Personal Passive Sampling Method for Nitrous Oxide in Air

Jhy-Charm Soo[1]*, John Nelson[1], Jennifer L. Roberts[1], Ana Barbero[1], Mark Jackson[1], Michael L. Kashon[1], Elizabeth Kao[2], and William P. Chisholm[1]

[1]Health Effects Laboratory Division, NIOSH, [2]School of Dentistry, West Virginia University, * Contact information: jsoo@cdc.gov

BACKGROUND

Description: Dental workers may develop short-term behavioral and long-term reproductive health effects caused by exposure to waste nitrous oxide (N_2O). **Situation/Problem:** The current compliance sampling method specifies collection by diffusion badge packed with molecular sieve 5Å adsorbent. However, the adsorbent is hydrophilic and prone to back-diffusion during passive sampling.

OBJECTIVE

1) To determine the performance characteristics of a new adsorbent, Barium –ZSM5, and

2) To evaluate its performance under conditions where current methods and materials are not adequate to address the NIOSH REL.

MATERIALS AND METHODS

❑ **Alternative adsorbent**
   ▪ *A cation Zeolite Socony Mobil–5 (Ba-ZSM5)*

❑ **Atmosphere generation and test condition**
   ▪ *A full factorial experiment: air flow, humidity, concentration*

❑ **TD-GC-MS analysis (in-house method)**
   ▪ **TD parameters:** Tube/trap desorption: 5 mins at 180°C with flow of 40 ml/min; Initial temp: -30°C. Under reverse desorption.
   ▪ **GC parameters:** A Restek Rt-Msieve 5A PLOT GC column. 2.0 ml/min Column flow. Temp ramp: 25°C/min to 260°C holding for 6 mins.
   ▪ **Internal standard:** Pentafluorobenzene
   ▪ **Retention time:** 8.7 mins (N_2O) and 11-13 mins (CO_2)

