A novel investigation into the application of non-destructive evaluation for vibration assessment and analysis of in-service pipes

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ABSTRACT

Flow-induced vibrations are a major problem in all oil and gas processing industries, so all piping systems which work non-stop for 24/7 require regular condition monitoring and inspection to assess changes in their dynamic characteristics and structural integrity in order to prevent catastrophic failures. A novel method of non-destructive testing and evaluation of these pipes, while in service, is proposed in this paper. The method enables early detection of the root causes and pinpoints the location of the impending failure due to excess vibration as a result of cyclic force induced by the flow prior to condition-based maintenance procedures. The technique relies on the combined application of Operating Deflection Shapes (ODS) analysis and computational mechanics utilizing Finite Element Analysis (FEA), i.e. linear elastic stress analysis. The effect on vibration levels on the in-service pipes is assessed and verified. The effect of any change in the forces corresponding to changes in the Differential Pressure (DP) at a constant flow rate through the pipes can then be estimated. It was concluded that maintaining the differential pressure above some “critical” threshold ensures the pipe operates under the allowable dynamic stress for a theoretically “indefinite” life cycle.

KEYWORDS

Modal analysis; Non-destructive testing; ODS; Pipe; Stress; Vibrations

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