

CLEANING PIG DESIGNS AND APPLICATIONS

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PIPELINE PIGS



- A cleaning pig is any free traveling cleaning device that is sent through a pipeline by product flow to scrape and brush foreign deposits, rust and dirt and fluids from the inside surface of the pipe.
- 500 + types of mechanical pigs.
- Pig length (inches) = 1 and ½ pipeline diameters.
- **Pipeline pigs may be designed for:** purpose, accommodation, economics, endurance, cleaning, flow efficiency improvement, flexibility, heat-resistance, chemical resistance, chemical batching, gauging, mapping, measurements, inspection, and other needs.



GENERAL CLEANING RULES

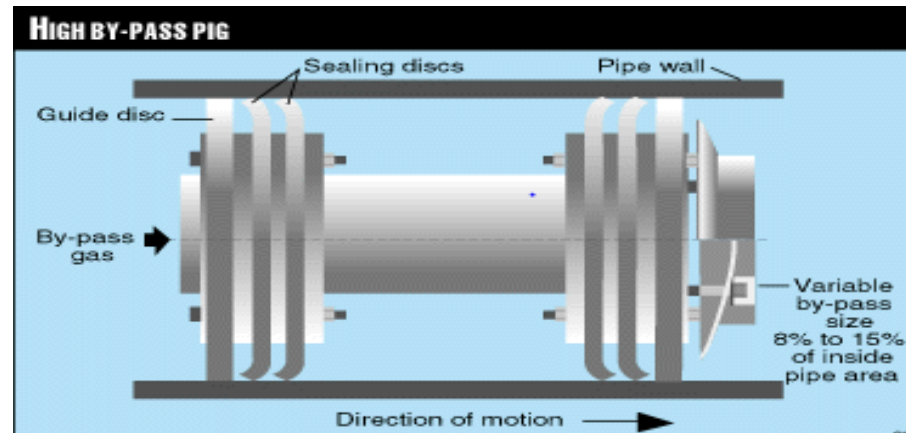


- Use the correct type of pig and frequently schedule piggings to maintain pipeline integrity and flow efficiency.
- Select the right pig design to clean the specific hold-up in the pipeline.
- A pipeline that can be pigged, should be pigged at least annually to prevent corrosive liquid & solids hold-up.
- Cleaning or utility pigs, when run on-stream, will have the speed of the pig dictated by the product flow rate.
- Most gas transmission pipelines flow at ranges between 10 and 17 feet per second.



PIG BY-PASS DESIGN

- All pigs, regardless of style, are 1% to 5% oversize, and thus are larger than the pipeline internal diameter.
- Most standard pigs are designed to bypass a small portion of the propelling medium during a pig run.
- By-pass averages between 2% to 15%, depending on the type of pig.
- Often, pigs may by-pass and leave as much 25% of the product in the pipe after a displacement run.



PIG LIFE

- **Depends on:**

- Quality of pipeline construction
- Pig velocity & design
- Interior line conditions (rough, semi-rough, smooth)
- Media in which pig runs



- Rules of Thumb:

100 miles (160 km) - for newly constructed onstream gas pipelines

150 miles (240 km) – for newly constructed product lines

200 miles (320 km) – for newly constructed crude oil lines



PIG SPEED



- **Suggested speed for effective utility pigging:**



- Pipeline Pre-commissioning/commissioning = 1-5 MPH (1.5-7.5 FPS)

- Routine Gas Pigging = 2-8 MPH (3-12 FPS)

- Routine Liquid Pigging = 1-8 MPH (1.5-12 FPS)

- ILI Tool Runs = 2-7 MPH (3-10 FPS)

Cast Urethane



Photo courtesy of Braid Industries



REASONS TO PIG

CLEANING, BATCHING, DISPLACEMENT & INSPECTION

- **1994 Legislation**

- Requires new hydrocarbon pipelines to be piggable.
- Requires certain existing pipelines to be modified to facilitate pigging.
- Requires pipelines to be pigged periodically, if piggable

- **Cleaning**

- Corrosion control - maintain pipeline integrity
- Flow efficiency
- To dewater lines after hydrostatic testing

- **Monitoring & Inspection**

- Identify design, manufacturing and construction defects
- To gauge or survey the I.D. of the pipe
- Provide information of developing problems



PIG APPLICATIONS

- **During Construction**

- Removing construction debris
- Acceptance testing – fill/dewater
- Commissioning

- **During Operation**

- Pipe wall cleaning
- Condensate removal
- Product separation (batching)
- Applying inhibitors

