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Health Monitoring for Optimum Management of an Agricultural Pipeline System using ICT

Tetsuya Suzuki
Faculty of Agriculture, Niigata University
950-2181, Niigata, Japan
Suzuki@agr.niigata-u.ac.jp

ABSTRACT

Damage evaluation of an agricultural pipeline system is normally used by non-destructive testing, such as elastic wave method. For effective maintenance and management of pipeline system, it is necessary to evaluate not only the degree of damage but also the water-flow conditions using ICT techniques. In this study, acoustic emission (AE) method was applied to be detecting flow conditions in service open type water pipeline system. The purpose of this research is development of detection method for water flow conditions in pipeline system based on ICT technique.

Keywords: Damage information, seismic wave-motion, irrigation infrastructure, acoustic emission, DeCAT, ICT technique

1. INTRODUCTION

In service agricultural pipeline systems, the condition for gas-liquid flow is the most important phenomena for maintenance and management (Nawa et al., 2002; JSMF, 2004). Deterioration of pipeline systems often results in overt-through degradation of water-tightness or water leak phenomena caused by gas-liquid flow effects, such as vibration of pipe material (Suzuki et al., 2010). For effective maintenance and management, non-destructive testing method need to be developed, because pipeline system is installed underground and the damage cannot be checked visually in service. In recent researches, it was reported that elastic wave method (e.g. acoustic emission, ultrasonic) is effective for evaluation of water-flow conditions in pipeline system (Matsui et al., 1986; Murakawa et al., 2006). Especially, the acoustic emission method is passive technique for detection of elastic wave from civil structures (JSCM, 2003).

In this study, AE method is applied to be detecting a gas-liquid flow in open type pipeline system. Two experiments were conducted:

Figure 1 Overview of model pipeline system.

laboratory model pipeline and in service open type pipeline system.

This paper reports quantitative method for evaluation of gas-liquid flow conditions in pipeline using AE parameter analysis which is based on ICT for pipeline systems.

2. DETECTION OF GAS-LIQUID FLOW IN OPEN TYPE PIPELINE USING AE METHOD

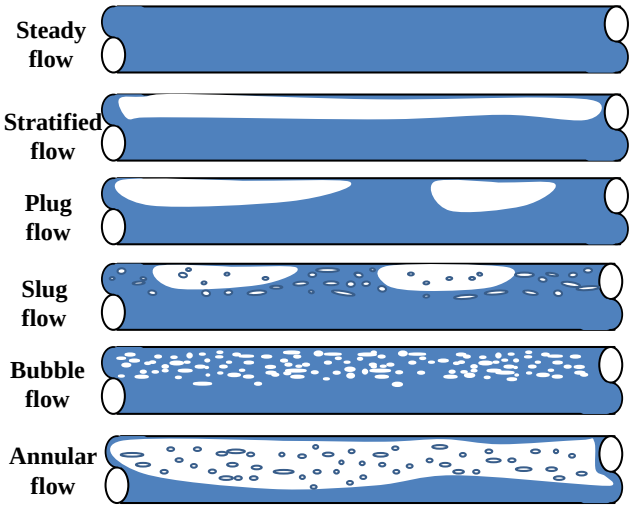

Figure 2 Gas-liquid flow form in pipeline.

2.1 Experimental procedure

The AE monitoring was applied to be detecting a gas-liquid flow in two experimental conditions which were laboratory model test and open type pipeline system in service. The laboratory model test was conducted to model pipeline system (Fig. 1) which was made by acrylic pipe of 100mm diameter. An amount of water flow was 3.6 to 24.0ℓ/s. The water flow signals were detected by AE. AE events generated under water flow in model pipeline were counted up to end of flowing process by AE processor (SAMOS; PAC). AE sensor of 30 kHz resonance was attached at surface of the model pipeline. AE monitoring conducted with 3-channel system was employed. For event counting, the threshold level was set to 45dB, and total amplification was 60dB. In service open type pipeline; the water flow signals were detected same AE method in the model pipeline monitoring. This pipeline system was composed of a PC pipe of 1,350 to 1,200mm diameter, which has been used for 26 years. AE monitoring was installed on the surface of air valve, which is near the air emission point. The duration of monitoring was 30 seconds at 1monitoring site. AE hits were detected by using AE sensor (resonance frequency: approx.150kHz). To count the number of AE hits, the threshold level was set to 40-45dB, with a total 60dB gain.

2.2 Results and discussion

The simulated flow conditions are composed 4 types (Steady flow, Stratified flow, Plug flow and Bubble flow; Fig. 2). The AE monitoring was applied to pipeline system, burst type AE waves are detected when gas-liquid flow conditions in pipeline system (Fig. 3). On the other hand, continuous AE waves of an irregular pattern are detected

when water is leakage or a free water surface exists. In service open type pipeline, this structure is detected burst type AE waves.

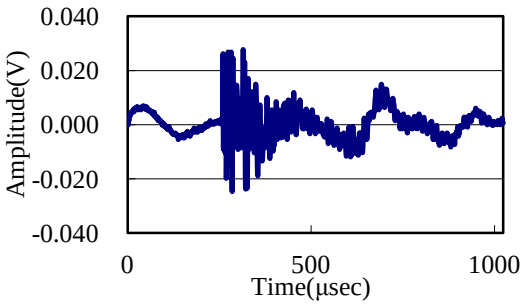

Figure 3 Detected Waveform due to gas-liquid flow.

Quantitative Evaluation of Two Phase Flow Conditions in model pipeline by AE Parameter Analysis. The gas-liquid flow characteristics in each monitoring site are evaluated by AE parameters. A typical relation between AE energy and average frequency is shown in Fig. 4. AE energy is defined as a relative value having 1000-count energy when the 10V peak value continued for 1msec. The AE energy is low at a low air mixed rate in model pipeline (Bubble flow>Plug flow, Stratified flow>Steady flow; Fig. 4). In air valve, results of AE monitoring are not same trend.

