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Research of explosives in an environment of high pressure and temperature using a new test stand

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ARTICLE INFO

Article history:
Received 29 October 2015
Accepted 10 February 2016
Available online 16 February 2016

Keywords:
Mining
Tests of explosives
Natural hazards prevention

ABSTRACT

In this article the test stand for determining the blast abilities of explosives in high pressure and temperature conditions as well as the initial results of the research are presented. Explosives are used in rock burst and methane prevention to destroy precisely defined fragments of the rock mass where energy and methane are accumulated. Using this preventive method for fracturing the structure of the rocks which accumulate the energy or coal of the methane seam very often does not bring the anticipated results. It is because of the short range of destructive action of the post-blast gases around the blast hole. Evaluation of the blast dynamics of explosives in a test chamber, i.e. in the pressure and temperature conditions comparable to those found "in situ", will enable evaluation of their real usefulness in commonly used mining hazard preventive methods. At the same time, it will enable the development of new designs of the explosive charges used for precisely determined mining hazards. In order to test the explosives for their use in difficult environmental conditions and to determine the characteristics of their explosion, a test chamber has been built. It is equipped with a system of sensors and a high-frequency recording system of pressure and temperature during a controlled explosion of an explosive charge. The results of the research will enable the development of new technologies for rock burst and methane prevention which will significantly increase workplace health and safety level. This paper presented results constitute the initial phase of research started in the middle of 2014.

1. Introduction

Use of explosives in conducting active rockburst prevention means, first of all, fracturing precisely defined fragments of the rock mass, where there may be, or where there is accumulated energy (Konopko & Myszkowski, 2005; Konopko, 2010). Effects of detonating an explosive charge, i.e. the range of lasting effects of an explosion depends on many factors. The crucial ones are: the type of rock where blast works are conducted, "energy" of explosives, blast hole diameter/explosive charge diameter ratio. Despite changing the parameters the range of lasting effects of detonating an explosive charge obtained during tests is at most 3–4 m from a blast hole (Bartoš, Przeczek, & Takla, 1998; Batko, 2002; Biliński, 1980; Chanukajev, 1974; Siskind, Steckly, & Olson,

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Peer review under responsibility of Central Mining Institute in Katowice.
http://dx.doi.org/10.1016/j.jsm.2016.02.001

1973). Because of relatively short range of destructive action of post-blast gases, independently on mechanical strength of coal and rocks, efficient use of the preventive method requires following a tight blast pattern. The problem also refers to methane prevention, as effective demethanation occurs only in the direct vicinity of a blast hole. In both cases – rockburst prevention and methane prevention – it seems necessary to devise new technologies of blasting rocks, which will expand the zones of intensive rock fracture.

New technologies of rockburst and methane prevention currently devised at the Central Mining Institute, Department of Rockburst and Rock Mechanics, are a development of the tried and tested technology of directed rock fracturing (Konopko, 1997; Myszkowski, 1996; Frejowski & Myszkowski, 2009). Yet, they require using drilling equipment which initiates the process of wide range directed rock fracturing, new generations of explosives with dedicated blast guidelines, new construction of explosive charges and methods of detonating.

At the Central Mining Institute, Department of Rockburst and Rock Mechanics design intent of a detonation chamber was devised, which enables studying dynamics of detonating an explosive charge in controlled pressure and temperature conditions. Producers of currently used blasting agents recommend using them in normal conditions i.e. pressure of 1000 Pa and temperature which does not exceed 50–60 °C. It is expected that results of tests of explosives conducted in the new device will enable, firstly, devising efficient methods of active rockburst prevention technologies and, secondly, increasing the amount of methane captured from coal seams, and in the future also of shale gas.

2. Materials and methods

The stand for testing explosives in high pressure and temperature conditions and determining characteristics of their detonation consists of a measuring set i.e. test chamber (Fig. 1a), hydraulic pump (Fig. 1b), switch board of power breaker (Fig. 1c) and high-frequency set recording results in digital form (Fig. 1d).

The total weight of the chamber is over 160 kg, that is why it was placed on a stand which provides easy access to all the

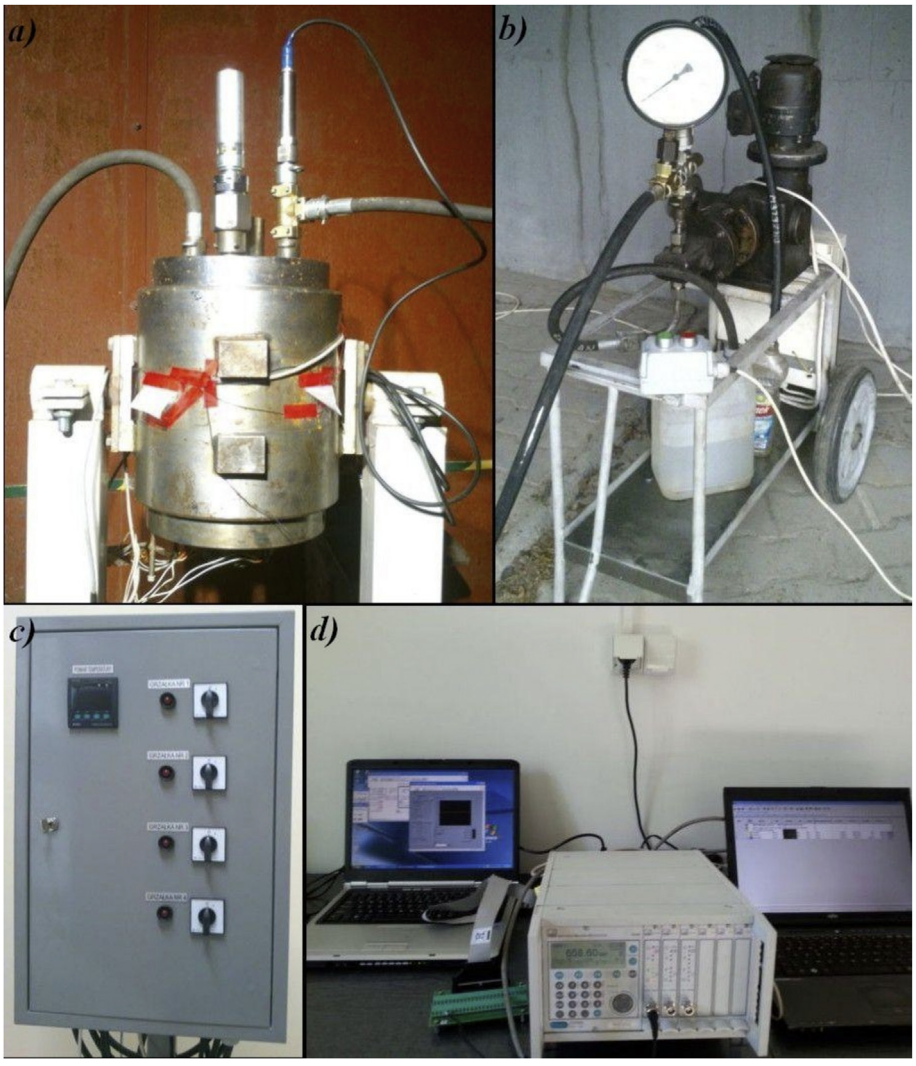

Fig. 1 – The stand for testing explosives: a) chamber for tests of explosives. b) switch board of power breaker. c) hydraulic pump. d) set recording test results.