- **For Inspection**

- Check for physical damage (geometry)
- To detect, corrosion, laminations or cracking
- Leak detection
- Sampling
- Line cover and subsea spanning



PIG DESIGNS

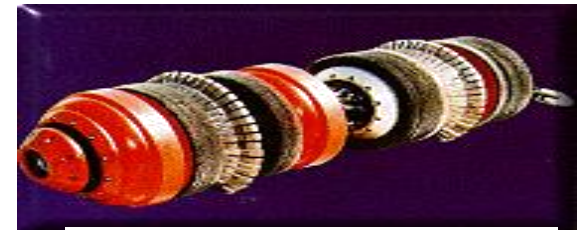
Utility Pigs – for cleaning and sealing

- Mandrel Pigs
- Poly Pigs and Foam Swabs
- Cast Urethane Pigs
- Spherical Pigs



In-Line Inspection Tools (high or low resolution - for wall loss)

- Magnaflux Leakage (MFL) Inspection
- Ultrasonic Inspection & Geometry



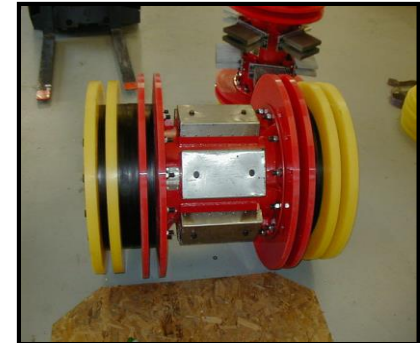
Gel Pigs

- Batching or Separator Gels
- Debris Pickup Gels
- Hydrocarbon & Dehydration Gels



MANDREL PIGS

- Mandrel Pigs are made up of component parts that mount on a steel body allowing multiple configurations and the replacement of individual parts.
- **Individual parts may consist of:** cups, magnets, and discs scraping elements, including brushes, or blades for cleaning.
- Most pig bodies are either aluminum or steel usually with 2 seals, front and rear, made of urethane, nitrile or neoprene.
- Pigs may be uni- or bi-directional during flowing conditions.
- These pigs are most suited for pipeline cleaning and chemical batching.



MANDREL PIG BRUSHES

- There are four main types of accessory brushes for cleaning pigs:

- Block Brushes



- Wrap Brushes



- Ring Brushes



- Pencil Brushes



Steel Mandrel Pigs
Wire Brush

FOAM PIGS

- Foam or polly pigs are versatile, flexible and usually the least expensive.
- They are made of open-cell polyurethane foam.
- They may be uni- or bi-directional in flowing pipelines.
- The foam may be bare (swab or squeegee) or can be coated with urethane for more durability and may contain wire bristle brushes or metal studs for more abrasive cleaning.
- The density of the foam ranges from 1 lb/cuft to 10 lbs/cuft.



SINGLE CAST URETHANE PIGS

- These single cast urethane pigs are available in sizes from 2" to 48".
- They are made of one piece urethane and offer flexibility in performance and capabilities.
- Pedal (expandable) pigs are used in telescoping (multi-diameter) pipelines.
- The pigs are used mainly as sealing pigs and for chemical batch treating, but can be equipped with cleaning elements.
- Some models allow cups, brushes and discs to be changed out when damaged or worn.
- Most carry pingers, magnets, or other devices.



SPHERICAL PIGS

- Spheres or ball pigs are the oldest and most recognized sealing pigs.
- Used to push liquids out of pipelines.
- **Three types of spheres:** [Inflatable](#), [solid](#), and [foam](#).
- Suitable for onshore and offshore gathering systems where pigging may be frequent and the system needs to be automated.
- Suitable for pigging laterals and can drop into downstream mainlines and be swept in by larger pigs.



PIG SELECTION AND APPLICATION

Cleaning Applications

	Sand/Sludge	Scale	Water	Paraffin	Bacteria
Swabs	Fair	Poor	Fair	Poor	Poor
Pollys	Good	Fair	Good	Poor	Good
Spheres	Poor	Poor	Fair	Poor	Poor
Cast Urethane	Good	Fair	Good	Poor	Fair
Mandrel Urethane	Excellent	Fair	Excellent	Fair	Fair
Bi-Directional	Excellent	Good	Excellent	Fair	Good
Brush Pigs	Poor	Good	Poor	Poor	Excellent
Plow Blades	Poor	Poor	Poor	Excellent	Fair
Gel Trains	Good	Poor	Good	Poor	Fair

CHEMICAL BATCH PIGGING



- In a dry gas pipeline, batch pigging involves running a batch of oil soluble inhibitor or biocide ahead of a single pig; or between two pigs so that the whole internal pipe surface is wetted.
- In a liquids pipeline, batch pigging can be used to separate products by reducing the interface between products.
- A cleaning pig should be run before batching to clean the pipe surface of contaminants and to prevent dilution of chemicals.
- Protective inhibitor film (1 mil thick) applied at an optimum pig speed of 5 to 7 feet per second (3 to 5 mph) is shown below using a dual pig train.



