

Safety Problems of Commercial Cap-sensitive Emulsion Explosives Turnover in the Territory of the Republic of Kazakhstan

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As a results of the rapid development in the territory of the States-parties of the customs union, including the Republic of Kazakhstan, of activities, connecting to mining with the usage of the explosion energy, in the territory of these countries mini-producing plants of commercial explosives based on ammonium nitrate as the main component occur very intensively.

More often, local extractive industry companies and service companies, using manufacturing experience of world-known corporations such as «Dyno Nobel», «Orica», «MAXAM», «TREAD CORPORATION» build their own mini-factories for the production of commercial explosives such as «ANFO», emulsion and water-gel explosives. The range of explosives manufactured at these mini-plants includes cap-sensitive patronize explosives. For example, a service company of Kazakhstan «Interrin» on its own mini-factory produces emulsion cap-sensitive explosive.



Figure 1. Left: explosive «Petrogen P»; right: explosive «Petrogen P», packaged

The most high-productive Kazakhstan plant for manufacturing of patronize cap-sensitive emulsion explosives is owned by the company JSC «Orica Kazakhstan». The range of this type producing explosives has two different recipes of preparing compositions «Senatel Magnum» and «Senatel Powerfrag», which are patronized into the polypropylene casing of different diameters.

Thus, the total annual quantity of produced in the Republic of Kazakhstan cap-sensitive emulsion explosives is more than eight thousand tons.



Figure 2. Fabrication shop of cap-sensitive emulsion explosives of the JSC «Orica Kazakhstan»

Simultaneously with the growth of the such kind of explosives production, the risk of unauthorized use with the purpose of illegal mining as well as for terrorist and criminal purposes increases, by the reason, that these products according to it depredation are close to TNT [1].

Table 1: TNT equivalent of certain cap-sensitive emulsion explosives

The name of explosive	TNT equivalent
«Petrogen P»	0,79
«Senatel Powerfrag»	0,85
«Senatel Magnum»	0,88

Insufficient degree of control over the industrial explosives turnover leads to their constantly increasing illegal use for criminal or terrorist purposes. Currently, the most popular requirements for turnover of industrial explosives control are licensing, authorization or other similar requirements for their storage, usage, transportation, sale and purchase and other commercial activities. These requirements do not fully provide the wide-spread control on the assumption, that "criminal elements", as usual, acquire explosives from the most available and least risky sources, such as leakage of legitimate stocks of industrial explosives on the stages of their manufacture, transportation, storage and usage (the most accessible source of theft).

Thus, the actual task is to provide the possibility of labeling (tagging) the industrial explosives in the stage of their production with the secret detection agent, that will allow to identify by technical means the product - as an explosive and to know the trademark of the detected explosive, its manufacturer, and other necessary information [2]. Taking into account the above aspects, one of the most important research

directions of the Kazakh National University named after Al-Farabi and Institute of Combustion Problems are dedicated to the subject of industrial explosive and the devices on their bases turnover safety.

Having analyzed literary sources, technical documentation and studied technological processes of production of cap-sensitive emulsion explosives authors identified the following problematic issues.

Table 2: Problematic issues of labeling (tagging) by the secret marking additives of industrial explosives in the stage of their production

Consecutive number	Content of the issue
1	Selecting the marking additive, serving as the remote identifier of explosive composition as the 1 hazard class product according to ADR classification.
2	Selection of the chemical substance, serving as the microcarrier with the ability to encrypt the necessary information in its molecular structure and its subsequent identification in the sample of the explosive composition.
3	Study of the marking additives influence on the consumer properties of explosive compositions.
4	Adjustment of the mechanism of explosive materials marking without the interruption in the process of their production.
5	Identification of the marked products during the quality control in the process of production.
6	The selection of the effective methods of identifying information about the marked product in a sample of the explosive composition.

For the first question the decision has been found in the Convention about the marking of plastic explosives for the purposes of their detection, adopted in Montreal at a diplomatic conference held by ICAO on February 12 - March 1, 1991 fully reveals the types of marking substances, injected into the composition of explosives in order to detect them remotely by technical or other means:

Marking substances are every types of the substances listed in the table 3 below. Marking substances, described in this table, are intended to be used in order to enhance the detectability of explosives by the devices for vapor detection. In each case, the marking agent is injected in the composition of explosive so that it has to be uniformly concentrated in the final product [3].

