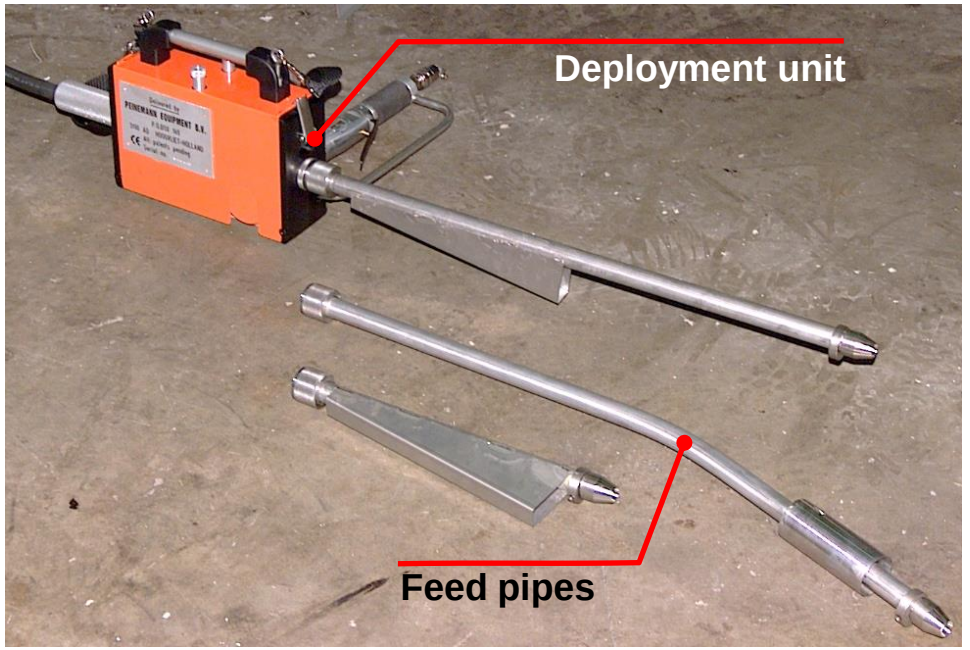
Heat exchanger cleaning – tubes internal

HAMMELMANN®

Semi automatic single lance tube claner 1-LTC

- Pneumatically powered lance deployment and retraction unit
- Only PULL nozzles possible
- For static pipe cleaning nozzles or Turbojets
- Operating pressure dependent on flex lances and nozzles which are used
- Flow rate also limited by nom.id of flex lance
- Increase safety; No hands directly on flex lance!
- Increased efficiency, better cleaning result due to uniform feeding speed
- Max. feeding speed: 0,5 m/s
- Weight: 9 kg





Heat exchanger cleaning – tubes internal

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Single lance tube cleaner 1-LTC in action

Ideal for inplant use. Quick setup, flexible, safe

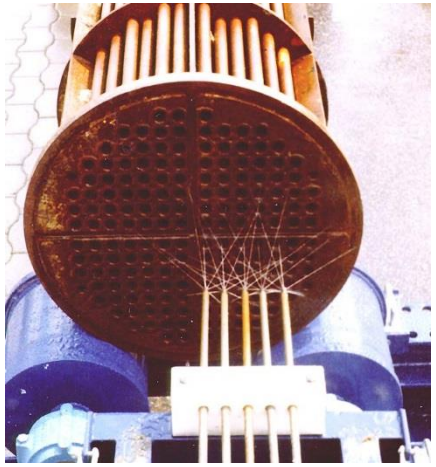
Working in all positions possible – horizontal, vertical, overhead

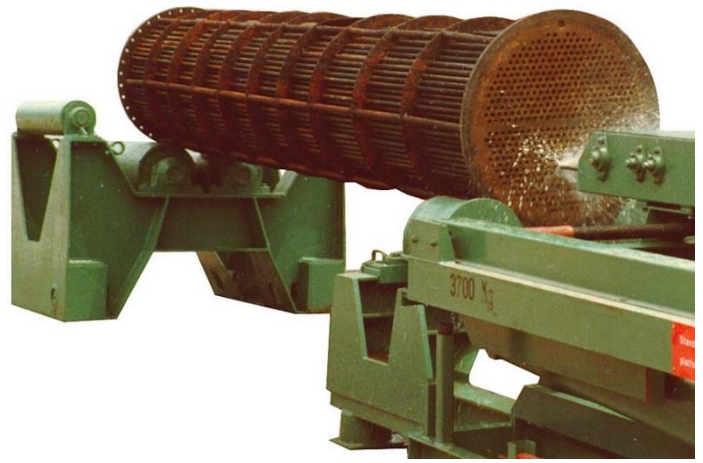
Heat exchanger cleaning – tubes internal

HAMMELMANN®

Multiple rigid lance tube cleaner

- High performance, up to five lances possible, with a corresponding high pressure pump unit
- Semi automatic operation
- Highest safety level
- For operation at a cleaning area – heat exchanger bundles have to be pulled out
- Frequently used for big shut downs
- Peinemann Equipment from Netherlands is world market leader –
  Cooperation with Hammelmann
- Combination with an outside bundle cleaning system possible – usefull supplement





Heat exchanger cleaning – tubes internal

HAMMELMANN®

Pipemaster - single rigid lance drilling system

- Designed to remove hardest deposits and clean fully clogged tubes
- PUSH nozzles possible for highest performance at fully clogged tubes
- Hydraulically driven rotating rigid lance
- Operating pressure up to 3000 bar
- Index-frame to position lance carrier system, max. bundle diamater approx. 2,0 m
- For horizontal or vertical operation (with an additional index-frame)
- Tube length up to 12,0 meter
- System will be adapted to customer requrements

Lance carrier and support system

Index-frame

Heat exchanger cleaning – tubes internal

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Pipemaster in action

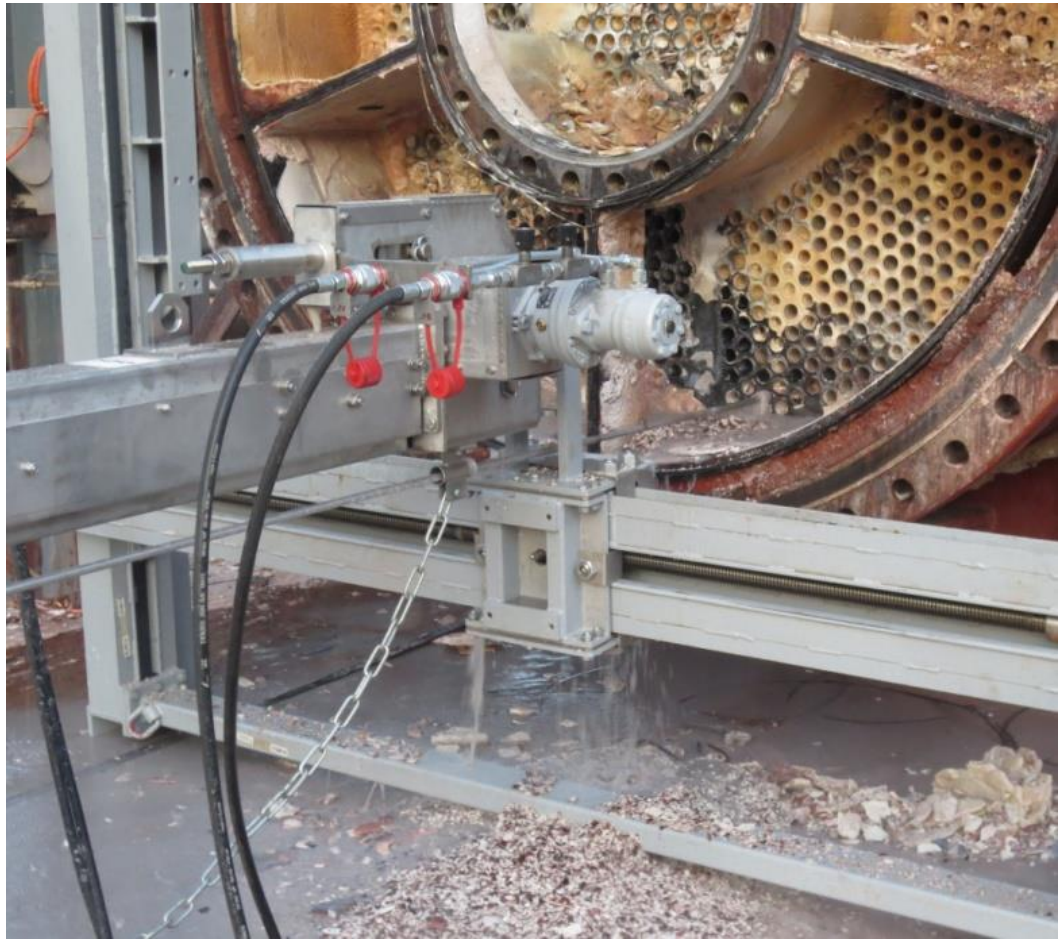
Pipemaster vertical – PVC plant

Pipemaster horizontal – Alumina refinery

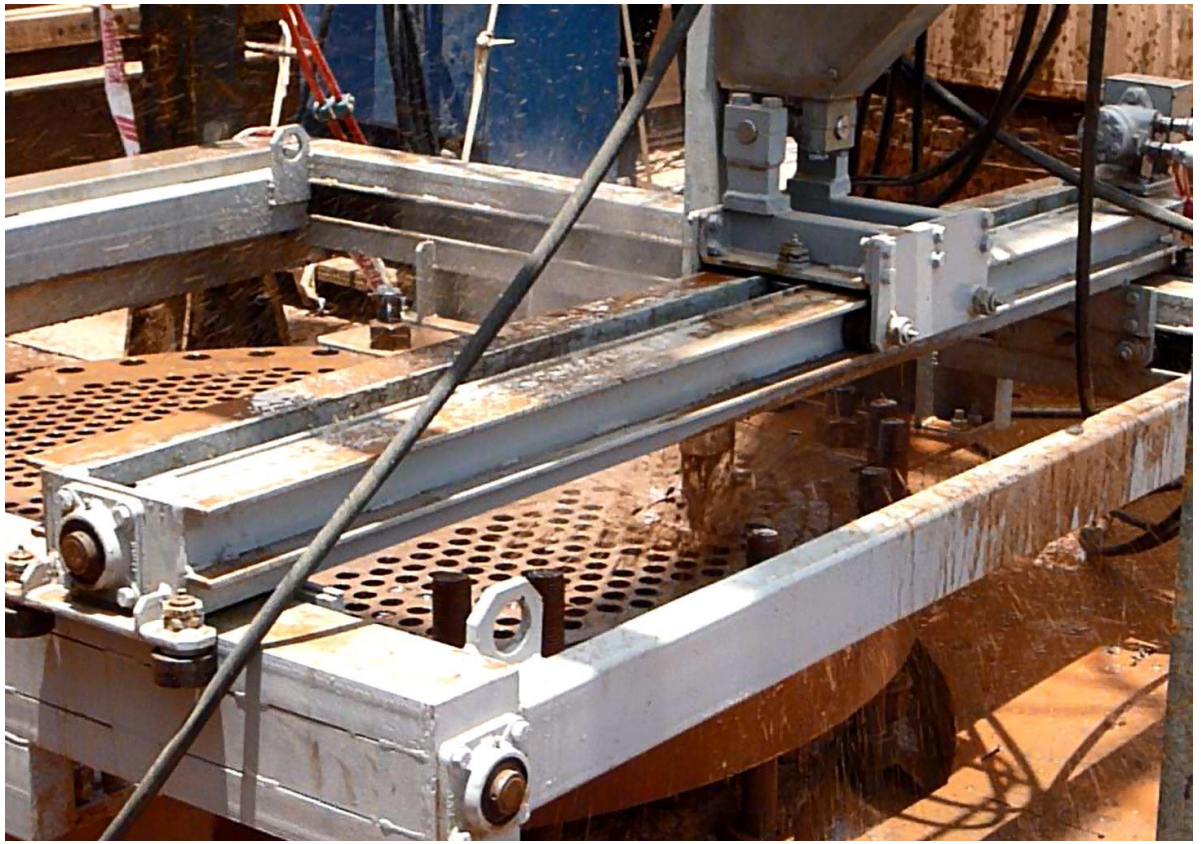
Heat exchanger cleaning – tubes internal

