

Introduction to Pipeline Cleaning

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What is Pipeline Cleaning

- The act of removing foreign material from a pipeline by physical and chemical methods.
- Simply running a pig does not mean that you are cleaning the line.



Why Clean?

- Preparation for inline inspection
- Increase efficiency
- Prevent corrosion
- Safety and regulatory
- Product change
- Prepare for commission / decommission
- Prepare for coating and rehabilitation



Solids Screening

- The nature of the deposits is most important for choice of cleaning regime
- Black powder was found to be the most challenging solid in gas transmission systems
- Oily solids will be typical in oil and product transmission lines



Typical Cleaning Methods

- Mechanical Cleaning
 - Utilizes pigs only
- Chemical Cleaning
 - Uses pigs in conjunction with Chemical Cleaner.
 - Gel Pigs



Chemical Cleaners

- Cleaning can be done mechanically or with water or oil but the results are the same as washing without soap
- For the same reason one uses soap to wash dishes, chemical cleaners help wash the inside of the pipeline



Attributes of a Good Cleaner

- Dispersible in carrier
- Penetrate deposits that coat the pipeline
- Suspends solids
- Carries the deposits out of line
- Settles and separates for reuse and disposal



Typical Solvents

- Diesel
- Water
- Methanol
- IPA
- Xylene
- Safety Solvents (aromatic 150-200)



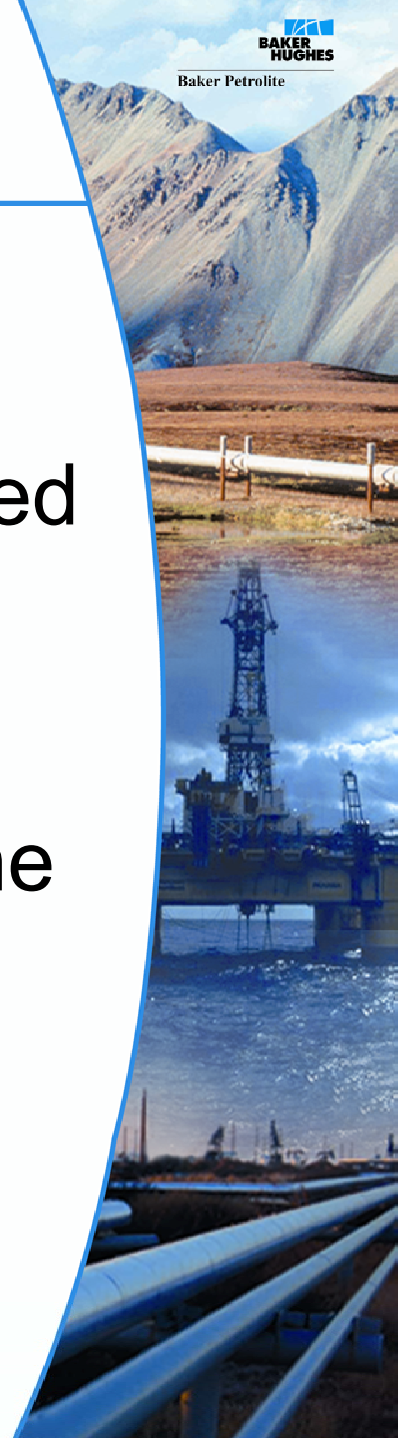
Solvent Selection

- Availability
- Convenience
- Cost
- Operational concerns
- Waste disposal



Typical Treatment

- 5% to 10% cleaner in solution
- Volume of cleaning solution is based on surface area of the pipe.
- Cleaning jobs require 2 to 10 runs with 4 runs typical depending on the desired results



Batch Volumes

- The batch size should be large enough to fill a minimum of 125' of the line.
- A rule of thumb for the batch size is:
distance (miles) x diameter x 3=volume

For example; A line that has a 20" diameter and is 40 miles long would be calculated as follows:

$$\begin{aligned} 40 \times 20 \times 3 &= 2400 \text{ gallons of cleaner} \\ &= 150' \text{ of pill} \end{aligned}$$



Calculating length of Pill

- On shorter lengths of line the 3xdxd calculation will not work
- The following equation should be used.

