



Air Quality Sciences

February 12, 2013

Mr. David Kight
Akida Holdings, LLC
13500 Sutton Park Dr. South
Suite 501
Jacksonville, FL 32224

Dear Mr. Kight:

Thank you for choosing Air Quality Sciences, Inc. (AQS), an ISO 17025 accredited IAQ company, for your product testing needs. Attached is the final report with product description change, which presents the test protocol and resulting data.

We appreciate this opportunity to assist you. If you have any questions or wish to discuss your results, please feel free to contact our Product Evaluation Group at (770) 933-0638 or (800) 789-0419.

Sincerely,

A handwritten signature in black ink that reads "Stephany I. Mason".

Stephany I. Mason, Ph.D.
Principal Scientist

Attachment: AQS Report: 17505-01



Air Quality Sciences

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**PRODUCT EVALUATION TESTING OF AN
AIR CLEANER PROTOTYPE DEVICE**

APS-200

Prepared For

AKIDA HOLDINGS, LLC

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EXECUTIVE SUMMARY

Project Description

Air Quality Sciences, Inc. (AQS) is pleased to present the results of its chemical removal efficacy evaluation testing of an “APS-200,” a prototype air cleaner device, as submitted by Akida Holdings, LLC. Testing was performed in a dynamic environmental chamber continuously dosed with formaldehyde, decane, and toluene to determine the volatile organic compound (VOC) removal efficacy during operation of the prototype air cleaner. The air cleaner was tested in a 1 m³ dynamic environmental chamber following the guidelines of ASTM D 5116 (1). Testing was conducted using standard environmental chamber operating conditions of 23°C, 50% RH and 1.0 air changes per hour (ACH). The chamber air was monitored for formaldehyde, decane, and toluene over a five hour period.

TECHNICAL SUMMARY

Test Product Description

AQS Identification	Product Description
17505-020AA	APS-200

Detailed Test Plan

AQS performed a study to evaluate the reduction in VOC concentrations resulting from the operation of a “APS-200” prototype air cleaner. For the test run, the chamber was dosed with formaldehyde, decane, and toluene to create steady state chamber concentrations using a gas mixture for decane and toluene and a permeation oven for formaldehyde. The chemical concentrations in the inlet air for the test were set at:

- a. Formaldehyde – 105 ± 5 µg/m³,
- b. Decane – 100 ± 5 µg/m³, and
- c. Toluene – 125 ± 5 µg/m³.

Prior to conducting the air cleaner chemical reduction testing, AQS conducted validation work to ensure stable and repeatable dosing was achieved. Testing of the powered on unit with no dosing was also conducted to determine emissions from the air cleaner and possible interference with the VOC reduction capabilities. For this testing, the unit was powered on for four hours prior to sampling. For the product test run, with the chemical dosing in process, the air cleaner device was loaded into the chamber. The system was allowed to equilibrate for a minimum of four hours and then, with the air cleaner off, air samples were collected over a 1-hr period for formaldehyde, decane, and toluene. Following the initial sample, the air cleaner was powered on while in the chamber and allowed to operate over a 4-hr period. The chemical dosing was maintained throughout the entire five hour test. Air samples for formaldehyde, decane, and toluene were collected at 1-hr intervals.

RESULTS

The measured chamber concentrations, in units of micrograms per cubic meter ($\mu\text{g}/\text{m}^3$), of formaldehyde, decane, and toluene during the powered on pre-dosing period and over the five hour dosing test period are presented in Table 2. The concentrations of formaldehyde, decane, and toluene, during the dosing test, as a percentage of the initial chamber concentrations are presented in Table 3. The powered on unit was observed to result in chamber concentrations of $46.1 \mu\text{g}/\text{m}^3$ for formaldehyde and $20.9 \mu\text{g}/\text{m}^3$ for toluene. These concentrations are 43% and 16% of the initial dosing concentrations for formaldehyde and toluene, respectively. No decane was observed. After four hours of operation, the "APS-200" prototype air cleaner resulted in a 64% decrease in the measured formaldehyde concentration, as compared to the initial dosed concentration, and corresponding 76% and 70% decreases in the measured decane and toluene concentrations, respectively. The data are also presented graphically as percent of initial concentration versus time, in Figures 1 through 3 for formaldehyde, decane, and toluene respectively.