HAMMELMANN®

Pipemaster in action



Pipemaster horizontal – Alumina refinery



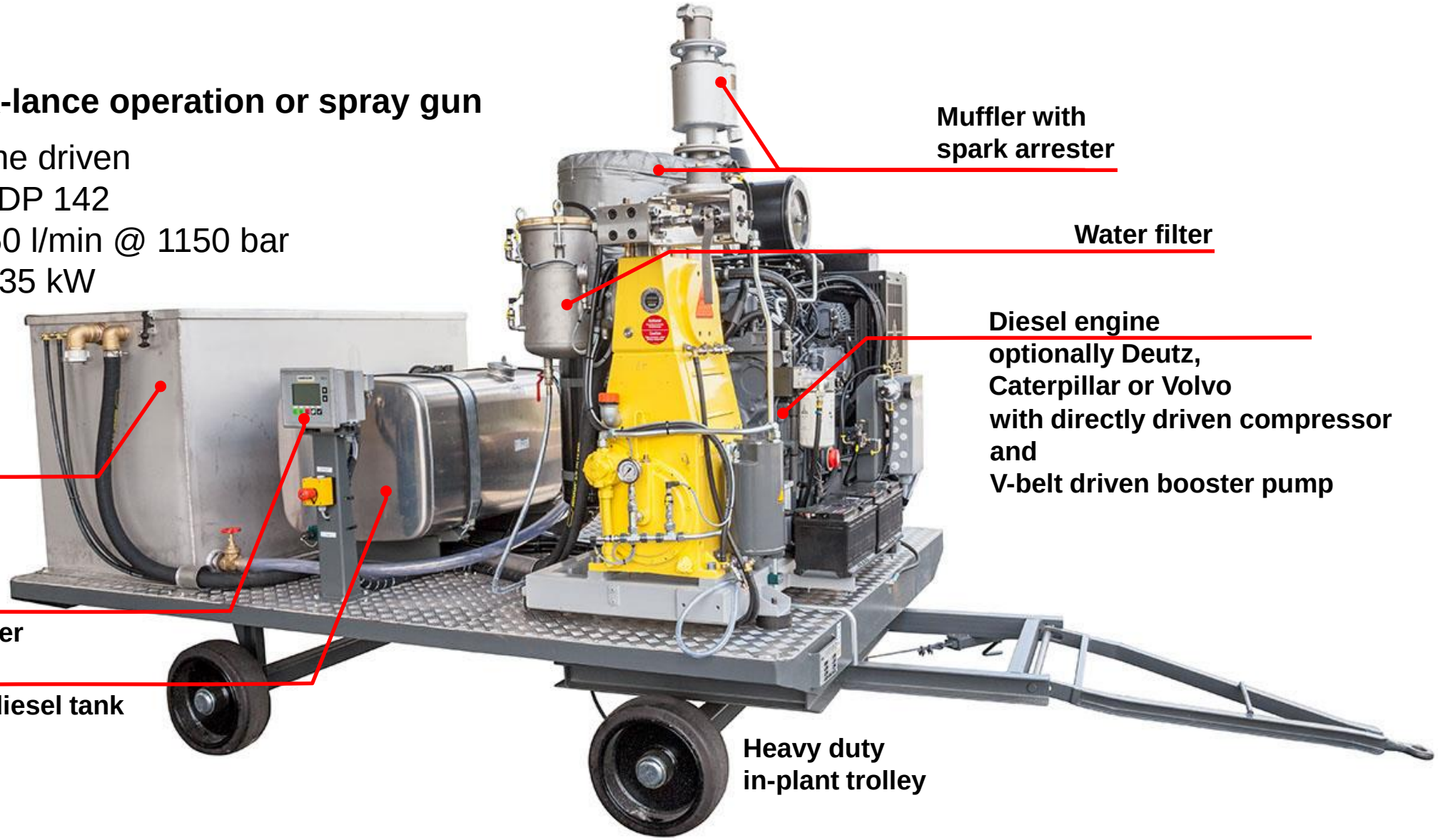
Pipemaster vertical -
cleaning a fully clogged tube

Pump units

HAMMELMANN®

For single flex-lance operation or spray gun

HDP 122 engine driven
since 2017 – HDP 142
Performance: 50 l/min @ 1150 bar
Motor rating: 135 kW

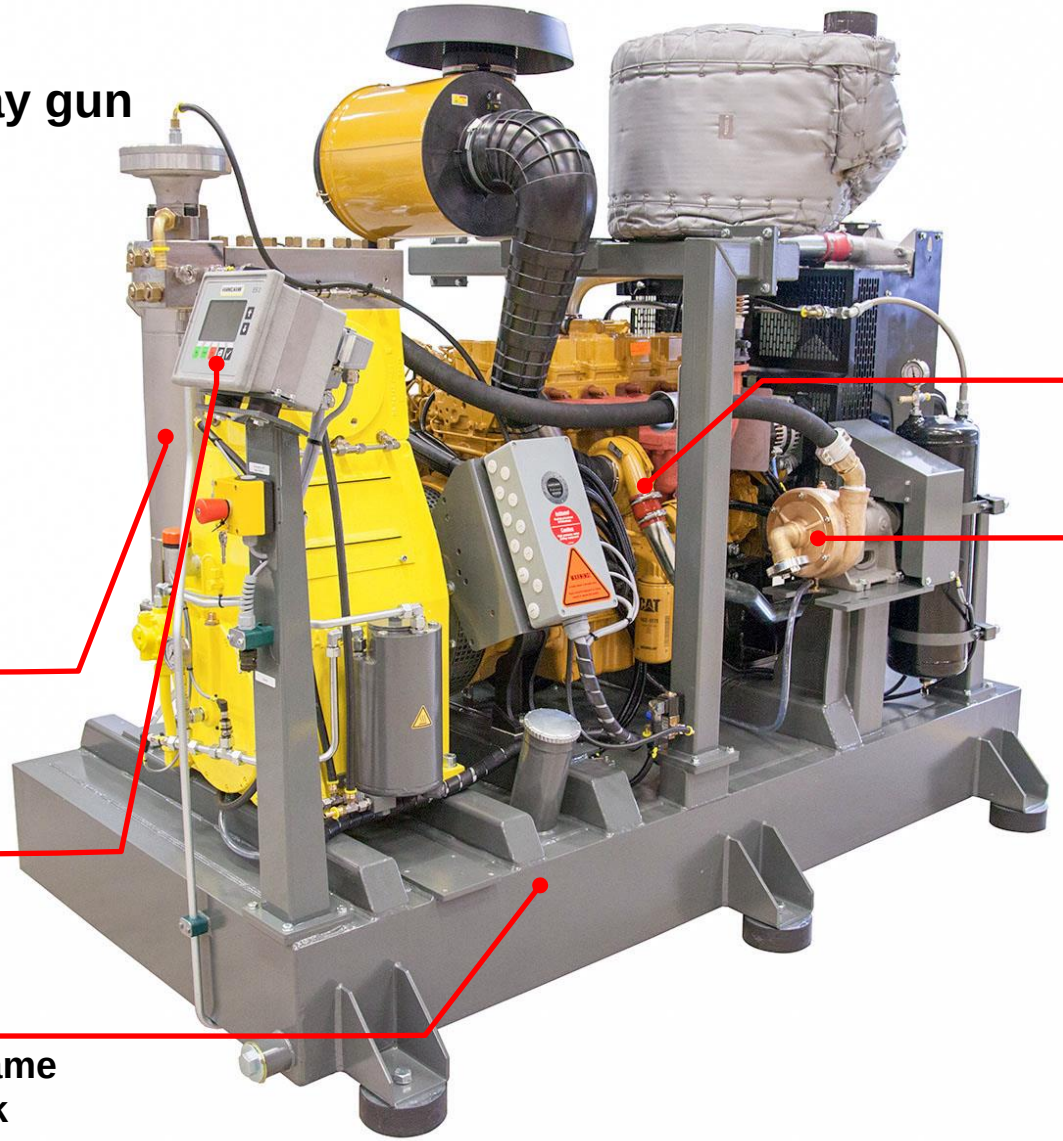


Pump units

HAMMELMANN®

For single flex-lance operation or spray gun

HDP 170 engine driven
since 2017 – HDP 200
„stationary design“
Performance: 87 l/min @ 1200 bar
Motor rating: 230 kW



Pump units – singe flex-lance or spray gun work

HAMMELMANN®

For single flex-lance operation or spray gun

Example:
HDP 122 electrically driven
since 2017 – HDP 142
Performance: 50 l/min @ 1150 bar
Motor rating: 110 kW

Heat exchanger cleaning – shell side

Semi automatic outside bundle cleaner OBC

- Spray bar with 3 to 5 nozzles moving alongside of the tube bundle
- All axis hydraulically controlled and moved
- Heat exchanger bundle supported on heavy duty rollers – tube bundle can be rotated
- In most cases operating pressure of 1000 bar is sufficient
- Flow rates greater than 200 l/min recommended (dependent on nozzle quantity)

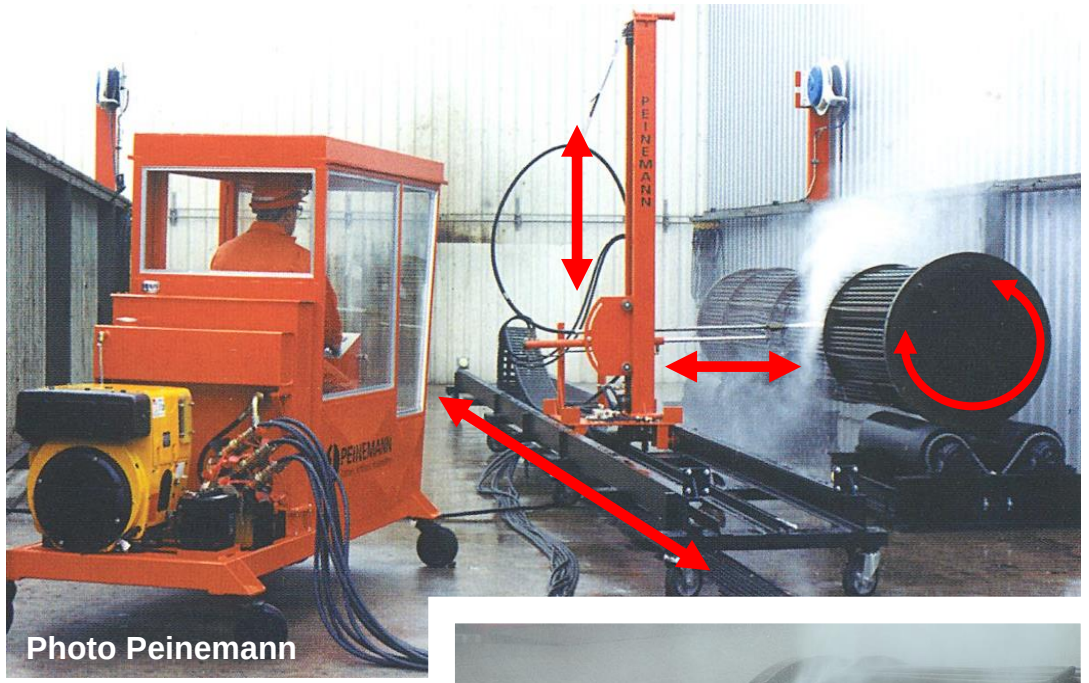
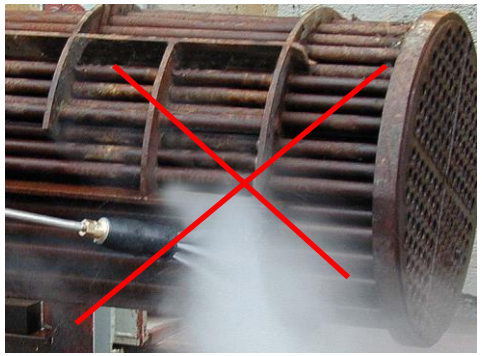


Photo Peinemann



Use of handheld spray guns is unefficient – too slowly and poor cleaning inside of tube bundle

