Study of dust explosion suppression by means of explosion suppression systems of different volumes

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1 Introduction

The presented research was aimed at developing and testing of a super fast explosion suppression systems of 2 dm^3 and 5 dm^3 volume, using smokeless powder or pyrotechnic material as an explosive charge and sodium bicarbonate or water as the suppressing materials.

2 Experimental Apparatus

The experiments were carried out on two prototype devices – steel container of two and five litres capacity, closed by means of an aluminum membrane (Fig. 1). Below the membrane, there was an exhaust connector pipe ended up with a dispersing head. Inside the container about 0.75 kg or 1.75 kg, respectively, of extinguishing powder or water were located. The membrane was ruptured by the explosion of specially developed smokeless powder charge, located inside perforated steel combustion chamber and mounted over the suppressing material surface. The amount of gases produced during the combustion of the explosive charge was sufficient to perforate the membrane and to disperse the extinguishing material into the protected volume. There was no over pressure inside the container during the watch time. The overpressure was produced only after triggering the system by the signal from the protected volume, sent by the pressure transducer or by photodiode reacting to a developing flame. The investigations of efficiency of the developed active explosion suppression system were carried out in the 1.25 m^3 explosion chamber (Fig. 2). Explosion was initiated in the corn starch-air mixture of 0.2 kg/m^3 concentration, dispersed pneumatically inside the chamber. The suppression system was triggered at different overpressures inside the protected volume. The dust explosion suppression process occurred as a result of activity of extinguishing powder blown out from the extinguisher, after membrane perforation by means of the compressed combustion products.

3 Experimental Procedure

In the course of the research, complex analysis of the system efficiency was carried out. The influence of the parameters and components as:

- type, mass and shape of explosive charge,

- number, energy and configuration of the chemical igniters,
- shape of the perforated combustion chamber,
- geometry of the outlet system from the container,
- membrane thickness and its primary incisions,
- shape of dispersion heads,
- value of overpressure inside the extinguisher

was taken under consideration.

During the research, the course of overpressure was measured in the explosion chamber and inside the extinguisher. The exemplary results of the explosion suppression process obtained by means of 2 dm^3 extinguishers are presented in Figs.3 and 4.

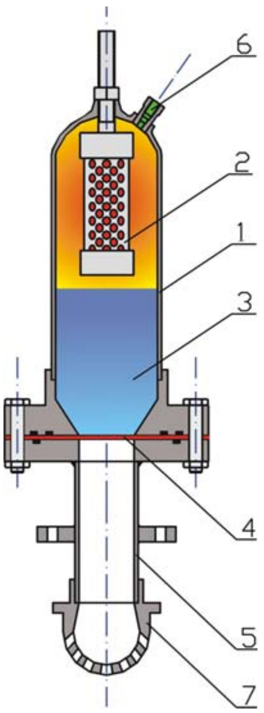

Fig. 1. Scheme of the extinguisher: 1 – steel container, 2 – perforated combustion chamber with explosive charge, 3 – suppressing material, 4 – membrane, 5 – connector, 6 – pressure transducer, 7 – dispersing head.

