

PPSA Pigging Seminar 2007

A new pipeline cleaning technology:
Hydraulically Activated Power Pigging
(HAPP™)

by
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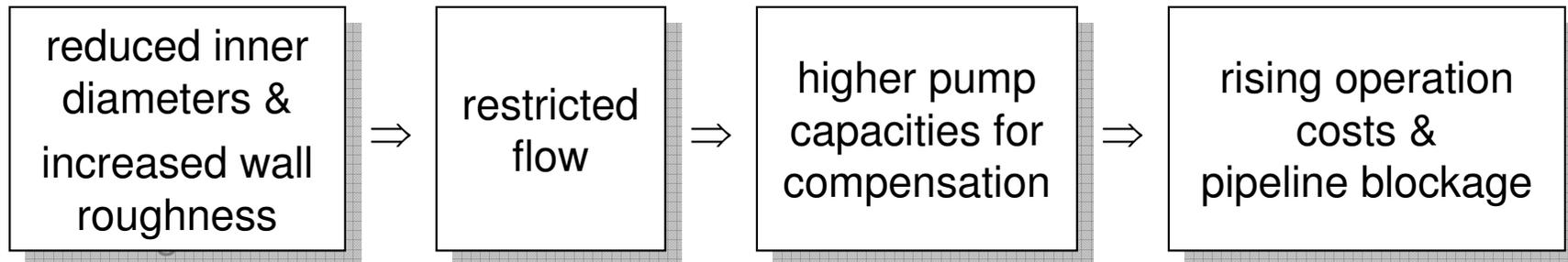
Introduction

Introduction

Deposition of wax, hydrates or other substances are a consequence of the ...

- chemical composition of the crude oil (i.e. wax content, ...)
- hydrodynamic conditions in the pipeline (i.e. flow velocity, turbulences,...)
- thermodynamic conditions in the pipeline (i.e. pressure, temperature,...)
- pipeline wall physics (i.e. material, roughness, ...)

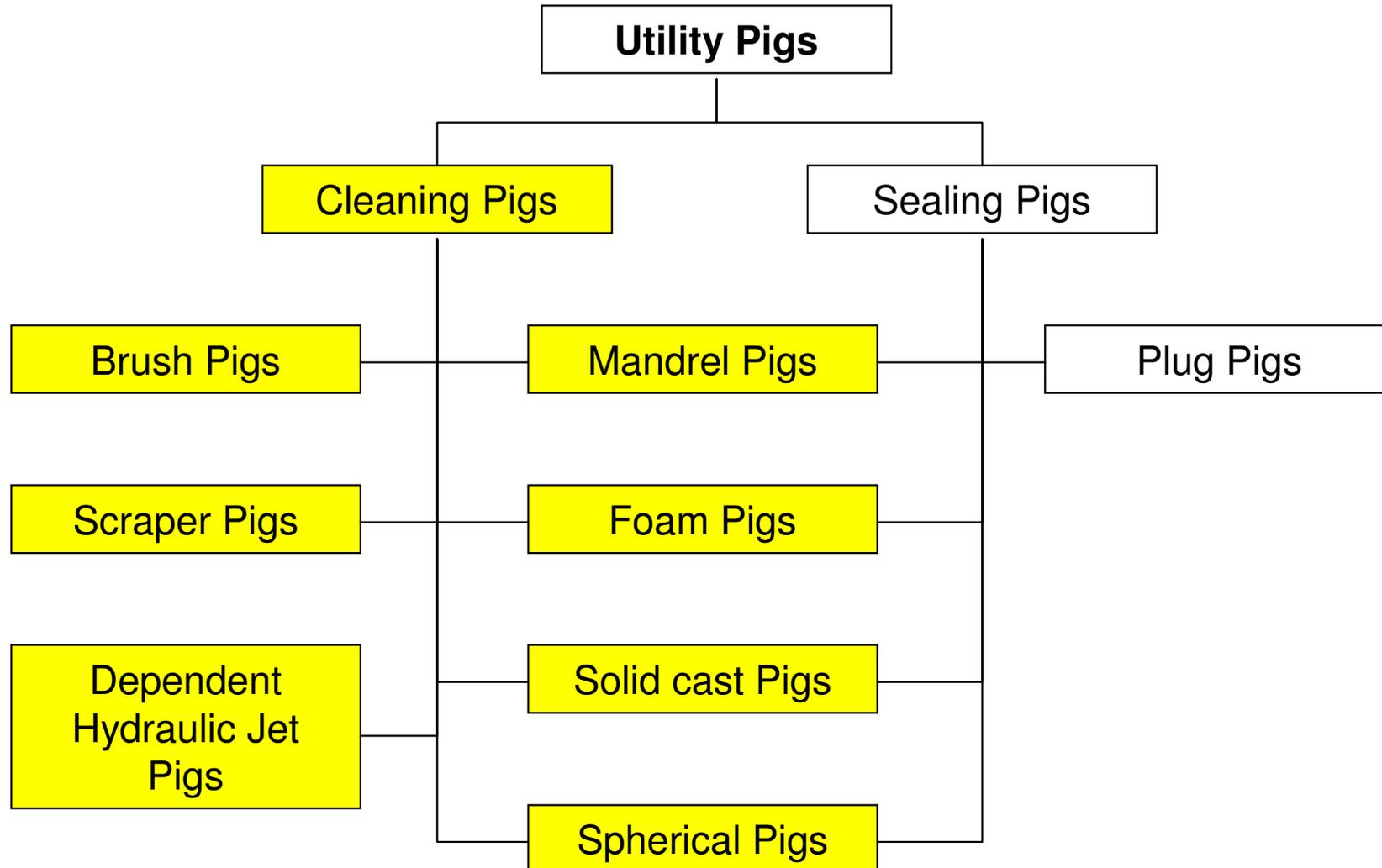
Consequences of deposition of wax, hydrates or other substances are ...