Heat exchanger cleaning – shell side

HAMMELMANN®

Semi automatic outside bundle cleaner OBC

Typical setup – Inside bundle cleaner and outside cleaner

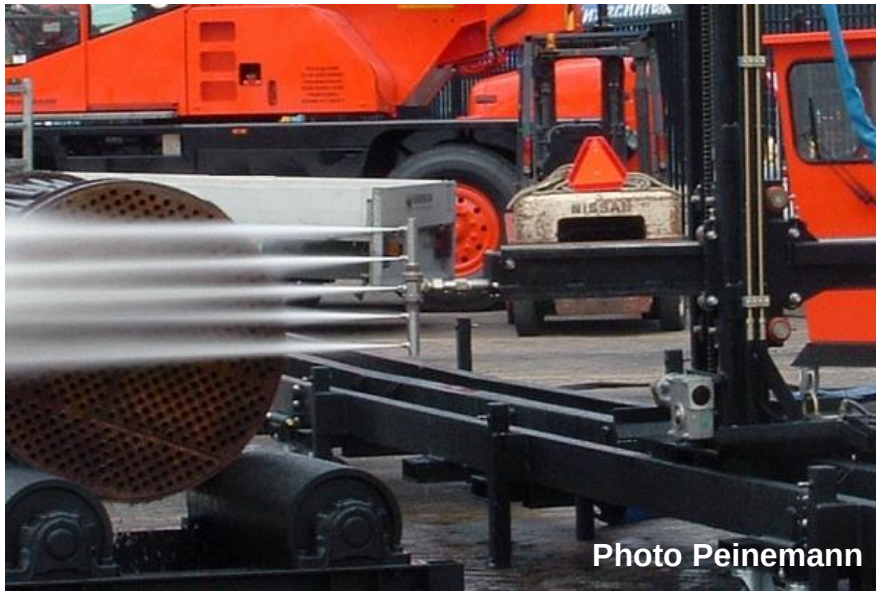
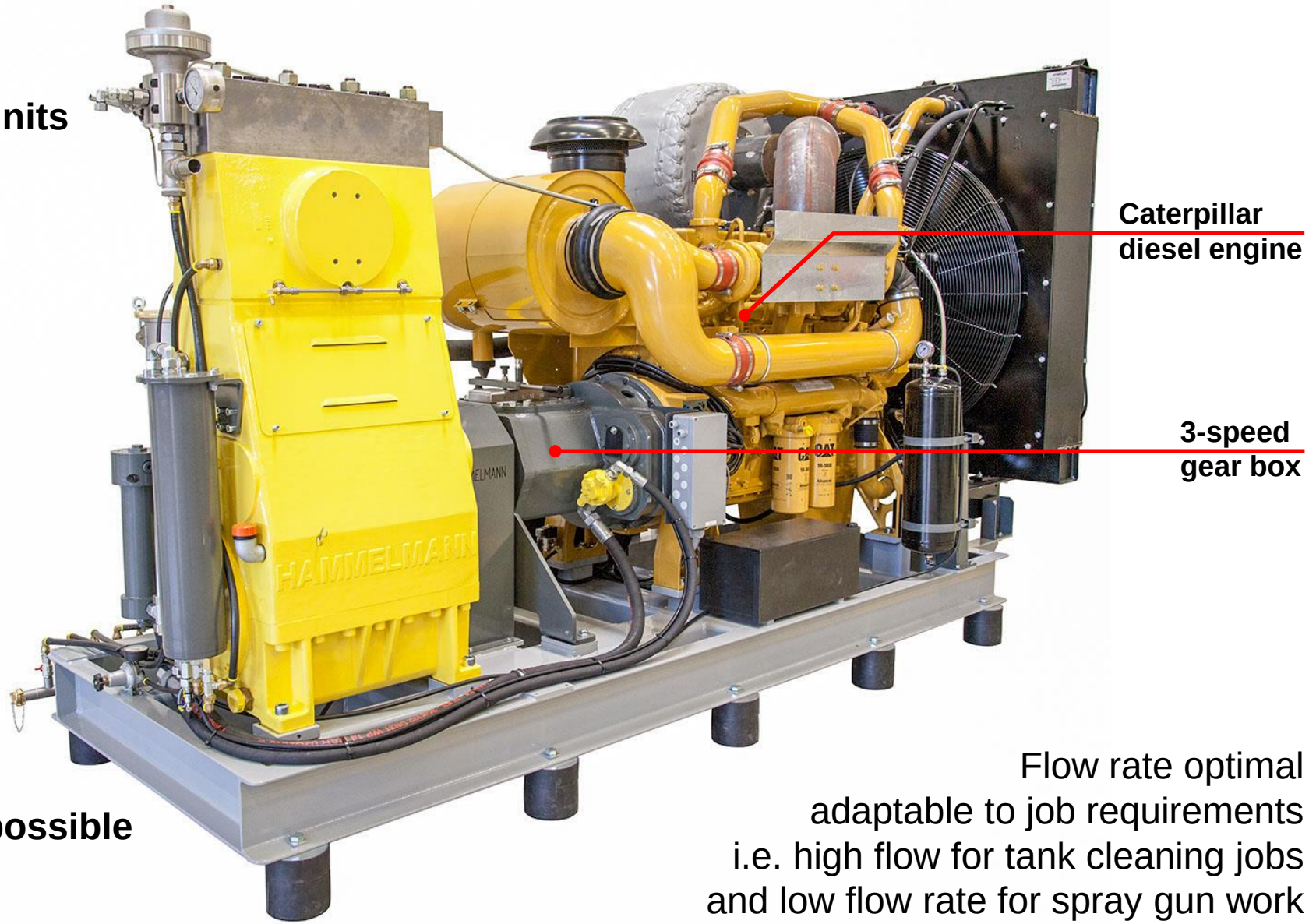


Photo Peinemann

Pump units

High performance pump units

HDP 500 engine driven
with a 3-speed gear box
Motor rating: 565 kW
Performance:
Max. op. Pressure: 1040bar
Flow rates:
1. gear: 262 l/min
2. gear: 131 l/min
3. gear: 44 l/min



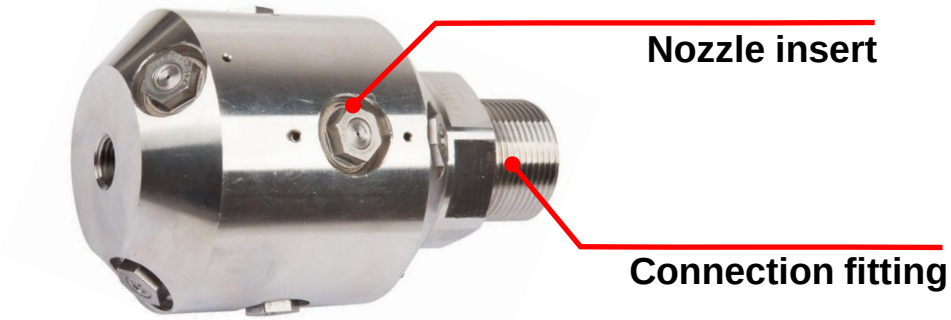
Fuel savings up 70 l/min possible

Flow rate optimal
adaptable to job requirements
i.e. high flow for tank cleaning jobs
and low flow rate for spray gun work

Pipe cleaning - manual

Static nozzle holder for pipe cleaning

- For use directly on high pressure hoses
- Different casing diameter available
- Types with different nozzle position and number of nozzles
- Exchangable connection fitting, allows an adaption to differnt high pressure hoses
- Operating pressure up to 1800 bar (dependent on fitting and nozzle type)
- Made of high tensile stainless stell



Pipe cleaning - manual

Static nozzle holder for pipe cleaning

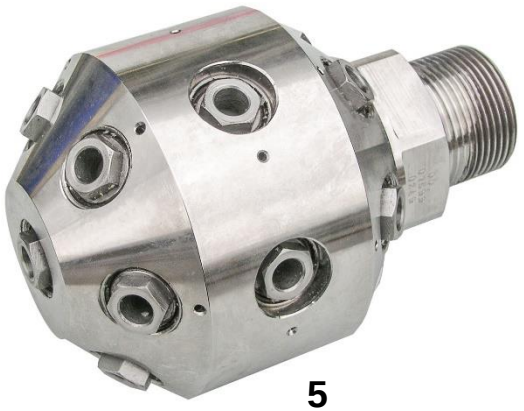
Selection of nozzle holder, no. 2 – 5 with exchangeable nozzle inserts

1

2

3

4



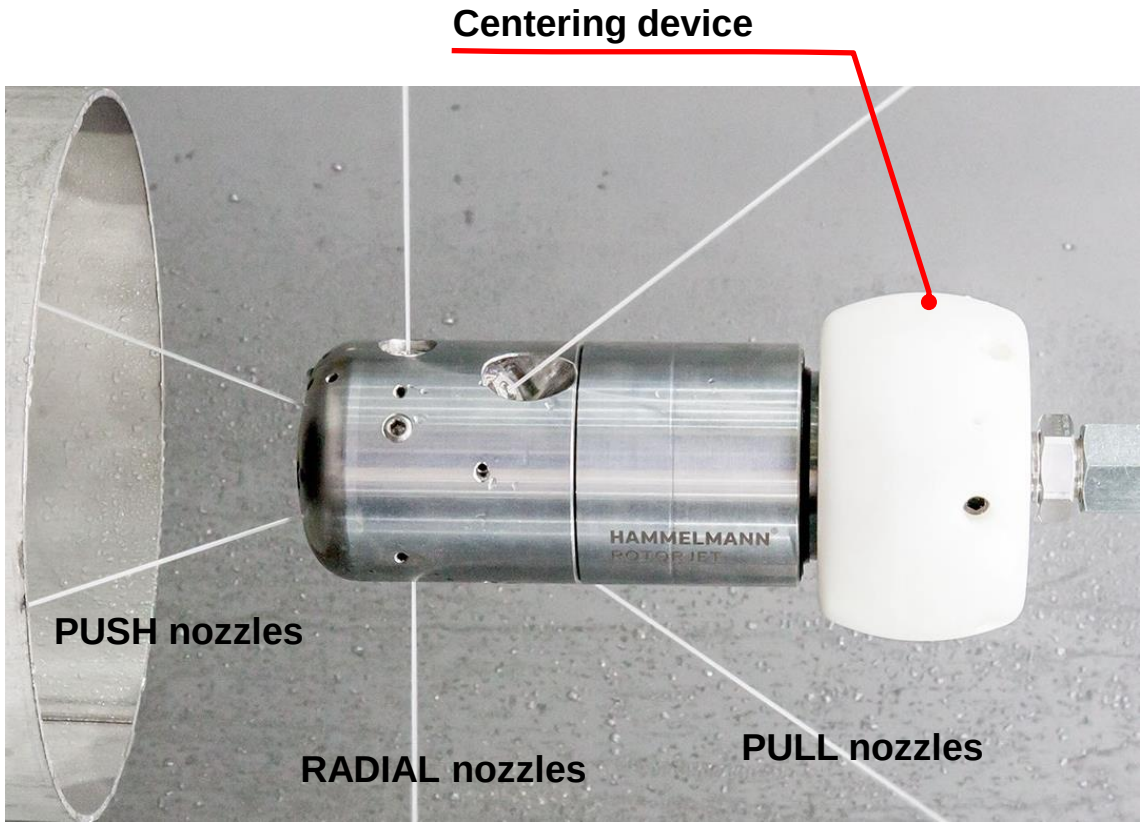
5

Nozzle holder can be used manually, or with different cleaning devices

Pipe cleaning - manual

Self propelled rotating nozzles for pipe cleaning

- For use directly on high pressure hoses
- Different types available, size mainly dependent on hydraulic performance
- Outside diameter from Ø 60 mm to Ø 166mm
- Equipped with an eddy current brake for rotation speed control (adjustanle at larger types)
- Exchangable connection fitting, allows an adaption to differnt high pressure hoses
- Operating pressure up to 3000 bar
- Flow rates up to 400 l/min



Pipe cleaning - manual

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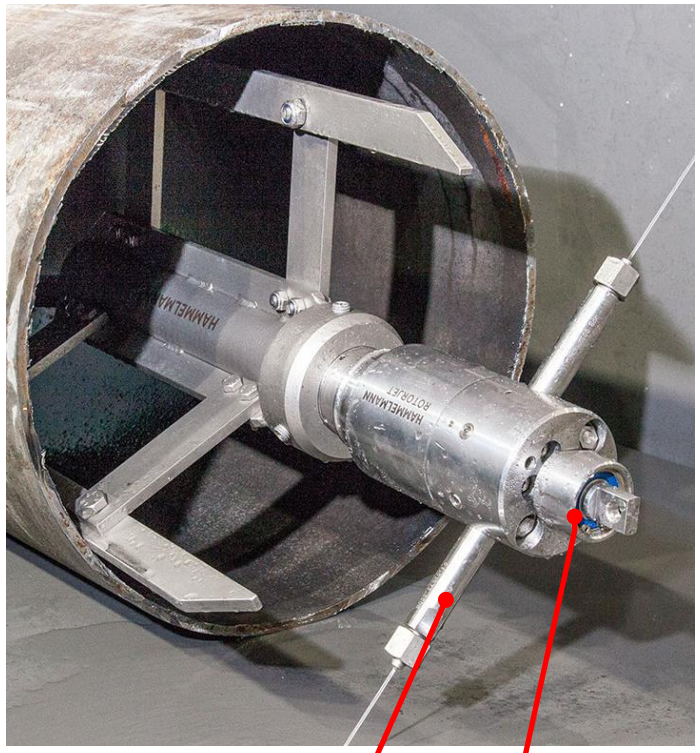
Self propelled rotating nozzles for pipe cleaning