RESULTS

Ba-ZSM5 adsorbent characterization
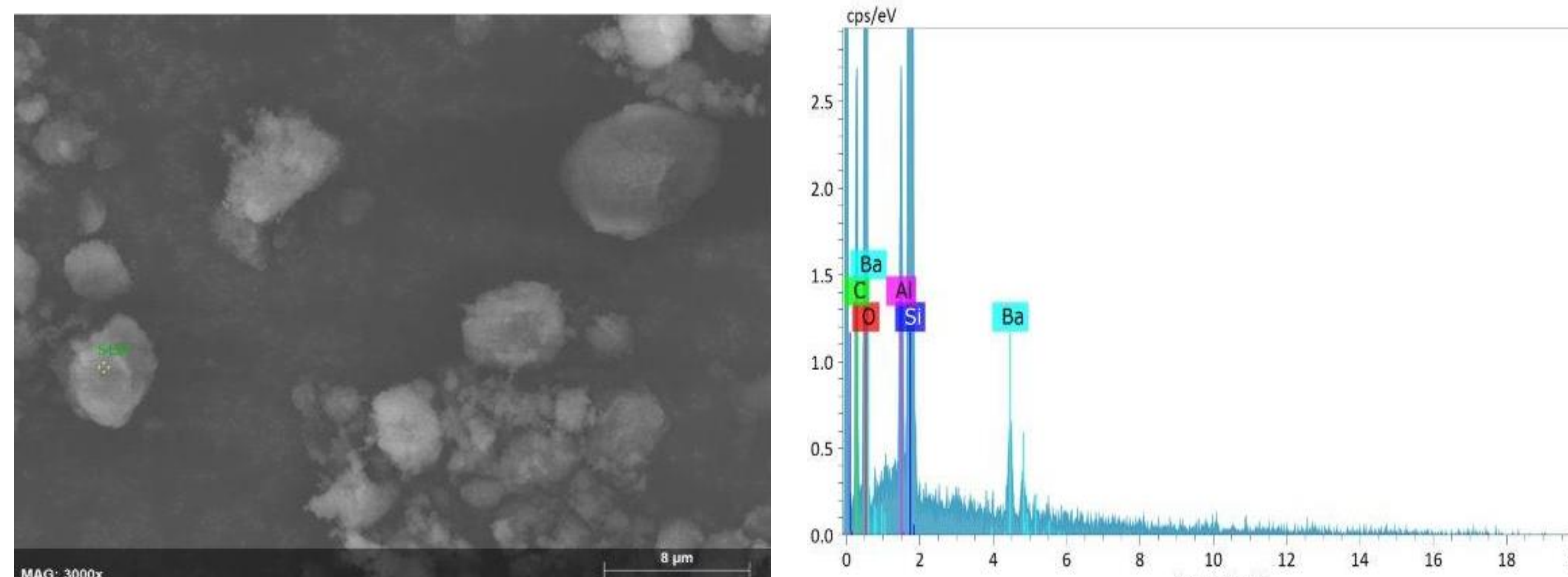
Irregular particles of Ba-ZSM5 were imaged by scanning electron microscopy. The major compounds of zeolites are silicon and oxygen, along with some aluminum. X-ray emission from these particles also showed the presence of the barium. Inductively coupled plasma-mass spectrometry identified silicon and aluminum, and showed ~6% barium inside the sample.
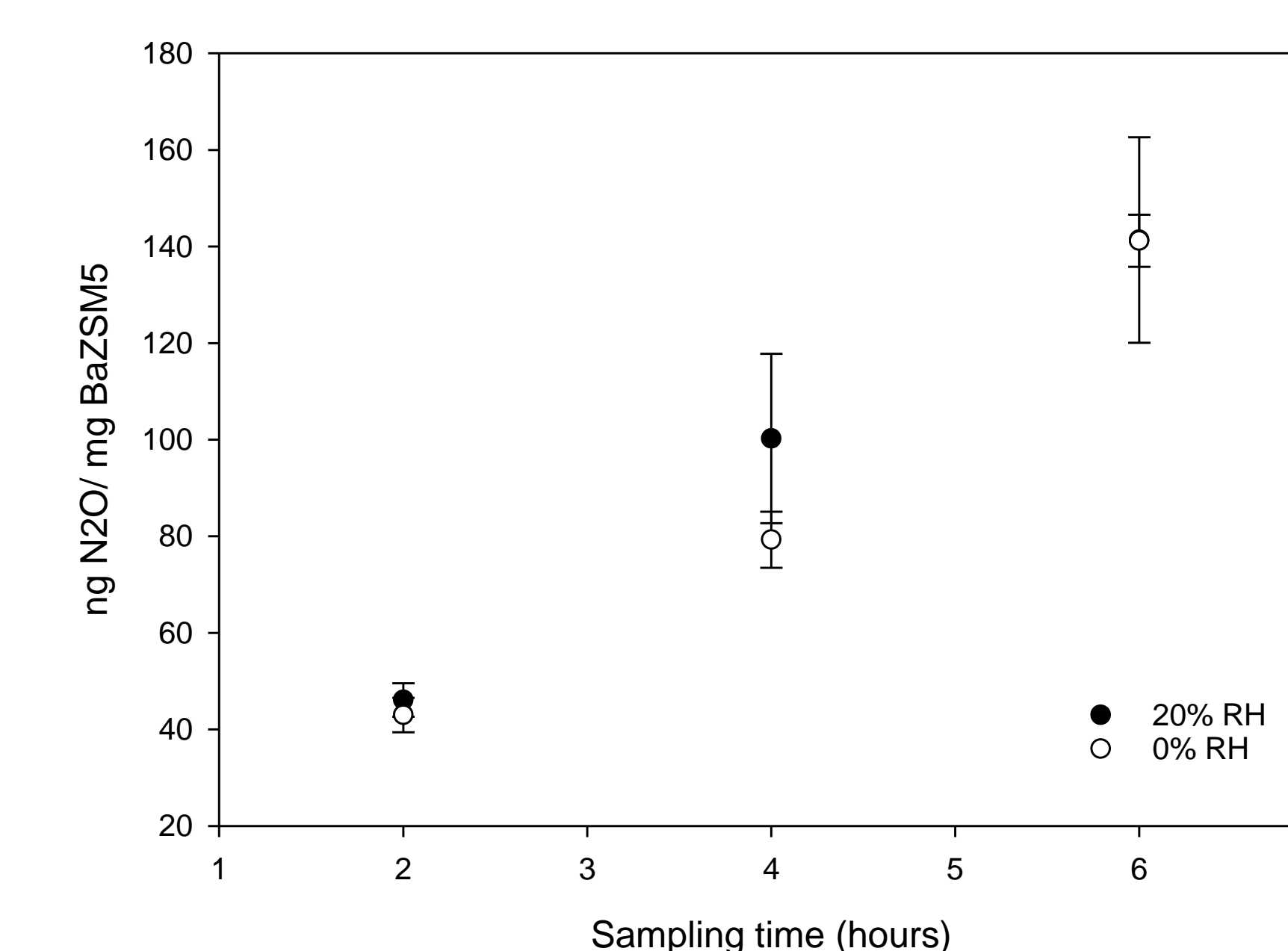
