

TOXIC FUMES FROM SHOCK-DAMAGED PERMISSIBLE EXPLOSIVES

Thomas C. Ruhe - Research Chemist
Michael S. Wieland - Supervisory Research Physicist
Explosives Group
Pittsburgh Research Center U. S. Bureau of Mines
Pittsburgh, PA
Phone: (412) 892-6416

ABSTRACT

Marginal detonation of explosives can produce more toxic fumes with higher nitrogen oxides (NO_x) than normal detonation. In delay blasting, shock waves from borehole charge explosions can impact those delayed charges still remaining in the delay pattern. This can result in partial desensitization, whereupon the explosive does not misfire, but detonates in a weak unstable fashion releasing a different/unusual spectrum of gaseous reaction products.

In this study, two candidate permissible water-gel explosives were compressively impacted by two different techniques. The first method, utilized a non-metal fixture consisting of two concentric glass tubes. Detonating cord wound within the annular space impulsively desensitized a cylindrical charge sample within the central tube. The glass fixture was installed in the 15-liter Bichel Gauge chamber utilized for containment and fume sampling. In the second method, a steel pipe fixture was used to produce a sharp transient hydrodynamic pulse that desensitized the charge sample. This charge assembly was fired in a 38,400-liter chamber, and the fumes were grab-sampled after 8 minutes dilution (mixing) time.

The fumes from the control and impacted (desensitized) shots were analyzed for carbon dioxide (CO_2), carbon monoxide (CO), and the combined nitrogen oxides [NO ($\text{NO} + \text{NO}_2$)]. Weighted toxicity results were calculated according to approval regulations (30 CFR 15 - promulgated November 18, 1988). To complete the toxicity computations, different ratios of NO_2/NO_x were presumed since NO and NO_2 were not measured separately. In a worst-case assumption, when NO_x was taken as 100% nitrogen dioxide, the impacted shots produced fumes that were two to four times higher than the permissible limit of 155 cc/g [toxic gas (cc)/explosive (g)]. Regardless of the ratio presumed, it was recognized that partially desensitizing explosives generally increases the toxicity of the reaction products generated, despite some reduction in total fumes.