INFLUENCE OF GAS GENERATED BY DETONATION OF EXPLOSIVES FOR CIVIL USES, ON THE WORK ENVIRONMENT

Attila Kovacs, *Phd. Eng., INCD INSEMEX Petrosani, Romania*
Cristian Raul Cioara, *Eng., INCD INSEMEX Petrosani, Romania*
Gabriel Vasilescu, *Phd. Eng., INCD INSEMEX Petrosani, Romania*
Emilian Ghicioi, *Phd. Eng., INCD INSEMEX Petrosani, Romania*
Edward Gheorghiosu, *Phd. Eng., student INCD INSEMEX Petrosani, Romania*
Daniela-Carmen Rus, *Phd., Eng., student, INCD INSEMEX Petrosani, Romania*
Ilie-Ciprian Jitea, *Phd. Eng., student, INCD INSEMEX Petrosani, Romania*

ABSTRACT*: External violent decomposition extreme reaction of explosives for civil uses leads to the generation of explosion gases explosion after detonation.*

From solid explosive material form to gaseous reached detonation during this process large molecules with complex structures suddenly turns into simple molecules releasing energy manifested significant mechanical work (increasing pressure) and heat (temperature rise).

In most situation gases resulting from the explosion are nitrogen oxides, carbon oxides and water vapours with properties vary according to the explosive concerned.

Both nitrogen oxides (NO, NO_2 , NO_3) and the carbon ones (CO and CO_2) are toxic gases and the maintain of their concentration levels in permissible limits in the workplace is important.

Determination of explosion toxic gases conducted by INCD - INSEMEX are meet modern continuous measurement of CO_x and NO_x under the seal of the enclosure where the explosive detonates.

KEYWORDS*: explosives, nitrogen oxides, carbon oxides, admissible limits.*

INTRODUCTION

The researcher activity for this project was focused to developing a high technological level of measurement system to determining the toxic gases resulted from detonation of explosive charge, with major influence of the health of persons in the exposure are. The requirements for this measurement regarding the standardised methods applied in Europe provide to check the concentration of the toxic gases (CO_x and NO_x) with possibilities to surveillance continuously in period of 20 minutes, in order to have the evolution of the concentration because some gases components are instable or could be solved in the water vapours.

1. DESCRIPTION OF THE APPARATUS AND METHODS

Room Explosion

This room is designed to withstand the forces that occur during detonation of explosives breeze with a minimum volume of 15 m^3 room. Actual size of the room must be known accurately to within ±2%. The camera is equipped with an effective mixing tool to ensure a homogeneous atmosphere in a few minutes after the explosion. The camera must be equipped with means for measuring the ambient temperature and pressure inside the chamber and should have holes for gas collection [7].

When using a circulating system chamber the volume and flow rate must be such as to prevent a significant loss of gases.

Apparatus for analysis

It should be appropriate analytical equipment used to continuously measure the amount of CO, CO_2, NO and NO_2 for 20 min. For example, you can use infrared technology to measure CO and CO_2 and a chemo

-luminescent analyser for NO and NO_x and our TESTO type measuring system is fulfilling this requirements.

Gas extraction equipment

It must be used an air pump and a device for measuring air flow to extract gas samples from the explosion chamber. The system not allows water vapour condensation in the sampling tube gas and the subsequent dissolution of NO_x.

Tube for detonation

The explosive charge is putted in a thick-walled steel tube (that is strong enough to withstand a large number of bursts), the inside diameter of 150 mm and inside length of 1400 mm.

Means of initiation

Means of initiation must be in accordance with manufacturer's specifications in accordance with EN 13631-10 *-Explosives for civil uses. High explosives. Part 10: Verification of the means of initiation* [8].

2. SAMPLES FOR TESTING

For cartridged explosives there must be used the minimum diameter cartridges available on the market. Bulk explosives should be placed in glass tubes or, if necessary closing tighter, they must introduced in aluminium tubes. The inner diameter of the glass tube or aluminium should be the minimum diameter recommended by the manufacturer for the use of explosives. The minimum length of the column of explosives to be 700 mm or at least 7 times the diameter of the load. The minimum explosive mass-volume ratio room must be 30 g/m^3 but not exceed 50 g/m^3. Every test need to be recorded the amount of explosives.

Cartridges should be fixed for coaxial transmission so as to ensure detonation. The length of the load does not exceed the length of the steel tube.

