REACTIVE SOLUTIONS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to and the benefit of the filing date of U.S. provisional application Ser. No. 60/557,146, entitled "Reactive Solutions," filed on Mar. 26, 2004, which is entirely incorporated herein by reference.

FIELD OF THE INVENTION

The herein disclosed invention is directed at the generation and containment of solutions incorporating reactive gases and their precursors. These solutions and formulations can be applied widely as disinfectants, odor control agents, decontamination and fumigation agents, liquid, gas, and air treatment materials, respiratory agents, food and beverage processing agents, neutralization agents, and in many industrial, residential, medical and military surface treatment operations.

BACKGROUND OF THE INVENTION

Over time the concentration of contaminants associated with porous and nonporous surfaces, and in fluids such as gases, liquids, and solutions, usually increases. In many consumer and industrial applications the concentration of these contaminants needs to be reduced before the surface or fluid is utilized. Many different technologies have been developed to accomplish this goal. In the treatment of surfaces, highly reactive chemical agents are often used. Preferred chemical agents provide intimate contact with all aspects of the surface. In the treatment of fluids, such as gases, liquids, and solutions, two dominant and significantly different strategies exist. The first strategy involves passing the fluid through filters and filtration devices which contain filters. In this strategy, contaminants are retained in the filter as the fluid passes through the filter. The second strategy involves the use of highly reactive chemical agents to decrease the concentration of contaminants. In this strategy, the chemical agents are introduced directly into the fluid, from a concentrated source. Many highly reactive chemical agents are regulated as pesticides and require specialized handling. The use of highly reactive chemical agents in many surface and fluid treatment applications is usually less costly, less complicated, and less time consuming than installing filters and filtration devices.

This invention does not involve the use of fluid filters or purification devices for gases, water, and other aqueous liquids, which remove contaminants from the gas, water, or other aqueous liquid passing through them.

This invention does involve the generation, storage, and delivery of highly reactive chemical agents to surfaces and to fluids such as gases, liquids, and solutions. Preferred highly reactive chemical agents of this invention are gases.

The unique and beneficial characteristics of gases such as chlorine dioxide, oxygen, sulfur dioxide, carbon dioxide, chlorine, and nitrogen containing gases are well known in many fields. These gases modify solution properties by interacting with both chemical and biological components contained therein. Methods for generating and packaging many reactive gases for transportation and for storage on-site when continual use is required have been extensively described. However, a particular distinction must be made with respect to chlorine dioxide gas generation, storage, and transport. Although this reactive gas has many beneficial characteristics, its generation is hazardous, it can not be packaged or stored safely, and therefore it can not be transported to or stored at the site of application. As a result, this highly versatile gas has been difficult to utilize in many small volume, low concentration applications, and by consumers in residential applications.

The instant invention provides novel materials and methods for safely, economically, and efficiently generating, containing, and utilizing chlorine dioxide gas in a wide range of concentrations. The instant invention facilitates the fabrication and wide dissemination of many new consumer, medical, industrial, and military useful materials and products which facilitate the direct introduction of highly reactive chemical agents onto surfaces and into fluids. The materials and methods are applicable to many other reactive gases including, sulfur dioxide, carbon dioxide, chlorine, oxygen, and gases which contain nitrogen as well as carrier solutions including polar and nonpolar liquids. The materials of the invention are widely and immediately available and the methods of the invention are extremely simple, allowing wide spread dissemination of products based upon the invention.

DESCRIPTION OF RELATED ART

Safe, convenient, batch mode preparation of small volumes of chlorine dioxide gas, sulfur dioxide, carbon dioxide, chlorine, gases which contain nitrogen, and other reactive gases continues to receive the attention and interest of many product development groups. While carbon dioxide and sulfur dioxide as well as nitrogen containing gases are easily stored and transported, the requirements for storage and transport of chorine dioxide precursor reagents, as well as generation of the gas, are much more complicated. Chlorine dioxide is commonly generated in batch mode through the mixing of metal chlorite and acidic solutions or solutions containing chlorine-based oxidizers. Chlorine dioxide can be generated continuously through use of both chlorite and chlorate salts and mixing or electrochemical equipment.

The patent literature and prior art associated with the storage of chlorine dioxide precursor reagents, and the generation of chlorine dioxide gas can be separated into three distinct arenas. The first arena contains description and application of mechanical devices and their methods of use. These mechanical devices target the controlled mixing and reaction of chlorine dioxide precursor reagents, separation of the product gas from the reaction solution, increasing the efficiency of reagent use, and ultimately controlling the delivery of gas into a liquid or gas phase system. Example art in this arena can be found in the following U.S. Pat. Nos. 4,683,039, 6,428,696, 6,203,688, 5,415,759, and 114,757.

The second arena contains description and application of powdered materials which contain all or some of the chlorine dioxide precursor reagents and their methods of use. These chemical systems target the protective storage of the precursor reagents, the mechanism of exposure of the dry powder and precursor reagents to water, and the interaction of the powdered components and precursor reagents with activators, to generate chlorine dioxide. Important considerations in the design of these powdered systems include the concentration of precursor reagents, the stability of the precursor reagents, the need for activating agents, sensitivity to liquid and vapor water, and the rate and duration at which chlorine dioxide gas can be generated. In the majority of powdered and compressed powder systems silicates, zeolites, and desiccants are used to carry the precursor reagents for generating chlorine dioxide and for protecting the reagents from water. Many preparations require spray drying or other rapid means of removing water from the precursor reagents. Exposure to