Experimental Report of Balloon

Zhang Chang-kai

March 14, 2016

Abstract

1 Experimental Purpose

According to the theoretical analysis of pressure-stretch relation of a rubber balloon, we have

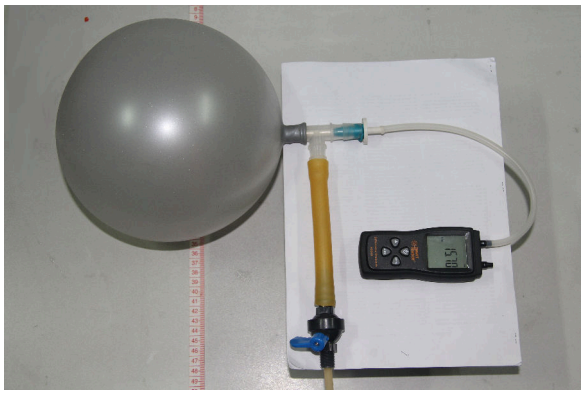
$$\delta p = 2C_1 \frac{d_0}{r_0}(\lambda^2\varepsilon^{-1} - \lambda^{-2}\varepsilon^{-7})(1 + \frac{C_2}{C_1}\varepsilon^2) \qquad (1)$$

where δp is the pressure difference of the air inside and outside balloon; ε is the stretch ratio; C_1 and C_2 are material constants; λ is the ratio of stretch in perpendicular directions; d_0 and r_0 are initial thickness and radius of the balloon.

This experiment is to verify the above relation.

2 Experimental Apparatus

The experiment set-up is shown as follows

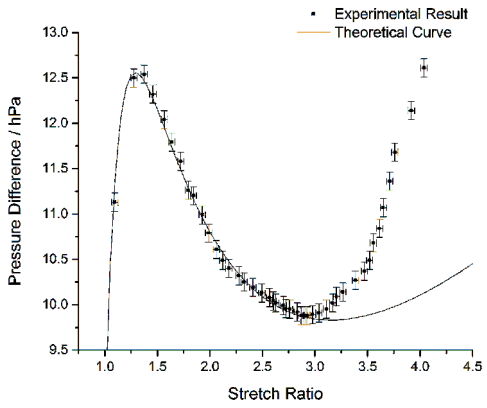


As is shown in the figure, a T-pipe connects the balloon, a manometer and a valve. A scale is placed to read the radius and pressure is obtained by manometer. The balloon is inflated at first to certain size, and the experiment starts as it deflates. The valve is used to control the rate of leaking. The deflation process is videoed for analysis.

The initial size at the end of inflation and the leaking rate are controlled to avoid the influence of Mullins effect and make experiments comparable.

3 Experimental Results

The experimental results are shown as follows



It is seen from the figure that the experimental points coincide with theoretical expectation very well when the deformation is small. However, the theory and experiment have a relatively large deviation at large deformation.

Thus, the conclusion is that relation (1) is applicable only at small deformation. This is considered to be the consequences of neglecting high order term during the derivation of the pressure-stretch relation.