COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS AND ON THE GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS
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EXPLOSIVES, SELF-REACTIVE SUBSTANCES AND ORGANIC PEROXIDES

Classification of ammonium nitrate emulsions, suspensions and gels

Minimum Burning Pressure of Commercial Explosives

Transmitted by the expert from Canada

Background

During the twenty-first session of the Committee of Experts on the Transport of Dangerous Goods, December 2000, it was decided to create a new entry for AMMONIUM NITRATE EMULSION or SUSPENSION or GEL, intermediate for blasting explosives (ANEs), in Division 5.1 (UN No. 3375). To determine whether a substance may be classified under this new entry, a new Test series 8 was also developed in the Manual of Tests and Criteria. This test series includes a thermal stability test, a gap test and the Koenen test. A larger scale heating test (8(d), vented vessel test) was originally also proposed but has been shown to have serious drawbacks, with results very dependent on test conditions. There is presently no internal ignition test, and one possibility here is the Minimum Burning Pressure Test (MBP) which is being examined by the Canadian Explosives Research Laboratory (CERL.) The test was described in a previous paper (UN/SCETD/21/INF.22). Some preliminary results are presented on four emulsions and a gel.

Modern water-based commercial explosives are intrinsically much less sensitive than traditional products such as dynamites or black powder. However, they have still been involved in a significant number of accidental explosions.

Accidental initiations of these explosives are all thermal in origin, and two broad categories can be defined. When the temperature of a sizable mass of explosive is globally elevated above a critical value, a runaway decomposition reaction may result (thermal explosion or cook-off.) When mechanical or thermal energy is deposited locally into the explosive a ‘hot spot’ results. Depending on conditions, initiation of a combustion reaction may result at the hot spot/explosive interface. The latter may propagate into a deflagration and even into a detonation, depending on the pressure and confinement conditions.

At atmospheric pressure, such local ignitions do not lead to self-sustained reactions in water-based explosives because the initial stage of combustion is endothermic and therefore not self-propagating. Thus there is a minimum pressure required for combustion to take place, referred to as the ‘Minimum Burning Pressure (MBP)’ of the explosive. Above the MBP, the explosive undergoes a normal combustion with a measurable burn rate which increases with increasing pressure. Eventually deflagration / detonation may result. In evaluating the hazards associated with water-based explosives operations, the MBP is an important parameter. For candidates for the ANE category, the test could be

used to determine the likelihood of deflagration or detonation during transportation including loading and offloading. A significant advantage of this test is that it does not require an extensive test facility. Nevertheless, in spite of its small scale it should predict well the behaviour of a much larger quantity of material.

RESULTS

Product	%H_20	MBP/ psi
Emulsion 1 Packaged Sensitized with amine nitrate, microballoons	**11.0**	**140**
Emulsion 2 Unsensitized	**11.7**	**520**
Emulsion 3 Unsensitized	**12.7**	**620**
Emulsion 4 Bulk ANE type	**16.8**	**>2200**
Slurry 1 Bulk Sensitized with amine nitrate	**12.0**	**600**

From these results it can be seen that the MBP depends on both the presence of sensitizers and the water content. There is a rapid increase in MBP around 15-16% water. These results support the possibility of using this test to distinguish between explosive and ANE classification.

Recommendations

- that work continue to investigate the MBP of emulsion explosives and gels as a function of water content and sensitizers

- that work continue to investigate the MBP of emulsion explosives at elevated temperatures representative of the corresponding maximum process or transportation temperatures.

- that, at some point in the future, MBP measurements be considered as part of the testing requirements for TDG classification of ANEs and other water-based explosives or precursors.

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