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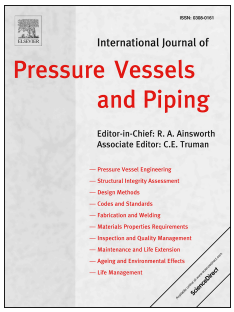

Dynamic behaviours of horizontal gas-liquid pipes subjected to hydrodynamic slug flow: Modeling and experiments

Lin Wang, Yiren Yang, Yuxing Li, Yating Wang

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Dynamic behaviours of horizontal gas-liquid pipes subjected to hydrodynamic slug flow: Modeling and experiments

Lin Wang[1,*], Yiren Yang[1], Yuxing Li[2], Yating Wang[3]

1. School of Mechanics and Engineering, Southwest Jiaotong University, Chengdu 610031, China

2. College of Pipeline and Civil Engineering, China University of Petroleum (East China), Qingdao 266580, China

3. CCTEG Chongqing Engineering Co., Ltd, Chongqing 400016, China

[*] Corresponding author: lincw_wang@qq.com

Abstract

The dynamic behaviours of gas-liquid pipes are difficult to predict because of the complex flow characteristics of gas-liquid two-phase flow and fluid-structure interactions. In this paper, a dynamics model capable of describing the characteristics of hydrodynamic slug flow and fluid-structure interactions involving centrifugal force and Coriolis force is presented to investigate the dynamic behaviours of horizontal pipes subjected to hydrodynamic slug flow. The motion equation is solved using the finite element method. Experiments are performed to measure the characteristics of slug flow and dynamic behaviours of horizontal pipes and to validate the theoretical results. The motion of pipes under different two-phase flow parameters are simulated, and some interesting and unexpected results are presented. Finally, the cumulative effect of fluid-structure interactions and slug characteristics on the dynamics of the system is discussed. This study is helpful for understanding the complicated dynamic behaviours of gas-liquid pipes and promoting pipeline safety.

Keywords: Pipe conveying gas-liquid two-phase flow; Hydrodynamic slug flow; Fluid-structure interaction; Dynamic behaviours.

1 Introduction

A fluid-conveying piping system plays a crucial role in various engineering applications such as oil/gas transportation, chemical processes, and power system. Internal two-phase flow-induced vibration (FIV) is very important to secure the reliability and integrity of the system [1].

According to a historical research by Païdoussis and Issid [2], Bourrieres (1939) was the first to publish a report on the dynamics of pipes conveying fluid. Over the past 40 years, hundreds of related studies have been reported, and the instability behaviours of flexible tubes subjected to internal single-phase flow is now