

A Novel, Catalytic Method For Destroying Chemical Warfare Agents, Insecticides And Pesticides

Dr. Stan Brown and Dr. Alex Neverov of the Department of Chemistry at Queen's University have developed a novel method for the decontamination of toxic chemical warfare agents, insecticides and pesticides.

The process is fast, catalytic, occurs at room temperature, and produces non-toxic products. It is broadly suitable for decomposing neutral organophosphorous compounds, including chemical warfare agents (e.g., G-, V- and VX-agents) and pesticides (e.g., paraoxon, fenitrothion).

In testing with live chemical warfare agents, full decontamination of both G- and V-agents is achieved within 30 seconds. In panel testing to explore surface decontamination, >99.9% decon is achieved within 10 minutes.

Description:

The controlled decomposition of organophosphorous agents is achieved through a catalytic alcoholysis promoted by metal ion catalysts in an alcohol solvent. The method comprises combining the organophosphorous compound with a non-aqueous solution, preferably an alcohol, comprising metal ions and at least a trace amount of alkoxide ions. The alkoxide ions serve to activate the catalyst.

Testing:

The system has been tested by a third-party organization on GA, GD and VX. In solution, full decontamination of all agents is achieved within 30 seconds. In panel testing to explore surface decontamination, >99.9% decontamination is achieved within 10 minutes (the earliest time point measured). The toxic degradation product of VX, EA2192, is not detectable at the detection limit of 0.5ng/mL.

Beyond this live agent testing, the method has been demonstrated to work for a variety of neutral organophosphates including phosphorous triesters, phosphonates, phosphorothioates (P=S and P=O(SAr) compounds), and phosphonothioates.

Proof-of-concept systems include:

1. Billion-fold acceleration of the methanolysis of paraoxon promoted by lanthanum catalyst. This system provides the largest reported acceleration for any man-made catalyst capable of promoting the solvolysis of a phosphate triester.
2. Cu(II)-mediated decomposition of phosphorothioate P=S pesticides: Cu(II)-ligand system promoted billion-fold acceleration of methanolysis of fenitrothion.
3. Catalytic degradation of pesticides paraoxon and fenitrothion through Zn^{2+} -catalyzed methanolysis.
4. Million-fold acceleration in destruction of V-agent simulants: La^{3+} -catalyzed methanolysis of phosphorothioates.

5. Millions-fold acceleration of the destruction of phosphonothioates with La^{3+} and a Zn^{2+} complex.

Benefits:

This method has a number of advantages:

- Catalytic: a billion-fold acceleration in reaction rate is achieved in model systems
- Occurs in non-aqueous media
- Can be performed at room temperature
- Can be performed under neutral conditions
- Produces non-toxic products
- Products are more easily disposed of than those of hydrolytic methods
- Displays excellent turnover of catalyst
- Enhances the solubility of the organophosphorous agents due to the greater hydrophobicity of the alcoholic medium, thereby improving decontamination

Status of Commercialization:

U.S. Patent No. 7,214,836 issued on May 8, 2007. Corresponding international patent applications are pending.

PARTEQ Innovations, the technology transfer office of Queen's University, is seeking licensees for the technology.

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