Today's ILI

Terry Shamblin

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Today's ILI

Originally pigs were used for maintenance service to clean water and crude oil lines. It is believed that the first devices were basically balls of barbed wire with burlap wrapped around them. As they passed through a line in the product they made a squealing sound and thus came the name "PIG".

Today's ILI

- Over the last 50 years the pipeline industry has seen many advancements in ILI processes and tools from cleaning pigs to geometry pigs to smart pigs, tracking systems and services, data analysis and reporting, and overall tool and vendor capabilities.

Cleaning Pigs

- Before starting an ILI program the subject pipeline needs to be relatively clean and that is usually accomplished with cleaning pigs.
- Early cleaning pigs were primarily spheres, foam pigs and polypigs.

Spheres

Foam Pigs

Poly Pigs

Today's Cleaning Pigs

- All of the mentioned are still utilized with many more new innovations and tool types out there today.
- Many configurations with steel mandrels, urethane cups and discs, brushes, magnets, studs, and guage plates.
- Rebuildable, can have many configurations, bi-directional, dual diameter, tracker cavities, and much more.

Turbo Series Pipeline Pigs
All-Urethane Pipeline Pigs

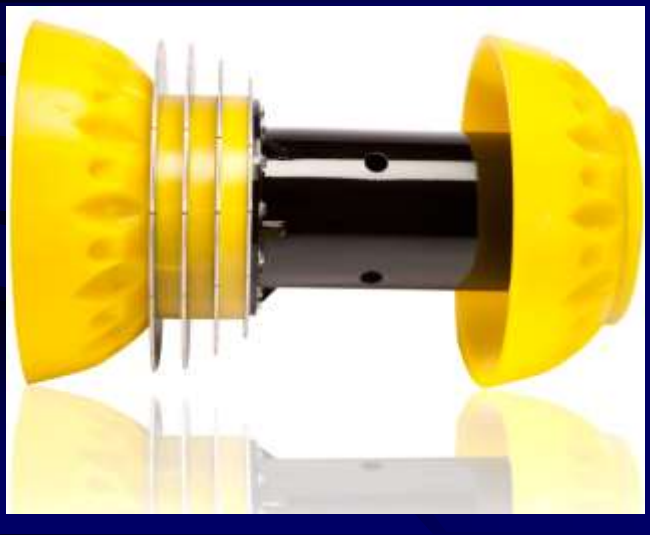
Pig Valve Pigs
For use in pig launching and receiving valves

Beast

Brush Cleaning with Guage Plate

Cleaning Train

Profile Guage Tool



Dual Diameter Cleaning

Pipeline Cleanng

Today's ILI - Geometry

- An important step in an ILI program is to measure pipeline geometry along the inspection length of the pipeline to record dents, mechanical damage, third party damage and pipeline configuration. It is also insurance to allow safe passage of the smart pig.

Early Geometry

Measured distance to feature with Odo wheels

Had 12- 24 sensors all wired to one channel

Recorded to tape or paper rolls with a stylus

Poor capability with clock position, bend radius and angle of bend

Today's Geometry

- Multiple channel standard and high resolution
- Digital technology, solid state recording
- Very accurate with bore measurement, bend radius, angle of bend, linear and clock position

Geometry

Geometry

Geometry

Smart Pigs

- The first commercial smart pig was introduced by Tuboscope in 1964 working off MFL technology utilized in down hole inspection. The tool had 6 sensors and only inspected the bottom ¼ of the pipe. It had no ODO wheels and recorded to magnetic reel to reel tape.

Smart Pigs

- First circumferential low resolution MFL pig in 1966
- First high resolution tool MFL was introduced in 1978
- First Ultrasonic tool introduced in 1986

Early Smart Pigs

- Low resolution MFL
- 12 – 24 sensors, did not have 100% circumferential coverage
- Recorded to reel to reel or DAT tape
- Lower POD level of 60 – 70%
- Data graded to 20% & above wall loss
- No internal external discrimination

Early Smart Pigs

- Clock position was determined from manual charts
- Casings shielded magnetic signal and data was poor from them
- Poor bend radius capabilities
- Data presented on large paper rolls with manual grading off a wheel chart
- Electromagnets – loss of power meant no MFL