PRODUCT EVALUATION METHODOLOGIES

Environmental Chamber:

The air cleaner device was tested in an environmental chamber 1.01 m^3 in volume, and chemical emissions were analytically measured. Environmental chamber operation and control measures used in this study complied with ASTM Standard D 5116. The chamber used is manufactured from stainless steel, and its interior is polished to a mirror-like finish to minimize contaminant adsorption. Air flow through the chamber enters and exits through an aerodynamically designed air distribution manifold also manufactured of stainless steel. Supply air to the chamber is stripped of formaldehyde, VOCs, and other contaminants, so that any contaminant backgrounds present in the empty chamber fall below strict levels ($< 10 \mu\text{g}/\text{m}^3$ TVOC, $< 10 \mu\text{g}/\text{m}^3$ total particles, $< 2 \mu\text{g}/\text{m}^3$ formaldehyde, $< 2 \mu\text{g}/\text{m}^3$ for any individual VOC). AQS chambers are process controlled and are equipped with a continuous data acquisition system for verification of the operating conditions of air flow, temperature, and humidity.

Air supply to the chamber was maintained at a temperature of $23^\circ\text{C} \pm 1^\circ\text{C}$ and relative humidity at $50\% \pm 5\%$. The air exchange rate was maintained at 1.0 ± 0.05 air changes per hour (ACH). Environmental chamber study parameters are presented in Table 1.

Analytical Measurements:

Formaldehyde

Emissions of formaldehyde were measured following ASTM D 5197 and USEPA Method TO-11A, measurement by HPLC, or high performance liquid chromatography (2, 3). Solid sorbent cartridges with 2,4-dinitrophenylhydrazine (DNPH) were used to collect formaldehyde and other low-molecular weight carbonyl compounds in chamber air. The DNPH reagent in the cartridge reacted with collected carbonyl compounds to form the stable hydrazone derivatives retained by the cartridge. The hydrazone derivatives were eluted from a cartridge with HPLC-grade acetonitrile. An aliquot of the sample was analyzed for low-molecular weight aldehyde hydrazone derivatives using reverse-phase high-performance liquid chromatography (HPLC) with UV detection. The absorbances of the derivatives were measured at 360 nm. The mass

responses of the resulting peaks were determined using multi-point calibration curves prepared from standard solutions of the hydrazone derivatives. Formaldehyde was quantified using authentic standard calibration. Measurements are reported to a quantifiable level of $2 \mu\text{g}/\text{m}^3$.

Volatile Organic Compounds

VOC measurements, specifically decane and toluene, were made using gas chromatography with mass spectrometric detection (GC/MS). Chamber air was collected onto a solid sorbent which was then thermally desorbed into the GC/MS. Instrumentation included a sample concentrator (Perkin Elmer Model TurboMatrix ATD or TurboMatrix 650), a Hewlett-Packard/Agilent 6890 or 7890 Series Gas Chromatograph and a Hewlett-Packard/Agilent 5973 or 5975 Mass Selective Detector (GC/MS). The sorbent collection technique, separation, and detection analysis methodology has been adapted from techniques presented by the USEPA and other researchers. The technique follows USEPA Compendium Method TO-17 and ASTM D 6196 and is generally applicable to C_6 - C_{16} organic chemicals with boiling points ranging from 35°C to 250°C (3 -7). Decane and toluene were quantified using authentic standard calibration. Measurements are reported to a quantifiable level of $2 \mu\text{g}/\text{m}^3$.