Calculate the gallons/ft

$$D^2 \times .0408 = \text{gallons/ft}$$

Then multiply by 125'



Example

- A 20" pipeline 15 miles long

$$20 \times 20 \times .0408 = 16.32/\text{gallons}/\text{ft}$$

$$16.32 \times 125' = 2040 \text{ gallons of cleaner}$$



Line Diameter	Length/ miles	Gal/ft	Gal of cleaning solution	Pill length
10	5	4.08	510	125
10	10	4.08	510	125
10	20	4.08	600	147
10	30	4.08	900	221
20	5	16.32	2040	125
20	10	16.32	2040	125
20	20	16.32	2040	125
20	30	16.32	2040	125
20	40	16.32	2400	147
30	5	36.72	4590	125
30	10	36.72	4590	125
30	20	36.72	4590	125
30	30	36.72	4590	125
30	40	36.72	4590	125
30	50	36.72	4590	125
30	60	36.72	5400	147



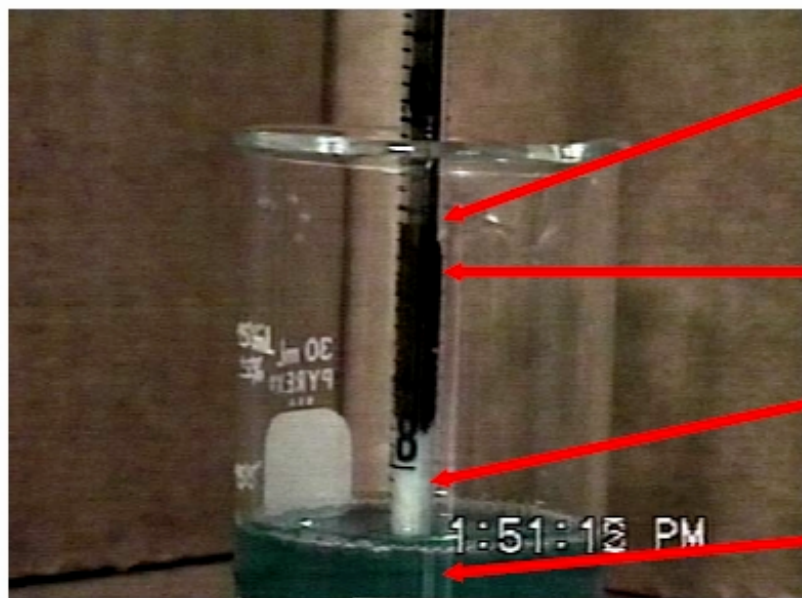
Steps to Cleaning

- System Analysis
- Evaluate deposits
- Specify cleaning goal
- Select and design cleaning system
- Clean
- Evaluate success



Penetration: The VAT test

- The VAT (Vertical Adsorption Test) or “Straw” test was designed to test the cleaners adsorption and penetration into solids from the pipeline.



Penetration Level

Pipeline Solid

Cotton

Cleaner

Oily Deposit Removal

- Oily deposits baked on in vacuum oven
- Coupons immerses in cleaner
- Amount of deposit removed quantified



95% Removal

Mechanical Design

- What equipment is available
 - Separation equipment
 - Tanks
 - Launchers and Receivers
- What are the operating constraints
 - Pressure
 - Flow
 - Diameter of the line.



Pig Selection

- Pig Selection is critical in any cleaning operation.
- If the line has never been pigged the first pig should be a foam (Poly) pig.
- As the cleaning progresses a more aggressive pig is used such as a disc pig equipped with brushes.





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Two Methods of Cleaning

Cleaning of pipelines is conducted in one of two ways

- Online-Without interruption of service
- Offline-Line is blown down.



Cleaning Online

- Performing the cleaning operation under normal flowing conditions
- Process requires separation equipment and multiple pig runs
- Cleaning solution is batched into the line and the pig is launched
- Pigs are equipped with jet holes to aid in agitation



PIG FLOW – STEP ONE – 06/26/02

Pig Enters Pipe



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PIG FLOW – STEP TWO – 06/26/02

Chemicals are injected



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PIG FLOW – STEP THREE – 06/26/02

Pig Moves Through Cleaning Pipe



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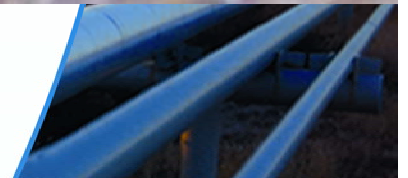






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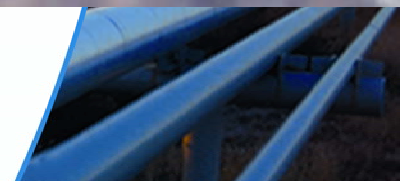