Prevention and cure strategies:

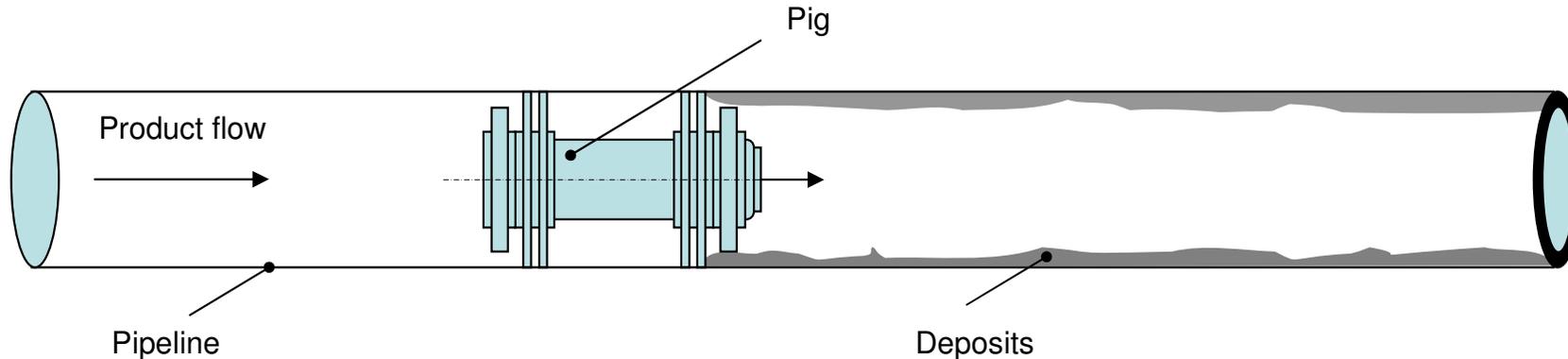
1. Adjustment of chemical, physical and thermodynamic crude oil properties.
2. Pipeline pigging...

Today's typical cleaning pigs



Characteristics of cleaning pigs

Cleaning force / effectiveness



Mechanical force (scrapping) between pipe inner wall and the pig's cleaning edge

- + easy to establish
- + a faster pig velocity results in a higher impact on deposits
- not controllable
- a faster pig velocity results in a superficial deposit removal
- up to many pig runs might be necessary
- cleaning edge smears wax back onto wall

High pressure water jets fed through hoses

- + very strong cleaning force
- + high effectiveness
- limited in reach

Characteristics of cleaning pigs

Deposit removal

Removed deposits are usually pushed out of the line with the pig moving forward

- ⇒ plug formation in front of the pig
- ⇒ high risk of pig getting stuck
- ⇒ several pig runs with different pig diameters might be required

Deposit removal with bypass flow through the cleaning pig

- ⇒ removed deposits are permanently flushed down-stream
- ⇒ less risk of plug formation thus pipeline blockage

Today's general rules to avoid pipeline blockage by accumulated deposits in front of pigs

1. select pig type(s)
2. thoroughly determine pig size (diameter)
3. determine number of cleaning runs needed

⇒ **Set-up of a pigging job requires extended time, effort and experience is very expensive!**

Characteristics of cleaning pigs

Pipeline operations

- Regular pigging programs:** • Pigging is done after build up of a defined wax layer or in periodical intervals
⇒ Line can be kept in operation
- Line heavily effected:** • A thoroughly established pigging program is required
• Several pigging runs
⇒ Operations are interrupted or reduced
- Line is blocked:** ⇒ No operations at all anymore!

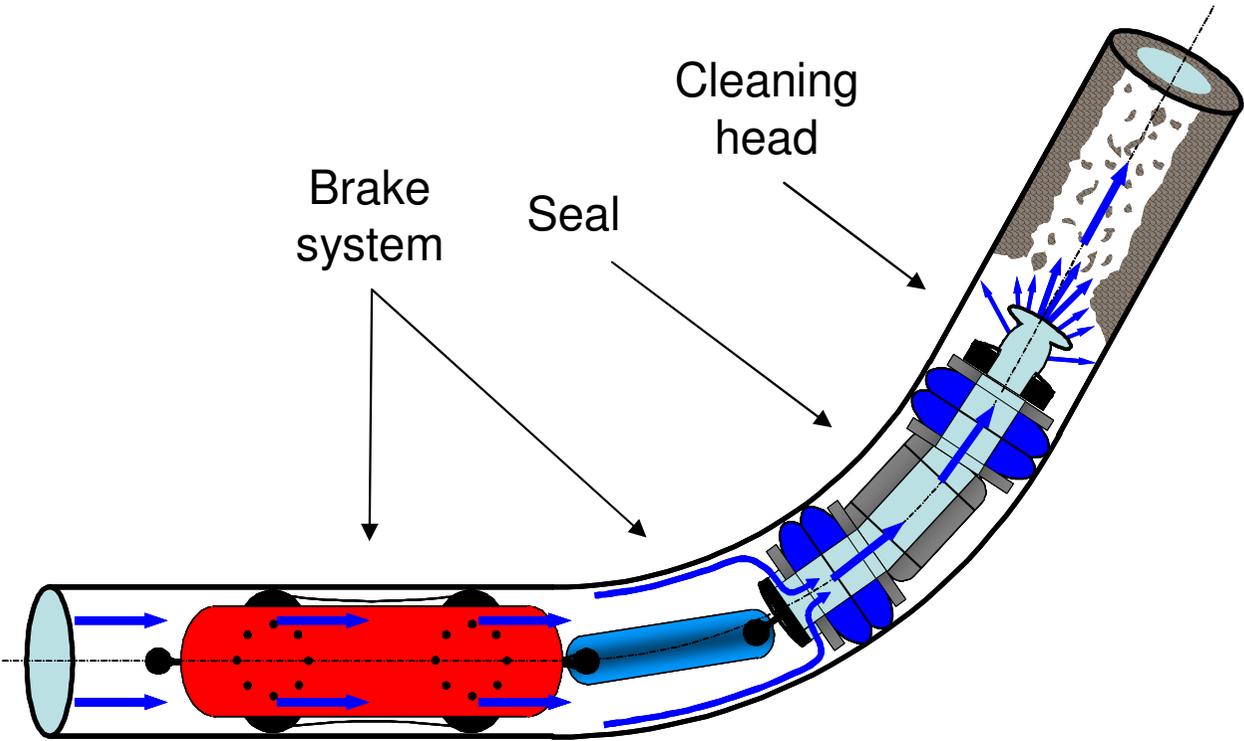
⇒ **Interruption of pipeline operations is most undesired by pipeline operators as it causes enormous secondary economic losses.**

