Leak Detection in Gas Pipeline using Hilbert-Huang Transform

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Keywords: Leak detection, gas pipeline, HHT, Ensemble Empirical Mode Decomposition

Abstract. This paper proposes a leak detection method using acoustic. The Hamming chirp signal injected into the pipeline system and the estimation of the leak location from the delay time passing by the reflection in the pipeline if there is a leak. By using Hilbert-Huang Transform (HHT), it can give a useful signal to verify the leak. HHT transforms Empirical Mode Decomposition (EMD)and Hilbert Spectrum analysis to perform time-frequency analysis. The leak location can be detected by multiplying by the speed of sound. This simple method gives accurate leak location and easy to implement.

Introduction

This project proposes a new criterion for new method of signal processing which is Hilbert-Huang Transform. This method actually was developed to study ocean wave because Hilbert-Huang Transform can analyse non-linear and non-stationary wave. The study on leak detection in acoustic before was done using cross-correlation analysis [1-3], cepstrum analysis [4-6], and also wavelet based-filtering [4, 5, 7, 8]. The experimental design was conducted using specific material of pipe. The several of parameter also give different results. The detection result can be simplified in term of time and location of the leak.

Wave Propagation in Pipeline

Current monitoring procedures require the multiple sensor such as pressure, flow meters or and valve sensor [8]. The passage of the wave can be detected by a change of pressure at a fixed point underneath of surface. So, the changes in the pipeline geometry such as valve, junction, blockage and leaks will create a reflection. This reflection is known as pressure wave that through inside the pipeline at the speed of sound [9]. The pressure wave is simulated using time domain based on transmission line modelling techniques [8, 10, 11]. Wave also can be detected by the motion of fluid particles. The time of reflected wave can be captured by generating pressure wave at certain location together with single remote sensor [1]. Speed is the distance travelled by wave per the time taken for the wave to travel to that distance. The length of the pipeline can be calculated by multiplying the time travel down in pipeline, t with speed of sound, a.

$$\mathrm{l} = ta \tag{1}$$

The pipe is assumed rigid because flexible pipes will slow down the speed of the system. The pressure waves only travel in the fluid [1]. The leak location in the pipeline can be calculated using this formula:

$$x_{leak} = \frac{at_r}{2} \tag{2}$$

where:

x_{leak}= distance of the leak (m) from measuring section

t_r= time travelling (s)

a=speed of sound (m/s)