THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

U.S. Environmental Protection Agency

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ETV Joint Verification Statement

TECHNOLOGY TYPE:	**AMBIENT AMMONIA MONITOR**		
APPLICATION:	**MEASURING AMMONIA EMISSIONS AT ANIMAL FEEDING OPERATIONS**		
TECHNOLOGY NAME:	**IonPro-IMS Ammonia Analyzer**		
COMPANY:	**Molecular Analytics**		
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The U.S. Environmental Protection Agency (EPA) supports the Environmental Technology Verification (ETV) Program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV Program is to further environmental protection by accelerating the acceptance and use of improved and cost-effective technologies. ETV seeks to achieve this goal by providing high-quality, peer-reviewed data on technology performance to those involved in the design, distribution, financing, permitting, purchase, and use of environmental technologies. Information and ETV documents are available at www.epa.gov/etv.

ETV works in partnership with recognized standards and testing organizations, with stakeholder groups (consisting of buyers, vendor organizations, and permitters), and with individual technology developers. The program evaluates the performance of innovative technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests (as appropriate), collecting and analyzing data, and preparing peer-reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance (QA) protocols to ensure that data of known and adequate quality are generated and that the results are defensible.

The Advanced Monitoring Systems (AMS) Center, one of seven technology areas under ETV, is operated by Battelle in cooperation with EPA's National Exposure Research Laboratory. In collaboration with the U.S. Department of Agriculture, the AMS Center has recently evaluated the performance of ambient ammonia (NH_3) monitors to measure NH_3 emissions. This verification statement provides a summary of the test results for the Molecular Analytics IonPro-IMS NH_3 analyzer.

VERIFICATION TEST DESCRIPTION

The objective of this verification test was to evaluate the IonPro-IMS's performance in measuring gaseous NH_3 in ambient air at two animal feeding operations. The verification test was conducted in two phases, each at separate animal feeding operations; the IonPro-IMS was not available for testing during Phase I and was tested at only one animal feeding operation during Phase II. The second phase of testing was conducted between October 20 and November 14, 2003, at a cattle feedlot in Carroll, Iowa. This site was selected to provide realistic testing conditions and was expected to exhibit a wide range of NH_3 concentrations during the test period. The verification test was designed to evaluate relative accuracy (RA), linearity, precision, response time, calibration and zero drift, interference effects, comparability, ease of use, and data completeness.

During Phase II of the verification test, the IonPro-IMS response to a series of NH_3 gas standards of known concentration was used to quantify RA, linearity, precision, and calibration/zero drift. NH_3 gas standards ranging from 0 to 1,000 parts per billion (ppb) NH_3 were delivered during Phase II. The IonPro-IMS response time, the time to reach 95% of the change in the stable signal, was also assessed during the delivery of the gas standards. Interference effects were quantified from the IonPro-IMS response to various chemical species that may be present at animal feeding operations; the potential interferent gases were delivered both in the presence and absence of NH_3. The IonPro-IMS continuous response to ambient air also was evaluated during Phase II as the comparability to simultaneous determinations by a time-integrated ambient NH_3 reference method (acid-coated denuders). Comparisons were made with reference samples that were collected on a five-per-day schedule for periods of between 2 to 12 hours for approximately 10 days during each phase, based on procedures in EPA Method IO-4.2.

QA oversight of verification testing was provided by Battelle and EPA. Battelle QA staff conducted a technical systems audit, a performance evaluation audit, and a data quality audit of 10% of the test data. This verification statement, the full report on which it is based, and the test/QA plan for this verification test are all available at www.epa.gov/etv/centers/center1.html.

TECHNOLOGY DESCRIPTION

The following description of the IonPro-IMS was provided by the vendor and does not represent verified information.