Characteristics of cleaning pigs

Comparison of cleaning pig features

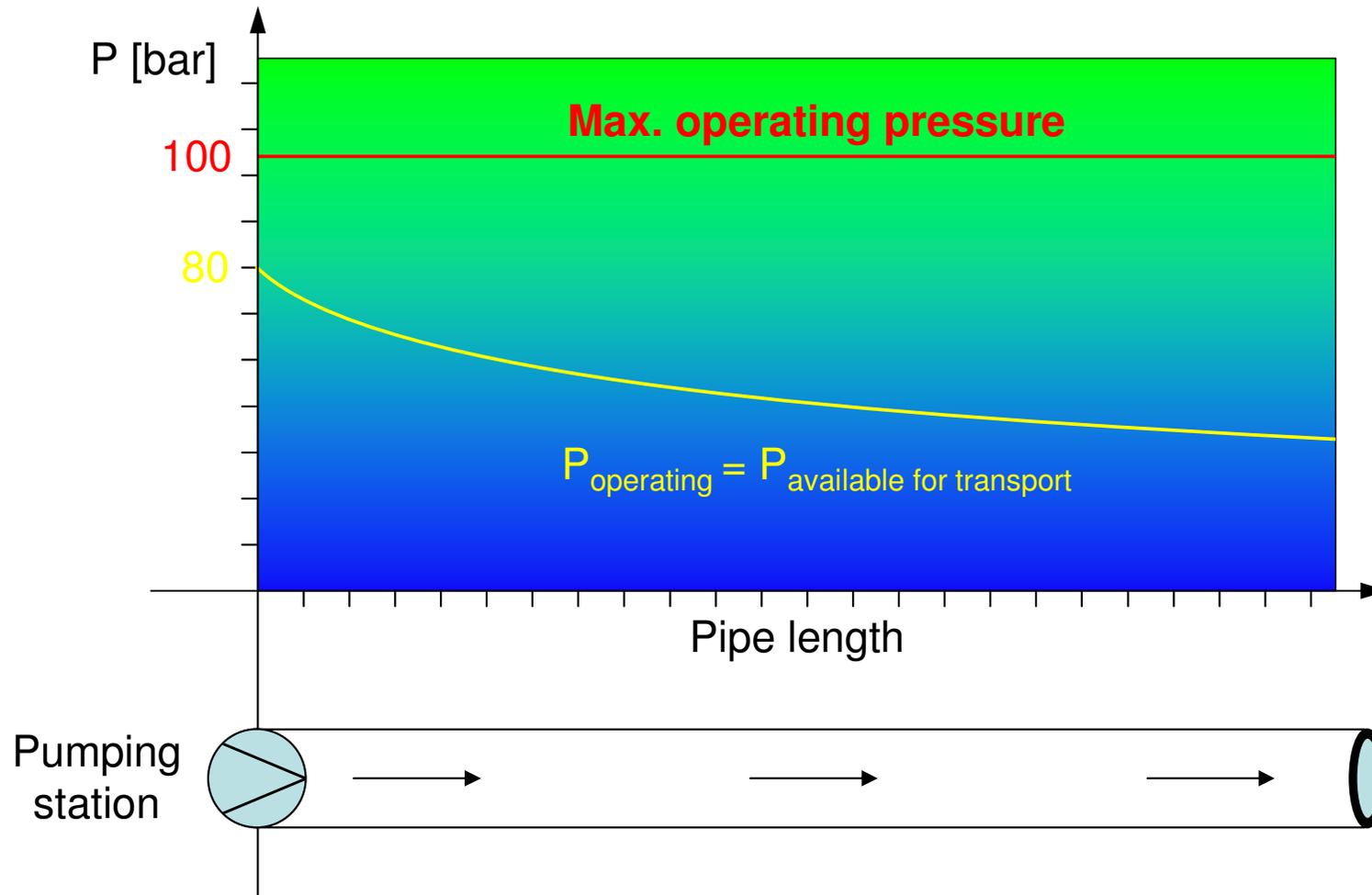
Pig \ Feature	Active cleaning force	N° of cleaning runs required	Risk of getting stuck	Adjustable travel speed	Reach	Cleaning effectiveness
Mandrel pigs	no	many	high	no	unlimited	low
Foam pigs	no	many	high	no	unlimited	low
Solid cast pigs	no	many	high	no	unlimited	low
Spherical pigs or spheres	no	many	high	no	unlimited	low
Brush pigs	no	less many	less high	no	unlimited	low/medium
Scraper pigs	no	less many	less high	no	unlimited	medium/high
Dependent Hydraulic Jet Pigs	yes	only one	none	yes	limited	very high

