CONSTANT CONCENTRATION DELIVERY DEVICE AND METHOD FOR VAPORIZED SUBSTANCES

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

The invention described herein may be manufactured and used by or for the government of the United States of America for governmental purposes without the payment of any royalties thereon or therefore.

BACKGROUND OF THE INVENTION

1. Field of the Invention

A device for, method for, and product of, providing a constant concentration, preferably constant flow, chemically or biologically enhanced gas.

2. Brief Description of the Related Art

Emissions of vapor phase chemicals and their concomitant global transport in the atmosphere have increased orders of magnitude over the past 100 years due primarily to anthropogenic releases associated with industrial, agricultural, domestic, and recreational activity. Closely associated with the increases in emissions of complex mixtures to the atmosphere are the ubiquitous occurrences of such atmospheric contaminants in areas far removed from any direct input source. Fish and other aquatic organisms have been demonstrated to be highly efficient at bioconcentrating many of these atmospheric contaminants from water, resulting in serious health risk to consumers. In addition, food chains based on aquatic organisms can lead to contamination of birds and mammals. Vapor phase transport of contaminants throughout the global environment is of great concern due to increasing energy production, industrial activity, and intensive agricultural on a worldwide basis. Further, the majority of people spend most of their lives in indoor areas and are exposed to the complex mixture of airborne chemicals present in such areas. Exposures to indoor air contamination is increasingly being recognized as having the potential to result in detrimental effects, e.g., the so-called Asick building syndrome.@ Consequently, monitoring the presence of and determining the biological effects of vapor phase contaminants in the atmosphere has immediate importance and will become increasingly critical for the foreseeable future.

Many scientists, such as those at the Columbia Environmental Research Center (CERC), are charged with, as an integral part of their research mission, the development of methods for sampling and analysis of environmental contaminants. Laboratories conducting analytical and toxicological research concerning the presence and toxicity of vapor phase chemicals must have facilities that are designed to provide a constant concentration of the airborne chemical or mixtures of chemicals for exposure studies or for calibration of air sampling devices in the case of determining the presence of ambient levels of atmospheric chemical contaminants. To accomplish these tasks, researchers and engineers have devoted enormous effort and extensive resources to design and construct systems to safely produce constant concentrations of vapor phase chemicals.

Generally the production of airborne chemicals involves either aerosols, i.e., an assembly of liquid or solid particles suspended in a gaseous medium at a particle size in the range 0.001 to 100 μm or particulate matter (PM) in various sizes, e.g., PM 10, PM 100, etc. Specifically, aerosols are generated from pure liquids, suspensions, or dry powders employing nebulizers, vibrating orifice mondisperse aerosol generators, spinning disk monodisperse aerosol generators or dry powder dispersers (see e.g., Johnson, D. L., K. D. Carlson, T. A. Pearce, N. A., Esmen, B. N. Thomas. 1999. Effects of Nebulization Time and Pressure on Lipid Microtubule Suspension and Areosol, Aerosol Science and Technology, 30:211–222; Phillips, M. L., C. C. Meagher, D. L. Johnson. 2001. What is Powder-Free?: Characterization of Powder Aerosol Produced During Simulated Use of Powder-Free Latex Gloves, Occupational and Environmental Medicine, 58:479–481; and Clinkenbeard, R. E, D. L. Johnson, R. Parthasarathy, C. Altan, K. H. Tan, R. H. Crawford, S. M. Park. 2002. Replication of Human Tracheobronchial Hollow Airway Models Using a Selective Laser Sintering Rapid Prototyping Technique, American Industrial Hygiene Association Journal, 63:141–150.). All these systems for producing airborne suspensions of chemicals and particulate matter involve relatively complex mechanical apparatus. Other than through the manipulation of temperature, few examples of systems for producing vapor phase chemicals soluble in the gaseous medium as individual molecules exist. These systems generally rely on some form of generator apparatus, e.g., a column of glass beads coated with pure chemical through which the gaseous medium passes, a multi compartment apparatus for generation of vapor phase chemicals in which in one or more compartments pure chemical is present and the gaseous medium is used to carry the vapor to subsequent compartments, etc. Both the inherent complexity of the mechanical apparatus and the variable physicochemical parameters of the test chemicals impede the use of any of these systems for studying complex mixtures of airborne chemicals.

Control of the production of the vapor phase chemicals in the currently used systems depends, in general, on mechanical manipulations, e.g., nebulizers, varying the temperature, saturating the gaseous medium with aerosol/particles, etc. There is a distinct lack of precedence for the controlled production of airborne mixtures using polymeric membrane diffusion of chemicals.

Although some non-ionic organic compounds are known to diffuse through synthetic nonporous polymers (see e.g., Comyn, J., Ed., Polymer Permeability, Elsevier Applied Science Publishers LTD: New York, N.Y., 1985.), use of these polymers as a control mechanism for generating vapor phase mixtures of organic chemicals is lacking. In addition, this type of system is unknown as a method to produce and deliver constant concentrations of complex mixtures of vapor phase organic chemicals for calibration of air samplers or for organism exposures. Current methods for generating vapor phase chemicals generally are designed to be used with single chemicals or very limited chemical mixtures and often result in the generation of aerosols rather than true vapor phase mixtures of chemicals.

Accordingly, there is a need in the art to provide a vapor phase mixture of chemicals or biologicals for administration, calibration and testing. The present invention addresses this and other needs.

SUMMARY OF THE INVENTION

The present invention includes a device for delivering constant concentrations of a vaporized substance comprising a chamber having walls defining an enclosed recyclable area, a gaseous medium inlet located through the walls of the chamber capable of sealing the interior of the chamber from the exterior of the chamber in the absence of allowing gas to