The IonPro-IMS is designed to continuously monitor NH_3 in ambient air and can operate outdoors in temperatures from -40˚C to 50˚C and within a relative humidity range of 0 to 100%. The IonPro-IMS uses ion mobility spectroscopy (IMS) to detect (0.1 ppb) and respond to changes in NH_3 concentration. The IonPro-IMS display updates the concentration readings once per second. Data from the IonPro-IMS can be acquired from either the serial RS232 output or the 4-20 milliamp signal loop using a data acquisition system (not included).

The operation of the IonPro-IMS cell is similar to time-of-flight mass spectrometry except that it functions at atmospheric pressure. Ambient air samples are drawn into the cell and over a semi-permeable membrane, allowing NH_3 to enter while attenuating possible interferents. Purified dry instrument air sweeps the membrane on the inside of the cell and delivers the sample to the reaction region. There the sample is ionized by a weak plasma formed by a nickel-63 source (sealed). A patented dopant material is added to the flow to enhance the ionization process and increase specificity. The ionized sample molecules drift through the cell under the influence of an electric field. An electronic shutter grid allows periodic introduction of the ions into a drift tube where they separate based on charge, mass, and shape. Smaller ions move faster than larger ions through the drift tube and arrive at the detector. A microprocessor evaluates the spectrum for the target compound and determines the concentration based on the peak height.

The IonPro-IMS is available in rack-mountable or wall-mountable configurations, the latter of which can be used for outdoor applications. The IonPro-IMS weighs approximately 23 kilograms. The only safety precaution necessary for the sealed nickel-63 source is a semiannual wipe test. An on-board permeation generator option

enables field calibration of the IonPro-IMS. The IonPro-IMS is capable of sampling through four separate channels for multipoint sampling. The cost of the IonPro-IMS ranges from $28,900 to $78,900, depending on selected options.

VERIFICATION OF PERFORMANCE

The performance of the IonPro-IMS was evaluated during Phase II of this verification test. The IonPro-IMS was installed inside a temperature-regulated instrument trailer, with a Teflon tube used to draw the outside air into the IonPro-IMS inlet. The following presents a summary of the performance of the IonPro-IMS NH_3 analyzer during Phase II of this verification test. The values presented in the table are based on 30-second average readings. Values in parentheses are 95% confidence intervals.

Performance Summary of the IonPro-IMS

Parameter	Phase I	Phase II
Relative accuracy[a]	The IonPro-IMS was not available in Phase I	Average RA = 18.3% Percent difference range = −18.6 to −18.0%
Linearity		Range = 0 to 1,000 ppb Slope = 0.815 (± 0.009) Intercept = 1.08 (±5.20) r^2 = 1.000
Precision		Average relative standard deviation = 1.0% Range = 0.6 to 1.5%
Response time		Rise time = 150 to 1,020 seconds Fall time = 90 seconds
Calibration/ zero drift		• No apparent drift in response to zero air. • No apparent drift in response to a 1,000-ppb NH_3 gas standard, although the response to the first calibration check was ~20% lower than other checks.
Interference effects[b]		Hydrogen sulfide (285 ppb): no apparent effect Nitrogen dioxide (95 ppb): no apparent effect 1,3-Butadiene (95 ppb): no apparent effect Diethylamine (96 ppb): -388% effect in 500 ppb NH_3; no apparent effect in zero air
Comparability		Slope = 1.565 (± 0.047) Intercept = −16.5 ppb (± 6.4) r^2 = 0.994
Ease of use		• Daily checks were simple and quick • Little skill required to operate • Drain condensed water from compressor daily • No maintenance required • Data loss of approximately 48 hours resulting from data collection failures[c]
Data completeness		92% data collected[c]

[a] Relative accuracy is expressed as an average absolute value of the percent difference from NH_3 gas standards.
[b] Calculated as the change in signal divided by the interferent gas concentration, expressed as a percentage.
[c] Although the IonPro-IMS was operating during 100% of Phase II, 8% of the data was not recovered due to computer/software failures during data collection. The failures did not appear to be caused by the IonPro-IMS.

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