Hydraulically Activated Power Pig Main Components



Energy balance

Pressure over pipe length

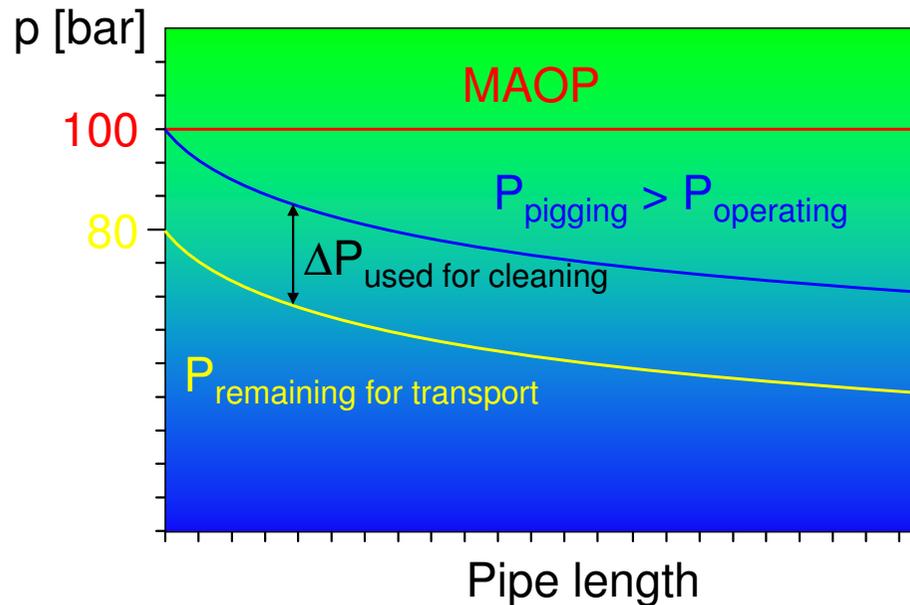


Energy balance

Two ways to drive a HAPP™

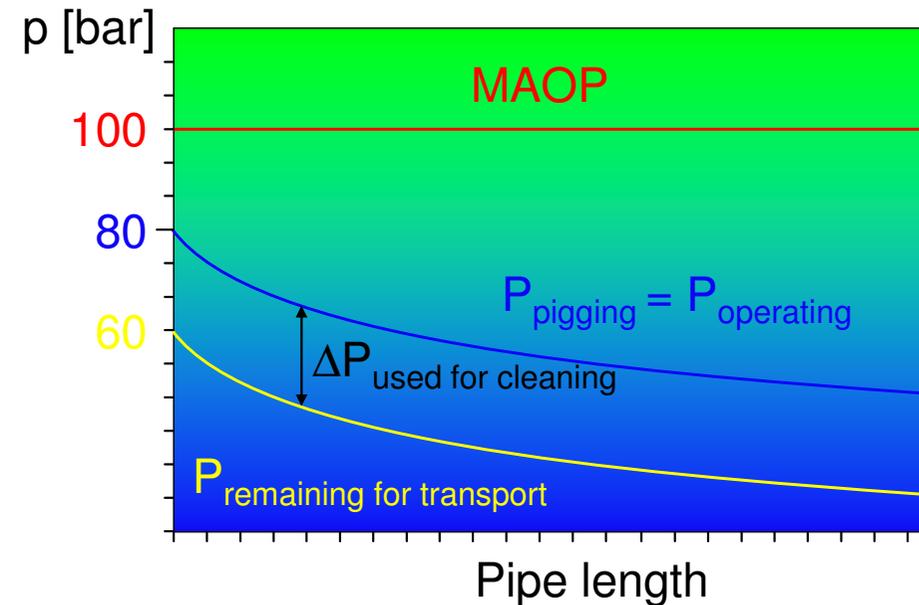
1. Pumping pressure can be increased:

- Required cleaning energy is taken from the additional pumping energy.
- Operating pressure and flow is entirely maintained



2. Pumping pressure can not be increased:

- Required cleaning energy is taken as part from the transportation energy.
- Operating pressure and flow are lowered for the energy share used for cleaning.

