Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 152 (2016) 620 – 626

Procedia Engineering

www.elsevier.com/locate/procedia

International Conference on Oil and Gas Engineering, OGE-2016

# Computational experimental studies on magnetoelastic effects in a metal filled elastomer

Gregory S. Russkikh[a]*

[a]*Omsk State Technical University, 11, Mira Pr., Omsk, 644050, Russian Federation*

**Abstract**

The article presents experimental data from a study of the magnetoelastic effect in metal filled elastomers. The matrix material is a synthetic isoprene rubber and a functional filler is magnetite finely dispersed granules. The dependencies of the magnetic field near the sample on the strain and stress are given.



Peer-review under responsibility of the Omsk State Technical University

*Keywords:* villari effect; magnetostriction; rubber; functional composite materials; vibration isolation Villari effect; magnetostriction; rubber; functional composite materials; vibration isolation

## 1. Introduction

One of the major performance criteria of technological equipment quality in chemical and refining industries in terms of labor protection is the object vibration and noise isolation. The basic materials used for vibration and noise isolation are elastomers. In the operation the working conditions of components and assemblies can be changed, for example, by changing the seasonal atmospheric temperature, changing operating parameters nodes themselves due to wear and tear. This may also change physical-mechanical or other characteristics of components with non-metallic structural members. These deviations may exceed the allowable range. The actual problem is maintaining the design characteristics of non-metallic construction materials under various changing types of impact - thermal, chemical, mechanical, operational, etc.

* Corresponding author. Tel.: +7-381-262-8558.
*E-mail address:* rgs@omgtu.ru



Peer-review under responsibility of the Omsk State Technical University
doi:10.1016/j.proeng.2016.07.665

Promising class of magnetoelastic and magnetostrictive materials [1-5] is materials that are composites with elastomer matrix and soft magnetic or hard magnetic filler. The vulcanization process can be carried out to obtain magnetization regular structure. The elasticity of the matrix allows changing linear dimensions matrix under the influence of an external magnetic field. Main materials used for the elastomeric matrix are silicone, polyurethane rubber.

Devices based on magnetoelastic materials may be used as sensors, mechanical oscillations harvesters, and active vibration isolation elements, including the oil and gas industry. An important direction of magneto materials development is to obtain products with high performance and relatively low cost.

## 2. Test samples

The paper discusses the results of the magnetoelastic effect study in a composite material based on synthetic isoprene rubber (IR) content of 30% in mass fraction. Technical grade N220 carbon particles and magnetite ($Fe_3O_4$) are used as a filler.

Introduction of the filler is carried out in an open roller mixer.

To evaluate the magnetoelastic effect a series of samples were made at 5, 10, 20, 30% magnetite and 25, 20, 10, 0% of carbon black, respectively (samples 1-4). Since the main mode of operation involves compressing the product, the shape of samples selected in accordance with GOST 265-77 [6] (Fig. 1).

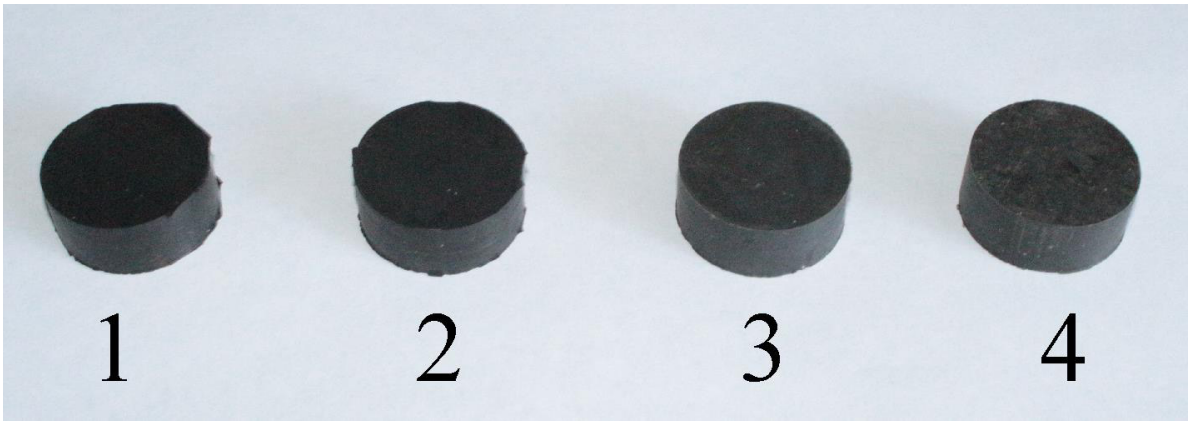


Fig. 1. Test samples.

## 3. Mathematical model

Assumptions of the mathematical model are the following:

1. The filler particles are magnetic dipoles distributed in a matrix of elastomer.
2. The filler particles are aligned along the magnetic field lines of the sample initial magnetization. The filler particles are forming parallel rows uniformly distributed in the sample volume.
3. The distance between the particles in the rows is less than between the rows.
4. Under the strain rows remain parallel.

Assumptions 2 and 3 are confirmed by the experimental data [3]. Fig. 2 shows SEM results of magnetic field managed sample.