Defense Systems Information Analysis Center

DSIAC TECHNICAL INQUIRY (TI) RESPONSE REPORT

UAV-Deployed Thermobarics for Suppressing Radiation Hazards

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ABOUT DSIAC

The Defense Systems Information Analysis Center (DSIAC) is a U.S. Department of Defense Information Analysis Center sponsored by the Defense Technical Information Center. DSIAC is operated by SURVICE Engineering Company under contract FA8075-14-D-0001.

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A chief service of DSIAC is free technical inquiry (TI) research, limited to 4 research hours per inquiry. This TI response report summarizes the research findings of one such inquiry. For more information about DSIAC and our TI service, please visit www.DSIAC.org.

ABSTRACT

The Defense Systems Information Analysis Center (DSIAC) received a technical inquiry requesting research on explosives bonding materials for thermobaric (TBX) devices consisting of boron 10 and aluminum. The purpose of this inquiry was to assess or identify research on using unmanned aerial vehicles (UAVs) for dispersing TBXs and fuel-air explosives (FAEs) in response to a nuclear facility incident. DSIAC contacted a TBX subject matter expert (SME) from Johns Hopkins University's Department of Chemical & Biomolecular Engineering for information relevant to the inquiry. The SME identified that UAVs have not yet been used to disperse TBXs or FAEs, but it could be an innovative technique. The SME also provided patents and articles related to using boron in TBXs and FAEs.

Contents

1.0 TI Request

1.1 INQUIRY

What research can be provided on explosives bonding materials for thermobaric (TBX) devices consisting of boron-10 (to affect a neutron absorber) and aluminum or other agents that might aid as alpha radiation blockers?

1.2 DESCRIPTION

The inquirer requested information on tests or documentation on using boron-10 (primary) or aluminum (secondary) for unmanned aerial vehicles (UAVs) deploying TBXs in response to a nuclear facility incident.

2.0 TI Response

The Defense Systems Information Analysis Center (DSIAC) contacted the Johns Hopkins University Energetics Research Group (JHU ERG) for help identifying a subject matter expert (SME) who could assist in responding to the inquirer's request. JHU ERG identified Dr. Gregory Aranovich as the SME on TBXs, who assisted DSIAC by providing a response to the inquiry.

2.1 UAVS FOR TBX/FUEL-AIR EXPLOSIVE (FAE) WEAPONRY

The idea of using UAVs for dispersing TBX or FAE mixtures is very interesting for many reasons. It can be used for various purposes, including the following:

- "Deflagrating" a chemical/biological cloud.
- De-mining.
- Using against terrorists in caves.
- Absorbing radiation.

Based on a technical literature search, the technique of using UAVs to disperse TBXs and FAEs has not yet been developed. However, the discussions in subsection 2.2.1 provide speculation that Russia is working on developing similar techniques.

UAV can be groundbreaking in TBX and FAE weaponry based on the following:

- It facilitates a controlled distribution of the energetic mixture.
- It provides the capability to form more powerful (local) shock waves.
- TBXs or FAEs can become precise weapons.

2.2 USING BORON IN TBX/FAE

Dr. Aranovich provided information on relevant patents, articles, and JHU research/interest in using boron in TBXs or FAEs.

2.2.1 Patents

The following are Russian patents that Dr. Aranovich identified as a "tip of the iceberg" in terms of research related to using boron in TBXs:

- The patent "Composition for a Fuel and Air Explosion" reports on using up to 30% of boron in a TBX charge [1].

- The following link provides information on a company focusing on boron and boron-containing polymers for absorbing fast neutrons: http://xn--80aabplh3bfmft5b6b.xn--p1ai/o-kompanii.html [2]. Their projects go through the Institute of Experimental Physics (Sarov) and Kurchatov's Institute.

2.2.2 Articles

The following documents contain information relevant to the inquiry:

- "Boron-Neutron Capture on Activated Carbon for Hydrogen Storage" by J. Romanos et al. [3].
    - This article reports on boron-neutron capture in system where boron is doped in nanopores of activated carbon.
    - This report also references two publications on such nanoporous structures authored by Dr. Aranovich and M. D. Donohue, including "Adsorption Isotherms for Microporous Adsorbents" [4] and "Adsorption of Supercritical Fluids" [5].

- "Thermobaric and Enhanced Blast Explosives (TBX and EBX)" by L. Türker [6].

    - This article provides a review on using boron in TBX mixtures. The main purpose of using boron in such mixtures is higher heat of combustion compared to nonmetallic mixtures and using aluminum powder. For this purpose, it is possible to use boron-10 and study protection against radiation/neutrons.

2.2.3 JHU Research

Particles of activated carbon doped with boron could be a possible component in UAV-deployed TBX. In the past, JHU has performed projects where particles of activated carbon were doped with other energetic components.

JHU has analyzed possible sources of information on aluminum and boron in TBXs. JHU's general conclusion was that aluminum for TBXs is well known (mostly to increase energy content). However, JHU could not find publications on using aluminum for suppressing radiation hazards. The use of boron (in general), such as boron hydride (or borane)-based compounds, for TBXs is also known. Boron hydrides are very energetic molecules containing only boron and hydrogen that can be used as components of TBX. However, JHU could not find publications or any indication of tests for using boron-10 for suppressing radiation hazard.

Researchers at JHU started a discussion on possible ways to disperse boron-containing additives using TBX techniques. Since capturing radiation/neutrons requires very specific dispersion and avoiding/delaying detonation, this can become a proposal for a new project.

REFERENCES

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[2] СпецБорЗащита. http://xn--80aabplh3bfmft5b6b.xn--p1ai/o-kompanii.html, accessed April 2019.

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[6] Türker, L. "Thermobaric and Enhanced Blast Explosives (TBX and EBX)." *Defence Technology*, vol. 12, no. 6, pp. 423–445, https://www.sciencedirect.com/science/article/pii/S2214914716300927, December 2016.

BIOGRAPHY

GREGORY ARANOVICH is the principal research scientist of Johns Hopkins University's Department of Chemical & Biomolecular Engineering. He is an expert in thermobarics, with over 38 years of experience in chemistry and chemical engineering. He has been recognized for several achievements in physical chemistry and chemical engineering, has over 12 Russian patents, and is the author of many publications and presentations related to chemistry and chemical engineering. Dr. Aranovich has a B.S. in physics from the Moscow Institute of Electronic Engineering, a Ph.D. in chemical engineering from the Moscow Institute of Steel and Alloys, and a D.Sc. in chemistry (habilitation) from Moscow State University.