Crack Mapping in Oil Pipeline Insulation Using a Nondestructive Technique

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Abstract: In this study, pulse velocity method was used to characterize cracks in the coating of the offshore oil pipes. The pulse velocity method used compressive waves with a frequency of 54 kHz. Based on the change in the velocity, it was possible to map the cracks on the surface and in the bulk of the insulation coating around the pipe.

1. Introduction

Offshore pipelines used under deep water have to withstand high pressure and well insulated from the surround cold water. Hence the pipes are coated with thermal insulating materials to ensure good hydrocarbon flow. In industry, thermal insulation systems are usually 5 layers or 7 layers. Figure 1 shows a typical 7-layer polypropylene (PP) based insulation system. The properties of the foam layer are critical to the overall system performance. The foam layer makes the largest contribution to the thermal resistance of the system and the foam layer is also the weakest structural component of the system. However, those polymers are degrading with time and eventually crack in service when those insulations can not accept bending and differential expansion under thermal cycling. In recent years, more and more researchers are prone to use nondestructive technique to test the materials because this technique is easier and more economic than traditional tests. The step was to use pulse velocity method to evaluate the quality of the insulation and detect and map cracks. The device used is shown in Fig. 2. The V-meter can generate compressive waves traveling along the materials and record the shortest travel time. Therefore we can calculate the pulse velocity with known distance and time. However the wave can not travel through the cracks and it has to detour the cracks. Those characters of waves can help us to relate material properties to pulse velocity and can also help us to detect and hence characterize the cracks in materials. With this technique, we successfully detected and mapped those cracks on pipes.

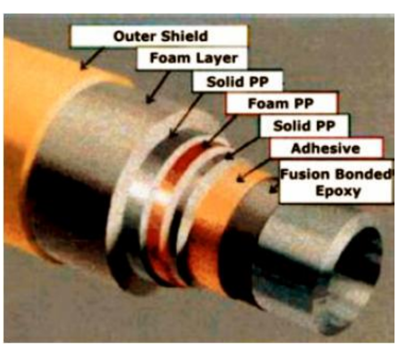

Figure 1 Seven-layer insulation system


Figure 2 V-meter

2. Objectives

The objective of this study was to map the pulse velocity along the length of the insulation coating and identify the cracks.

3. Cracked pipes

Figure 3 cracked pipes

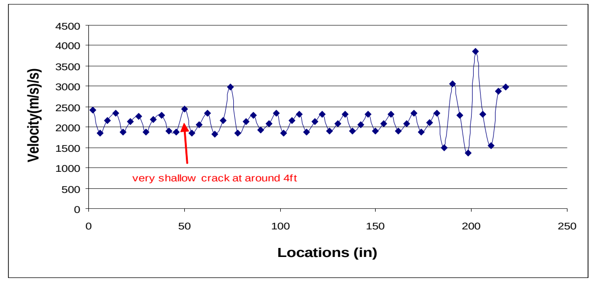

Figure 4 Pulse Velocity Profile for Pipe 2

4. Results

The surface pulse velocity of the composite coating was about 2000 m/sec. The pulse velocity across cracks varied from 0 to 1500 m/sec (Figs 3, 4&5). The difference in the velocity may represent the depth of crack.

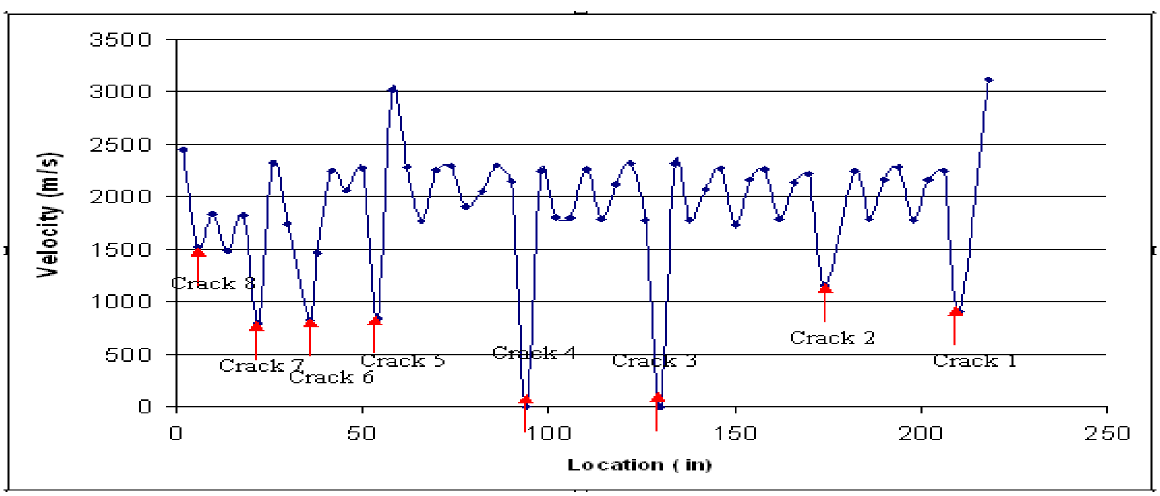

Figure 5 Pulse Velocity Profile for Pipe 1

5. Conclusion

The pulse velocity change mapped well with the surface cracks observed on the insulation coatings.

6. Acknowledgements

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7. References

1. ASTM standard C 597-97, “Standard Test Method for Pulse Velocity Through Concrete”.
2. The James V-meter manual, James Instruments INC. Non Destructive Systems.