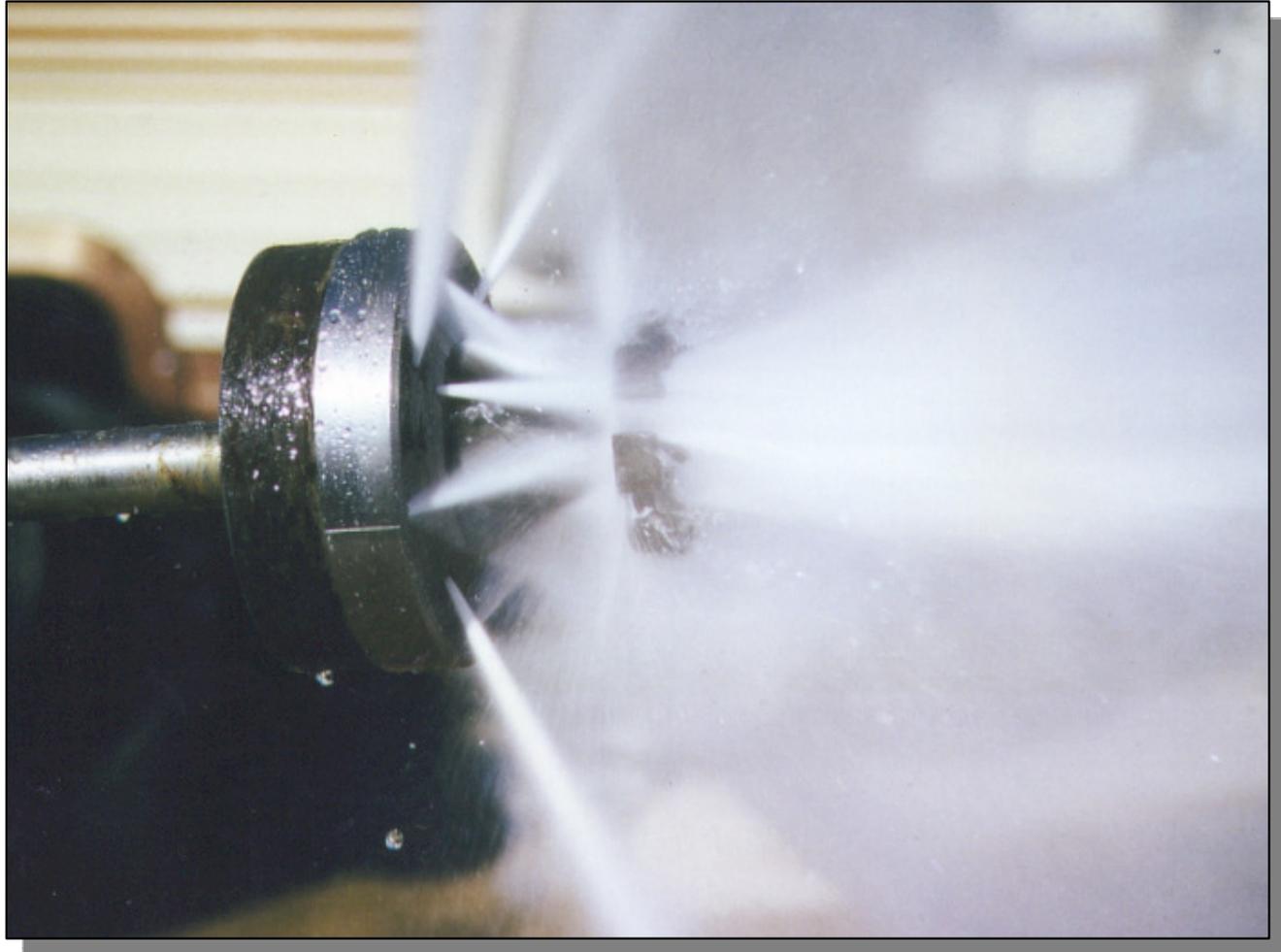


$$\text{Cleaning energy} = \Delta p \times \text{flowrate}$$

Technical features

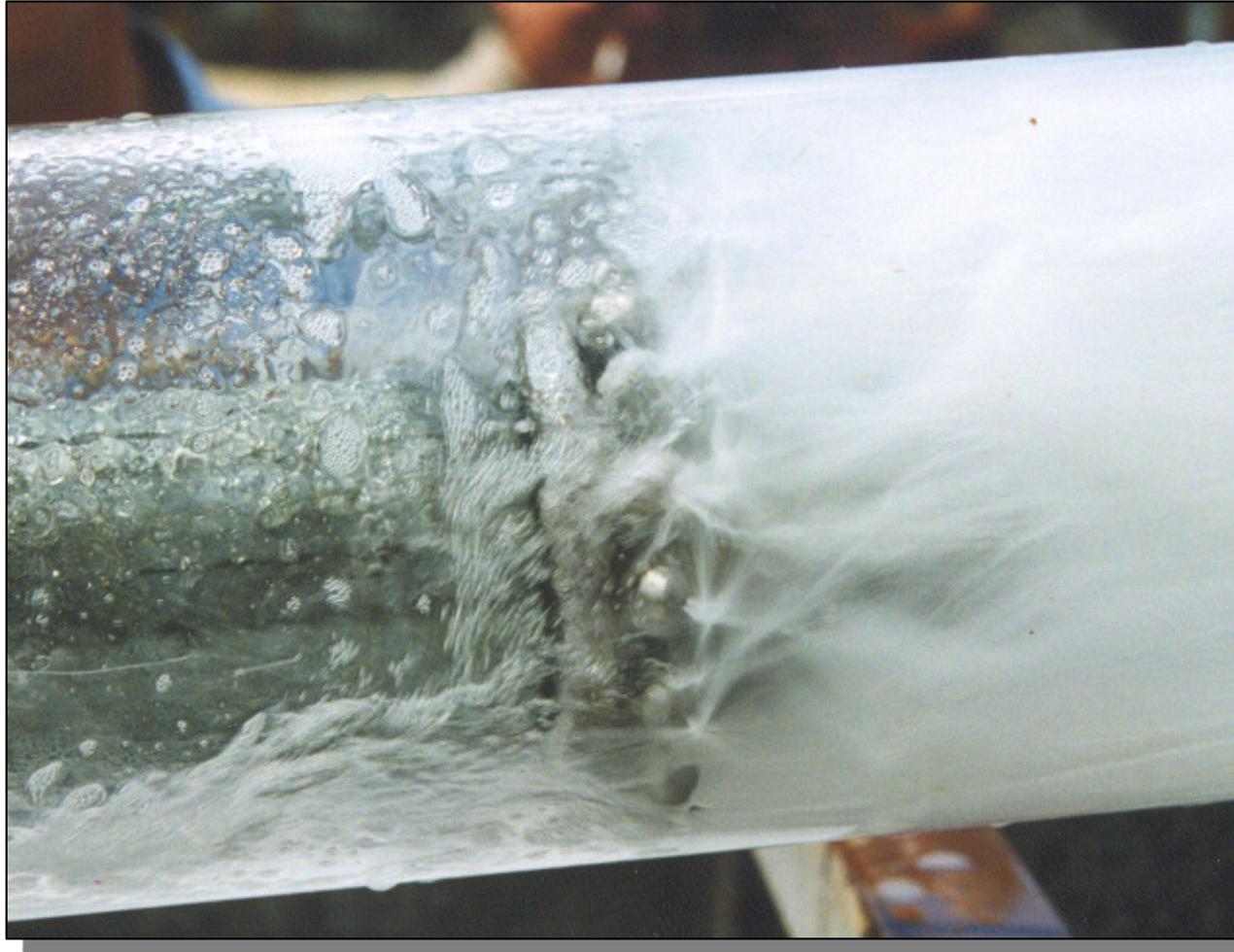
Pipeline inner diameters:	> 6”
Cleaning method:	high pressure fluid jets
Cleaning efficiency:	one single pigging run \Rightarrow 100% clean deposit removal even out of pits freeing of captured water
Cleaning pressure needed: ...	depending on deposit properties (usually 10 - 30bar)
Travel direction:	reversible (flow reverse)
Brake force:	adjustable, remains the same over the cleaning run lowers to zero if an obstacle blocks the pig
Travel speed:	adjustable down to 60 times slower than the fluid speed
Removal of debris:	continuously by bypass flow
Pipeline operations:	can be maintained while pigging
Pipeline geometry:	negotiation of T-fittings, steps, deformed pipe ID, welding lines, elbows, etc.