Computational Fluid Dynamics simulation
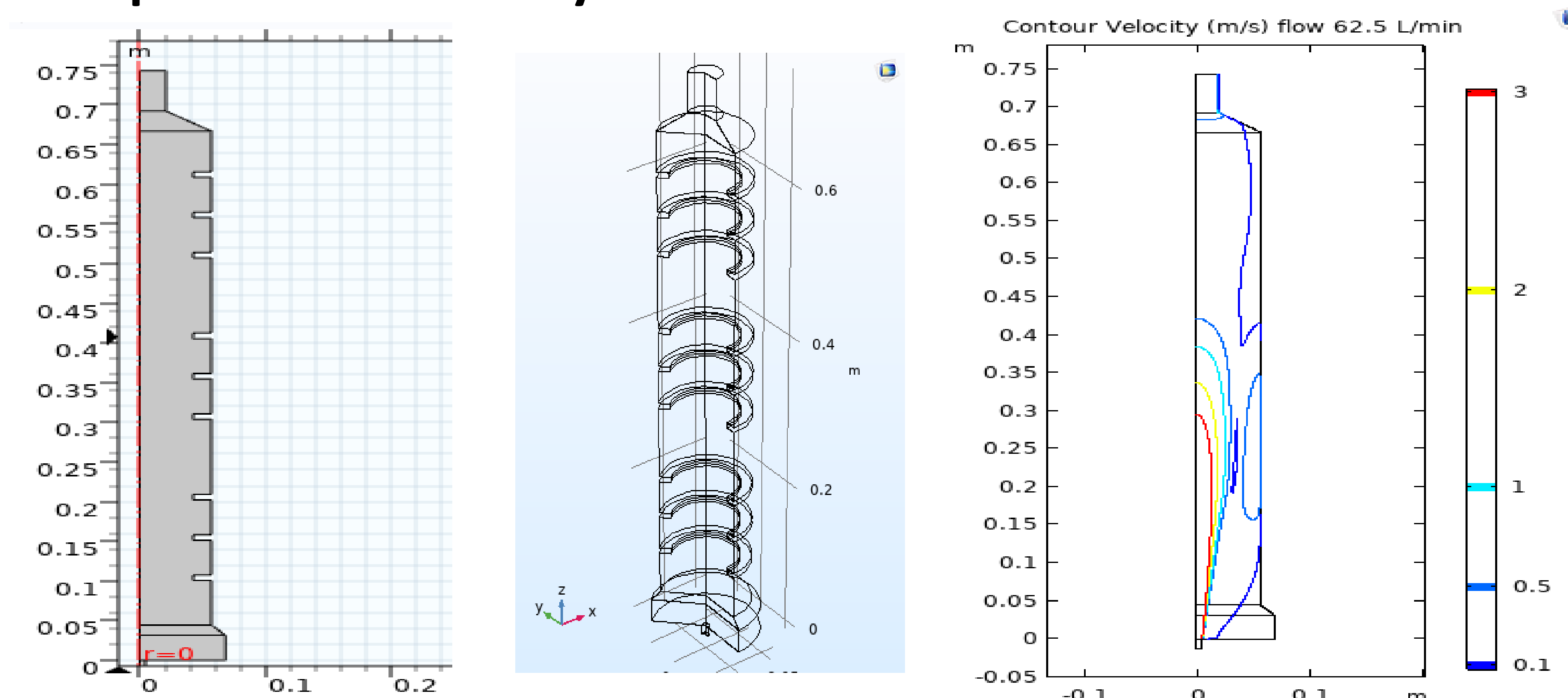
The face velocity around the sampling ports was in good agreement with the typical workplace environment (< 0.3 m/sec) (Baldwin and Maynard, 1998). CFD simulation done with COMSOL Multiphysics® version 5.4.
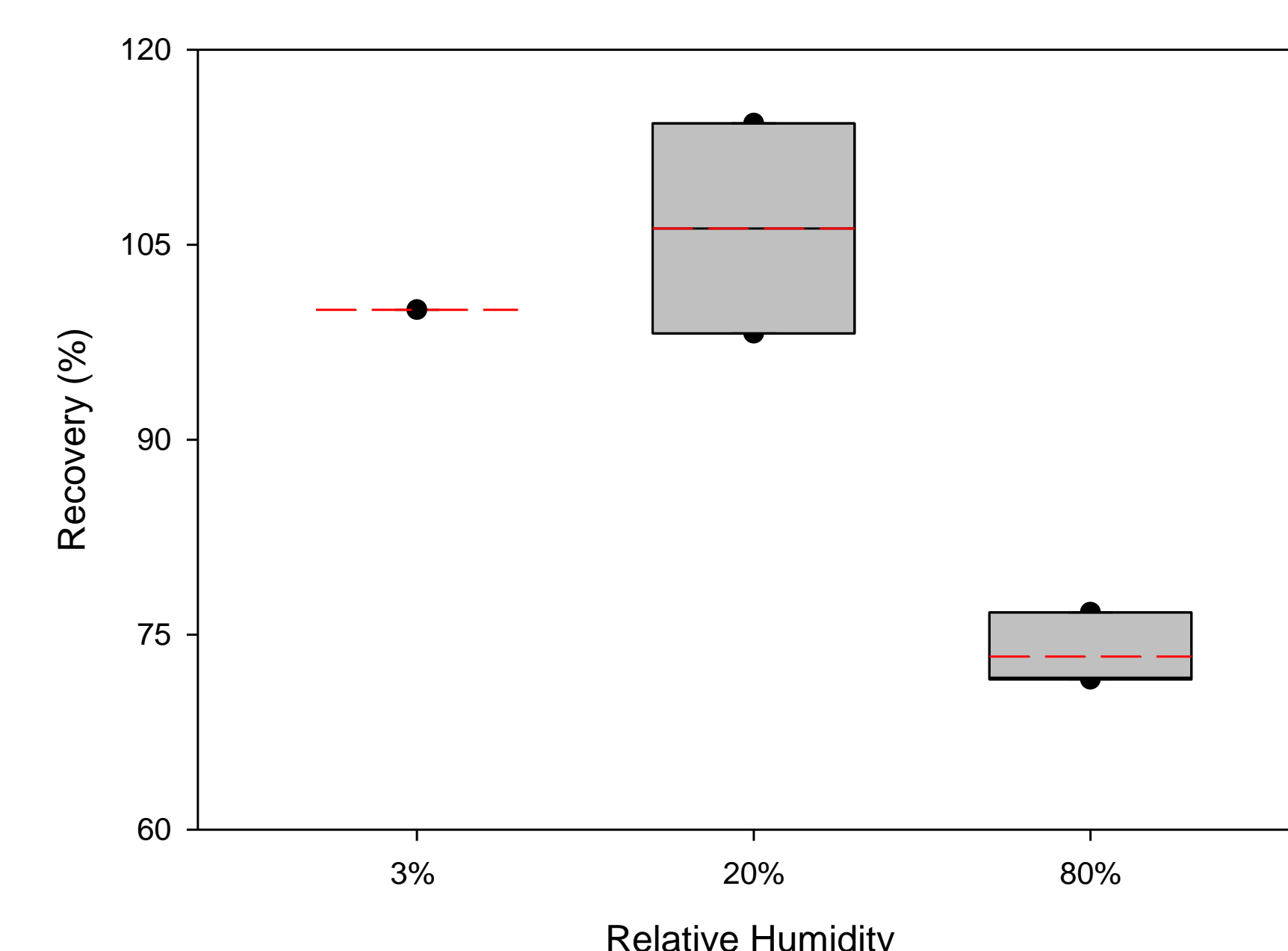
Time dependency

Small humidity effect

No back diffusion effect

ADDITIONAL WORK

The preliminary data showed the TD-GC-MS technique is a promising tool to analyze N_2O trapped on the barium exchanged ZSM5 adsorbent selected in the present study. A full-factorial experiment will be executed to determine the uptake rate. Further methodology improvements will be pursued, such as application of a diffusion cap assembly with a silicone membrane (Polydimethylsiloxane) to ameliorate humidity effects. Finally, performance comparison with other types of cation doped ZSM5 adsorbents will be made.