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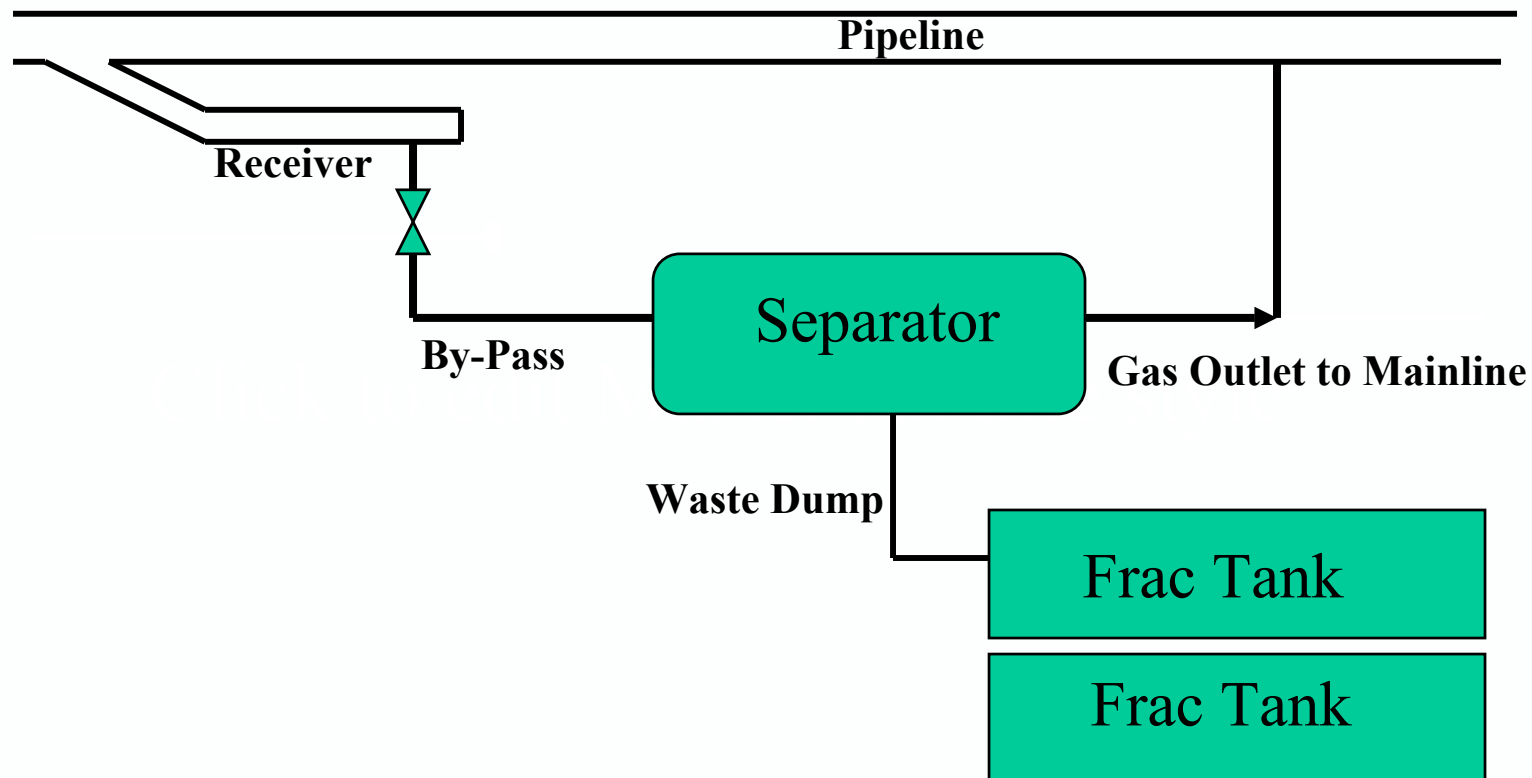
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Typical Separator Installation





300 MMSCFD Separator

12" Inlet and Outlet









Cleaning Offline

- Performed with the line out of service
- Cleaning solution is run in a multiple pig train, generally 1 to 2 runs required
- Pig train is moved with gas, product, nitrogen, air or water during hydrotesting
- No jetting holes on the pigs







First Pig Run with Cleaner



Pig After First Cleaning Run



Barrel After Third Cleaning Run

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Pig After Third Cleaning Run

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Dispersible

- To be effective the chosen cleaner must be at least dispersible in the chosen carrier medium with water and diesel being the two most common
- A typical application will use from 5 to 10 percent cleaner in solution