Cleaning head



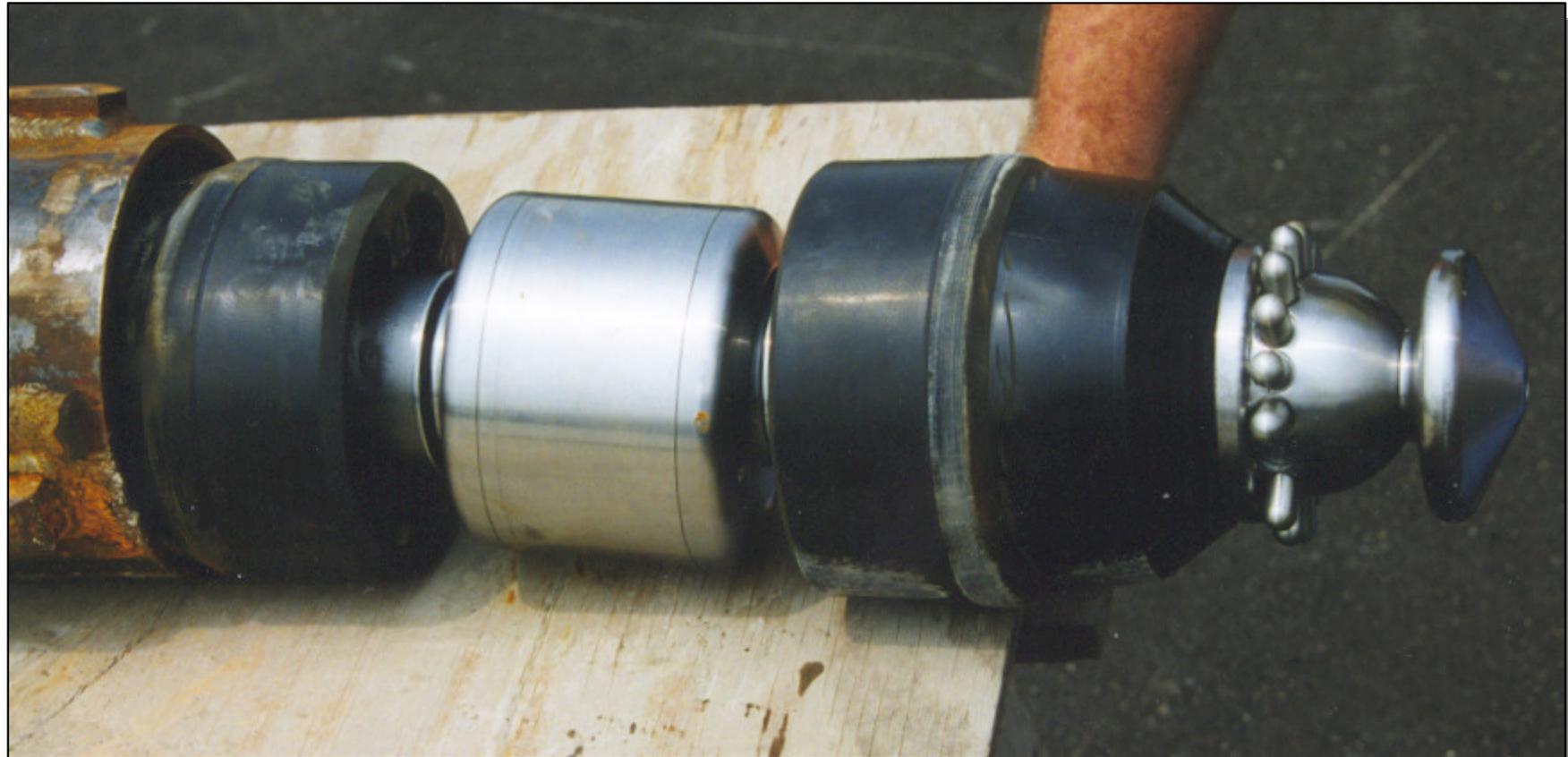
Cleaning head connected to 288 psi (19,8 bar), 48 gpm (182 l/min) water supply.

Cleaning head



Flow pattern of a cleaning head at 140 psi (9,7 bar) and 160 gpm (606 l/min).

Seal unit with cleaning head



Seal body with rigid and wear resistant seal cups installed.

