Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 152 (2016) 281 – 287

Procedia Engineering

www.elsevier.com/locate/procedia

International Conference on Oil and Gas Engineering, OGE-2016

The application of compact thermistors for the temperature conditions analysis of small-sized long-stroke low-speed stages of piston compressors

Goshlya R.Yu.[a], Busarov S.S.[a]* , Gromov A.Yu.[b], Nedovenchany A.V.[a], Busarov I.S.[a]

[a] *Omsk State Technical University, 11 Mira pr., Omsk, 644050, Russian Federation*
[b] *LLC Scientific and Technical Complex «Cryogenic engineering», 97, bld. 1, 22 Partsiezda st., Omsk, 644105, Russian Federation*

Abstract

The task on studying the thermal conditions of small-sized long-stroke low-speed stages of piston compressors is solved. The bead thermistors are applied for a placement of a temperature sensor with small diameters of cylinders. Calibration of a given sensor is executed, the error of measurements is defined.

Peer-review under responsibility of the Omsk State Technical University

Keywords: long-stroke piston compressor; working processes; mathematical modeling; cylinder cooling; discharge temperature; temperature measurement, resistance sensors.

1. Introduction

In experimental studies of working processes in piston compressor units, there has always been a serious problem of a gas temperature measurement in the flow part elements with small geometrical sizes.

The problem is related to the solution of tasks to reduce the sensor dimensions.

There are several ways of the gas temperature measurement in a PC (piston compressor) working chamber using thermocouples and resistance thermometers [1,2,5,6,10,11,13,14,15].

* Corresponding author. Tel.: +7-923-674-7252.
E-mail address: bssi1980@mail.ru

Peer-review under responsibility of the Omsk State Technical University
doi:10.1016/j.proeng.2016.07.704

Inertial sensors with a subsequent temperature recalculation are applied to obtain actual values [1,5]. Using this method of calculation, we cannot obtain accurate results as in recalculating a heat-transfer coefficient is accepted either constant or altering under the certain law set which results in an additional error [1,5]. We can obtain the accurate law of the heat-transfer coefficient change only in experiments, but it is very expensive in most of cases.

The method is used in which two sensors with a different lag effect and the subsequent recalculation for the true temperature are involved. There is no heat-transfer coefficient impact in this case, but the lag effect of the both sensors [1,5,14,15] is not taken into account. A design complexity arises in placing the sensors practically in the same point.

Virtually inertialess wires are applied. The diameter of such wire is to be from 4 to 10 microns according to many authors. With 16.7 rps rotation frequency and 8 microns wire diameter the error in defining the temperature does not exceed 0.3%, a phase shift is lesser than 3^{o}, and with the diameter reduction up to 4 microns the error decreases threefold. However, such sensors are to be handled very carefully because of their low reliability.

The placement of the sensors described above inside the flow part elements with the characteristic size about 10 mm is almost impossible. Therefore**,** the development of application technology for compact sensors in small-sized stages is relevant.

2. Study subject

Fig. 1 shows the study subject – a long-stroke stage with a bead thermistor. It is obvious from the figure that the arrangement of gas distribution elements does not allow the sensors of more than 3-5 mm to be placed in a working chamber. The bead sensor due to its size is easily placed both in a discharge chamber, and between the gas distribution elements.

The thermistor is a resistance thermometer made on the basis of mixed oxides of transition metals, classified according to a temperature resistance coefficient (positive and negative TRC). Structurally there are the following types of thermistors: bead (0.01-1.0 mm); disk (2.5-18.0 mm); cylindrical (3.0-42.0 mm); thin-film with the thickness of a sensitive film no more than 0.2 mm and thick-film (0.2-1.0 mm).

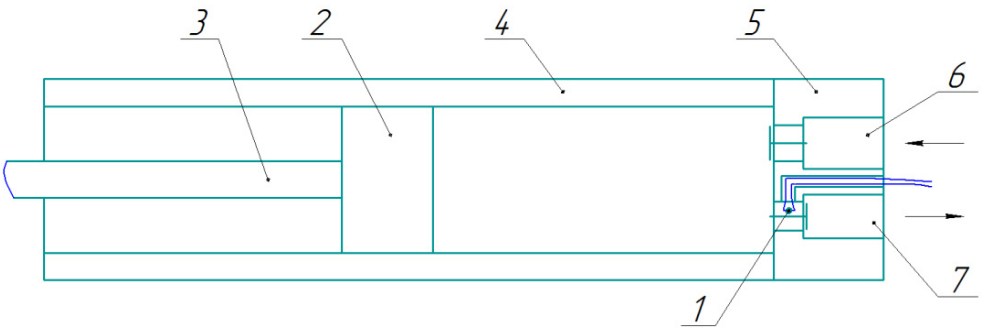

Fig.1. A long-stroke stage with a bead thermistor: 1 - a bead sensor; 2 – a piston; 3 – a rod; 4 – a cylinder; 5 –a cover; 6 – a suction valve; 7 – a discharge valve.

The key thermistors parameters are a nominal resistance, a resistance change dependence on the temperature and a temperature resistance coefficient (TRC).

The main requirements to the thermoresistors are a large TRC value; relation linearity R(t); stability in time; reproduction of parameters.

A low speed and a high heat retention are the drawbacks of metal thermoresistors. The bead semiconducting thermoresistors have no these drawbacks, the parameters are shown in Table 1, the appearance and the thermometer overall dimensions are given in Fig. 2.