

SENSITIVITY OF SALTS OF 5,5'-AZOTETRAZOLE WITH NITROGENOUS BASES, THEIR CRYSTALLINE HYDRATES, AND MIXTURES WITH OXIDANTS TO DETONATION PULSE

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Abstract: High-energy salts of 5,5'-azotetrazole with nitrogenous bases are the promising components for a wide range of energy-enhanced materials. The sensitivity to detonation pulse of 5,5'-azotetrazole salts with nitrogenous bases, crystalline hydrates of 5,5'-azotetrazole salts, and mixtures of 5,5'-azotetrazole salts with oxidants in small diameter charges was studied by determining the minimal initiating charge of triacetone triperoxide and hexamethylene triperoxydiamine. The minimum initiating charges were determined, the influence of crystallization water and oxidizers was shown, and the critical diameter of detonation of the studied substances was estimated.

Keywords: salt of 5,5'-azotetrazole; crystalline hydrate of 5,5'-azotetrazole salts; mixtures of 5,5'-azotetrazole salts with oxidizers; minimum initiating detonation charge; triacetone triperoxide; hexamethylenetriperoxydiamine

DOI: 10.30826/CE22150112

Table Captions

Table 1 Combustion characteristics of $G_{u_2}AzT$ and TAG_2AzT and their mixtures with oxidizers [12]

Table 2 Explosive properties of AzT salts [2–7, 13]

Table 3 Minimal initiating charge of hexamethylene triperoxydiamine (HMTD) and triacetone triperoxide (TATP) for AzT and trinitrotoluene salts

Table 4 Minimal initiating charge of HMTD and TATP for stoichiometric mixtures of AzT salts with oxidizers

References

- Thiele, J. 1989. Ueber Azo- und Hydrazoverbindungen des Tetrazols. *Liebigs Ann.* 303:57–78.
- Hiskey, M. A., N. Goldman, and J. R. Stine. 1998. High nitrogen energetic materials derived from azotetrazolate. *J. Energ. Mater.* 16:119–127.
- Hammerl, A., T. M. Klapotke, H. Noth, and M. Warchhold. 2001. $[N_2H_5]_2^+[N_4C=N=N-CN_4]^{2-}$: A new high-nitrogen high-energetic material. *Inorg. Chem.* 40:3570–3575.
- Sivabalan, R., M. B. Talawar, N. Senthilkumar, B. Kavitha, and S. N. Asthana. 2004. Studies on azotetrazolate based high nitrogen content high energy materials potential additives for rocket propellants. *J. Therm. Anal. Calorim.* 78:781–791.
- Hammerl, A., M. A. Hiskey, G. Holl, T. M. Klapotke, K. Polborn, J. Stierstorfer, and J. J. Weigand. 2005. Azidoformamidium and guanidinium 5,5'-azotetrazolate salts. *Chem. Mater.* 17:3784–3793.
- Sivabalan, R., M. Annyappan, S. J. Pawar, M. B. Talawar, G. M. Gore, S. Venugopalan, and B. R. Gandhe. 2006. Synthesis, characterization and thermolysis studies on tiazole and tetrazole based high nitrogen content high energy materials. *J. Hazard. Mater.* 137(2):672–680.
- Tappan, B. C., A. N. Ali, S. F. Son, and T. B. Brill. 2006. Decomposition and ignition of the high-nitrogen compound triaminoguanidinium azotetrazolate. *Propell. Explos. Pyrot.* 31:163–167.
- Akhapkina, L. E., P. A. Postnikov, Min Tant M'e, A. I. Levshenkov, and V. P. Sinditskii. 2011. Sintez i issledovanie soley 5,5'-azotetrazola s azotistymi osnovaniyami [Synthesis on investigation of 5,5'-azotetrazole salts]. *Uspekhi v khimii i khimicheskoy tekhnologii* [Advances in Chemistry and Chemical Technology] 25(12):54–58.
- Levshenkova, L. E., V. P. Sinditskii, and A. I. Levshenkov. 2013. Issledovanie termicheskogo raspada guanidinovoy i ammonievoy soley 5,5'-azotetrazola [Study of thermal decomposition of guanidinium and ammonium 5,5'-azotetrazole salts]. *Uspekhi v khimii i khimicheskoy tekhnologii* [Advances in Chemistry and Chemical Technology] 27(2):131–136.
- Levshenkova, L. E., N. A. Muriljov, W. H. Aung, A. I. Levshenkov, and V. P. Sinditskii. 2015. Raspad onievkx soley 5,5'-azotetrazola v zhidkoy faze [The decomposition of onium 5,5'-azotetrazole salts in liquid]. *Uspekhi v khimii i khimicheskoy tekhnologii* [Advances in Chemistry and Chemical Technology] 29(8):53–55.
- Levshenkova, L. E., and A. I. Levshenkov. 2015. Sintez i svoystva soley 5,5'-azotetrazola s azotistymi osnovaniyami [Synthesis on investigation of 5,5'-azotetrazole salts].

- Vestnik Buryatskogo gosudarstvennogo universiteta* [Bulletin of the Buryat State University] 3:31–35.
- Levshenkov, A. I., and L. E. Levshenkova. 2015. Goreniesmesey onievykh soley 5,5'-azotetrazola s okislitel'yami [Combustion of mixtures of 5,5'-azotetrazole onium salts with oxidizers]. *Chemical Physics and Mesoscopy* 17:331–338.
 - Han, Y. H., Y. Z. Yang, Z. M. Du, Z. M. Li, Q. Yao, Y. H. Wang, and Z. Y. Hu. 2016. The formulation design and performance test of gas generators based on guanidinium azotetrazolate. *Propell. Explos. Pyrot.* 42:276–282.
 - Abe, M., T. Ogura, Ya. Miyata, K. Okamoto, Sh. Date, M. Kohga, and K. Hasue. 2008. Evaluation of gas generating ability of some tetrazoles and copper (II) oxide mixtures through closed vessel test and theoretical calculation. *Sci. Technol. Energ. Ma.* 69(6):183–190.
 - Bucerius, K. M., F. W. Wasmann, and K. Menke. 1993. Stable, nitrogen-rich composition. Patent 5,198,046. 4 p.
 - Petreykin, A. A., D. S. Antipov, A. A. Kunakov, L. E. Levshenkova, and A. I. Levshenkov. 2016. Razrabotka metodiki opredeleniya minimal'nykh initsiiruyushchikh zaryadov dlya nizkoplotnykh brizantnykh VV [Development of the method for determining the minimum initiation charges low density]. *Uspekhi v khimii i khimicheskoy tekhnologii* [Advances in Chemistry and Chemical Technology] 30(8):37–38.
 - Antipov, D. S., A. A. Petreykin, A. A. Kunakov, L. E. Levshenkova, and A. I. Levshenkov. 2016. Detonatsionnaya sposobnost' prostykh ammonalov v zaryadakh malykh diametrov [Capacity detonation binary ammonal in charge in charge of small diameter]. *Uspekhi v khimii i khimicheskoy tekhnologii* [Advances in Chemistry and Chemical Technology] 30(8):8–9.

Received January 19, 2022

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