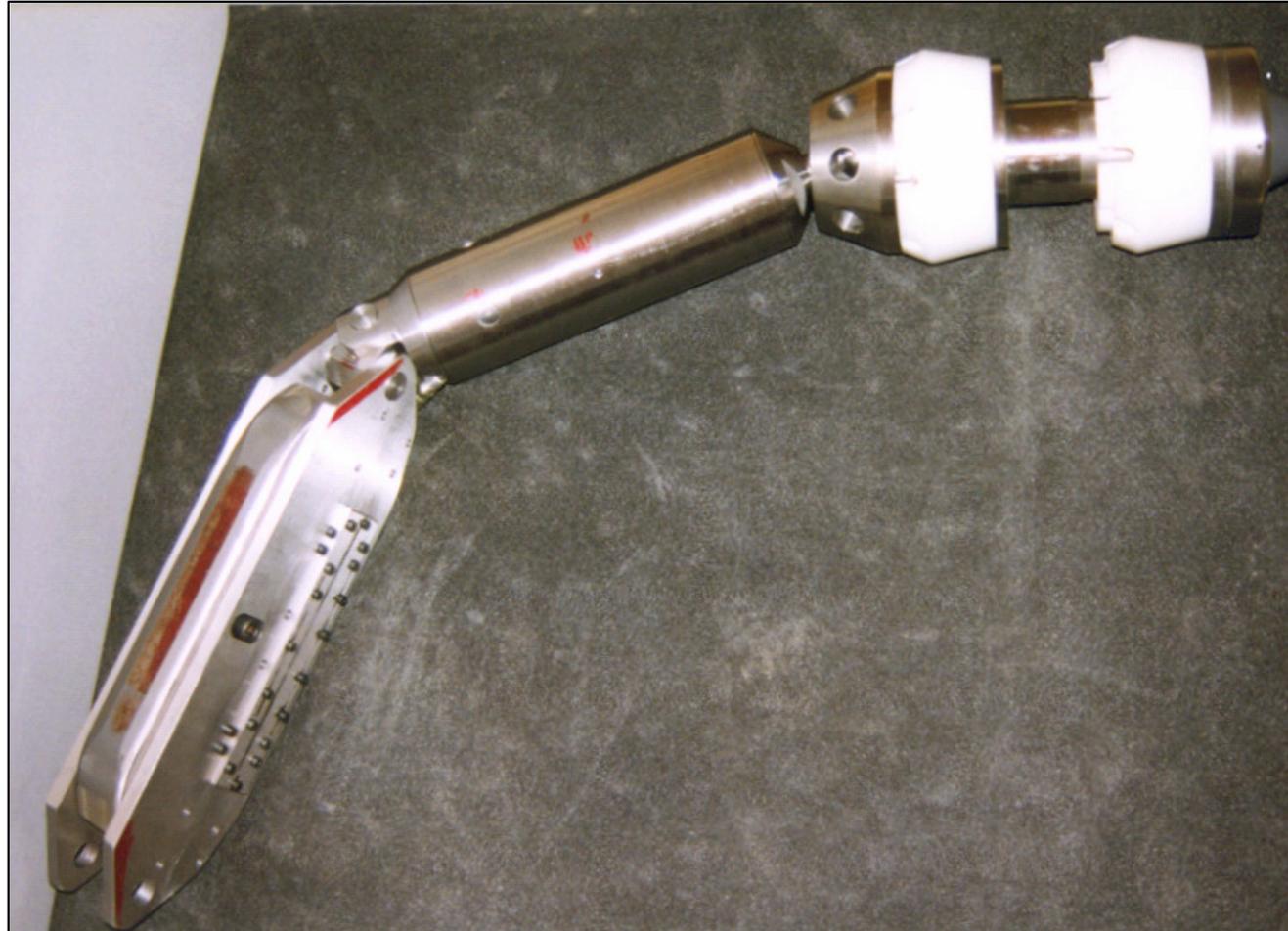
Brake mechanism



Test set-up to determine the brake systems' travel speed/brake force characteristics. A hydraulic ram was used to pull the brake systems through a pipe section.