Pipe cleaning - manual

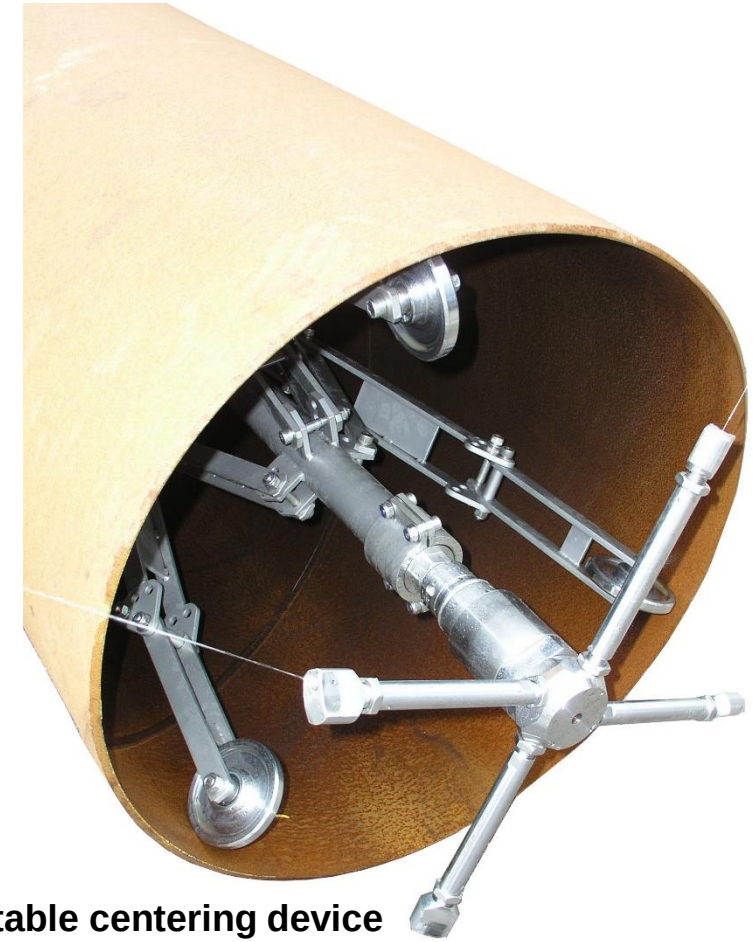
Optional available accessories

Slege / centering device



Nozzle extension arms

Pulling device



Adjustable centering device

Pipe cleaning – hose rotating devices

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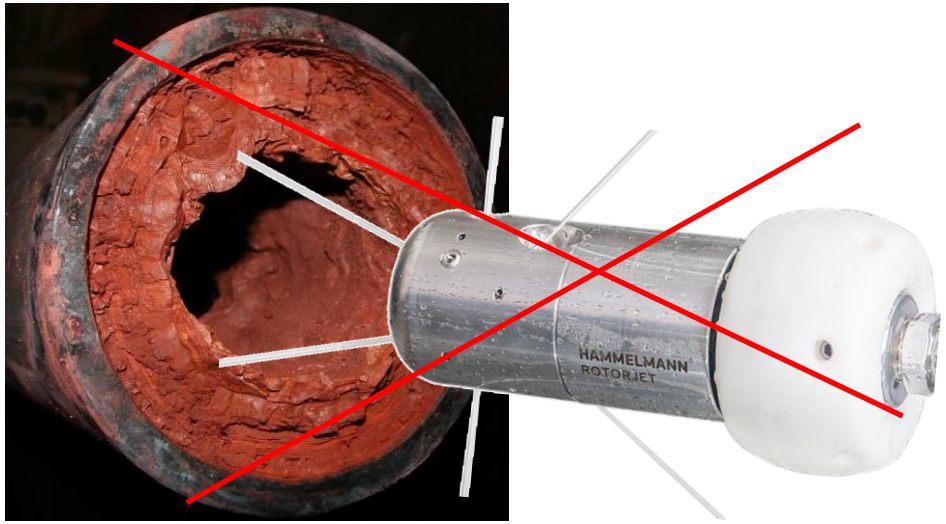
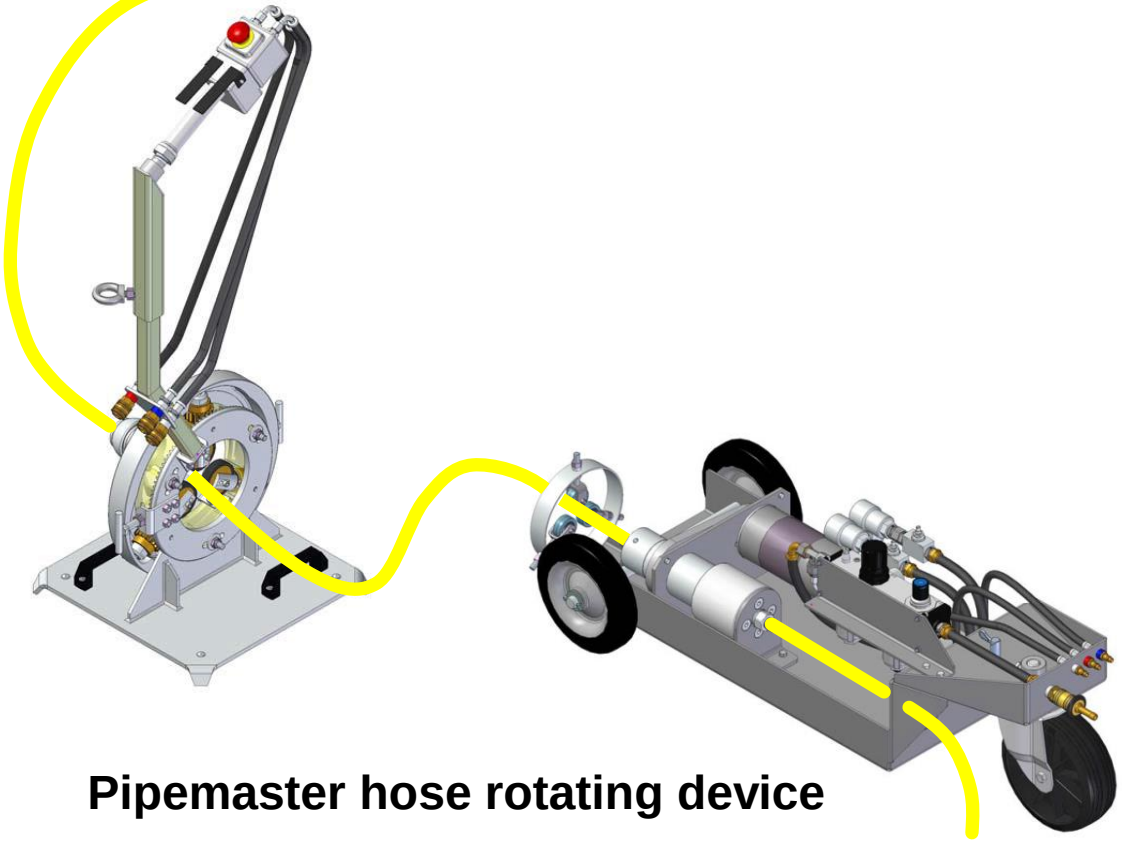
Self-propelled rotating nozzles are not ideal to remove heavy deposits or at fully clogged pipes



Rotation speed is too fast – performance too low

Life time of the rotorjet short

Operation mostly uneconomic



Pipemaster hose rotating device

Pipe cleaning – hose rotating devices

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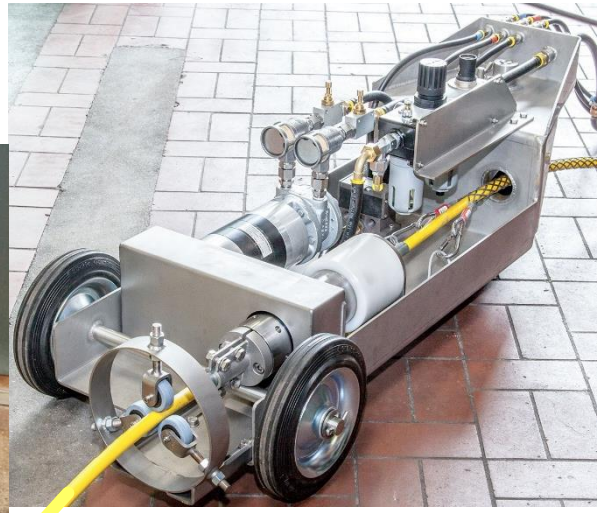
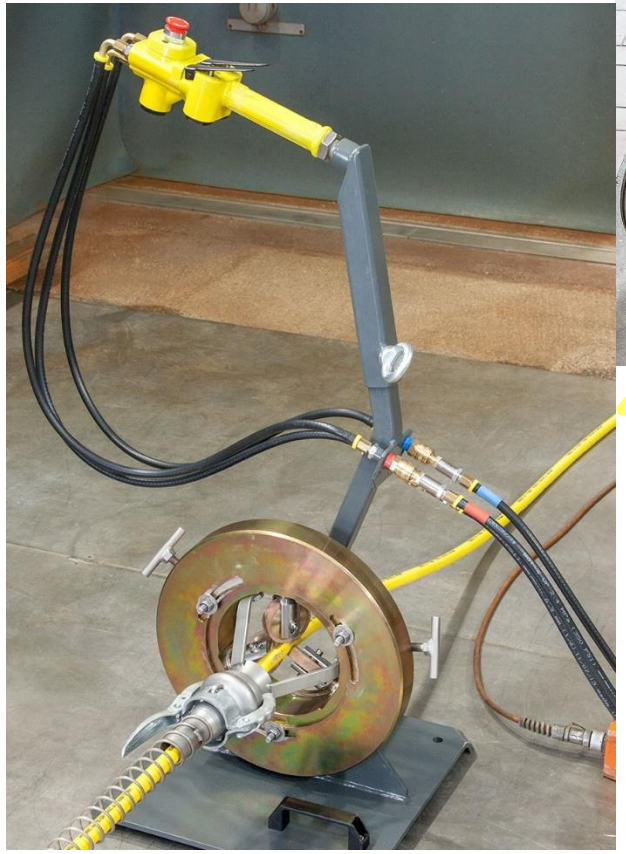
Pipemaster hose rotating device

- Slow rotation – especially to clean pipes with heavy and hard scale and pipe blockages
- Entire hp-hose rotates, no self propelled expensive rotorjet inside the pipe
- adjustable feeding and retraction speed
- Uses static pipe cleaning nozzle heads
- Pneumatically driven
- Pipe lenth up to 60 m
- Cleans pipeline bends as well

Nom. id 8, 3000 bar, flow rate 50 l/min
Nom. id 12, 1800 bar, flow rate 100 l/min
Nom. id 20, 1600 bar, flow rate 200 l/min



Hose rotating unit



Hose feeding device

Pipe cleaning – hose rotating devices

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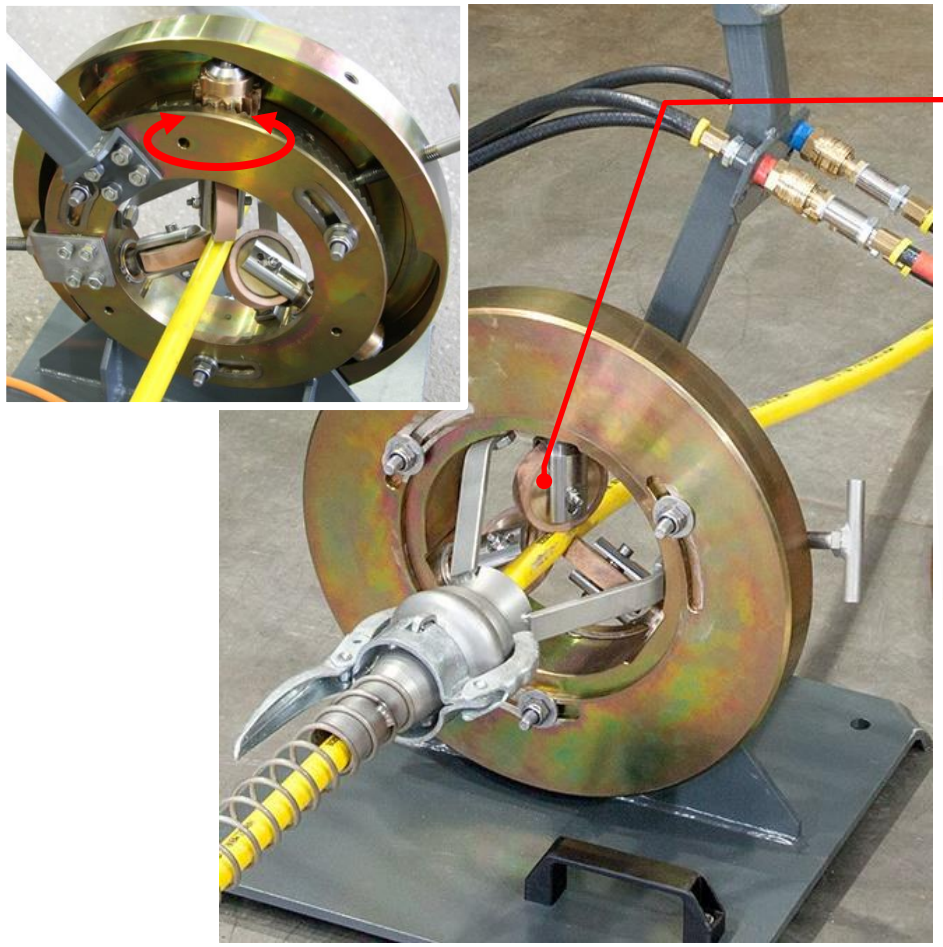
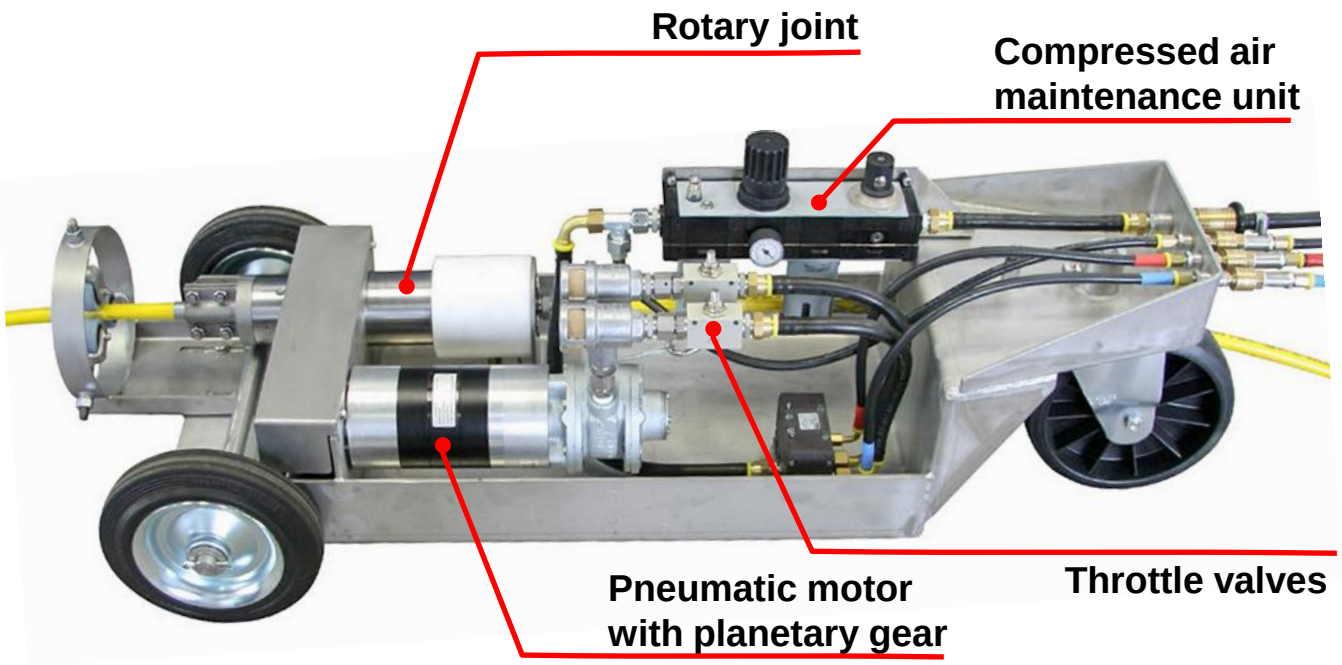
Hose feeding device