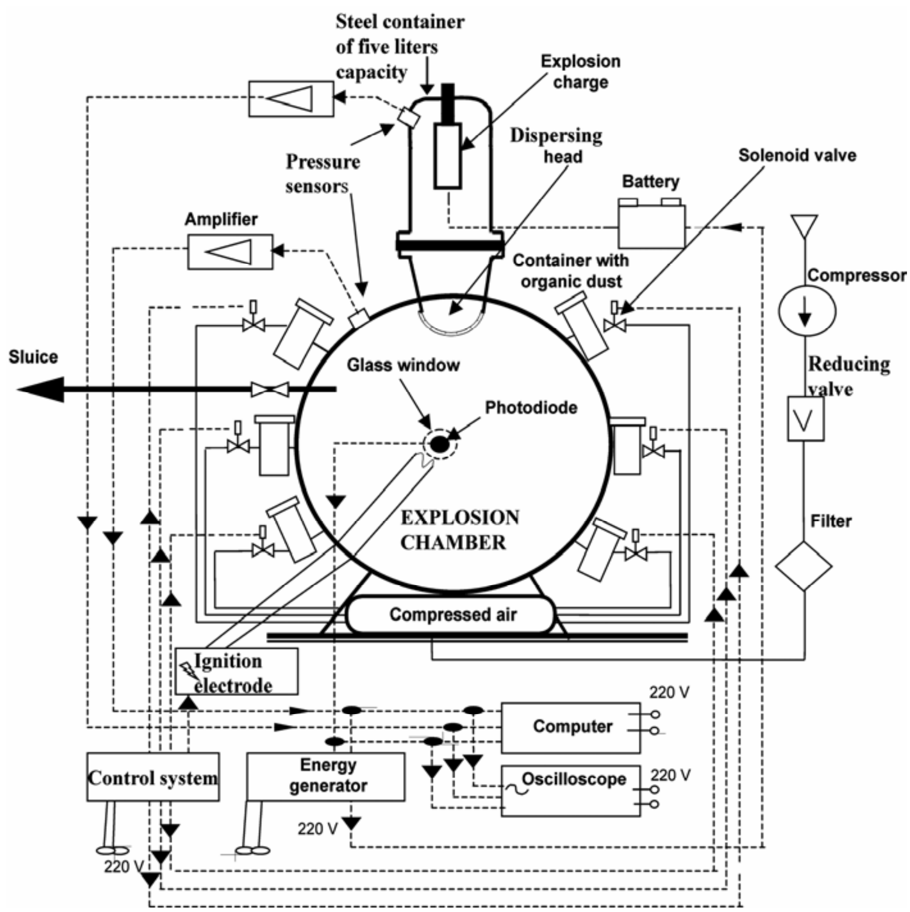

Fig. 2 . Scheme of the research stand with the 1.25 m^3 explosion chamber

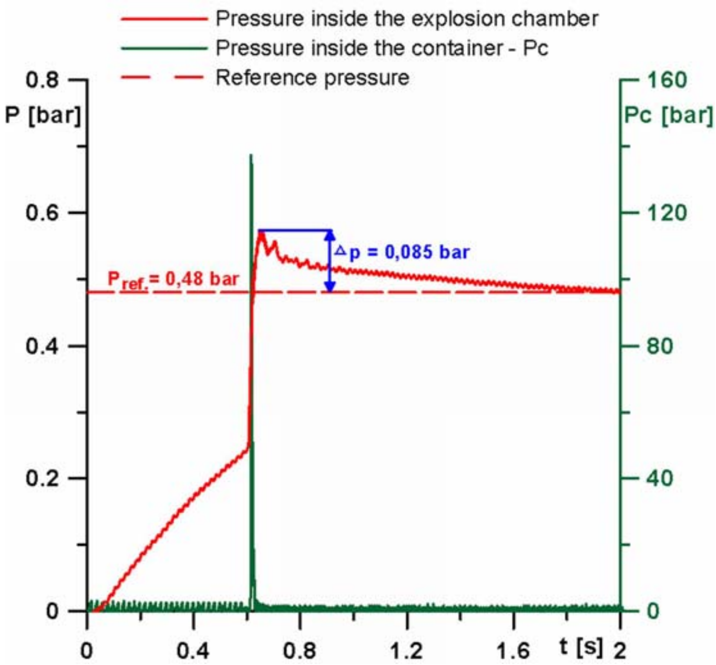

Fig. 3. Course of the overpressure inside the 1.25m^3 test chamber during explosion of the corn starch (C = 0.2 kg/m^3) and inside the extinguisher. Two extinguishers. Activating threshold overpressure Δp=0.05 bar.

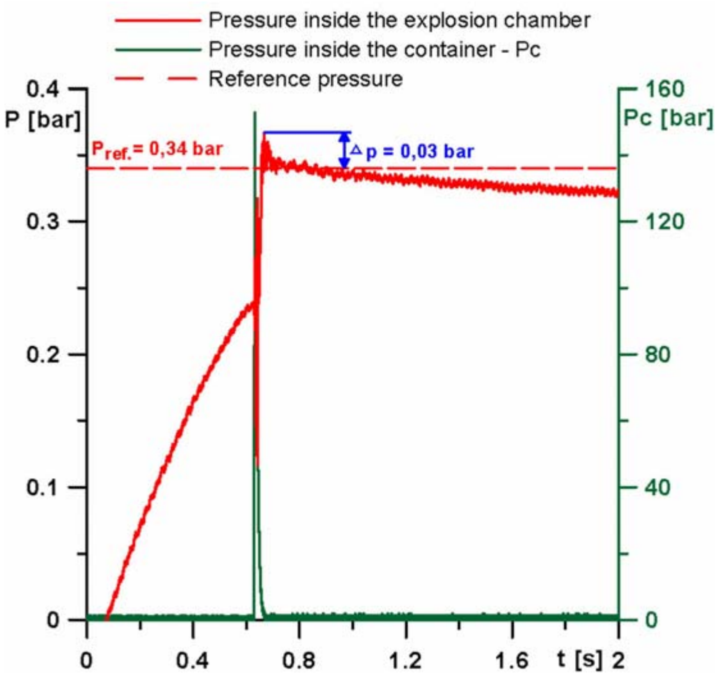

Fig. 4. Course of the overpressure inside the 1.25 m^3 test chamber during explosion of the corn starch (C = 0.2 kg/m^3) and inside the extinguisher. One extinguisher installed on the top, activated by photodiode signal 0.35 V.

4 Conclusions

Final outcome of the work is a suppression system, characterized by high efficiency and reliability, independently from applied extinguishing substance. Research proved also that for dust explosion water is a very good suppressing medium.
The tests carried out for containers of 2 dm^3 and 5 dm^3 volume show that if the system is constructed properly, the dispersing time of the suppressing material is independent from the container volume.

References

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