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REVIEW ARTICLE

Prohibition of toxic chemicals for sustainable environment

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Abstract

A large number of chemical toxic agents developed throughout the 20th century for their use in warfare can cause widespread injury and death even used in smaller amounts. They are named as chemical weapon agents and classified in various classes such as blood agents, blister agents or vesicants and nerve agents, depending upon their mode of action on human beings. These harmful chemicals also have adverse effect on the environment. All chemical substances are potential poisons depending on their amount and duration of exposure. The dose and excessive exposure of any substance can cause injury or death. Thus exposure is a function of the amount of chemical involved and the time and frequency of its interaction with biota. The ultimate adverse effect of toxicants is death but it can be observed as an abnormal undesirable or harmful change due to exposure.

Keywords: Chemical toxic agents, vesicants, potential poisons, excessive exposure, death.

Introduction

In environmental science, sustainability always refers to the natural resources and their proper management. It has the main objective of a real increase in well-being and standard of life for the common and the same can be maintained over long term without degrading the environmental qualities. Thus, future generation will have the opportunity to use their resource to meet their own needs. High population growth rate of human population exploits or over uses the natural resources (both renewable and non-renewable resources) to meet their own needs. Humans are using renewable resources (e.g. forests, grasslands, sea, food, fishes etc.) at a faster rate than they can be replenished within a specific period. Sometime these resources are over consumed to such an extent that they become endangered or eliminated from the nature. Thus, judicious use of natural resources can sustain our environmental resources so that they continue to provide benefits to all living organisms (Pani, 2007). Sustainable natural resources and their environments are the central elements of sustainable development. Environmental sustainability refers to the maintenance and regeneration of fresh and clean air fertile soil and essential biotic resources, which in turn depend on avoiding serious disruption of ecological processes. Global warming, acid rain, soil erosion, deforestation, desertification, climatic changes and use of hazardous chemicals are the major threats to the environmental sustainability (Pani, 2010). In this review, efforts have been made to understand the various aspects of toxic chemicals and their effect on environment. The objective of this review is to provide a comprehensive document for various methods and techniques used for the analysis of samples containing toxic chemical agents.

Management of hazardous chemical agents

The frequent use of chemical weapon agents was begun with the World War I (Jeffery *et al*., 1997). Weapons that associated with toxic chemicals and their precursors are needed to be eliminated. In order to reduce the use of these chemical agents in 1997, 95 nations signed CWC (Chemical Weapon Convention), an international arms control agreement. The treaty's purpose is reflected in its full name: *Convention on the prohibition of the development, production, stockpiling and use of chemical weapons and on their destruction*. The all signatories are required to take necessary steps in the destruction of chemical weapons including their production facilities. CWC is mainly functioning by two components one is declarations made by state parties and other is on-site inspection. The on-site inspection is carried out by the organization for the prohibition of chemical weapons inspectors, while the state parties are responsible for the providing the information related to chemical industries situated within their state and producing or using various chemical agents which are considered as cause of high risk. These agents are divided in to three categories: schedule 1, schedule 2 and schedule 3. Organisation for the prohibition of chemical weapons (OPCW) annually conducts an international proficiency test in which participation of all the national authority laboratories of each signatory state or country is compulsory. In this test, the samples are spiked at trace level with different matrices. All the participating laboratories have to identify these spiked compounds from the sample within 15 d time (Manley, 2002; Geers, 2010). OPCW is similar to international atomic energy agency in a number of aspects (IAEA Bulletin, 3/1993) and basically argues the peaceful uses of chemistry for socio-economic development (Meyer and Masters, 2007).

Subsequently, to meet the valuable requirements of OPCW, a number of countries gave a generous support to destruction of their stored chemical weapon agents. At present, out of 195 UN recognized countries, 188 are member of CWC (Oliver*,* 2010). Five countries including Angola, Egypt, Somalia, Syria and North Korea have not signed for CWC, while two countries (Burma and Israel) have to ratify to the treaty. As a result of above, about 25% of the total stockpile declared has been destroyed in Sep 2003 under the OPCW verification regime (OPCW chemical disarmament, Dec 2003). United States and Russia are in the progress of destroying the stockpiles (Australian Govt., Dept. of foreign affairs and trade). While the three countries, Albania, south Korea and India have completed 100% destruction of their stockpiles in the year of 2007, 2008 and 2009 respectively (Stanic, 2004).

Analysis of convention-related chemicals

A number of physical and chemical methods have been developed for the identification of organic as well as inorganic chemicals. Critical thinking, judicious use of natural resources and the help of advance technology can be very effectively applied to the solution of environmental problems. For example, use of raw material which can produce less waste and the manufacturing products can be reused or recycled when they become waste and the application of advanced biotechnologies (biological waste treatment) and use of best available catalyst for efficient synthesis to save energy and raw materials. The analysis of the convention's related chemicals (CRCs) is one of the most important task as the each laboratories of every signatory country have to participate in an inter laboratory proficiency test on yearly basis. General strategy for identification of toxic chemicals has been given in various review articles (Edwin *et al.,* 2002; Robbin, 2010). The analysis of samples with some well-known techniques such as nuclear magnetic resonance is not very useful as it contain only trace amount of analytes. However, the uses of more sophisticated NMR techniques have been reported previously (Mesilaakso and Tolppa, 1996; Albaret *et al.,* 1997; Edwin, 2002; Meier, 2004; Koskela *et al.,* 2006; Gennadi *et al.,* 2007; Mazumder *et al.*, 2010) have verified the determination of acetonitrile-hexane partition coefficient of O,O' dialkyl methylphosphonates by NMR spectroscopy. A large number of analytical methods have been developed for the analysis of CRCs using diversified mass spectrometric techniques like gas chromatography combined with inductively coupled plasma mass spectrometry (GC-ICP-MS) (Oliver*,* 2010), automatic thermal desorption gas chromatography mass spectrometry (Tak *et al.,* 2009; Lee *et al.,* 2011; Oliver *et al.,* 2012), liquid chromatography mass spectrometry (David *et al.,* 2004), liquid chromatography tandem mass spectrometry (Mia *et al.,* 2012), gas chromatography mass spectrometry (Pardasani *et al.,* 2004), ion-pair liquid chromatography electrospray ionization tandem mass spectrometry (Tak *et al.,* 2007).

Conclusion

The use of gas chromatography coupled to mass spectrometry was considered as an excellent technique because of its wide range application, reliability and reproducibility. By identifying the toxic chemicals using gas chromatography coupled with mass spectrometer, one may systematically, scientifically characterize the potential adverse health effects from exposure to the toxic chemicals. This will also help to set up proper risk management procedures. By accurate quantification of the toxic chemicals, one can estimate the toxic potential of a chemical. It may be further used to determine the persistency of chemicals in the environment, bioaccumulative power of a chemical and the degree of toxicity, which in turn will help to achieve a sustainable environment for future generation.

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