Analysis of the noise and vibration in the pipe near PIG Launcher

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Abstract

The Korea Gas Corporation is a company that imports Liquified Natural Gas (LNG) from foreign countries and supplies the gas to urban gas companies in several cities. Incheon LNG Terminal store liquefied natural gas and supply a natural gas in cities across the country. natural gas is supplied through the buried pipeline 30 inches in diameter. There is the PIG Launcher to check the status of buried pipeline close to the beginning of the buried pipeline at Incheon LNG Terminal. The noise and vibration was generated inside the pipe near the PIG Launcher. The noise sounds like beating a small drum. the other hand, It was not easy to find out the cause. Because there is no equipment that make a noise and vibration. In addition, a similar structure with pipe near the PIG Launcher are present in many other places, but did not have a problems such as the noise and vibration. This study was began to solve such problems. The accelerometer was mounted and measured three hundred points outside the pipe to find cause of the vibration and noise. We measured a sound pressure at one point to confirm the correlation between the vibration and noise. In conclusion, We could find out the cause and exact location of the noise and vibration by measuring. The source of a noise & vibration is a meeting area of t-branch pipe. We guess that damage of PIG BAR may cause the noise and vibration in pipeline.

1. Introduction

Excessive piping vibration can cause serious problems. Fatigue in flanges, supports, and connections are the most obvious problems, but in some cases failure from pipe fatigue also occurs. In this paper we present results of an investigation that characterizes the vibration of a pipe with a natural gas flow passing through it. Experiments were conducted in normal flow where the influences of pipe vibration were investigated. The pipe vibration was characterized by accelerometer instruments mounted on the surface of the pipe at multiple locations. The noise and vibration was generated inside the pipe near the PIG Launcher. The noise sounds like beating a small drum. the location is a area of t-branch pipe which the

pipe from PIG launcher and the pipe from receiving terminal meet. A amplitude of noise & vibration was changed according to the flow. (Fig.1)

Noise and Vibration generation in pipelines involves a sequence of events: disturbance of the flow, generation of internal hydrodynamic or acoustic pressure fluctuations or both by the disturbed flow, excitation of pipe wall vibration by the fluctuating internal wall pressure field, and finally generation of external noise radiation by the vibrating pipe wall. Hence, when the Turbulent gas flow inside pipeline is disturbed by a flow discontinuity such as a bend, a valve, a junction, an orifice plate, or some other form of internal blockage, the statistically uniform fluctuating internal wall pressure field which is characteristic of the undisturbed flow that one would expect in straight runs of pipe, and the associated noise and vibration response, is significantly modified.

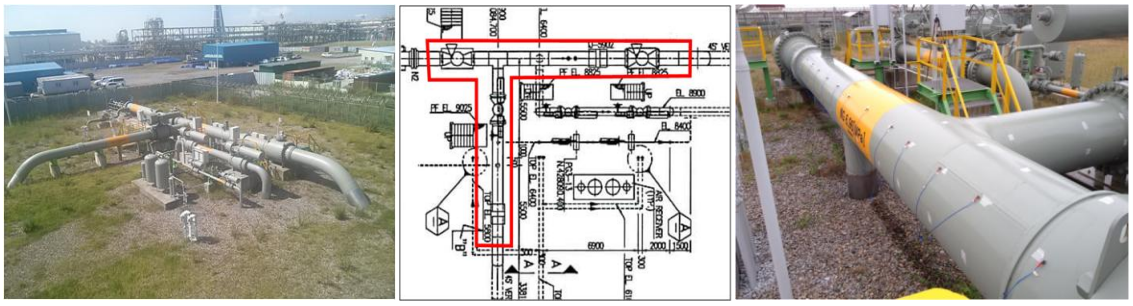
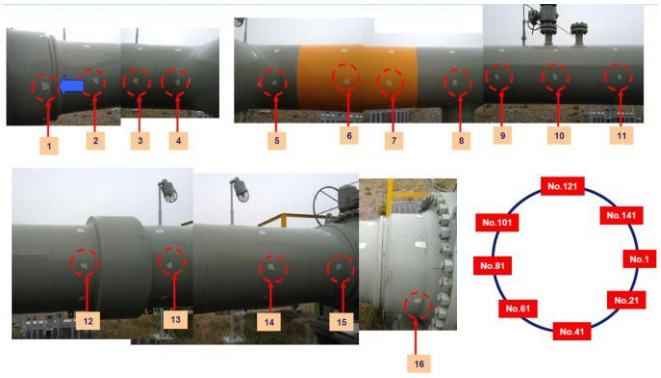


Fig.1 Pipeline with noise and vibration

2. Measuring vibration

The following Fig. 2 shows sensing direction, a location of measuring point. A second set of sensors was located 45 ° around from the first, and next sensors was mounted 45 ° repeatedly from the front sensor radially at the pipe wall. the space mounted sensor was 50cm along a longitudinal direction of pipe. The accelerometer was mounted and measured 300 point on the pipe to search cause of pipe vibration and noise, and we measured a sound pressure at one point to confirm the correlation between pipe vibration and noise.