Hose rotation unit



Pipe cleaning – hose rotating devices

Rotating hose reel

Slowly rotating hose reel with a capacity of about 100 m hp-hose DN20

Controlled unwinding / feeding by the reaction force of a PULL-nozzle

Retraction by a powerfull hydraulic drive

Nozzle holder

Pipe cleaning – hose rotating devices

HAMMELMANN®

Rotating hose reel

- Very slow rotation advantegous at very hard scale – high performance, defined cleaning result
- Controlled feeding \ winding speed
- Backward movement of the nozzle by the hose reel allows easy removal of the cleaned off scale
- Uses static pipe cleaning nozzle heads
- Lower operating costs in comparison to a rotorjet (rotorjets are subject to heavy wearing)
- Pipe lenth up to 90m (horizontal)
- Increased safety due to automatization
- Pipe diameter: Ø 70 mm up to Ø 500 mm

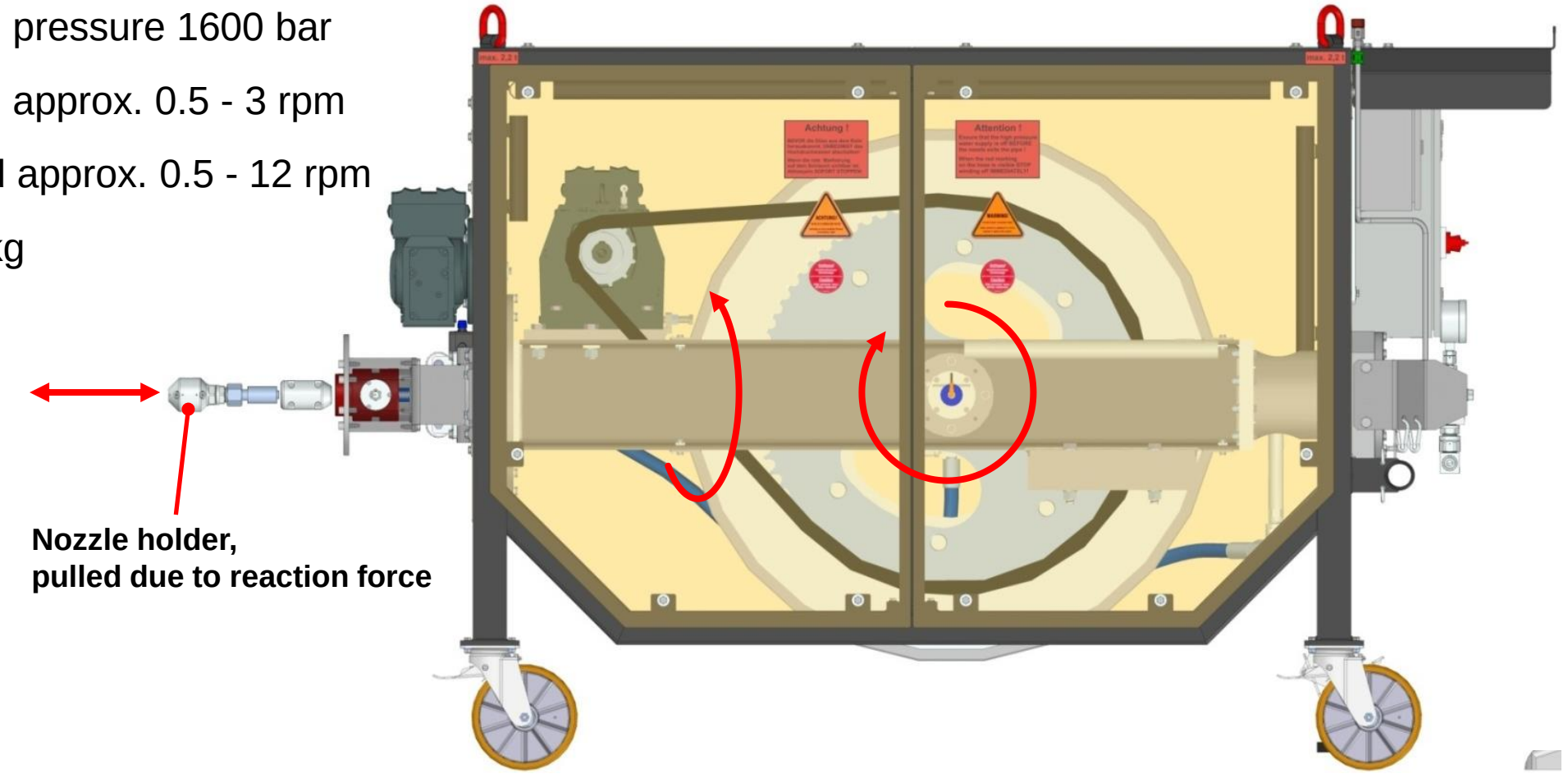
Recommended pump performance:

Above 500kW – 212l/min @ 1290bar

Pipe cleaning – hose rotating devices

Function – technical data:

- Max. operating pressure 1600 bar
- Winding speed approx. 0.5 - 3 rpm
- Rotation speed approx. 0.5 - 12 rpm
- Weight 1650 kg



Nozzle holder,
pulled due to reaction force

Pipe cleaning – hose rotating devices

Pipe cleaning – hose rotating devices

HAMMELMANN®

Pipe work cleaning
with a rotating hose reel

JPU – Jacket Pipe Unit
Or pipe digester

Pipe cleaning with a Tank Cleaning Units TCU´s

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How to clean pipes like this?

Pipe cleaning with a Tank Cleaning Units TCU´s

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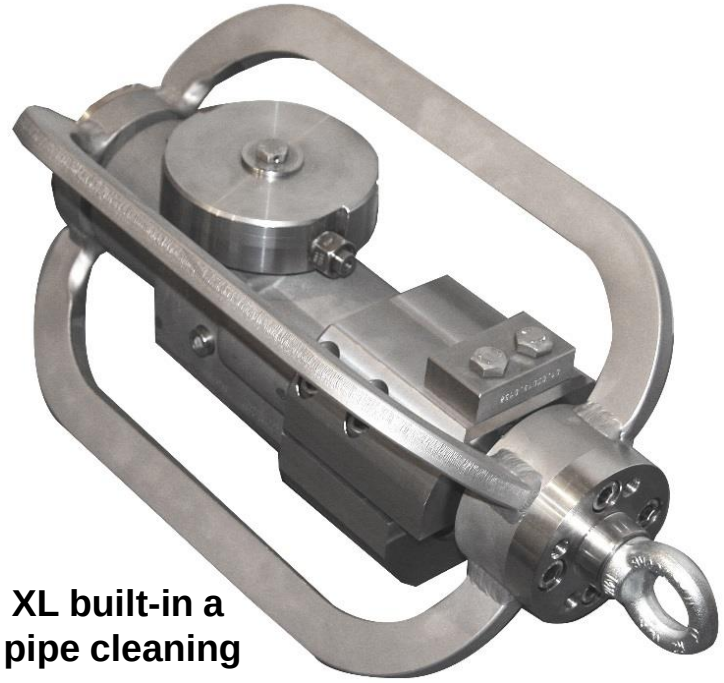
With a tank cleaning head in a sledge?

Fed by reaction force of one nozzle

Smallest possible pipe diameter: Ø 200 mm



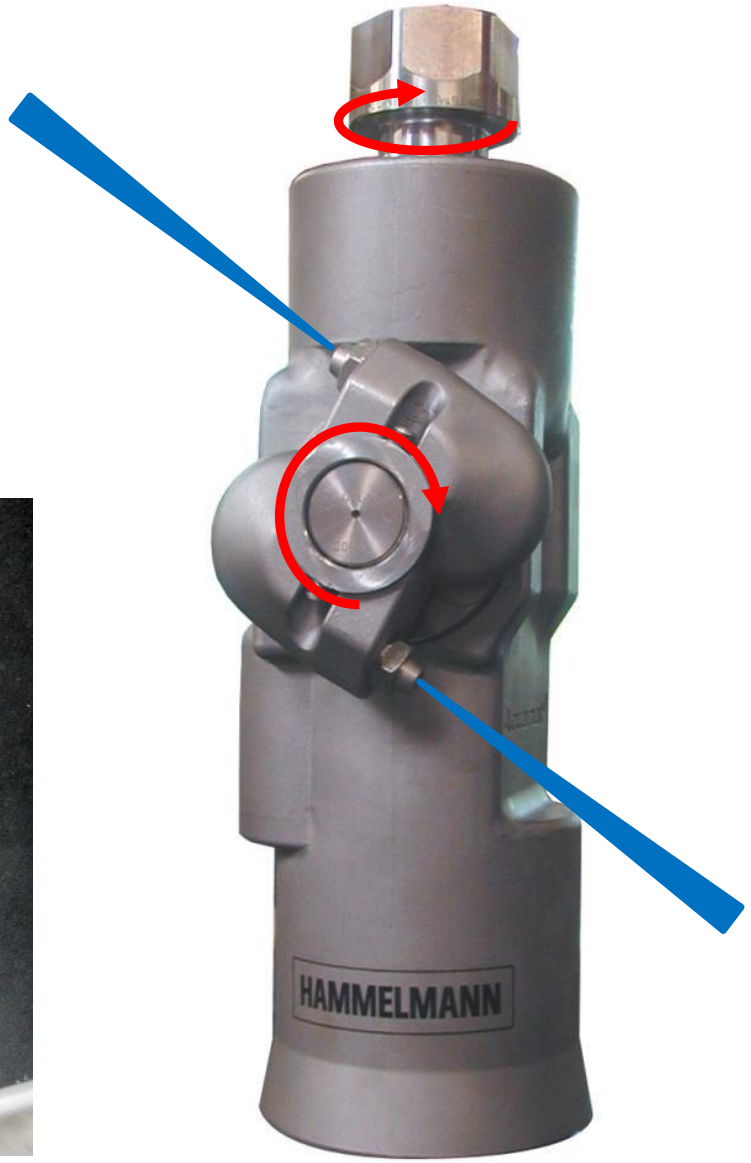
TCH type XL built-in a slege for pipe cleaning

Tank and vessel cleaning – Tank Cleaning Units TCU´s

How does it work?

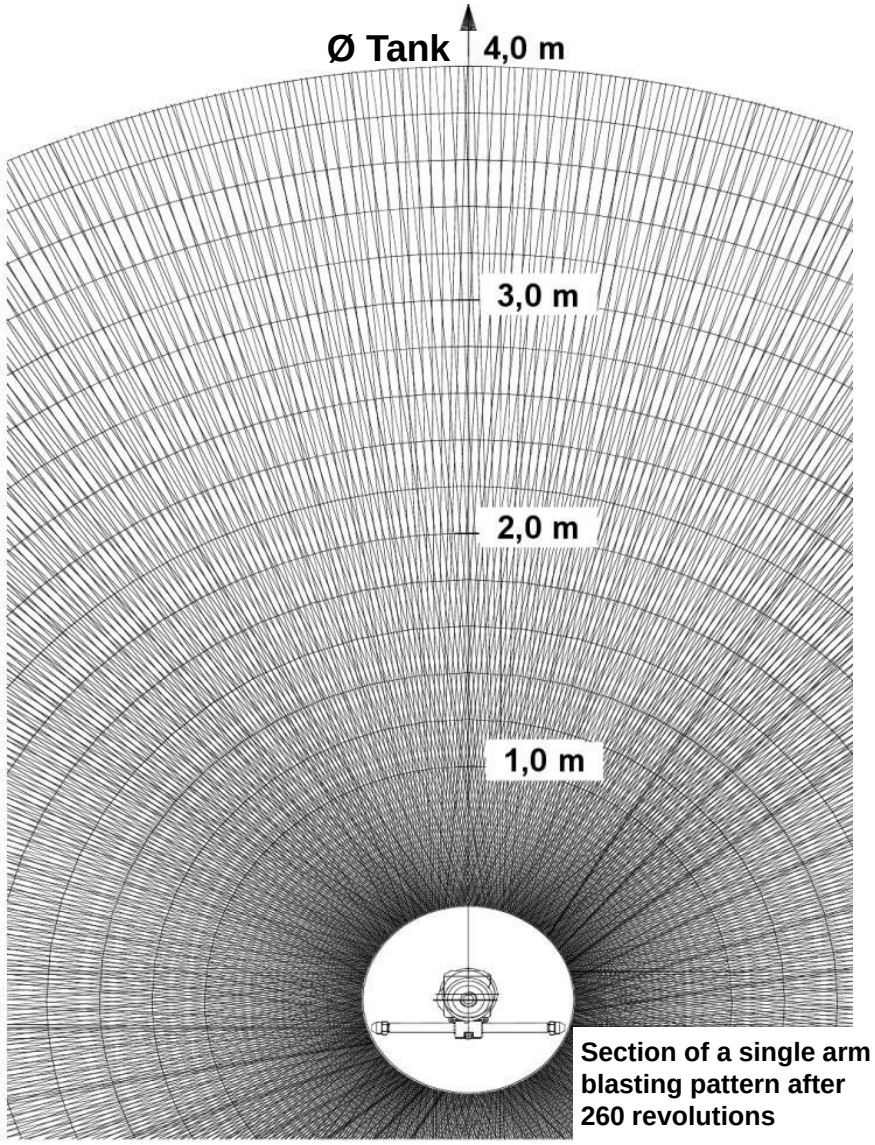
Self-propelled system functions in three dimensions to clean tanks, autoclaves, reactors, vessels and pipe work etc.