Today's Smart Pigs

- High Resolution MFL
- Large array of sensors
- Solid state recording to memory boards
- 80% or greater POD
- Data graded to +/- 5%
- Internal/External discrimination
- Grading Spec. +/- 10% 80% of time

Today's Smart Pigs

- Full grading through casings and other structures
- Most all MFL tools can navigate 1.5 D radius bends
- All data recorded to flash memory
- Clock position for all anomalies determined by onboard gyros
- Rare earth magnets – full time MFL

Today's Available Smart Pigs

- High Resolution Geometry – Utilized to locate and size dents, buckles, bends, third party damage and pipe geometry
- High Resolution MFL (Magnetic Flux Leakage) – Main usage to locate and measure internal/external corrosion.

HRGeo-HRMFL-UT

HRMFL

HRMFL

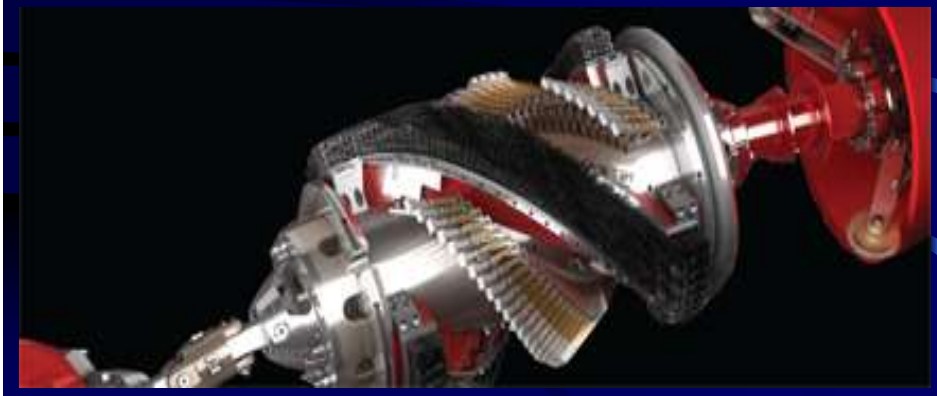
HRMFL

Today's Available Smart Pigs

- TFI - Transverse Flux Induction - MFL magnets are oriented circumferentially to locate and measure axial cracks.
- Spiral MFL - Magnets and sensors spiraled around the tool axially and circumferentially to locate corrosion and cracks

TFI

SMFL



Today's Available Smart Pigs

- Ultrasonic - Compression wave - Uses ultrasonic compression waves to locate and size corrosion. A fluid couplant is required.
- Ultrasonic - Shear wave - Ultrasonic shear or angled waves utilized to locate and size axial cracks. A fluid couplant is required.