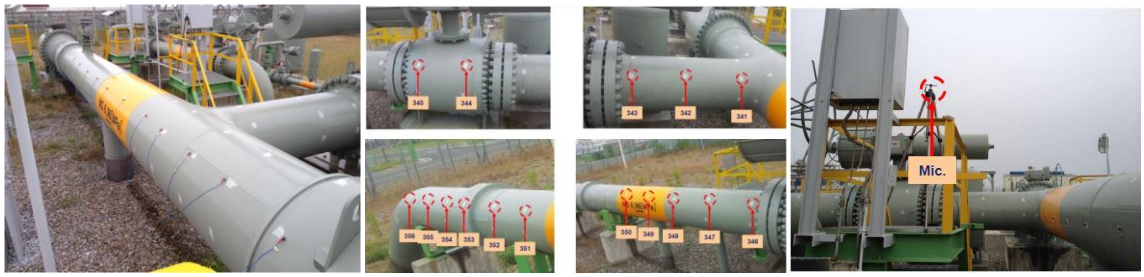


Fig. 2 Measuring point for vibration and sound pressure

3. Analysis of data

Structural vibration can be measured by electronic sensors that convert vibration motion into electrical signals. By analyzing the electrical signals, Signal analysis is generally divided into time and frequency domains; each domain provides a different view and insight into the nature of the vibration.

3.1 ODS analysis

Operating deflection shape (ODS), is a term often used in the structural vibration analysis, known as ODS analysis. ODS analysis is a method used for visualization of the vibration pattern of a machine or structure as influenced by its own operating forces. This is as opposed to the study of the vibration pattern of a machine under an (known) external force analysis, which is called modal analysis. An operating deflection shape shows the deformation of a structure at a specific frequency or during a time waveform playback. ODS shows the response of a structure to both resonant and forced vibration, and is generally very representative of the real world data. We could find out the cause and exact location of the noise and vibration by ODS analysis. following Fig. 3 show that the source of a noise & vibration is a meeting area of t-branch pipe.

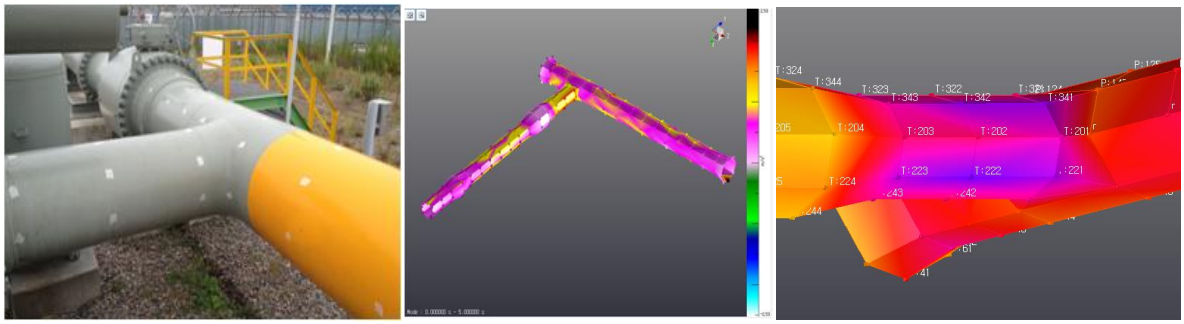


Fig. 3 Operating deflection shape

3.2 Time and Frequency analysis

Analysis starts by analyzing the signal as a function of time. An oscilloscope, data acquisition device, or signal analyzer can be used to acquire the signal. Fig. 4 shows a vibration that is measured at maximum vibration point and plotted versus time. Fig. 5 shows a sound pressure that is measured at a position near pipe and plotted versus time.

