Inhalation Exposure System Design for Highly Reactive Toxic Industrial Chemicals

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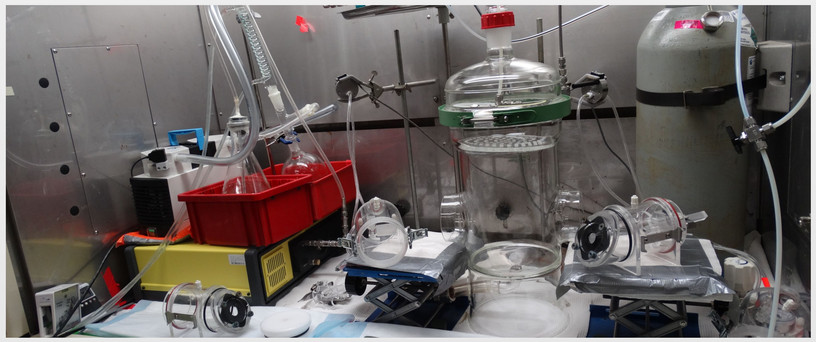
Introduction

Investigating the health effects of acute, high-dose exposure to toxic, reactive chemicals such as epichlorohydrin and hydrazines poses a significant technical challenge. Standard laboratory systems are inadequate for this research because the very materials they are made of, such as common plastics and metals, react with these volatile compounds. This chemical interaction prevents the accurate and safe replication of real-world exposure scenarios including those following industrial accidents.

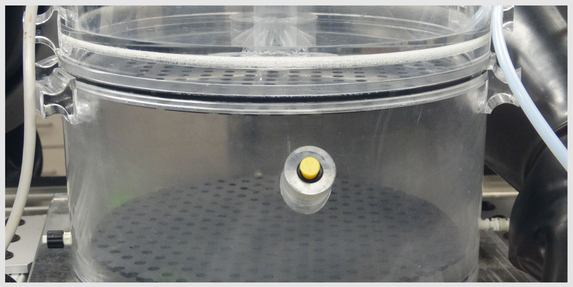
Capability Description

In our lab we design modular customizable solutions to work with acutely toxic industrial chemicals which can also be highly reactive or corrosive. The modularity of the systems enables us to tailor the exposure to a wide variety of gas mixes, aerosols, dusts, or vapors.

Inert Systems

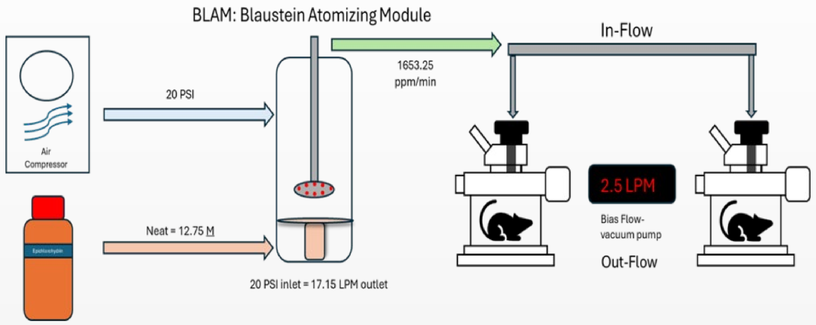


Custom glass system designed for anhydrous ammonia and other extremely corrosive gas exposure.



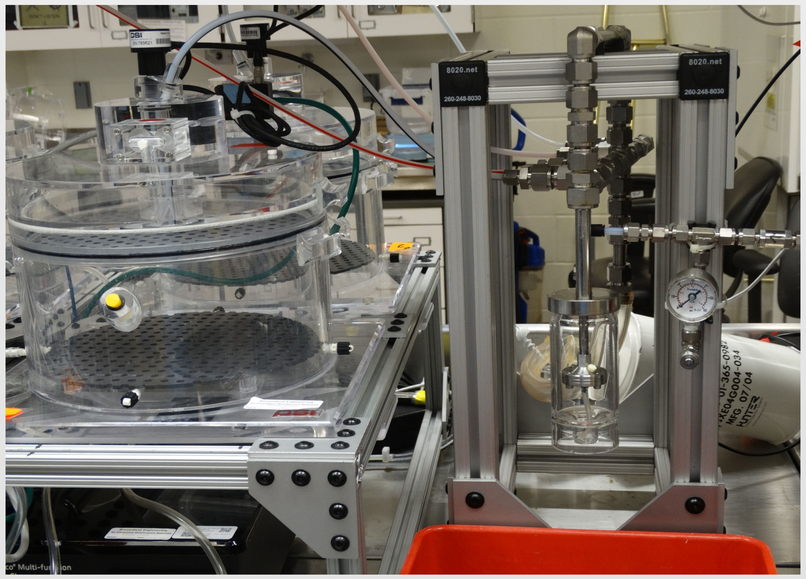
Clouding in an acrylic chamber after exposure to epichlorohydrin due to epoxide formation.

Overcoming the Challenge



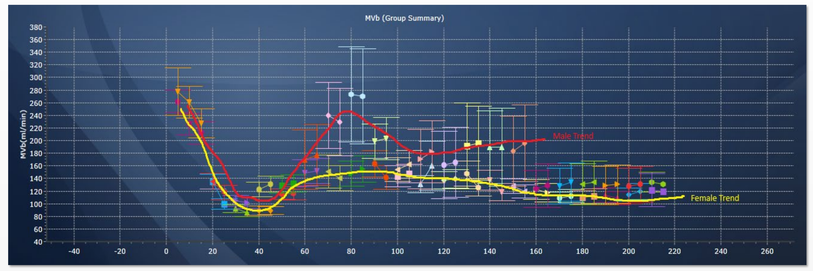
From design concept to construction the systems average about 3 to 4 months depending on any specialty hardware procurement.

Creating custom-designed systems are necessary to overcome the challenge of chemical and material reactivity. Commercial systems are usually designed to minimize expense of construction, while our systems are designed with the specific threat chemical at the forefront. Modular approaches combining gas/vapor/aerosol/combustion generators, exposure chambers, and data acquisition components create customized inhalation exposure systems with integrated real-time physiological monitoring capabilities.

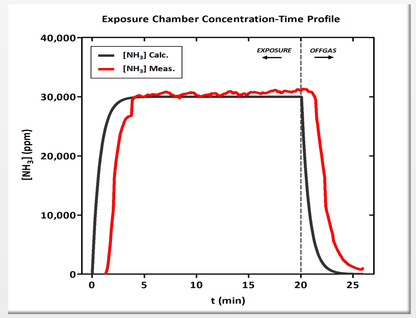


Customized aerosol delivery system made of non-reactive stainless steel, PTFE tubing, and glass Collison jar with steel and ruby Blaustein Atomizing Module (BLAM, CH Technologies) which supplies aerosol into whole body plethysmographs (DSI).

System performance



Whole body plethysmography data captured from epichlorohydrin exposure system. This system allows for conscious, unrestrained respiratory data to be collected before, during, and after the exposure.



Example concentration quantification data captured from anhydrous ammonia exposure system with a Fourier Transform Infrared spectrophotometer (FTIR, Gasmet Technologies).

Disclaimers

The experimental protocol was approved by the Animal Care and Use Committee at the United States Army Medical Research Institute of Chemical Defense (USAMRICD), and all procedures were conducted in accordance with the principles stated in the Guide for the Care and Use of Laboratory Animals and the Animal Welfare Act of 1966 (P.L. 89-544), as amended.

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