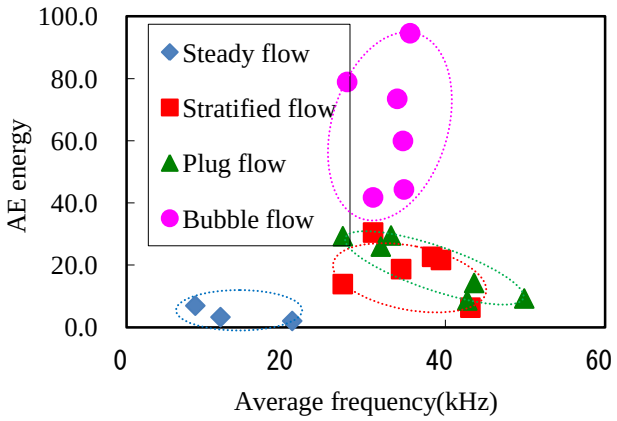

Figure 4 Relation between average frequency and AE energy in gas-liquid flow conditions (Model pipeline, Ch1).

AE characteristics in service open type water pipeline. AE generation behavior in air emitted valve is detected 656 hits/ 300s, which is 2.01 times higher than in the underground, line (Figs. 5 & 6). Therefore, Calculated AE parameters are almost positively concerned with gas-liquid flow conditions in open type pipeline. Detected waves are able to be quantitatively evaluated by AE parameters, such as AE energy, average frequency and AE hit rate.

3. CONCLUSIONS

In this study, the acoustic emission (AE) method was applied to evaluation of gas-liquid flow in open type pipeline system. Two experiments were conducted: laboratory model tests and in service open type pipeline monitoring. The simulated flow conditions are composed 4 types in model pipeline. The burst type AE waves are detected when gas-liquid flow conditions. These detected AE waves can be quantitatively evaluated using AE parameters. As for the relationship AE hit rate, energy, average frequency and hydraulic conditions are evaluated. To conclude, evaluation of gas-liquid flow in service pipeline systems can be quantitatively evaluated through NDT monitoring using acoustic emission method.

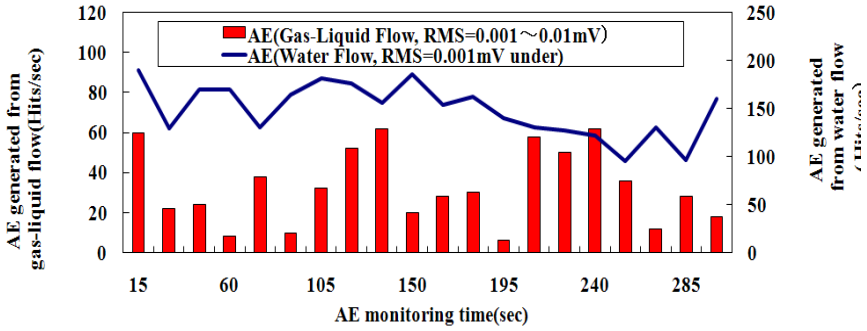

Figure5 AE generation behaviors in service pipeline.
(Monitoring site: air emitted valve)

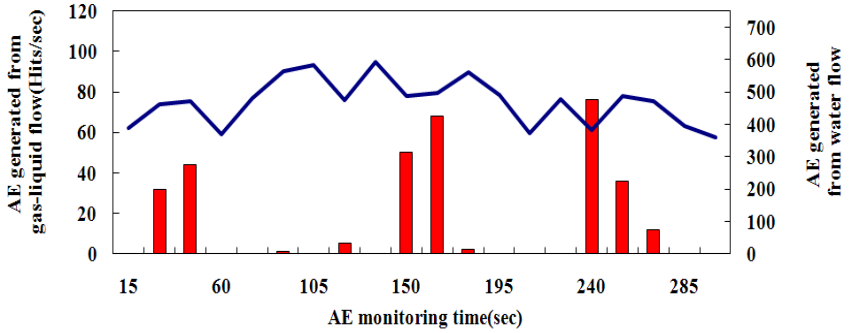

Figure 6 AE generation behaviors in service pipeline.
(Monitoring site: underground line)

REFERENCES

JSCM B-5706, 2003. Monitoring method for active cracks in concrete by acoustic emission.

JSMF 2004. Characteristics of Gas-liquid flow in Agricultural Pipeline, Handbook of Multiphase Flow, 448-453.

Matsui, G, Aizawa, T. and Morita, A. 1986. Statistical Properties of Differential Pressure Fluctuations and Flow Patterns in Horizontal Gas-Liquid Two Phase Flow (Differential Pressure between the Top and the Bottom of a Tube Cross-Section), *Journal of Mechanical Engineering*, 52, 478, 2337-2344.

Murakawa, H., Kimura, H., Yamanaka, G. and Aritomi, M. 2006. Measurement of Two-Phase Flow using Multi-Wave Ultrasonic (Liquid and Gas Velocity Measurement and Phase-Separation Technique using Ultrasonic Time-Domain Cross-Correlation Method), *Progress in Multiphase Flow Research*, 1, 17-23.

Nawa, N, Sonoda, K., Iwata, H. and Suzuki, T. 2002. Survey and Evaluation Method for Deteriorated Agricultural Pipeline Function, *JSIDRE*, 70 (12), 31-36.

Suzuki, T., Naka, T., Taruya, H., Tanaka, Y. and Aoki, M. 2010. Evaluation of Gas-Liquid Flow in Open Type Pipeline by Acoustic Emission, *Journal of Structural Engineering*, 56 A, 665-670.

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