

Laboratory Validation of AT586 Ozone Sampler

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AT586 Ozone Sampler

Assay Technology's 586 ozone vapor sampler consists of a fiberglass wafer treated with sodium nitrite encased within a 76-port polypropylene sampling grid and contained within a polypropylene sampler body.

Ozone, being a very strong oxidizing agent, readily reacts with nitrite on the fiberglass; the oxidation converts nitrite to nitrate. This method of using nitrite-coated filters for the measurement of ozone (developed by Koutrakis, et al, *Anal. Chem.*, **1993**, 65 (3), 209-214) has been employed in air sampling in favor of more complicated sampling methods (e.g. impingers). By utilizing the chemistry of ozone and nitrite, the nitrate formed from nitrite oxidation can be recovered from the glass fiber filter media and can be analyzed by a modified OSHA ID-214 method using ion chromatography (IC). The amount of nitrate can be used to directly calculate the ozone exposure.

1. Test Apparatus & Method

Ozone concentrations were created by irradiation with a broad spectrum UV light. A copper tube was used as a damper on the ozone generation, in order to tune to specific concentrations. The ozone was dynamically mixed with flow-controlled input air provided by the Miller-Nelson 501 atmosphere conditioner, and then passed through an inert acrylic chamber containing diffusive samplers under test. Air flow from the MNR instrument was verified by calibration. The ozone concentration was monitored throughout the entire test using a real-time Dasibi Environmental Corp Ozone Analyzer. Exposure concentrations were further verified by active sampling cassettes (2 glass filters treated with nitrite), sampled from locations in the chamber bracketing the samplers under test.

2. Desorption Efficiency (DE)

Desorption efficiency (analyte recovery) was determined to be 100%, as the nitrate formed during oxidation has no affinity for the glass fiber filter.

3. Verification of Diffusive Sampling Rate

Per internal quality specifications, samplers are evaluated periodically to assess performance and to compare to reference samples (cassettes). The degree to which results for the AT586 samplers agree with results for the reference tubes is the essence of the evaluation.

In a 2014 laboratory chamber study of AT586 samplers for verification of diffusive sampling rate, the samplers show agreement within an average of approximately 10%. The tests were conducted as described in Section 1, using two separate chamber exposures at two different concentrations, corresponding to an 8-hr TWA of 0.5 and 1 times the OSHA PEL (0.1 ppm TWA). Table 1 shows the results from the study.

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Table 1. 2014 evaluation of AT586 samplers compared to reference cassettes at two concentration levels

Sample Description	Chemical Analyte	Qty (ug)	Volume (L)	Time (min)	Concn (ppm)
Level A Cassette-1	OZONE	39	53.5	60	0.37
Level A Cassette-2	OZONE	42	56.5	60	0.38
Level A Cassette-3	OZONE	42	49.4	60	0.43
Average					0.39
Level A AT586-1	OZONE	1.5	1.82	120	0.41
Level A AT586-2	OZONE	1.3	1.82	120	0.37
Level A AT586-3	OZONE	1.6	1.82	120	0.43
Level A AT586-4	OZONE	1.4	1.82	120	0.39
Level A AT586-5	OZONE	1.5	1.82	120	0.42
Level A AT586-6	OZONE	1.4	1.82	120	0.41
Level A AT586-7	OZONE	1.5	1.82	120	0.37
Level A AT586-8	OZONE	1.5	1.82	120	0.43
Level A AT586-9	OZONE	1.5	1.82	120	0.39
Level A AT586-10	OZONE	1.6	1.82	120	0.42
Average					0.40
CV					6%
% of Reference					103%
Sample Description	Chemical Analyte	Qty (ug)	Volume (L)	Time (min)	Concn (ppm)
Level B Cassette-1	OZONE	21	53.5	60	0.20
Level B Cassette-2	OZONE	20	56.5	60	0.18
Level B Cassette-3	OZONE	19	49.4	60	0.19
Average					0.19
Level B AT586-1	OZONE	0.71	1.82	120	0.2
Level B AT586-2	OZONE	0.75	1.82	120	0.21
Level B AT586-3	OZONE	0.76	1.82	120	0.21
Level B AT586-4	OZONE	0.79	1.82	120	0.22
Level B AT586-5	OZONE	0.85	1.82	120	0.23
Level B AT586-6	OZONE	0.73	1.82	120	0.2
Level B AT586-7	OZONE	0.72	1.82	120	0.2
Level B AT586-8	OZONE	0.8	1.82	120	0.22
Level B AT586-9	OZONE	0.73	1.82	120	0.2
Level B AT586-10	OZONE	0.77	1.82	120	0.21
Average					0.21
CV					5%
% of Reference					111%

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4. Background (Blank) Determination

Unexposed samplers were analyzed by Method AT586 to determine background analyte levels on the sampler prior to sampling.

As described above, the ozone sampler contains a wafer impregnated with nitrite ions. Since all commercially available nitrite salts contain small amounts of nitrate impurities, a background blank is expected from the pre-existing nitrate (not ozone-oxidized nitrite). This concentration of nitrate must be subtracted before ozone concentration is calculated on a sample in the lab. The blank correction procedure for the AT586 sampler is identical to that used with sampling cassettes as described in OSHA 214. In the case of the AT586 sampler, in accordance with AIHA-sanctioned procedures, the detection limit of ozone has been derived from the standard deviation of the nitrate blank. Although the ozone blank due to residual nitrate is significant (ca 0.2 μg), the standard deviation of the blank for multiple samplers is significantly smaller (ca $\pm 0.06 \mu\text{g}$) than the absolute value of the blank as demonstrated by representative manufactured lots:

Lot 7D16 (Blank – 0.17 \pm 0.06 μg)

Lot 2G17 (Blank – 0.18 \pm 0.07 μg)

Lot 5D17 (Blank – 0.25 \pm 0.05 μg)

Background is monitored over the shelf-life of each product lot for blank correction purposes.

Unexposed wafers suitable for blank correction for use by outside laboratories analyzing the AT586 samplers are available from Assay Technology.

5. Atmospheric Effects

Air Velocity & Orientation – Previous studies demonstrated that there is no significant effect of air velocity and orientation on sampling rate

Temperature and Humidity – Previous studies demonstrated the absence of an effect of temperature and humidity on sampling rate in the range 0 – 50°C and 10 – 80% RH.

6. Summary Comments

Sampler AT586 has been evaluated for sampling ozone. The overall system accuracy expressed as Maximum Total Error (95% confidence) is estimated at $\leq 25\%$ at PEL.

Capacity	16 ppm-hrs
Sampling Time	15 minutes – 8 hours
Air Velocity	15 – 150 cm/sec
Temperature	0 – 50°C
Humidity	10 – 80% RH

For maximum shelf life, the product should be stored under refrigerated conditions, but does *not* need to be stored under refrigerated conditions after sampling.

The recommended maximum holding time after sampling is 14 days at room temperature.



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It is recommended that AT586 samplers be used within the envelope of conditions specified above, but, in general, minor excursions outside these limits would be expected to have only minor effects. Longer or shorter sampling times are possible but have not been evaluated.