USWM - UT

UT

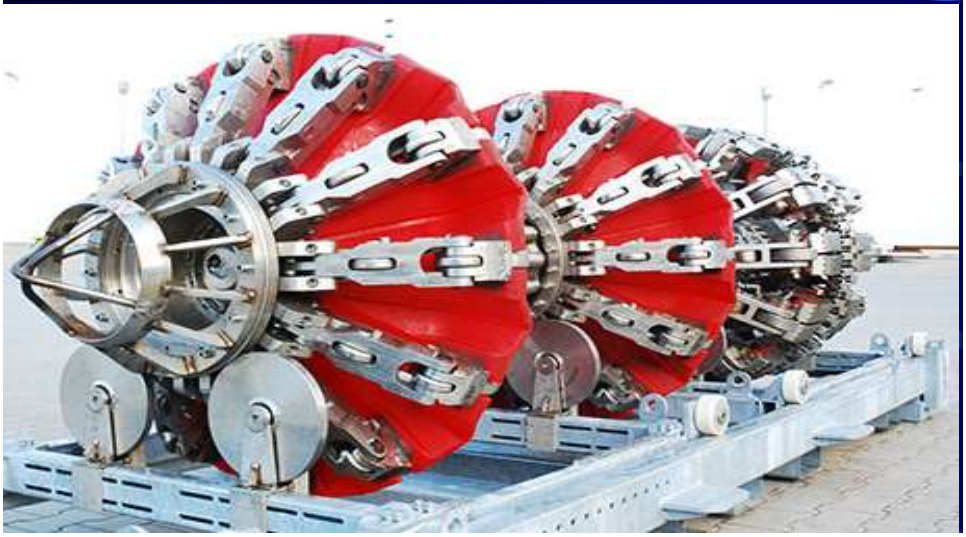
Today's Available Smart Pigs

- EMAT – Electromagnetic Acoustic Transducer - Ultrasonics that are induced into the pipe wall without a fluid coupler
- Dual Diameter MFL - MFL tools with magnet and sensor setups that can compress and expand to inspect multiple pipe diameters
- Coating Tool - Low voltage Eddy current utilized to locate coating holidays

EMAT

Dual Diameter

Dual Diameter

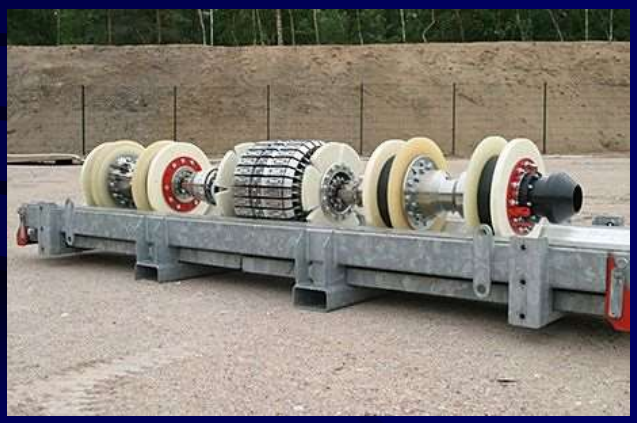


Coating Tool

Todays Available Smart Pigs

- PGS Tool - To determine pipeline material grades
- Low Pressure, Low Volume MFL Tool - To allow inspections to be completed at lower than normal pressures and flows.

PGS Tool



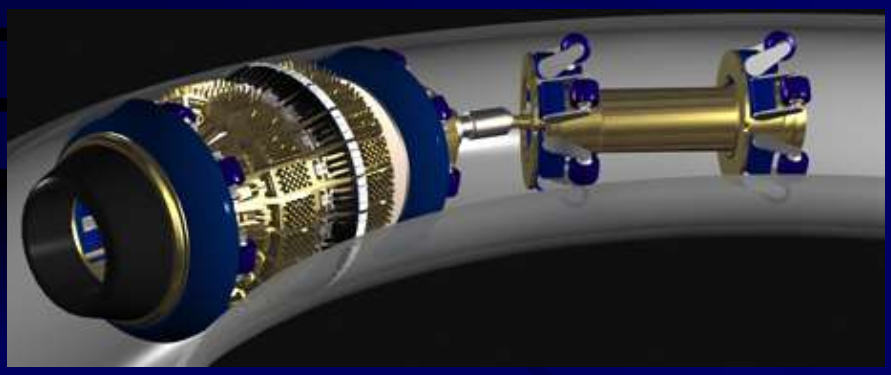
Low Pressure, Low Volume MFL

Today's Available Smart Pigs

- Speed Control - Many MFL pigs can be setup with large variable orifices that can be opened and closed to maintain desired flows in products.
- INU, IMU, GPS - Inertial Navigation Unit, Inertial Mapping Unit, GPS - With aid of an above ground survey this unit will provide 3D positioning for all pipeline features

Speed Control

HRMFL w/Speed Control



Today's ILI – Smart Pigs

- The trend in today's inspection world is to run combo tools for efficiency. The most common usage is high resolution geometry combined with high resolution MFL and INU.

HRMFL - Combo

Today's ILI - AGM

- Early AGM's (Above Ground Markers) were heavy, bulky and unreliable.
- Some were generators hooked to a large coil of wire.
- Others were large electromagnets hooked to a car battery.

Today's AGMs

- Today's AGMs are small, easy to use and very reliable.

Submit signals to pig and records position with full GPS.

AGM

AGM

Today's ILI – Major Vendors

- Baker Hughes
- Enduro PLS
- GE – PII
- NDT
- Rosen
- TDW


Smart
Pig