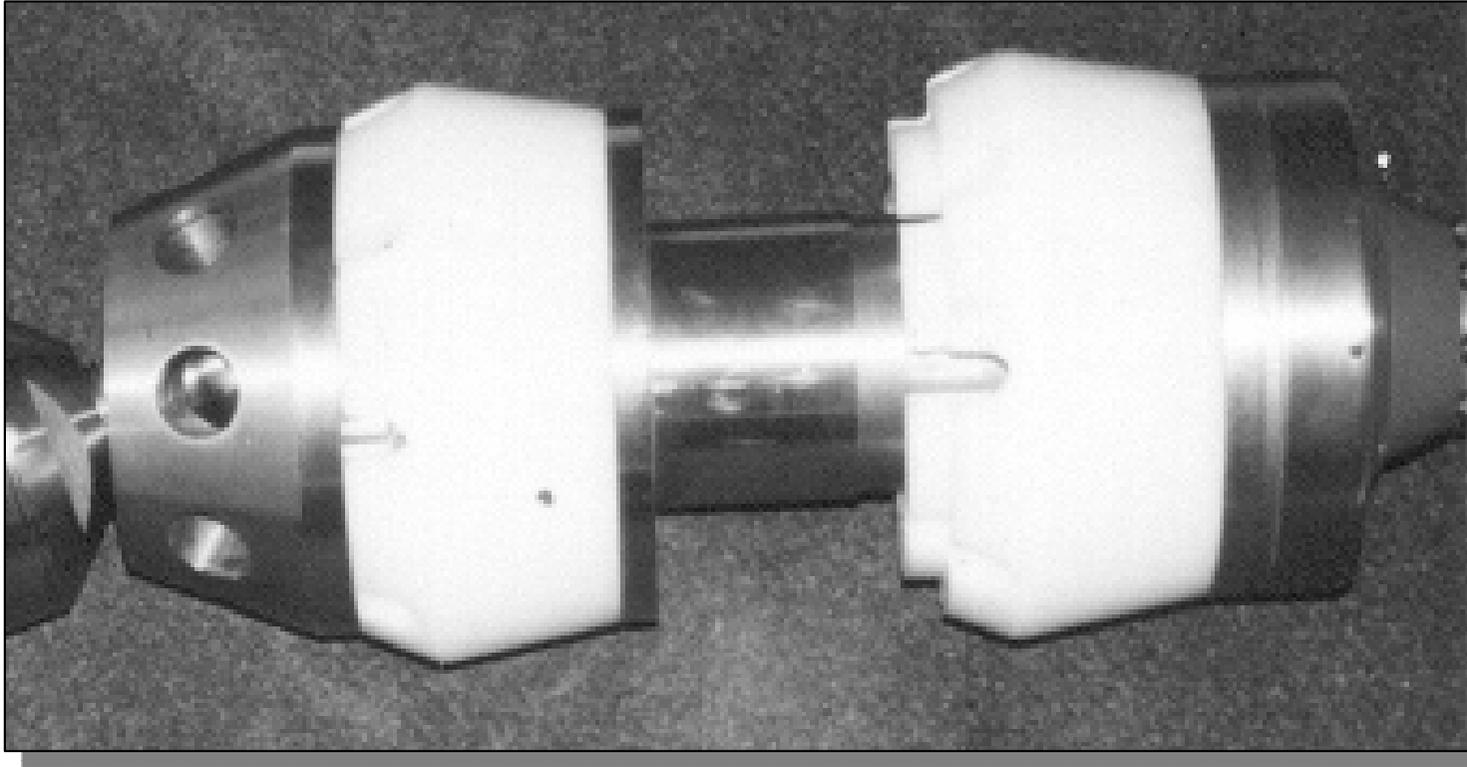
HAPP™ – units

HAPP™ prototype unit



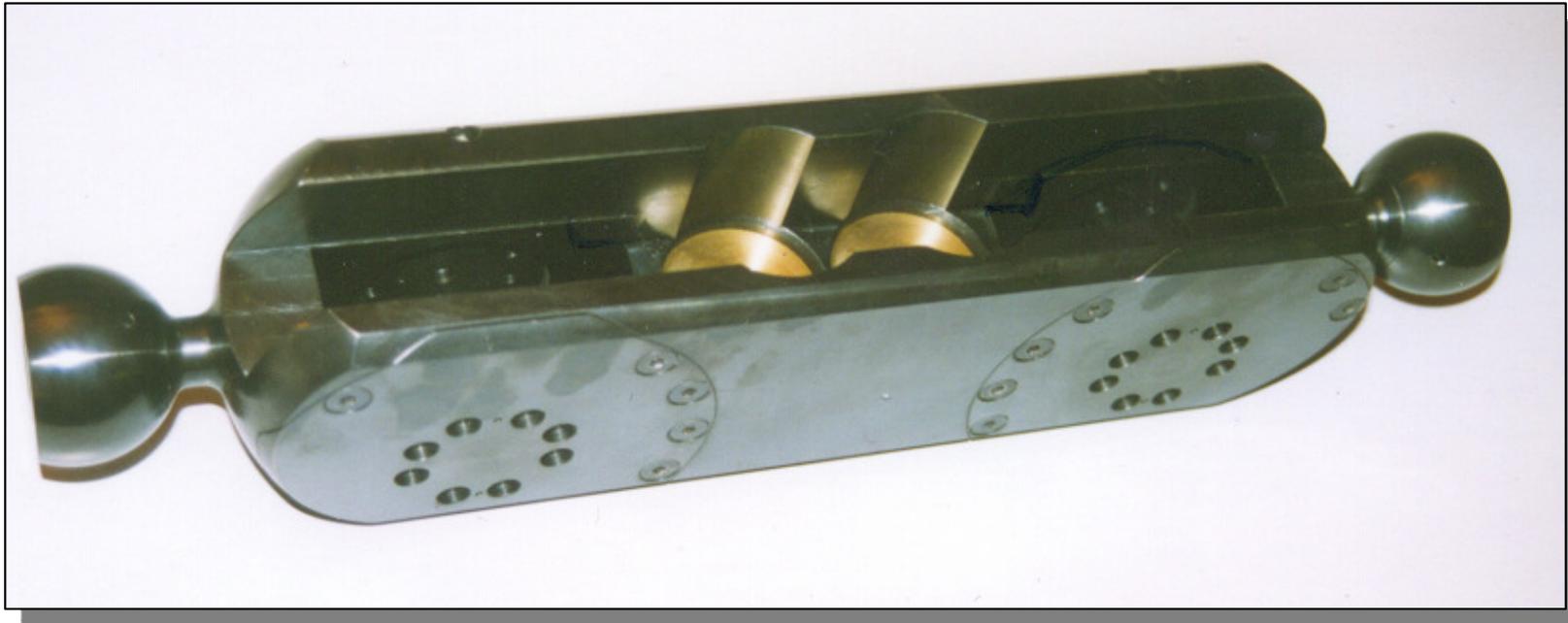
HAPP™ prototype design based on the cleaning head and brake system tests.

Seal unit



Seal incorporating seal body with polyurethane seal cups.

Brake unit



Housing of the brake unit

Launch of a HAPP™ unit



HAPP™ ready for launching

Reception of a HAPP™ unit



HAPP™ after a cleaning run of the 7.3 miles, 6.25 inches Braheney Line [operated by Equilon Pipeline Company, Denver City, TX pipeline contained 4 elbows à 22.5°, radius: 1.5 D]

References

References

The 6 inch HAPP™ has been tested as following:

Cleaning efficiency has been tested & verified in paraffin contaminated spool pieces of the test loop facilities of SHELL E&P Technology Company, Houston, USA.

Mechanical reliability has been tested & verified in the test loop of Aqua Drill International, Dickinson, Texas, USA.



A complete & successful cleaning job has been carried out at the 7,3 miles onshore crude oil line in Denver City, Texas, USA.

[Brahoney Line, ID: 6,25", operated by Equilon Pipeline Company]



Advantages...

... with respect to other pigging technologies on the market

- Operations:**
- Pipeline operation can continue while pigging.
 - No limits in operation reach.
- Effectiveness:**
- The adjustable and controlled travel speed allows an extraordinary pigging effectiveness: With only one single cleaning run the pipeline is 100% clean!
 - Various cleaning heads are available for removal of all kind of deposits.
 - Active pigging: The local pressure difference across a HAPP™ can be transformed in any kind of cleaning energy (brush, high pressure fluid jets, rotating, etc.).
 - The HAPP™ construction allows negotiation of T-fittings, steps, deformed pipe ID, welding lines, elbows, etc.
- Debris removal:**
- Hydraulically activated cleaning prevents plug formation by constantly carrying away debris downstream.
- Safety:**
- No conventional pig blocking due to debris plug in front of it.

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Thank you for your attention!

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