CHEMICAL BATCH TREATING WITH PIGS

Treating Applications

	Start-Up	Inhibitor	Biocide	Paraffin Solvent
Swabs	Good	Fair	Poor	Poor
Pollys	Good	Fair	Fair	Poor
Spheres	Poor	Poor	Poor	Poor
Cast Urethane	Good	Excellent (a)	Excellent (a)	Good (b)
Mandrel Urethane	Good	Excellent	Excellent	Good (b)
Bi-Directional	Excellent	Good	Excellent	Good (b)
Brush Pigs	Poor	Poor	Good (c)	Poor
Plow Blades	Poor	Poor	Poor	Fair
Gel Trains	Good	Good (d)	Good (d)	Fair

- Notes:**
- (a) Holes can be drilled in the center casting to apply chemical
 - (b) Check solvent/disc or cup material for compatibility
 - (c) Use swab behind brush pig to aid in launch
 - (d) Specialty gels incorporate inhibitors or biocides

INTELLIGENT PIGS

METAL-LOSS TOOLS			CRACK-DETECTION TOOLS		CALIPER TOOLS	MAPPING TOOLS
Magnetic Flux Leakage (MFL)		Ultrasonic (compression wave)	Ultrasonic (shear wave)	Transverse MFL		
Standard-resolution (SR) MFL	High-resolution (HR) MFL					

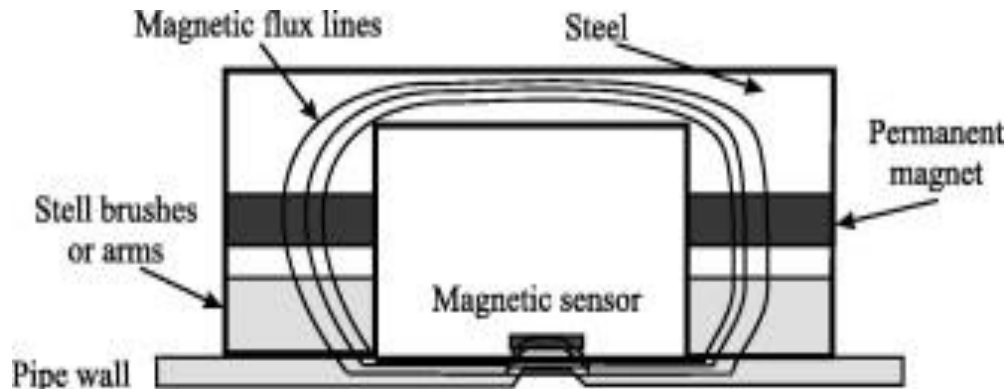
GEOMETRY PIGS

- A geometry/caliper pig is a configuration pig that uses mechanical arms or electro-mechanical means to measure the bore of the pipe.
- It is designed to record conditions in gas and liquid pipelines, such as dents (deformation anomalies), buckles, wrinkles, ovality, bend radius and angle, pipeline constrictions, and occasionally indications of significant internal corrosion by making measurements of the inside surface of the pipe.
- It can sense changes in girth welds and wall thickness at designated locations and is usually run in pipelines before intelligent pigs are run.

