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Characterization of Erythritol Tetranitrate Physical Properties

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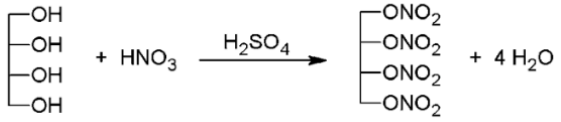
Abstract: The article describes the molecular structure and fundamental physical properties of erythritol tetranitrate (ETN). Although ETN is simple nitrate ester this explosive is described in the literature relatively briefly. The molecular structure of ETN was characterized by single-crystal X-ray diffraction. The structure of the ETN molecule is composed of the central carbohydrate chain and two pairs of facing coplanar ONO_2 groups. The crystal density of ETN is 1.827 $g\,cm^{-3}$. It is a non-hygroscopic compound. Solubility in water was determined in a temperature range from 5 °C to 80 °C. ETN is slightly soluble in water; solubility at 20 °C is on the same level as that of PETN.

Keywords: Erythritol tetranitrate · ETN · X-ray diffraction · Density · Solubility

1 Introduction

Erythritol tetranitrate (ETN) is a simple nitrate ester structurally similar to nitroglycerine (see Scheme 1). This ester of nitric acid was first synthesized in 1849 by Stenhouse [1]. Although it is a structurally simple and easily synthesized powerful explosive, only a few authors have paid attention to it as an explosive in the past. The main reason was the high cost caused by limited availability of erythritol (ETN precursor), which was obtained by costly extraction from seaweed, algae, or lichen [2]. Later, production of erythritol via acetylene chemistry did not significantly change anything; the price of ETN was still too high for industrial use [3]. However new technology for erythritol production using microbial methods from osmophilic yeasts has been developed recently [4]. The price of erythritol has been significantly reduced and its technological accessibility is no longer a limitation.

Unfortunately, the properties of ETN are described only briefly in scientific literature [3,5–7]. Research into the fundamental parameters of this explosive is therefore important. There have been plenty of articles concerning the medical effects and uses of erythritol tetranitrate (it is used as an effective cardiovascular medicine [5]), but only a few remarks have appeared in tertiary literature about its explosive properties. The subject was addressed three years ago by Oxley et al. [8], who published some analytical data for ETN, along with certain physical and explosive properties. The thermal behavior and decomposition kinetics of pure ETN and its mixtures with pentaerythritol tetranitrate (PETN) and hexogen (1,3,5-trinitro-1,3,5-triazinane, RDX) have also been published recently [9]. We decided to study fundamental physical characteristics of this nitrate ester that, according to our best information, have not been published to date. The results of our research are summarized in this article.



Scheme 1. Synthesis of ETN.

2 Experimental Section

Caution: Erythritol tetranitrate is a powerful explosive, sensitive to external stimuli. Its sensitivity to friction and impact is on the level of PETN. The standard safety procedures for preparation and handling of explosives must be used.

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