Two synchronized rotation movements – nozzle holder & inlet shaft gear ratio of the two axes is approx. 18 : 1



Tank and vessel cleaning – Tank Cleaning Units TCU´s

- Nozzle reaction forces completely balanced
- Deployment hanging on a hp-hose possible
- **or** mounted on a high pressure pipe, attached to a custom built cleaning device
- Slow rotation speed, adjustable by an eddy current breake between 5 and 45 rpm
- Works in three dimensions – 360 °
- Can handle huge pump performance in comparison to it´s size and weight
- Different sizes and working pressures available
- Important is a powerfull (large diameter), focused waterjet with a long range, doesn’t make sense with ultra high pressure



Section of a single arm blasting pattern after 260 revolutions

Tank and vessel cleaning – Tank Cleaning Units TCU´s

Available sizes

L 1800
100l/min@1800bar

L 1500 plus
300l/min@1500bar

XL 1600
430l/min@1600bar

XXL
500l/min@1600bar

Special versions:

- Chemicalresistant
- High flow rate, low pressure
- Pressure tight (for work in overpressure atmosphere)

HAMMELMANN®

Different nozzle holder and nozzle inserts covering a wide range of applications

Nozzel holder

Type „S“

Type „V“
with extention arms

Type „L“

Nozzel inserts

Type „A“

Type „B“

Type „M“

Type „L“

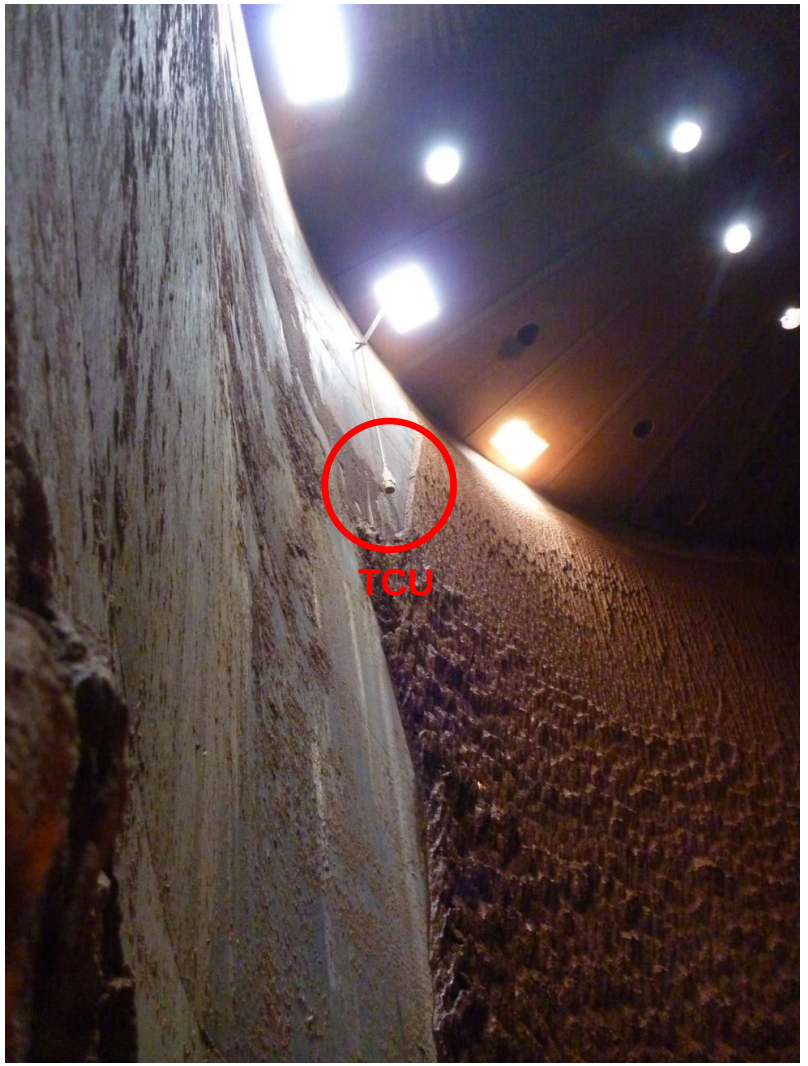
Tank and vessel cleaning – Tank Cleaning Units TCU´s

HAMMELMANN®

Application: Vessel descaling

TCU deployed by a hp-hose

Pump performance:
277 l/min @ 1570bar – 800kW



Tank and vessel cleaning – Tank Cleaning Units TCU´s

HAMMELMANN®

Application: Vessel descaling

TCU deployed by a hp-hose or

Hp-hose through a scaffolding pipe for easy positioning

Pump performance:
166 l/min @ 1570bar – 500kW

Tank and vessel cleaning – Tank Cleaning Units TCU´s

HAMMELMANN®

Application: Pipe socket descaling

Hp-hose through a scaffolding pipe for easy positioning

Pump performance: 166 l/min @ 1570bar – 500kW

Tank and vessel cleaning – Tank Cleaning Units TCU´s

Pump units for mobile applications

Containerized diesel driven pump units most common
Easy to transport, flexible, quick set up, protected

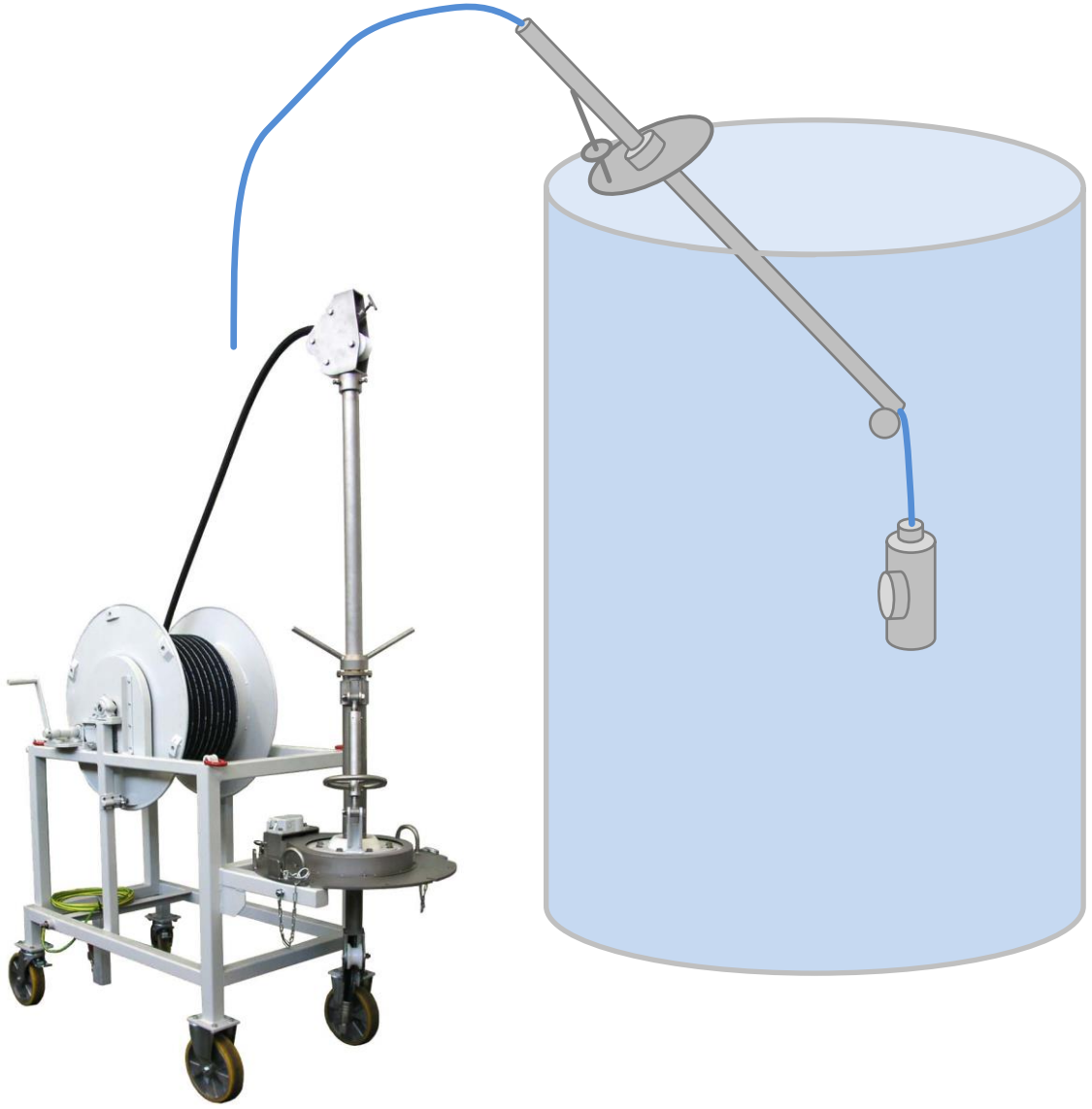
HDP 502 unit
Performance: 262l/min@1040bar
Motor rating: 565 kW

Tank and vessel cleaning – Tank Cleaning Units TCU´s

HAMMELMANN®

TCU – hp-hose deployment device with guide pipe and hose reel

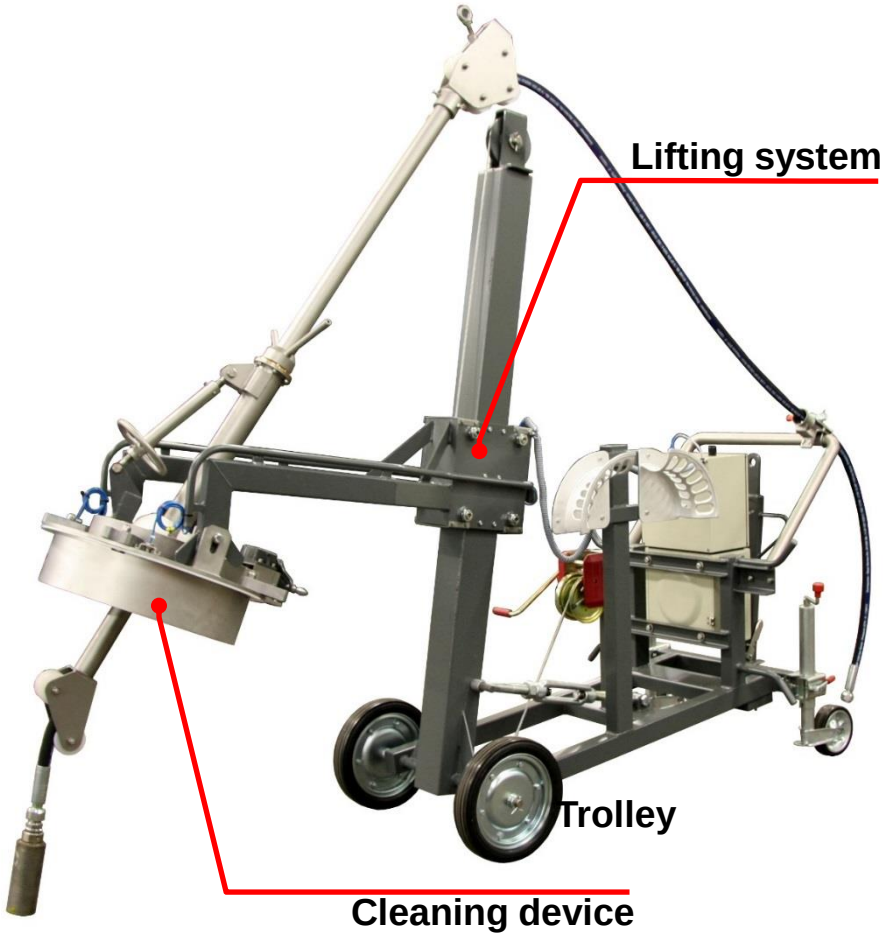
- Mobil, with storage rack for the lance / cover assembly
- For cleaning inside large vessels
- Lance swings and rotates
- It advances / retracts by slide action