Individual VOCs were separated and detected by GC/MS and then identified using AQS' specialized indoor air mass spectral database when available. Other compounds were identified with less certainty using a general mass spectral library available from the National Institute of Standards and Technology (NIST). This library contains mass spectral characteristics of over 75,000 compounds as made available from NIST, the USEPA and the National Institutes of Health (NIH). A match is first sought in the AQS database, which includes data for the gas chromatographic retention time of the compound in addition to the mass spectrum. This additional information, along with the use of spectra generated on AQS equipment, makes confidence in identifications made from the AQS database higher than in identifications made using only the NIST/USEPA/NIH mass spectral library.

QUALITY CONTROL PROCEDURES FOR ENVIRONMENTAL CHAMBER EVALUATIONS

Air Quality Sciences, Inc. is an ISO 17025 accredited testing firm. AQS' quality control/assurance plan is designed to ensure the integrity of the measured and reported data obtained during its product evaluation studies. This QC program encompasses all facets of the measurement program from sample receipt to final review and issuance of reports. As an ISO 17025 accredited firm, AQS' product control, testing, data handling, and reporting protocols and procedures are standardized and controlled.

Chamber Evaluations

One of the most critical parameters in AQS' product evaluations is the measurement of ultratrace levels of gaseous chemicals, typically in the ppb air concentration range. This necessitates a very rigidly maintained effort to control background contributions and contamination. These contributions must be significantly less than those levels being measured for statistically significant data to be obtained. AQS addresses this control in many directions including chamber construction materials, air purification and humidification, sampling materials and chemicals, sample introduction, and analysis.

Supply air purity is monitored on a weekly basis, using identical methodology to the chamber testing. Preventative maintenance ensures supply air purity, and corrective action is taken when any potential problems are noted in weekly samples. Supply air filter maintenance is critical for ensuring the purity of the chamber supply air. Chamber background samples are obtained prior to product exposure to ensure contaminant backgrounds meet the required specifications prior to product exposure. Results of this monitoring are maintained at AQS and available for on-site inspection.

All environmental chamber procedures are in accordance with ASTM D 5116 and D 6670 (8) and meet the data quality objectives required.

Various measures are routinely implemented in a product's evaluation program. These include but are not limited to:

- appropriate record keeping of sample identifications and tracking throughout the study;
- calibration of all instrumentation and equipment used in the collection and analysis of samples;
- validation and tracking of all chamber parameters including air purification, environmental controls, air change rate, chamber mixing, air velocities, and sample recovery;
- analysis of spiked samples for accuracy determinations;
- duplicate analyses of 10% of all samples evaluated and analyzed;
- multi-point calibration and linear regression of all standardization;
- analysis of controls including chamber backgrounds, sampling media, and instrumental systems.

VOC and Aldehyde Measurements

Precision of TVOC and aldehyde analyses is assessed by the relative standard deviation (%RSD) from duplicate samples, defined as the standard deviation of each data set divided by the mean multiplied by 100. VOC accuracy is based on recovery of toluene mass spiked onto sorbent material. QC data on TVOC measurements conducted for the 12 month period ending June 30, 2012, showed an average precision measurement of 5.5% RSD based on duplicate measurements and 101.5% recovery based on toluene spikes. Aldehyde accuracy is based on Workplace Analysis Proficiency Scheme (WASP) formaldehyde proficiency test results. QC data on total aldehyde measurements (including formaldehyde) for the 12 month period ending June 30, 2012, showed an average precision measurement of 2.3% RSD based on duplicate measurements and an average accuracy of 2.6% RPD based on WASP results. Performance audits have been conducted on-site at AQS by the U.S. Environmental Protection Agency for several industry test programs. They are favorable and are open for review at AQS. Third party proficiency and round robin testing for low level VOCs for national and international programs are continuously conducted and reported in AQS' quarterly Quality Assurance Report, available to all customers.

