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Current Status of Long Range Pipeline Inspection Method for Nuclear Power Plant

Jaesun Lee [a], Younho Cho [a*], Paul Jackson [b]
[a] *School of Mechanical Engineering, Pusan National University, Busan*
[b] *NDT & Asset Reliability Group, Plant Integrity Ltd., Cambridge, UK*
[*] *Corresponding author: mechcyh@pusan.ac.kr*

1. Introduction

Nondestructive evaluation (NDE) technique has developed rapidly in the past decades as a tool for materials assessment, structural integrity tests and manufacturing control. Many new NDE technologies have been developed for this purpose, including eddy current, acoustic emission, thermography, etc[1-3]. Among these techniques, ultrasonic NDE receives a lot of attention for such advantages as low cost, easy for operation, high sensitivity. Bulk waves are commonly used in conventional ultrasonic NDE because they are easy to implement. The disadvantage of using these methods is that inspections are usually done on a point-by-point basis, which takes a long time to finish an inspection of the entire structure. Nuclear power plants consist of pipelines not only primary nuclear power system also secondary part. Therefore, proper method is applied for investigating pipeline inspection in short time.[4]

2. Long Range Pipelines inspection

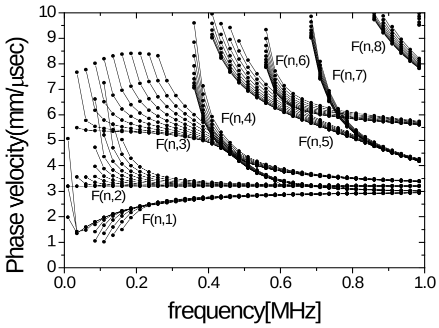
Guided wave is well-known method to evaluate long range pipelines. Guided wave has great potential to inspect long range pipelines in short time with reliable inspection data.

2.1 Long Range Pipeline Inspection

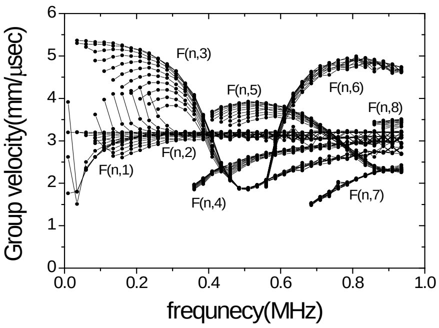
To evaluate long range pipeline, 8" schedule 40, 60 meter pipeline is used for the experiment. Fig. 1 shows long range pipeline. In this pipeline, pipe support, weld and defects are installed to analyze wave signal from artificial structures.

Fig. 1. Long range pipeline inspection specimen

To inspect long range pipeline, Teletest Focus plus was used to generate and receive guided wave. Teletest Focus Plus has maximum 80 separated channels to control individual transducer. Frequency range for this system is 20 to 125 kHz. The greatest concern on guided wave signal analysis is dispersion characteristic. Guided wave has different wave propagation velocity with respect to frequency and thickness of specimen. Fig. 2 shows guided wave propagation mode on pipelines. [5]



(a)



(b)

Fig. 2. Guided wave dispersion characteristic on pipe: (a) phase velocity dispersion curve, (b) group velocity dispersion curve

2.2 Transducer system

For 8" schedule 40 pipe, for longitudinal and torsional wave mode generation and receiving 120 ultrasonic transducers installed on a collar system. Fig 3 shows transducer system on the pipe.

This transducer system can be controlled by 8 channel sector. Therefore wave signal can be compared by wave signal difference between neighboring sectors. [6]

Fig. 3. Transducer system

3. Experimental result

The guided waves propagate different wave velocity with respect to wave mode.

Fig 4 shows experimental result for 51 kHz central frequency excitation and L-mode. Guided wave propagate forward and backward direction 17 m each side. This method shows long distance pipelines can be inspected at single inspection time for forward and backward direction. Pipe indicators such as weld, pipe support and defect are well distinguished at the wave signal.

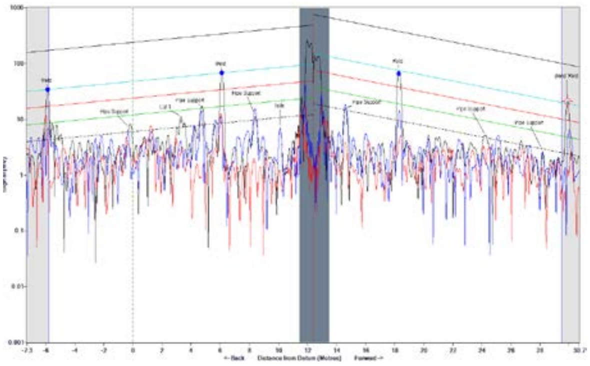


Fig. 4. Long range pipeline inspection signal for 51kHz L mode.

Fig 5 shows the same inspection result with Fig. 4. However, cental frequency is 91 kHz for the experiment. Frequency tuning is very important factor to inspect long range pipelines even with same equipment system.

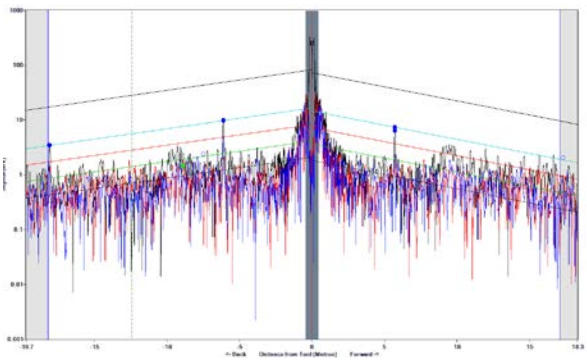


Fig. 5. Long range pipe inspection signal for 91 kHz L mode.

3. Conclusions

Long range pipelines are inspected by guided wave inspection system. Frequency tuning is important factor to analyze wave signal in the case of guided wave. This method can be applied for long range pipeline inspection for secondary pipeline and buried pipelines.

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