Penetrates Solids

- The cleaner solution should penetrate through all the deposits
 - Waxy and oily deposits should be softened and dissolved
 - Solid deposits should be loosened and modified to aid in removal
- Penetration time is typically kept to about 60 seconds based upon treatment volume and pig speed

Suspends Solids

- While traveling down the line, the deposits must remain in solution and not redeposit
- Solids are suspended by a combination of physical and mechanical means
- The mechanical means is by moving the pig fast enough to maintain turbulence but slow enough so that the cleaner still penetrates (typically 6-8 ft/sec)
- Surfactant modifies the particle



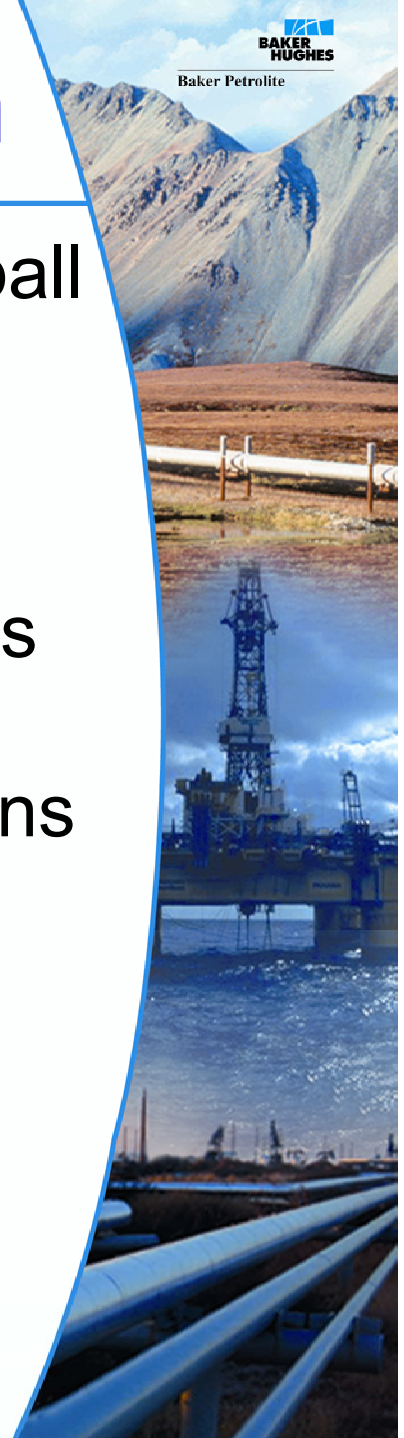
Corrosion

- If solid deposits remain in a line, corrosion is likely to occur at those locations
- In a dirty line corrosion inhibitors can not migrate to the pipe wall
- Water will accumulate under deposits resulting in corrosion



Cleaning to Prevent Corrosion

- Wet gas pipeline, 6", pigged weekly with ball pig, 3.8 MMCFD @ 713 PSI
- 49 MPY corrosion rate, CI treatment not lowering rate
- Pigged 1 time 5% CLW3060 in 800 gallons 200° F water
- Pigged 7 times 5% CLW3060 in 400 gallons water
- Reduced base corrosion rate to 7 MPY
- After continuous corrosion inhibitor treat, corrosion rate <1 MPY



Safety and Regulatory Compliance

- Some solid deposits (e.g. iron sulfides) are pyrophoric and present safety hazards when opening a line or on filters for line equipment such as compressors
- Pipelines have maximum operating pressures and by keeping the line clean both the designed flow rate and pressure may be maintained

Cleaning for Smart Pigging

- 20", 70 mile gas transmission line
- Two attempts at running dummy pigs both times the pigs got stuck
- Cost of \$500K and still not able to run smart pig
- 4 runs CLO3073 at 8% in diesel
- 18,000 lbs of solids removed from line
- Successful smart pigging



Efficiency

- For 12 inch line, a smooth 5% deposit buildup will reduce throughput by 10% or require a 30% increase in operating pressure.
- If the buildup is uneven, throughput could drop by 35% or require a 140% increase in operating pressure.
- By operating with less obstructed pipeline, more product may be transferred at a lower cost

Pigging for Efficiency

- 94 miles, 30" gas transmission line
- Efficiency drop from 85% to 66%
- Numerous pig runs without chemical failed to increase efficiency
- 10 pig runs were made, 6 with 10% CLW 3060 in 7500 gallons water, 4 drying runs
- Removed more than 120,000 lbs. of solid
- Final efficiency 92%