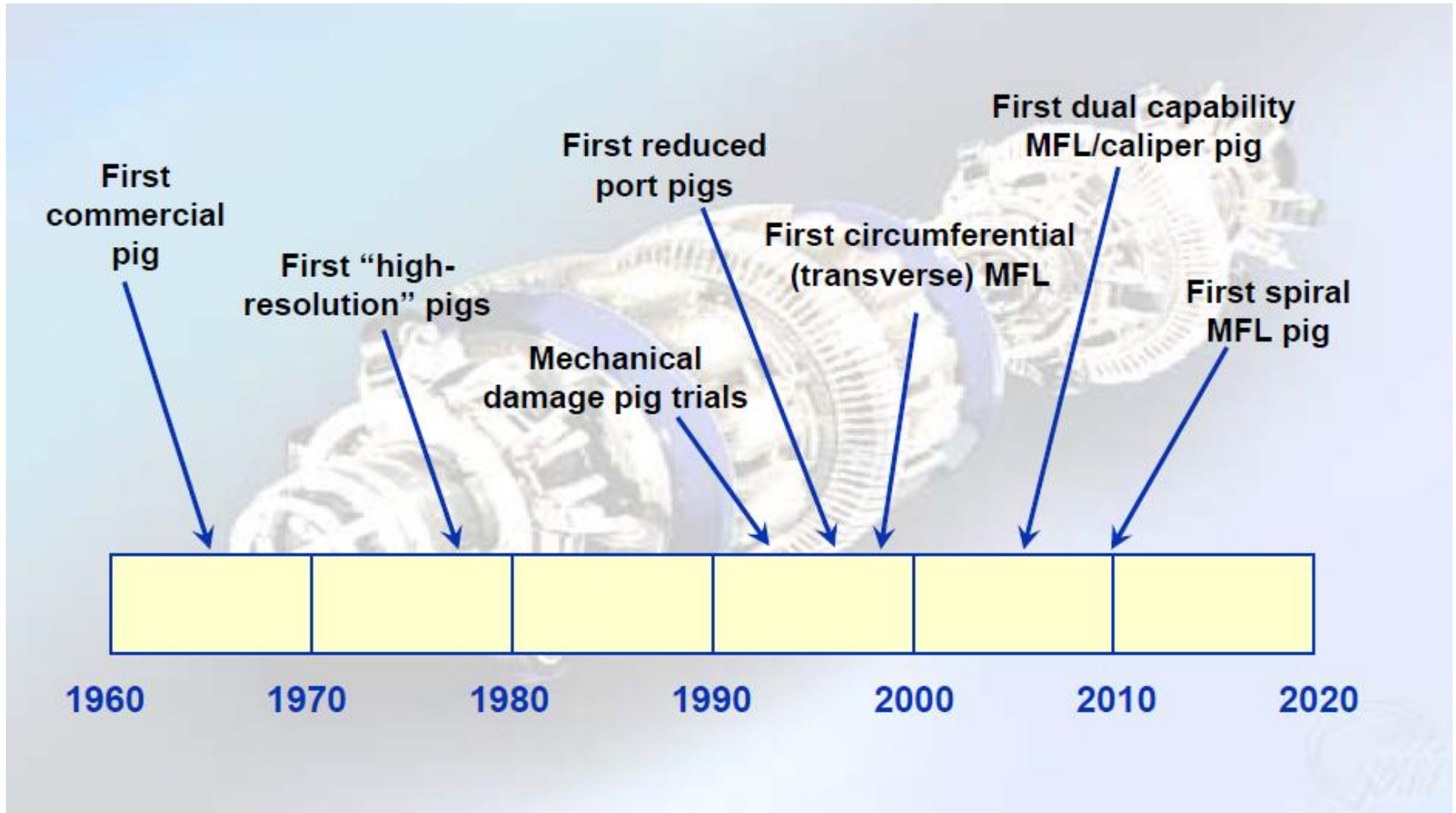


IN-LINE INSPECTION PIGS

- A sophisticated in-line inspection tool (pig) run through a segment of pipeline to determine areas of defects of both internal and external pipe walls.
- Provides recordings which indicate the severity and location of the defect.
- **Magna-flux Leakage (MFL):** Flux-leakage technology will saturate sections of pipe with a strong magnetic field and the flux path is recorded.
- Leakage or variations in the flux path, as it travels through the steel pipe are detected by magnetic sensors situated between the magnetic poles, and can be directly related to areas of metal loss.



MFL HISTORY



IN-LINE INSPECTION (SMART) PIGS

- **Ultrasonic Technology (UT)** uses a transducer to emit a pulse of ultrasonic sound through the pipe which travels at a known speed.
- On entering the internal pipe wall, there is an echo, and another echo as the pulse reflects off of the external wall.
- The time taken for these echo's to return provides a virtual direct reading of the wall thickness.
- Unlike the MFL tools (pigs) which have a maximum allowable wall thickness, the UT tools (pigs) have a minimum.
- MFL tools used most effectively in gas pipelines, UT tools operate best in liquid pipelines.



SMART PIG SCHEDULING

- [May 12, 1994](#) – PHMSA promulgated regulations requiring new transmission pipelines and pipeline replacements to be designed to allow the passage of internal inspection tools (Pigs).

SCHEDULES

- Gas Pipeline Segment Run Intervals – Every 7 years
- Liquid Pipeline Segment Run Intervals – Every 5 years
- External Corrosion, Internal Corrosion, and Stress Corrosion Cracking are time dependant threats which must be assessed if present.



END