REFERENCES

1. ASTM D 5116, "Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products." ASTM, West Conshohocken, PA, 2010.
2. ASTM D 5197, "Test Method for Determination of Formaldehyde and Other Carbonyl Compounds in Air (Active Sampler Methodology)." ASTM, West Conshohocken, PA, 2010.
3. EPA, "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air - Second Edition," (EPA/625/R-96/010b), Center for Environmental Research Information, Office of Research and Development, USEPA Cincinnati, OH, 1999. <http://www.epa.gov/ttnamti1/files/ambient/airtox/tocomp99.pdf>
4. Bertoni, G., F. Bruner, A. Liberti, and C. Perrino, "Some Critical Parameters in Collection, Recovery, and Gas Chromatographic Analysis of Organic Pollutants in Ambient Air Using Light Adsorbents." J. Chromatogr., 203, 263-270 (1981).
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6. Mangani, F., A. Mastrogiacomo, and O. Marras, "Evaluation of the Working Conditions of Light Adsorbents and Their Use as Sampling Material for the GC Analysis of Organic Air Pollutants in Work Areas." Chromatographia, 15, 712-716 (1982).
7. ASTM D 6196 "Practice for the Selection of Sorbents and Pumped Sampling/Thermal Desorption Analysis Procedures for Volatile Organic Compounds in Air." ASTM, West Conshohocken, PA, 2009.
8. ASTM D 6670, "Standard Practice for Full-Scale Chamber Determination of Volatile Organic Emissions from Indoor Materials/Products." ASTM, West Conshohocken, PA, 2007.

TABLE 1

ENVIRONMENTAL CHAMBER STUDY PARAMETERS

Customer:	Akida Holdings, LLC.
AQS Sample Identification:	AQS17505-020AA
Date Received:	August 3, 2012
Product Description:	APS-200
Product Loading:	1 unit /1.01 m ³
Test Conditions:	1.00 ± 0.05 ACH 23° C ± 1° C 50% RH ± 5% RH
Test Period:	08/08/2012

TABLE 2
MEASURED CHAMBER CONCENTRATIONS OF FORMALDEHYDE, TOLUENE, AND DECANE
($\mu\text{g}/\text{m}^3$)

PREPARED FOR: AKIDA HOLDINGS, LLC.
PRODUCT: 17505-020AA, APS-200

CAS NUMBER	COMPOUND	PRE-DOSING POWERED UNIT	DOSING SAMPLE TIME INTERVAL (HOUR)				
			Fan Off	Fan On			
			-1 – 0	0 – 1	1 – 2	2 – 3	3 – 4
50-00-0	Formaldehyde [†]	45.6	107	64.4	41.9	39.4	37.9
124-18-5	Decane [†]	0	103	55.2	27.8	25.3	24.7
108-88-3	Toluene (Methylbenzene) [†]	20.9	128	79.0	41.2	39.7	38.1

[†]Quantified using multipoint authentic standard curve.

TABLE 3
PERCENT REDUCTION OF INITIAL DOSED CHAMBER CONCENTRATIONS

PREPARED FOR: AKIDA HOLDINGS, LLC.
PRODUCT: 17505-020AA, APS-200

CAS NUMBER	COMPOUND	SAMPLE TIME INTERVAL (HOUR)			
		Fan On			
		0 – 1	1 – 2	2 – 3	3 – 4
50-00-0	Formaldehyde [†]	40%	61%	63%	64%
124-18-5	Decane [†]	38%	68%	69%	70%
108-88-3	Toluene (Methylbenzene) [†]	46%	73%	75%	76%