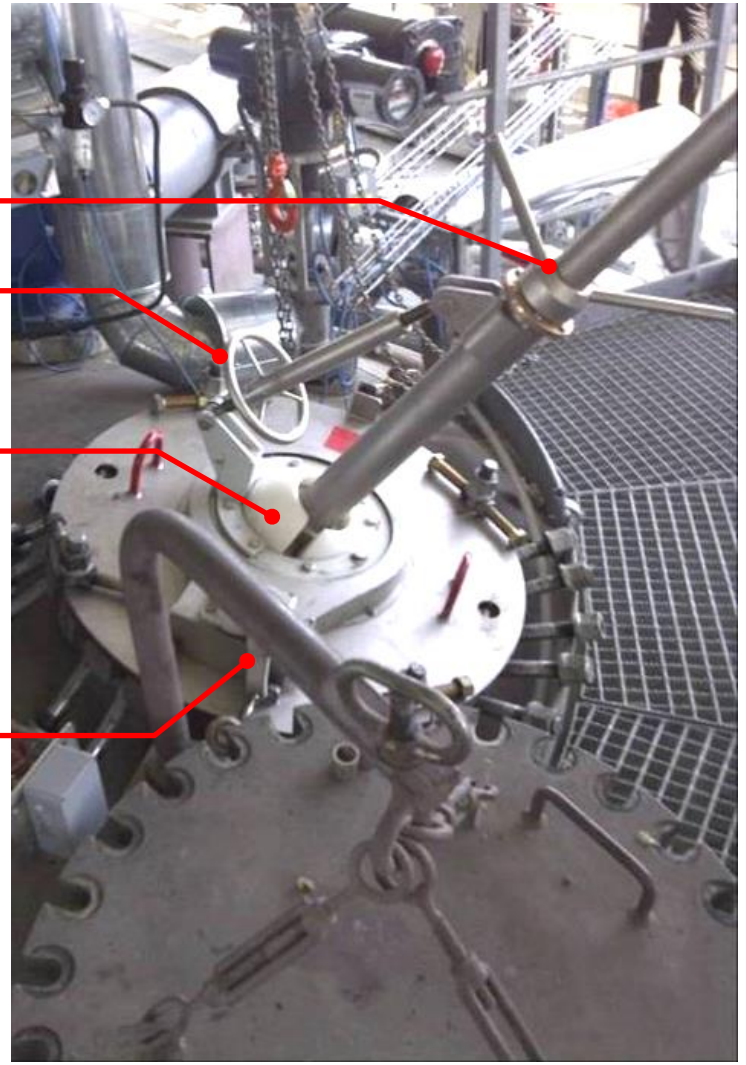


Tank and vessel cleaning – Tank Cleaning Units TCU´s

HAMMELMANN®

TCU – hp-hose deployment device with guide pipe





Tank and vessel cleaning – Tank Cleaning Units TCU´s

HAMMELMANN®

Application: Reactor for ABS production

TCU deployed by a telescope system

- Periodically to be cleaned from production deposits
- Customer demand: No man in tank!
- Operating pressure: 500 bar
- Flow rate: 360 l/min
- TCU XL 500bar, high flow in use
- Hazardous area, Atex zone 1

View into the vessel

Tank and vessel cleaning – Tank Cleaning Units TCU´s

HAMMELMANN®

Application: Reactor for ABS production

HAMMELMANN®

Pump units for stationary applications

Electrically powered pump units

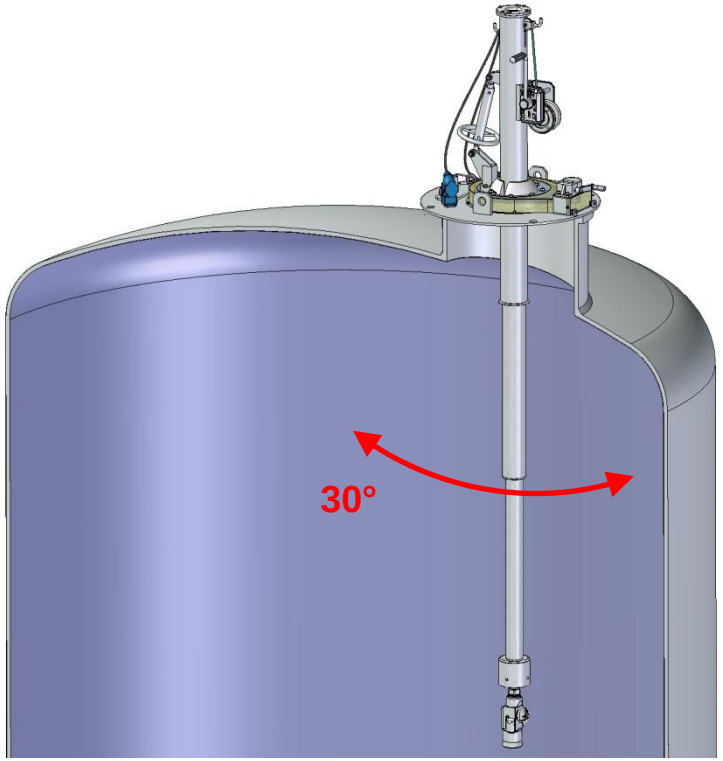
- Energy efficient, especially when equipped with a VFD (variable frequency drive)
- No maintenance costs for the motor
- Silent operation
- High voltage motors available for big pump units
- No exhaust emissions
- Low heat emissions, ideal for indoor installation

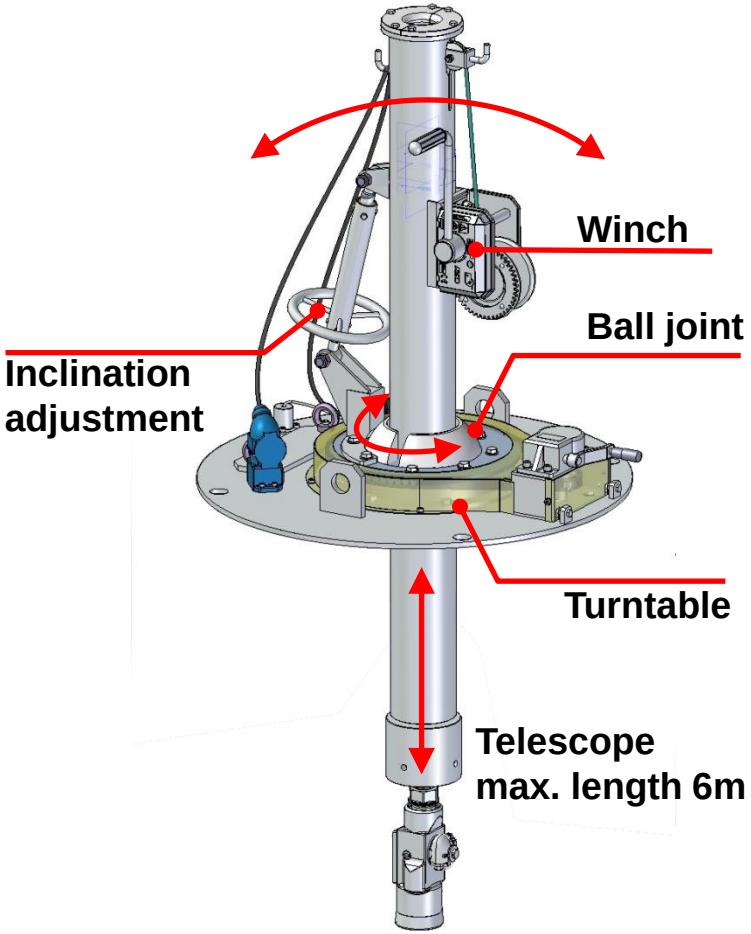
Tank and vessel cleaning – Tank Cleaning Units TCU´s

HAMMELMANN®

Telescope system

- Vertical deployment only
- Three axis adjustment
- TCU lowered by a manual winch





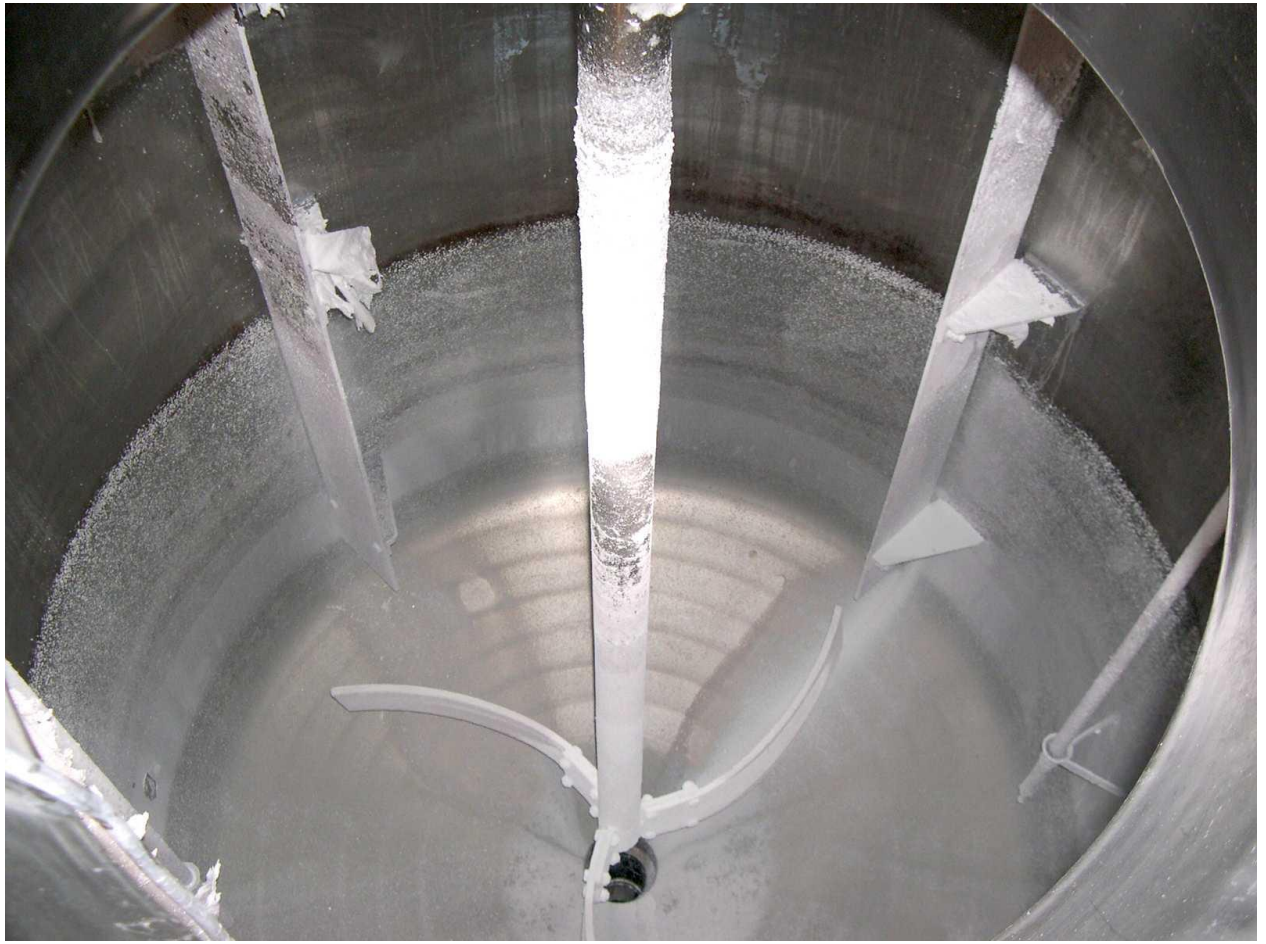
Tank and vessel cleaning – Tank Cleaning Units TCU´s

HAMMELMANN®

Application: Reaktor – Autoclav for Latex production

TCU deployed by a hose reel system

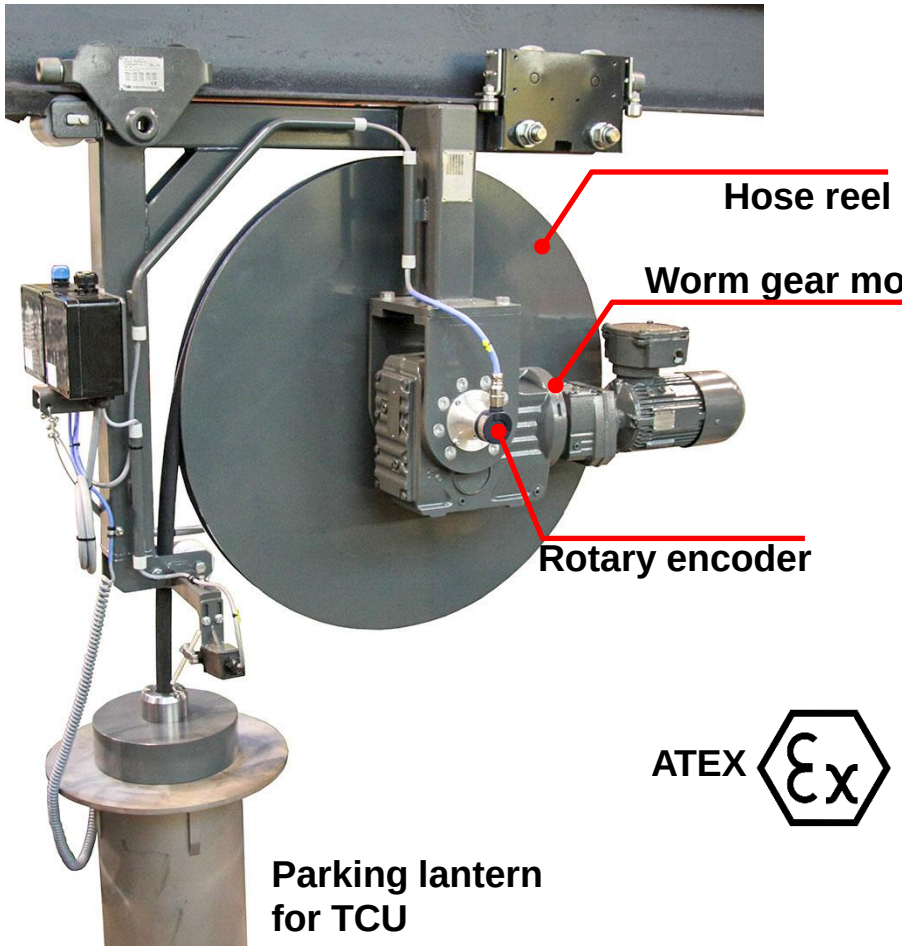
- Periodically to be cleaned from production deposits or flushing / cleaning
- To prevent a contamination of the following batch by a product change
- Fully automatic system, pump and cleaning device controlled by DCS
- Operating pressure mostly around 500 bar
- Flow rate: 100 - 200 l/min

