Zeki Gokce





GUIDED WAVES ON PIPELINES

- Low frequency Ultrasound (20-100kHz)
- Developed for Corrosion Under Insulation
- First introduced into the market in 1997 by TWI Ltd
- Established method for screening pipelines
- Inspection of inaccessible areas



CONVENTIONAL UT VERSUS LRUT



WAVE MODES IN PIPES



PIPE WALL DISPLACEMENTS



DISPERSION CURVES - PIPES



GUIDED WAVE RESPONSES



DIFFERENT REFLECTED WAVES



PROPAGATION OF AXI-SYMMETRIC WAVES

Axi-symmetric waves, Longitudinal or Torsional, will propagate in both directions from a single ring.

To prevent the wave from propagating in both directions a second ring is introduced. This ring will be phase delayed with respect to the first one.

When using the Longitudinal wave mode it is necessary to dampen the unwanted L(0,1) wave mode. This necessitates a third ring.

For optimum cancellation of L(0,1) the spacing between the rings must be equal to the L(0,1) wavelength, so the test frequency needs to be adjusted accordingly.

The delay between the signals applied to the rings is equal to the spacing divided by the wave velocity.

TORSIONAL ONLY MODULES

- 3 Ring torsional only modules
- -3rd Ring Provides 66% greater sound energy
- 5 transducers at 2 spacings
- -30mm
- -45mm
- Specifically for lines unsuitable for Longitudinal
- -Liquid filled lines
- -Thick pipes
- Proven better penetration over 2-ring







5-RING TORSIONAL



GOOD DATA QUALITY – 180M 590' IN EITHER DIRECTION



Reflectivity with reflector Cross Section – constant depth

Stippense bai zeigeletheath thizzenois doubled fagginiaanse dathighs hig bhaven demonstrate simplified to the implication of the reflector also increases.



% of Depth or circumferential length



Reflectivity with reflector Cross Section – constant circum extent



% of Depth or circumferential length



Reflectivity with reflector Cross Section – constant depth



The relationship between a defect of known size and its amplitude can be ascertained.

The problem is that in reality the amplitude of the defect is known and As information about the defects we are trying to ascertain its size. aspect ratio is not know, an error is introduced into the estimation of the defects true size. The real size of the defect could be anywhere between X and Y, depending on whether it is shallow and wide or deep and narrow.

C-SCAN TO COMPLEMENT A-SCANS

- Also called synthetic focussing
- Single wave mode transmitted
- Pipe features cause mode conversion
- The collection of reflected modes is analysed
- The inferred location and extent of features is presented on a map



SECONDARY FOCUSING

- Focusing allows the energy to be concentrated where the defect is, increasing sensitivity and giving position and size information
- Sound energy concentrated in one region
- Focus results link directly to Report Manager
- Rotation 8 times around pipe
- 4 times greater sensitivity
- Multi defect focus capability





FOCUSSING – INFORMATION ABOUT THE CIRCUMFERENTIAL EXTENTS



APPLICATIONS



Roads Crossings



Buried Pipe



Jetty

Lines



Gas

Pipelines

TANK FARM PIPEWORK

deal for application of guided waves:

- Long lengths of pipes
- Insulated line
- Link lines
- Jetty line inspection
- Bund wall penetrations
- **Culvert Inspection**
- Road crossings



REFINERY PIPEWORK

- Corrosion under Insulation
- Corrosion at simple Pipe-supports
- Hot pipe inspection max 350°C
- Inspection of elevated pipe
- Flare line inspection
- Jetty pipe work



OFFSHORE APPLICATIONS

- Corrosion under insulation
- **Riser inspection**
- Deck penetrations
- Splash zone inspection
- Fretting on Caissons
- Caisson inspection
- Top side pipework
- Seals for deck hatches and fire seals



OTHER INSPECTIONS

- Road Crossings
- **River Crossings**
- Transmission lines
- Unpiggable pipelines
- **Buried pipelines**
- Insulated Sphere legs
- Air-soil interface



MULTIMODE MODULES



INSPECTION OF FURNACE TUBES

- Difficult to inspect using conventional techniques
- Cut the U-bends off for access and an internal tool
- Expensive in cost and time
- Guided Waves can screen pipes quickly during shut-down
- Access is difficult for conventional tooling



INSPECTION OF FINNED TUBES

Torsional: nothing could be seen using Torsional mode Longitudinal: both the pipe end and the defect could be identified <u>Only Teletest</u> capable of Longitudinal





LONGITUDINALLY WELDED PIPE SUPPORTS



GOOD DATA QUALITY – 180M 590' IN EITHER DIRECTION



REVERBERATIONS – LIQUID FILLED LINES



REVERBERATIONS



Wheels (and the second second

SUMMARY

Guided Wave Testing can inspect 10s of meters of pipe from one location with good probability of detection.

- A screening tool the allows operators to prioritize localized inspection where needed.
- Extremely valuable for inspection of inaccessible areas.
- A cost effective method for inspection of non-piggable pipe
- An important tool for inspection of pipe
- Consider LONGITUDINAL

