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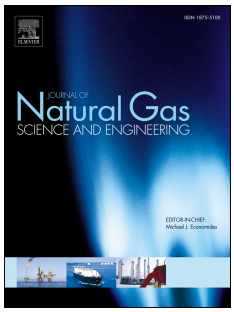

A numerical study on differential pressure needed for ball pig motion in pipelines based on nonlinear hyperelastic material model

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A numerical study on differential pressure needed for ball pig motion in pipelines based on nonlinear hyperelastic material model

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Abstract

In this paper, numerical investigations are carried out in order to evaluate the essential differential pressure for running a ball pig in a pipeline. 2nd order polynomial hyperelastic material model, fitted to uniaxial tension test data of sample polyurethane, is utilized as the material model. Four main parameters include pipe internal diameter, ball pig oversize ratio to pipe internal diameter, ball pig thickness ratio, and ball pig material hardness are investigated via finite element simulations. It is shown that the differential pressure is a linear function of the ball pig thickness ratio as well as the material hardness while is a polynomial function of the oversize ratio factor. Moreover, the differential pressure does not considerably depend on the absolute value of pipe internal diameter. Results can help pigging operators and manufacturers having more accurate prediction of differential pressure needed for pipeline cleaning and de-watering via ball pigs.

Keywords: Ball pig, hyperelastic, differential pressure, pipeline pigging

1. Introduction

Pipelines are from the most expensive and valuable assets of any company dealing with oil and gas transportation and distribution. Reliable and safe transportation of oil and gas via pipelines requires proper operation of the pipeline as well as preventing the pipeline from problems like blockage, pig stuck, hydrate formation and wax deposit as well as damages like cracks, corrosion, dents and geometric defects. For all of the mentioned problems, there are several methods for prevention, detection and repair of occurred failures. A review of pipeline integrity management solutions is provided in (Kishawy and Gabbar, 2010; Singh, 2013; Revie, 2015).

Pipeline pigging is one of the solutions for damage detection as well as pipeline cleaning and commissioning. The basic of pig motion in a pipe is differential pressure between upstream and downstream of the pipe which causes a pressure drag applied on the pig. A comprehensive study on pipeline pigs is presented in (Tiratsoo, 1992; Cordell and Vanzant, 2003). Moreover, a brief review of fluid driven pigs is performed in