NAHIDH MAHMOOD ALI. STUDY OF THE RESPONSE OF A CONDUIT CONVEYING FLUID DUE TO A FORCED VIBRATION . UNIVERSITY OF TECHNOLOGY. Department of Mechanical Engineering. PH.D.

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Abstract

This work investigates the response of a conduit (thin wall pipe) conveying fluid due to a forced vibration. Several end pipe supports, like fixed-fixed, pinned-pinned, fixed-free and flexible-flexible were adopted. The pipe is made of copper with (1m) length and (1mm) thickness, and the effect of some design parameters, such as pipe diameter (2.45 cm, 5cm, 7.5cm, 10cm) and fluid flow velocity (corresponds to Reynolds numbers of range 250-1500), were studied.

A theoretical model for the dynamic behavior of the pipe was investigated, as well as, solving the fluid flow Navier-stokes governing differential equations. Finite element method was employed to formulate both the structure and fluid flow equations, and a FORTRAN language computer program was developed to implement the above analysis. Also, numerical simulation (ANSYS 12.0) software was applied, as well as experimental measurements were carried out, where a test rigs was designed, built, and implemented in order to validate the suggested theoretical results. The natural frequencies, the corresponding mode shapes, the pipe deformations, stresses and shell vibration modes creation were calculated in addition to the fluid flow properties and the fluid-structure interaction solution.

From the results obtained, a well agreement was found between the experimental and both theoretical analysis, for the values of natural frequencies and shell vibration modes creation. Also, it was concluded that as the (d/t) ratio increases, the shell vibration modes generate clearly, and the flexible-flexible supported pipe has the lowest natural frequencies, while the fixed-free supported pipe permits for shell vibration modes creation at all natural frequencies, in comparison with other supports. Concerning the fluid- structure analysis, it was concluded that the fixed-free pipe has a great influence on the fluid flow deformation, and in general, the values of natural frequencies, pipe deformations and stresses were less than those of pipes without fluid.

Generally, it was found that the increase in fluid flow velocity reduces the natural frequencies of the pipe, and as the fluid flow Reynolds number increases, the pipe deformations and stresses of the structure

decrease. And, this could be caused due to the mass and damping effects of fluid flow within the limits of velocities corresponding to the Reynolds numbers applied.

Keywords: pipe conveying fluid. finite element method. shell vibrational mode. fluid-structure interaction. ANSYS software.