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Al Nashef et al.

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(54) **PROCESS FOR THE DESTRUCTION OF SULFUR AND NITROGEN MUSTARDS, LEWISITE, AND THEIR HOMOLOGOUS/ANALOGUES IN DEEP EUTECTIC SOLVENTS**

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(52) **U.S. Cl.**
USPC **588/401**; 588/300; 588/313; 588/314;
588/318; 588/400

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588/400, 401
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

H223 H 3/1987 Seiders et al.
5,545,799 A 8/1996 Ritter

6,479,723 B1 11/2002 Malhotra et al.
6,569,353 B1 5/2003 Giletto et al.
7,037,468 B2 5/2006 Hammerstrom et al.
7,070,773 B2 7/2006 Conerly et al.
7,102,052 B2 9/2006 McVey et al.
7,125,497 B1 10/2006 Tucker et al.
7,214,836 B2 5/2007 Brown et al.
7,763,768 B2 * 7/2010 Al Nashef et al. 588/316
7,812,211 B2 * 10/2010 Al Nashef et al. 588/316
8,147,792 B2 * 4/2012 Al Nashef et al. 423/581
2004/0009095 A1 * 1/2004 Giletto et al. 422/28
2009/0008262 A1 * 1/2009 Al Nashef et al. 205/352
2009/0012345 A1 * 1/2009 Al Nashef et al. 588/316
2009/0012346 A1 * 1/2009 Al Nashef et al. 588/316

FOREIGN PATENT DOCUMENTS

WO 98/16332 A1 4/1998
WO 00/56700 A1 9/2000
WO 02/26381 A2 4/2002
WO 02/26701 A2 4/2002

OTHER PUBLICATIONS

AlNashef, Inas Muen, "Electrochemistry of Superoxide Ion in Room Temperature Ionic Liquids and its Applications to Green Engineering," PhD Dissertation, 2004; College of Engineering and Information Technology, University of South Carolina.

* cited by examiner

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(57) **ABSTRACT**

The subject invention provides a potentially economically viable process for the destruction of small to large quantities of sulfur and nitrogen mustards and lewisite, their homologous/analogues, and similar chemical warfare agents at ambient conditions without producing any toxic by-products. The process uses the superoxide ion that is either electrochemically generated by the reduction of oxygen in deep eutectic solvents or chemically by dissolving Group 1 (alkali metals) or Group 2 (alkaline earth metals) superoxides, e.g. potassium superoxide, in deep eutectic solvents.

12 Claims, No Drawings

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