Capturing the Exhaled Protein Aerosol: Evaluation of Rodent-Based Systems.

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INTRODUCTION

The utilization of exhaled proteins as biomarkers for disease is a relatively recent advance -- an advance in need of validation with breath condensate from animal models of pulmonary disease.

We have addressed the need to collect rodent-breath by modifying the operation of nose only exposure systems. Our initial efforts showed that the Cannon Nose Only exposure system (Lab Products, Seaford, DE) can be modified to allow efficient collection of breath condensate. The Cannon Nose Only exposure system has a central column that has two key features:
-- a small volume; and
-- a direct path (no bends) to the outside.

By taking advantage of these two features, utilizing zero-humidity air, and reversing the airflows in the inverted system, we have demonstrated that the Cannon system can be used to simultaneously collect breath condensate from 50 mice or rats.

A second rodent-breath collection system has now been evaluated: We report and compare similar modifications to the first working version of the Vaccine, Nose-Only-Exposure System (CH Technologies (USA) Inc., Westwood, NJ. -- In this system, the shortest path from the animal port to an exit resembles a narrow cylindrical channel.

APPROACH:

For flow rates similar to the minute ventilation of mice, we measured penetration from the animal port for two cases:

(1) with an aerosol of 15 nm diameter spheres; and

(2) with air at 90 % RH and 36 degrees centigrade.

Aerosol: Generation and Detection:
Nanospheres were generated with a Graphite Aerosol Generator (GFG-1000, Palas, Karlsruhe, Germany), and detected with a Scanning Mobility Particle Sizer (SMPS 3936, TSI, St. Paul, MN). Compressed argon and house air were used as carrier gases. The aerosol was passed through a small mixing chamber before entering the breath collection system.

Figure 1. Inverted Cannon System

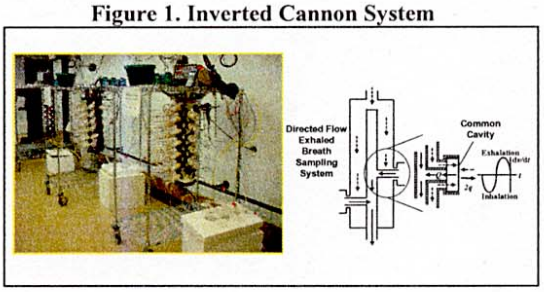


Figure 2. Jaeger Vaccine System

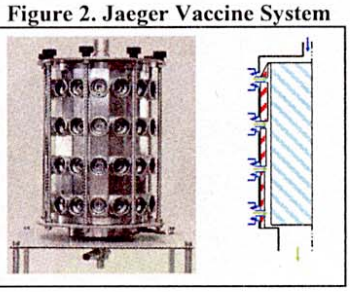
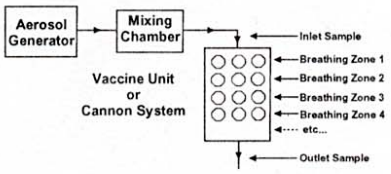
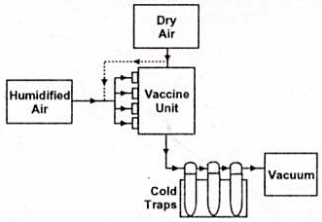


Figure 3. Nano-particle Penetration



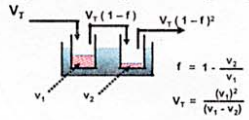
Humidified Air -- Generation, monitoring, and Collection:
Four ports on the Vaccine Unit each received 100 ml/min of humidified air. The humidified air was generated by passing dry-warm air over the surface of warm water. Air humidity and temperature were monitored using a chilled mirror hygrometer (D2/Hygro-M2, GE Infrastructure Sensing, Wilmington, MA.).

Figure 4. Water Vapor Penetration



Sample collection:
The total air flow (200 ml/min/port) was collected using a series of three glass cold traps (Model PRG-6565-13, Prism Glass Inc, Raleigh NC.). Brass sleeves and dry ice were used to chill the glass traps.

Figure 5. Vapor Sampling



Reproducibility:
Aerosol and humidity experiments were repeated three times.

RESULTS:

Figure 6. Penetration of 13-15 nm diameter particles

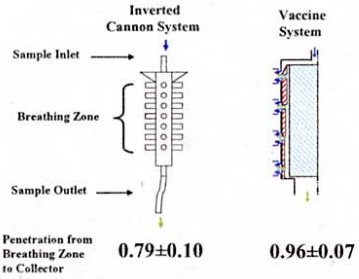


Table 1. Water Vapor Penetration (Vaccine System)
0.95±0.04

CONCLUSIONS:

Penetration:

• For breath collection, the Vaccine Unit functioned similarly to the Cannon System:
-- greater than 90% penetration of nanoparticles or water vapor.

Configuration:

• As long as the dew point of the exhaled air is rapidly dropped to below the temperature of the system walls,
-- the impact of system configuration appears to be minor.

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