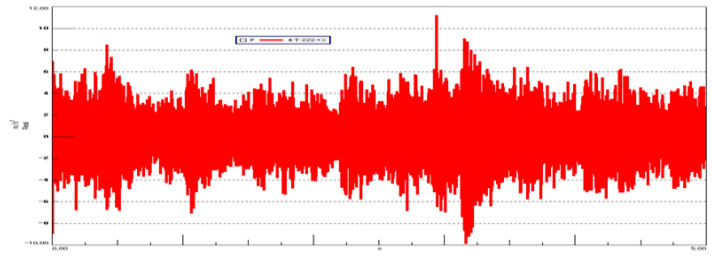


Fig. 4 Vibration that is measured at maximum vibration point

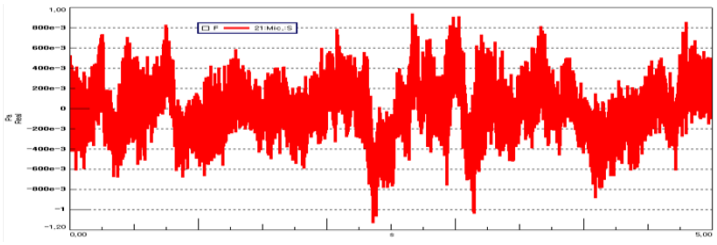


Fig. 5 Sound pressure that is measured at a position near pipe

Time-frequency representations are used to analyze or characterize signals whose energy distribution varies in time and frequency. They map the one-dimensional time-domain signal into a two-dimensional function of time and frequency. A time-frequency representation describes the variation of spectral energy over time.

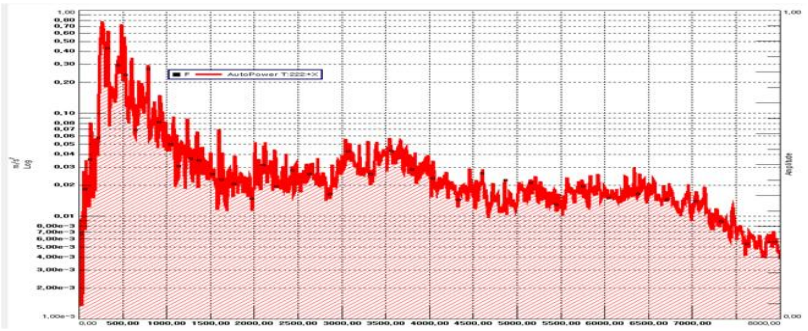


Fig. 6 Frequency spectrum

Fig. 6 shows that dominant frequency is below 600Hz. It is mainly because a structure make vibration.

3.3 Short-time Fourier transform

Short-time Fourier transform (STFT), is a signal processing method used for analyzing non-stationary signals, whose statistic characteristics vary with time. In essence, STFT extracts several frames of the signal to be analyzed with a window that moves with time. If the time window is sufficiently narrow, each frame extracted can be viewed as stationary so that Fourier transform can be used. With the window moving along the time axis, the relation between the variance of frequency and time can be identified. We could see that frequency change with time from Fig. 7, It say that cause of vibration is not periodic oscillation such as pump.

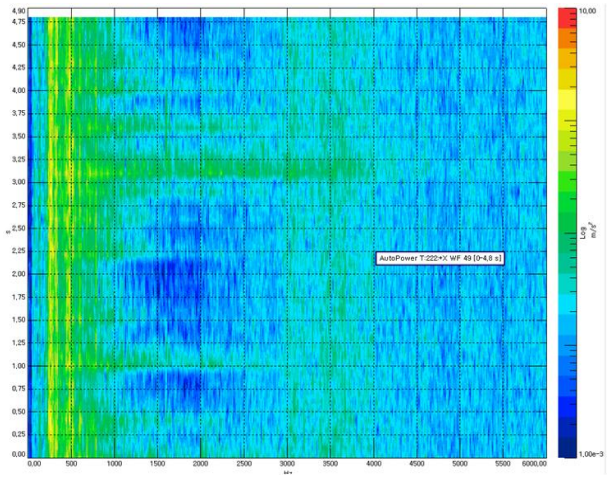


Fig. 7 Short-time Fourier transform

We came to the conclusion as above measuring and analysis. vibration and noise of pipeline could be leaded from vibration inside pipeline. We assumed that dominant frequency is below 600Hz. It is mainly because a structure make vibration. The source of a noise & vibration is a meeting area of t-branch pipe. we guess that the dominant frequency may be made from vibration by damaged pig bars.

A pig is a device inserted into a pipeline which travels freely through it, driven by the product flow to do a specific task within the pipeline. These tasks fall into a number of different areas: (a) Utility pigs which perform a function such as cleaning, separating products in-line or dewatering the line; (b) Inline inspection pigs which are used to provide information on the condition of the pipeline and the extent and location of any problem (such as corrosion for example) and (c) special duty pigs such as plugs for isolating pipelines. Pig

bars prevents an incoming pig from entering the bypass line. Fig.8 shows pig and t-branch pipe with pig bars.

Fig. 8 pig and t-branch pipe with pig bars

4. Conclusion

In this paper we present results of an investigation that characterizes the vibration of a pipe with a natural gas flow passing through it. Experiments were conducted in normal flow where the influences of pipe vibration were investigated. We could find out the cause and exact location of the noise and vibration by measuring. The making point of a noise & vibration was a meeting area of t-branch pipe. We guess that damaged pig bars may cause the noise and vibration in pipeline.

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