FIGURE 1

**PERCENTAGE OF INITIAL CHAMBER CONCENTRATION OF FORMALDEHYDE
PRODUCT: 17505-020AA, APS-200**

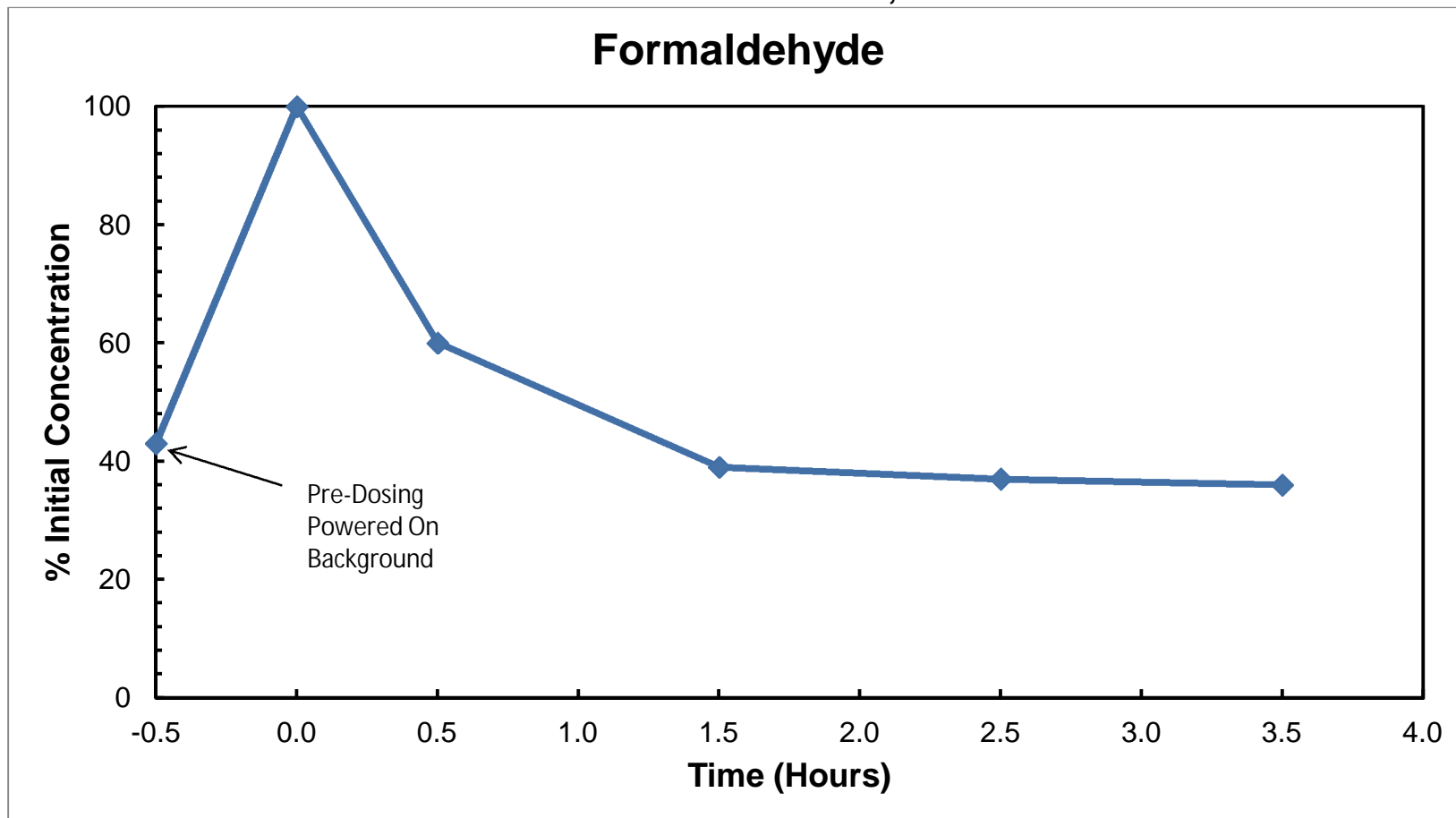


FIGURE 2

**PERCENTAGE OF INITIAL CHAMBER