3. TEST PROCEDURES

Load central insert steel orifice. The charge shall detonate. Allow gas to mix a maximum of 5 minutes. How should be the initial sampling of gas from the explosion chamber. It measures the concentration of gas for 20 min. continuously.

If in the explosion chamber is sufficiently gas tight after the initial mixing of CO and CO_2 concentration remains constant. As the NO and NO_2 further give rise to side reactions, need to extrapolate the measured concentration to the initial concentration obtained. The initial concentration of each compound of nitrogen can be obtained by plotting concentration of conjugate according to the time elapsed from the explosion, and when extrapolating to zero the curve results [7].

Starting with initial concentrations as determined from chamber volume and quantity of explosives detonated, we had calculated the amount of each toxic gas in litter per kilogram of explosives (at standard temperature and pressure).

The test should be performed three times.

Fig.1. Bunker for the testing toxic gases

4. TEST REPORT

The test report shall conform to EN ISO / IEC 17025 [10] Additionally the following information must be provided:

a) a reference to the document, that is, EN 13631-16;

b) the volume and initial temperature explosion chamber, temperature and method of drying gas sampling tube gas;

c) the diameter and length of the cartridges used, as well as the material and quality of the coating cartridge;

d) opening and closing means used;

e) the quantity of each of toxic gas (CO, CO_2, NO and NO_x) calculated for each burst, the l/kg;

f) the average quantity of each toxic gas in l/kg.

5. RESULTS OF PILOT TEST

Specifications	Unit measu-rement	Testing no. 1	Testing no. 2	Testing no. 3
Explosion chamber volume	m^3	15		
The amount of explosive	kg	0,600		
The length of the column of explosives	m	0,700		
Means of initiation	-	Electric detonators no. 8 + buster		
The initial temperature of the explosion chamber °	°C	11	11	11
The amount of CO (measured)	ppm	838	1025	805
The amount of CO_2 (measured)	%	0,40	0,39	0,41
The amount of NO (measured)	ppm	366	300	365
The quantity of NO_x (measured)	ppm	464	350	533
The amount of CO (calculated)	l/kg	19,63	24,30	18,80
The amount of CO_2 (calculated)	l/kg	90	87,50	92,50
The calculated amount of NO	l/kg	8,45	6,80	8,43
The amount of NO_x (calculated)	l/kg	10,88	8,03	12,60
The average amount of CO	**l/kg**	**20,91**		
The average amount of CO_2	**l/kg**	**90**		
The average amount of NO	**l/kg**	**7,89**		
The average amount of NO_x	**l/kg**	**10,50**		

6. CONCLUSIONS

This new equipment is fulfilling the requirements of the harmonized European standard and allows a proper measurement of the toxic fumes generated by the explosives, with hazardous impact for the health of personnel in underground works (shafts, tunnel etc.) [5].

The bunker and the automatized measuring system can generate exact information with recoding on a data-base for calculations and to let comparison to be made with the producer producers provisions specified in technical data sheets [6].

7. BIBLIOGRAPHY

[1] DIRECTIVA 93/15/CEE a Consiliului din 5 aprilie 1993 privind armonizarea dispoziţiilor referitoare la introducerea pe piaţă şi controlul explozivilor de uz civil.

[2] HOTĂTÂRE NR. 207 DIN 17 MARTIE 2005 privind stabilirea cerinţelor esenţiale de securitate ale explozivilor de uz civil şi a condiţiilor pentru introducerea lor pe piaţă.

[3] Fodor, D. – *Ingineria Împuşcărilor, Materiale şi Tehnici de lucru (2)*, Editura Namaste – Timişoara 2007, Editura Corvin – Deva 2007, Vol.1.

[4] Fodor, D. – Ingineria Împuşcărilor, Materiale şi Tehnici de lucru (2), Editura Namaste – Timişoara 2007, Editura Corvin – Deva 2007, Vol.2.

[5] D. Fodor, „*Explozivi industriali*", Editura INFOMIN, Deva, 2000.

[6] Tat, S., Zaporojan, M., Fissgus, K. - *Explozivi şi tehnica împuşcării în industrie*, Editura Tehnica, Bucureşti 1985.

[7] EN 13631-16, Explosives for civil uses. High explosives. Part 16: Detection and measurement of toxic gases.

[8] EN 13631-10, *Explosives for civil uses. High explosives. Part 10: Verification of the means of initiation.*

[9] EN 13857-1:2003, *Explosives for civil uses. Part 1: Terminology.*

[10] EN ISO/CEI 17025, General requirements for the competence and testing of calibration laboratories (ISO/IEC 17025:1999).