ISSN 0511-5728
The West Indian Journal of Engineering
Vol.43, No.2, January/February 2021, pp.54-68

Flow Induced Vibrations of Oil and Gas Piping Systems: Wall Pressure Fluctuations and Fatigue Life Assessment

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(Received 12 May 2020; Revised 16 December 2020; Accepted 23 February 2021)

Abstract: *Engineers and analysts primarily rely on the Energy Institute's (EI) Guidelines for the Avoidance of Vibration Induced Fatigue Failure in Process Pipework to determine the possibility of a piping system failing due to flow induced vibration. Whilst the EI Guidelines provides a quantitative measure for the likelihood of failure and gives possible remedial actions, certain key parameters such as the fatigue life cannot be obtained. In this work a procedure for incorporating the underlying wall pressure fluctuations in a finite element model for the purpose of determining the fatigue life of a piping system is provided. Numerical simulations are used to determine the fatigue life for a flowline transporting natural gas at three different flow velocities; 65 m/s, 130 m/s and 170 m/s. The study also experimentally investigates the wall pressure fluctuations associated with single phase flow in a geometrically complex manifold. Extensive wall pressure fluctuation measurements associated with water flowing at 1.6 m/s and air flowing at 3 m/s are presented. It has been shown that owing to the dramatic changes in geometry, the pressure fluctuations associated with a fully developed turbulent flow are significantly greater than that observed at an undisturbed position. Unlike the simple 90^o elbow or mitre bend, the fluctuations within the manifold remain pronounced with no decay in amplitude. Specifically, for the case of water flowing at 1.6 m/s it is observed that the mean square pressure along the manifold falls within the range of 113 dB and 116 dB, whilst the undisturbed position had a mean square pressure of 104 dB. For the case of air flowing at 3 m/s, the mean square pressure ranged between 101 dB and 107 dB throughout the entire manifold.*

Keywords: *Fatigue Assessment, Flow Induced Vibration, Piping vibrations, Piping manifold, Random Vibration, Wall Pressure Fluctuation*