Experience in Argentina

- OFF LINE CLEANING 2005
- 384 km of 16 “ GasTransmission line
- Wax deposits inside
- 8 % of Cleaner in Cleaning Solution was used
- Solvents : Diesel + Xylene



Experience in Argentina

- Pipeline pressure was reduced at 75 psi
- Natural GAS was used to move the pills
- Launcher/Receiver Modifications :



FIRST CLEANING RUN



SECOND CLEANING RUN



THIRD CLEANING RUN



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BAKER
HUGHES
Baker Petrolite



6 th Cleaning Run



Experience in Argentina/ Chile

- ON LINE CLEANING 2006
- 485 km of 24 “ GasTransmission line
- Black powder deposits
- 8-10 % of Cleaner in Cleaning Solution was used
- Solvent : Diesel
- ILI Inspection after cleaning



INJECTION



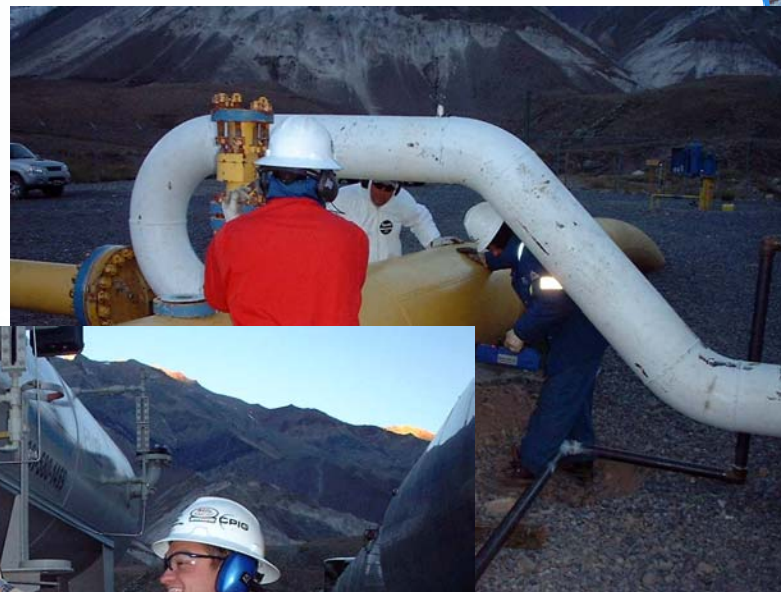
SEPARATOR



SEPARATOR INSTALLATION



Baker Petrolite



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FRAC TANKS



Baker Petrolite



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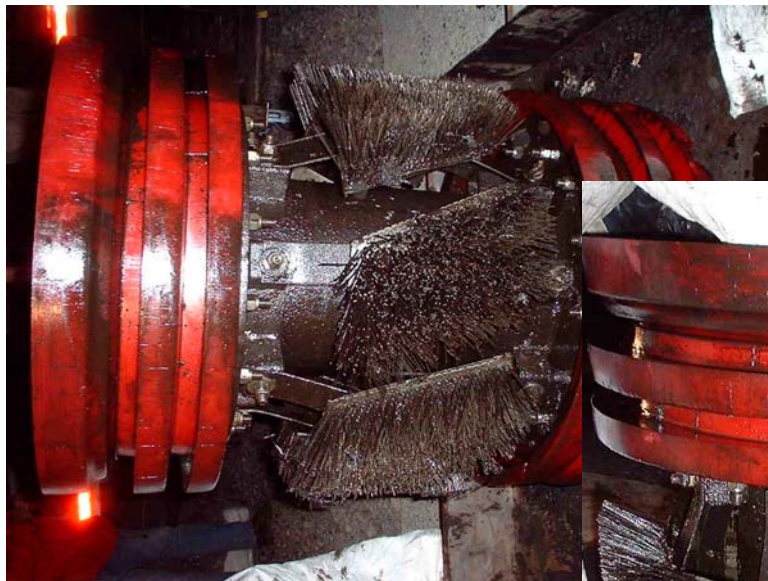
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FIRST RUN



4 th RUN



INSPECTION TOOLS AFTER CLEANING

- GA

- CA

- M



Conclusions

- Pipeline cleaning is necessary and required for numerous reasons including
 - High corrosion rates due to deposits
 - Loss of operating efficiency
 - Intelligent pigging of a line
- A systems approach is required to design a chemical cleaning program
- Deposit analysis is critical to the successful choice of a chemical cleaner based upon performance requirements