Table 3: The minimum concentration of a marking agent in the finished product after manufacturing

Name of marking agent	Molecular formula	molecular weight	The minimum concentration
ethylene glycol (EGDN)	$C_2H_4(NO_1)_2$	152	0,2 % by weight
2,3-dimethyl-2,3 dinitrobutane (DMNB)	$C_6H_{12}(NO_2)_2$	176	0,1 % by weight
para-mononitrotoluene (p-MNT)	$C_7H_7NO_2$	137	0,5 % by weight
mononitrotoluene ortho (o-MNT)	$C_7H_7NO_2$	137	0,5 % by weight

Every explosives, which include after their manufacturing any of the designated marking agents in the required minimum level of the concentration or in excess of this level is considered to be marked.

The research work of the authors is devoted to the 2-6 problematic issues. The aim of the research is to reveal in amount of chemicals the most appropriate according to its properties in order for using it as marking substances of the industrial explosives. Determine the principles of data encryption (code of the country of manufacture, the production, the manufacturer, produced batch and the date of manufacture, etc.) in the microcarrier (marking additive). Choose the most accurate and effective physical and chemical methods of identification (analysis) of marked industrial explosives.

At this stage, the authors reviewed the known methods of secret marking of explosives. The description of the secretive informative marking of commercial explosives is given by adding into their composition marker-substances (identifiers), which can be detected by special methods of analysis in the composition of explosive [4]. Informational content is achieved by information coding with the use of combinatorial code - given by a combination of marker substances. Secrecy of marking is provided by the use of marking substances in minute quantities, detectable only by special methods of physical and chemical analysis. The spectrophotometric characteristics of certain marking substances were studied and their concentration limits were determined by PE-5400UF spectrophotometer. The results of reading marking information, introduced into the cap-sensitive emulsion explosive composition «Senatel Magnum» by the provided method, were reviewed.

"Encoding" of secret microcarrier for a certain type of product and its manufacturer was made in the following sequence:

1. Name of the manufacturer country - the Republic of Kazakhstan
2. Name of the product - «Senatel Magnum» ST AO 39302496-003-2009
3. Manufacturer's name - JSC "Orica-Kazakhstan"
4. Number of the produced batch - 576
5. The date of the production - November 30, 2016



Figure 3. Research of the cap-sensitive emulsion explosives marking in company JSC «Orica Kazakhstan»

After the marking processes, there is a possibility to detect visually the presence of the marking agent in the composition of the explosive during the quality control.

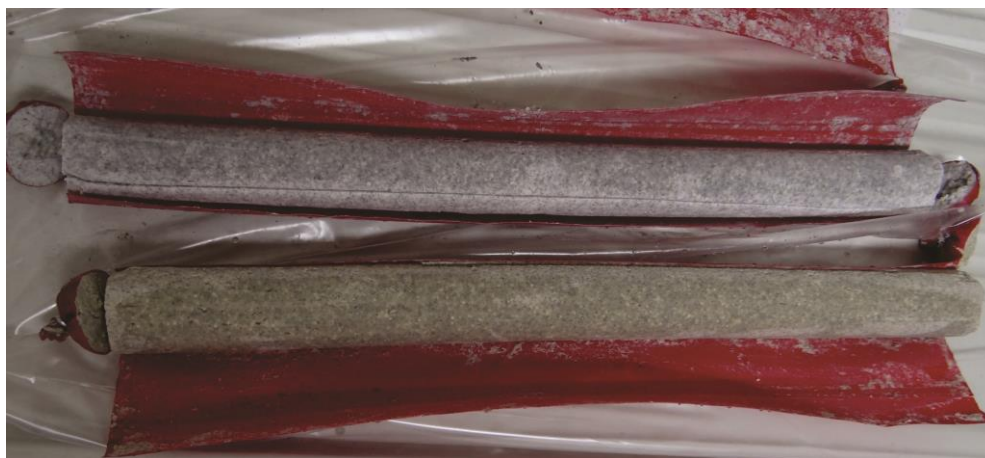


Figure 4. Above: the explosive «Senatel Magnum» without a marking agent; bottom: marked explosive «Senatel Magnum»

The spectrophotometric method of determination of marking substances in samples of marking explosives compositions was developed. It is proved that the proposed marking method of explosive compositions, in addition to the secrecy, has the wide opportunities to encrypt the information. At the same time, it is possible to combine many known methods of different kinds of the text and digital information encoding, which must to be specified in the marking.

Currently, the samples of marked explosive «Senatel Magnum» are tested in specialized laboratory in order to study in a full the effect of marking additives on consumer properties of the explosive composition.

The authors continue to perform the research works on the subject. Planned completion date - 2019.

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