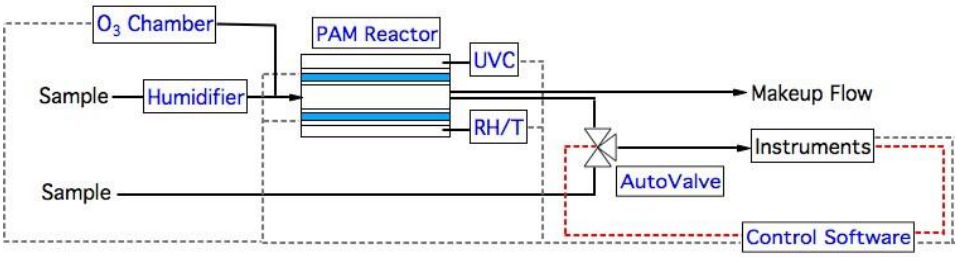
AERODYNE RESEARCH, Inc.

Potential Aerosol Mass (PAM) Oxidation Flow Reactor

A highly oxidizing environment that simulates oxidation processes on timescales of days in the atmosphere in minutes in real time.



Typical setup for measurements incorporating PAM reactor. Control software facilitates data- logging at 1 Hz and automated control with event sequencing for unattended operation (dashed grey = analog input/output; dashed red = digital input/output)

APPLICATIONS

- Laboratory or field studies of secondary aerosol generation via gas-phase hydroxyl (OH) radical or ozone (O_3) oxidation of gas-phase precursors.
- Heterogenous oxidation of primary aerosols.
- Compatible with gas and particle mass spectrometry techniques.
- Complement to laboratory smog chamber techniques commonly used to generate secondary organic aerosol (SOA).

ADVANTAGES

- Based on Penn State flow reactor design introduced by Kang et al. (2007) and further evaluated by Lambe et al. (2011).
- Field deployable.
- Wide range of oxidant exposure times attainable with dimmable UV lamps (primary emission intensity at λ = 254 nm) at high measurement throughput/ resolution.
- OH/HO_2 and OH/O_3 ratios similar to tropospheric ratios. Amounts of OH, HO_2, and O_3 are 100 to 10,000 times larger than in the daytime troposphere, simulating days of atmospheric oxidation in minutes.

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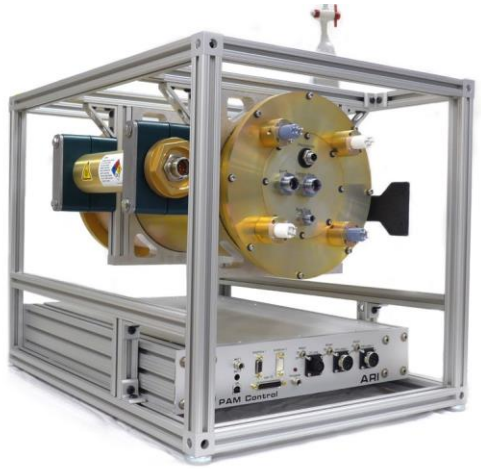
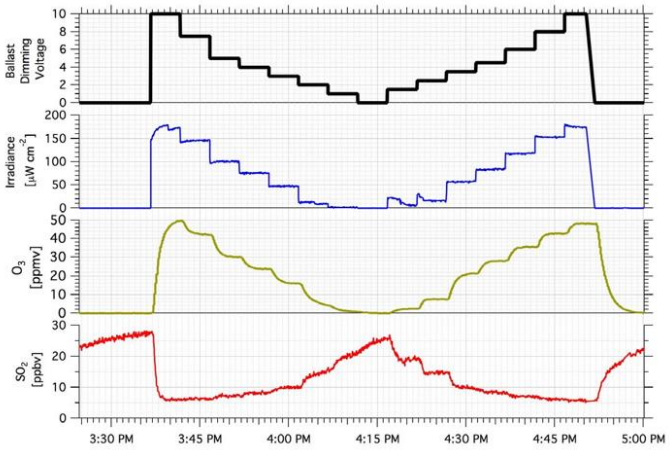
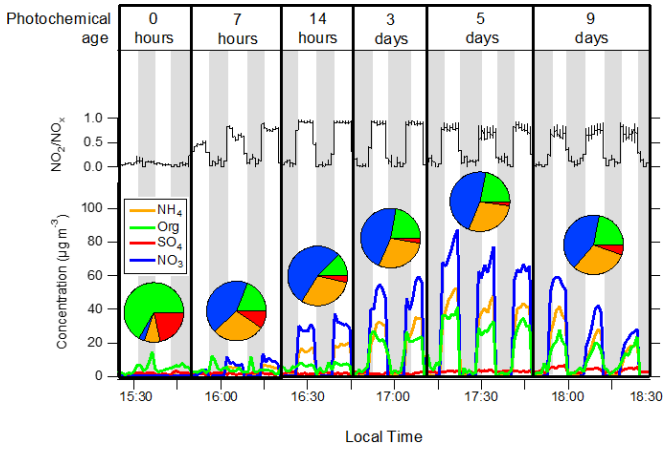




Time series from an example OH exposure calibration experiment using SO_2 as a reactive tracer species. The dimming voltage applied to UV lamp ballasts is stepped from 0-10 VDC, which varies the UV irradiance and the ozone mixing ratio in the PAM chamber.



Example measurements obtained with a PAM reactor. Secondary ammonium, sulfate, organic, and nitrate aerosols are generated from OH oxidation of gas-phase motor vehicle emissions inside the Fort Pitt Tunnel in Pittsburgh, Pennsylvania, USA (Tkacik et al., Environ Sci. Technol, 2014). Shaded periods are when the tunnel air bypassed the PAM reactor.

OH Exposure	2×10^{11} to 2×10^{12} molec cm^{-3} sec at 100 sec residence time
Size	26" x 16" x 30", 30 lbs [66.04 cm x 40.64 cm x 76.20 cm]
Electric Power	160 W max; 110VAC/60Hz or 220VAC/50Hz
Components	PAM reactor with ozone-free and ozone-producing UV lamps ; ozone chamber; UVC photodetector; Nafion humidifier; RH/T sensor; electronically actuated 3-way valve ("autovalve"); user interface for analog/digital controls; Windows PC control software; PAM_chem photochemical box model
Required Accessories	N_2 purge gas for UV lamps; carrier gas; instrument and makeup flows; Windows PC
Suggested Accessories	O_3 analyzer; flow controllers; ozone scrubbers; MATLAB license; SO_2 or CO analyzer for OH exposure calibrations if needed

PUBLICATIONS

Kang, E., M. J. Root, D. W. Toohey and W. H. Brune, Introducing the concept of Potential Aerosol Mass (PAM), Atmospheric Chemistry and Physics 7(22), 5727-5744, 2007.

Lambe, A. T., A. T. Ahern, L. R. Williams, J. G. Slowik, J. Wong, J. P. D. Abbatt, W. H. Brune, N. L. Ng, J. Z. Wright, D. R. Croasdale, D. R. Worsnop, P. Davidovits and T. B. Onasch, Characterization of aerosol photooxidation flow reactors: heterogeneous oxidation, secondary organic aerosol formation and cloud condensation nuclei activity measurements, Atmospheric Measurement Techniques 4, 445–461, 2011.

Additional references available at https://sites.google.com/site/pamwiki/

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