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This paper studies the stress-strain state of an *U*-shaped expansion bellows under an internal-pressure induced load. The bellows is considered as a corrugated shell of revolution under axisymmetric load. The governing equations have been derived and the numerical calculations of the stress-strain state were carried out. A variant of the classical shell theory based upon Lagrangian mechanics was used. The finite-difference method was applied to solve the obtained system of ordinary differential equations. The ultimate internal pressure resulting in plastic deformations was determined. A simulation of the loss of equilibrium stability of the expansion bellows was performed. The ANSYS software was used for Finite-Element Method (FEM) in order to calculate the stress-strain state in the bellows.

Elastic shell; Corrugation; Expansion bellows; Stability; Finite Element Method.

Introduction

Expansion joints are typically employed in pipe installations for reducing the stresses caused by temperature and pipe vibration. Expansion bellows is a corrugated shell of revolution under internal pressure of fluid. It is crucial to ensure strength and stability of such structures in their design, operation and maintenance.

Calculating the ultimate internal pressure at which the expansion shell either proceeds to the state of plasticity or loses its stability presents both scientific and practical interest.

The goal of this study was to find this ultimate pressure by means of mathematical and computer modeling.

The first part of the study is concerned with simulating the bellows by a thin elastic corrugated shell. We have established a system of ordinary differential equations (ODE) and obtained its numerical solution. The ultimate pressure at which plastic strain of the bellows starts was found by the von Mises criterion.

Numerous papers containing theoretical [1–8] as well as numerical results [9, 10] have been dedicated to shell simulation. A complete system of equations for shells is often derived from equations of three-dimensional elasticity theory by introducing certain simplifications. However, it is preferable to involve a direct