CONCENTRATION OF DECANE
PRODUCT: 17505-020AA, APS-200**

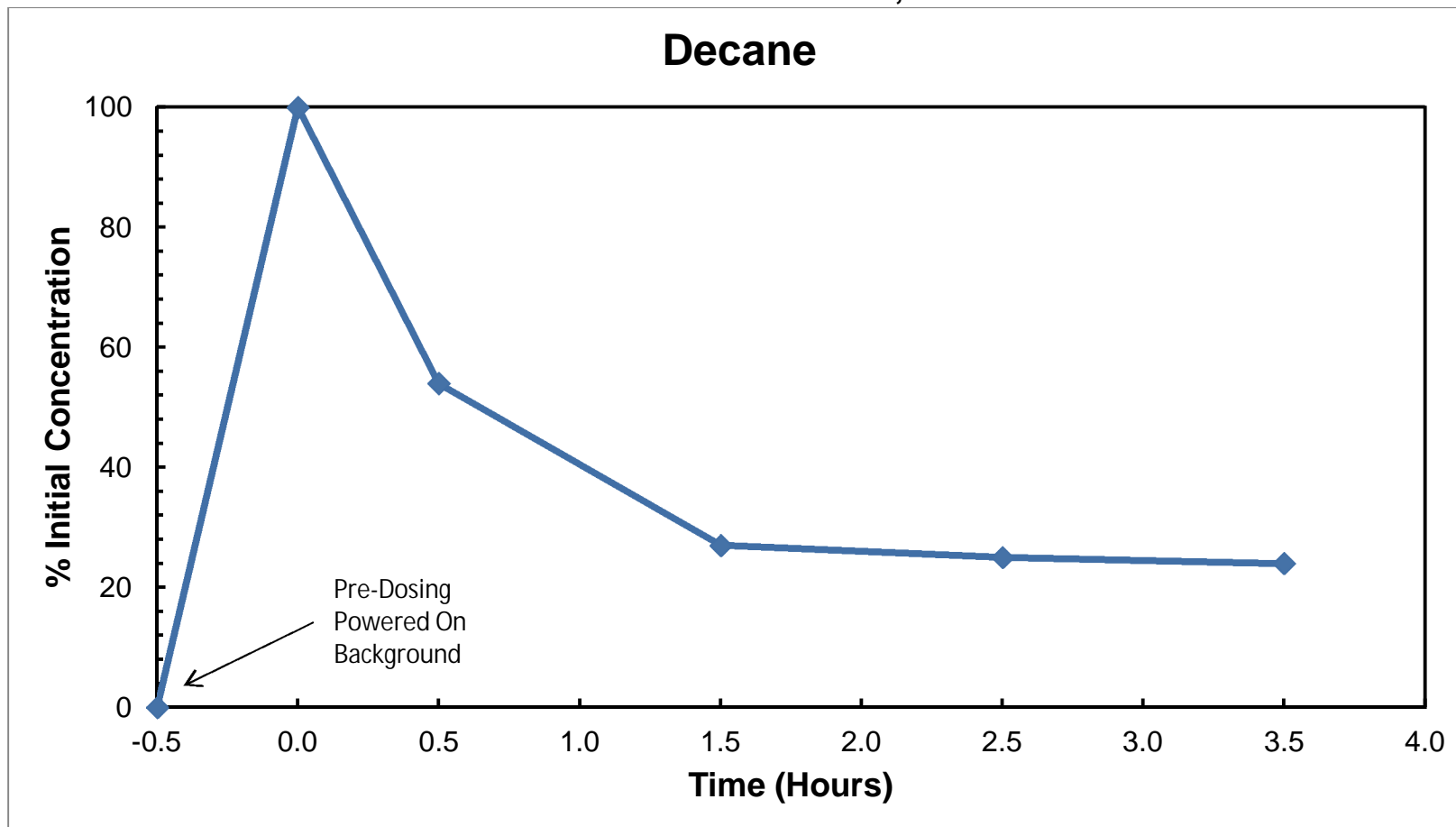


FIGURE 3

**PERCENTAGE OF INITIAL CHAMBER CONCENTRATION OF TOLUENE
PRODUCT: 17505-020AA, APS-200**