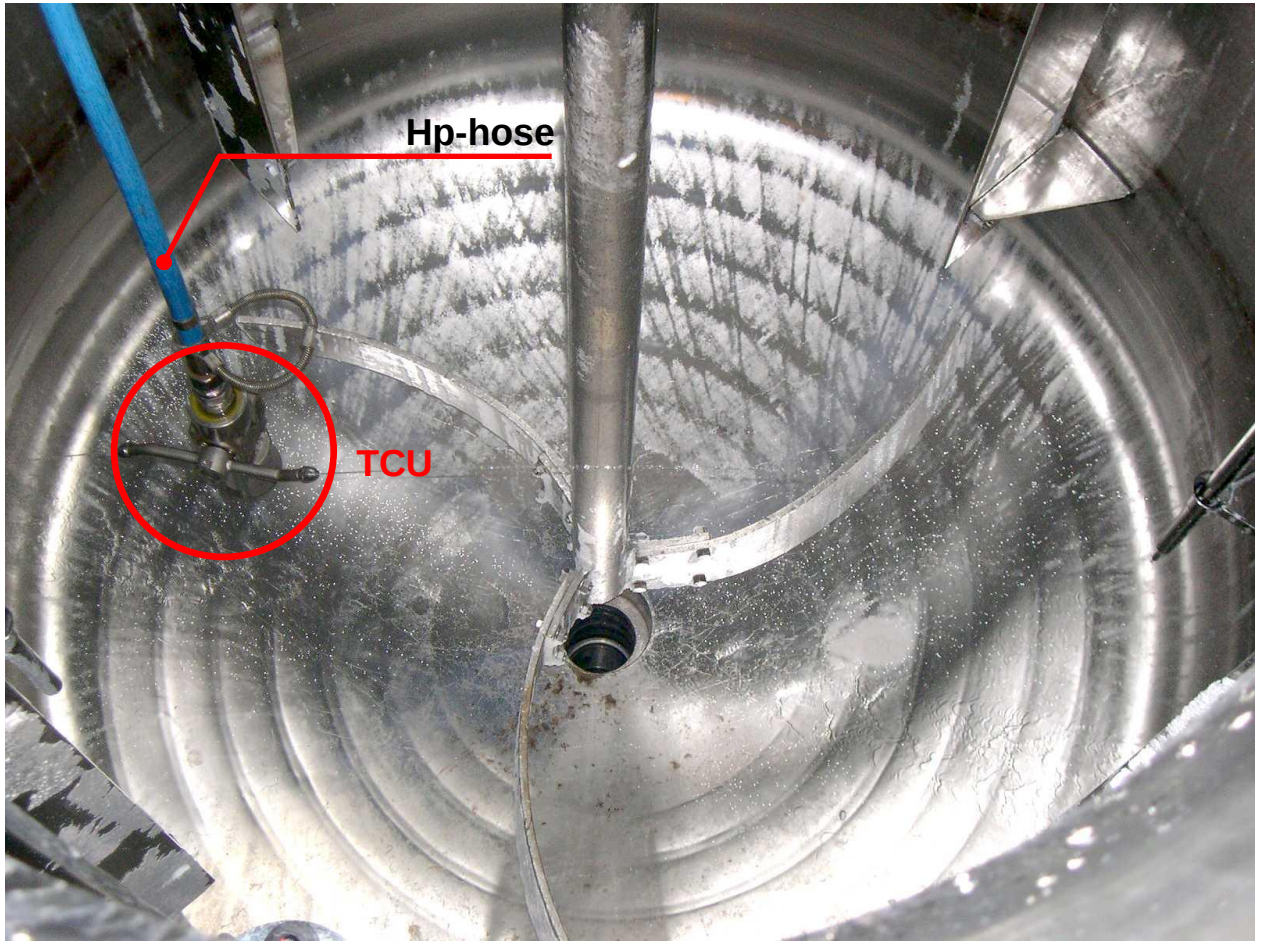


Tank and vessel cleaning – Tank Cleaning Units TCU´s

HAMMELMANN®

TCU deployed by a hose reel system - suspended from the ceiling





Tank and vessel cleaning – Tank Cleaning Units TCU´s

HAMMELMANN®

Application: Reaktor – Autoclav

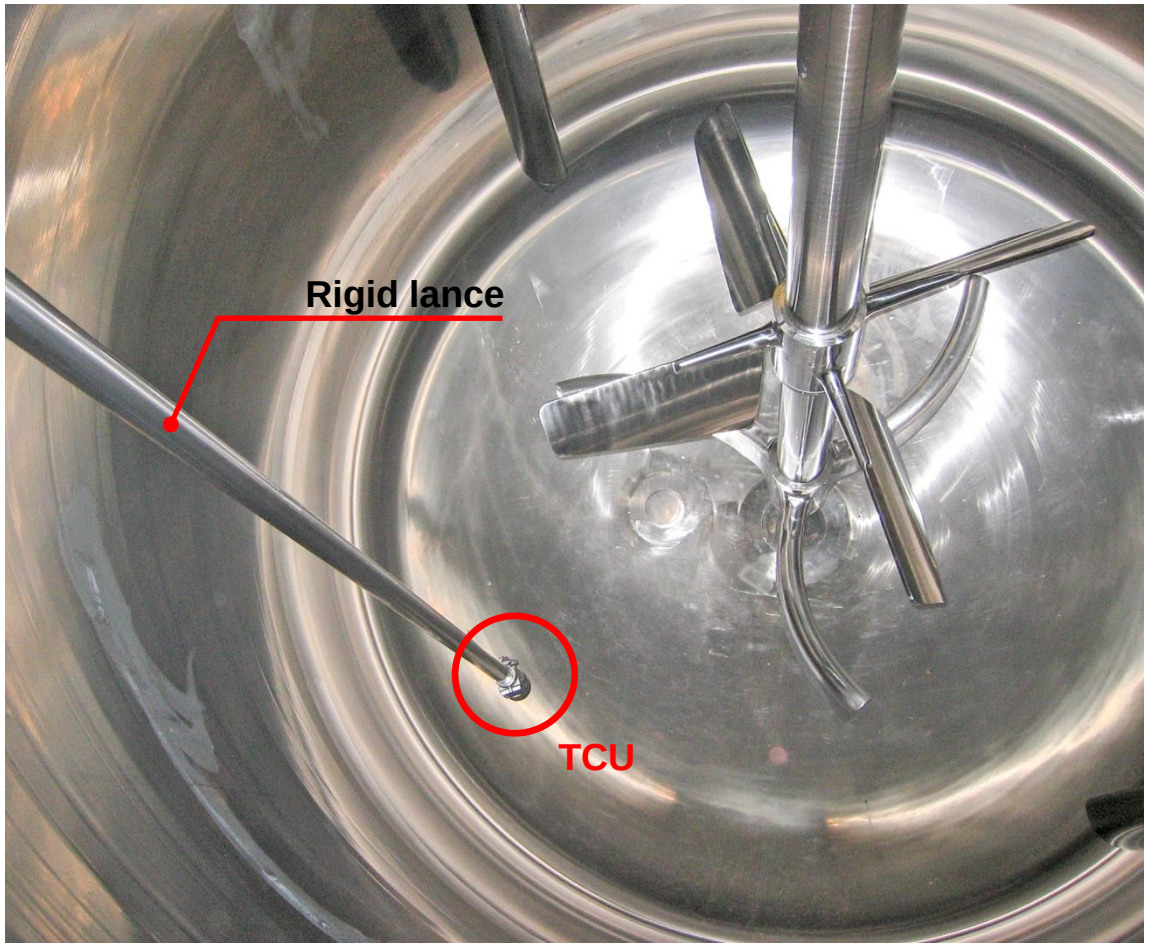
TCU deployed by a rigid lance system

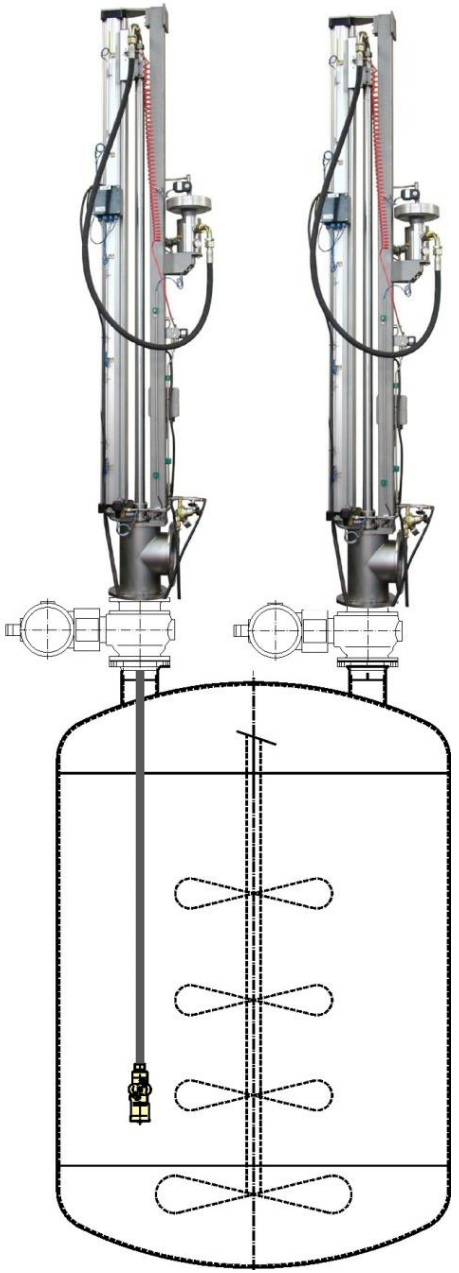
- TCU deployed by rigid, water bearing lance
- Two devices enable a nearly 100% clean vessel
- Posibilty of two TCU´s operating simultaniously in the same vessel – for shorter cleaning cycle
- Operating pressure up 1000 bar possible
- Maximum stroke length: 6,0m
- Gas tight – it means, no gases from inside the vessel can get into atmosphere during cleaning
- Atex certification possible
- Lance is extended and retracted by a pneumatic cylinder, at longer strokes by a chain drive

Tank and vessel cleaning – Tank Cleaning Units TCU´s

HAMMELMANN®

TCU deployed by a rigid lance system

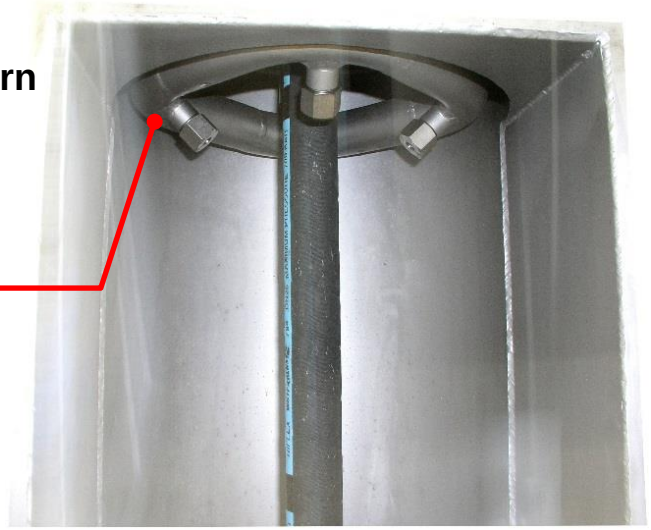




HAMMELMANN®

Hose reel system with a low pressure jetting ring

- For cleaning of vessels containing sticky products
- The TCH is lowered by a powered hose reel
- A low pressure jetting ring cleans the high pressure hose during retraction
- Change over valve to switch two different pressure steps



Tank and vessel cleaning – Tank Cleaning Units TCU´s

TCU deployed at a ridig lance system

- Fixed lance for tank and reactor cleaning
- Fan-jet to flush TCU during hp-cleaning optinal available
- Molile system, i.e. for IBC cleaning

Application: IBC cleaning

Pump: HDP 42 or HDP 72

Flow rate: about 50 l/min

Operating pressure:
400bar for latex residues, for glue or other sticky products up 700bar

HDP 42 motor driven
Performance: 45 l/min @ 440 bar
Motor rating: 37kW

Many thanks for your attention!