UNIVERSITI TEKNOLOGI MARA

VIBRATION INDUCED FATIGUE FAILURE PREDICTION IN PROCESS PIPEWORK

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ABSTRACT

The vibration in piping system has been a great threat in industry. This vibration has become a leading source of pipe failure especially in oil and gas industry with 21% of the pipework failure on the topsides facilities were due to vibration and fatigue failures in the North Sea of UK, reported by the UK's Health & Safety Executive (HSE). Due to this, it is essential to identify the potential area susceptible to flow induced vibration earlier during design phase. Once identified, possible solutions can be recommended in order to eliminate or reduce the excessive vibration, if not controlled, can lead to fatigue failure. This research aims to identify potential FIV which can lead to fatigue failure if excessive. Following the guideline published by Energy Institute on the Avoidance of Vibration Induced Fatigue Failure (AVIFF), the assessment was done accordingly. From qualitative and quantitative assessment until the process of simulating the piping system through simulation software based on the recommended action identified, the processes were done following all the required steps. By calculation and detailed analysis, several lines were identified to have high failure potential. By using computational fluid dynamic (CFD) and finite element analysis (FEA), the simulation models of the piping system were produced to compare with the final results. Changes to the pipe nominal diameter and wall thickness were applied to the effected lines. After changes applied, simulation was repeated with CFD tools and it was verified that changes made were able to reduce vibration on the line. It was recommended that changes in pipe diameter and wall thickness can reduce flow induced vibration.

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CHAPTER 1

INTRODUCTION

1.1 RESEARCH BACKGROUND

Piping system is an assembly of various components function to transport fluid from one location to another. In oil and gas industry, transportation of hydrocarbon through piping requires a proper measure and observation because of the variation in the velocity and pressure of the hydrocarbon. On the topside facilities, the process pipework need to be assessed properly ensuring safe flow from the start till the end process. Any damage can cause unwanted incident to happen on the site.

Vibration problems have obstructed many smooth operations in the industrial plants due to fluid flow. If excessive and not properly controlled, this phenomenon can lead to a significance loss in the production as the process require frequent maintenance and repairing which resulted in high cost investment. Vibration has been a threat to the piping system since it can lead to a sequence of event that can damage the system or even all the facilities. Not only in oil and gas industry, in other industries as well, for instant nuclear industry, it has been reported that this vibration has been a major cause of concern for several decades.

This flow-related vibration is generally known as flow-induced vibration (FIV). Fatigue failure in process piping caused by vibration is due to the change of mechanical energy excited by the movement of fluid to noise. FIV is a common phenomenon that can lead to vibration induced fatigue failure. FIV is caused by the internal fluid structure interaction due to pressure fluctuation and momentum exchange of the fluid flow and the structure. The Norwegian Petroleum Safety Authority has reported the instance of fatigue failure that possibly coming from FIV which have resulted in pipe damage (Parkinson, 2014).

In this study, qualitative and quantitative assessments are the techniques that are used to analyze on the oil and gas piping system. Qualitative assessment is the