# APPLICATION NOTE
# SXC-20 VOC MONITOR

# SONIC FOG VOC TESTING

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December 2, 1996

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**Objective:**

To determine as exactly as possible the Volatile Organic contamination (VOC) which exits the Sonic Fog in the exhaust, both of the clean room and the drain box. This Organic contamination is IPA or (2-Propanol), the drying fluid used in the patented Sonic Fog process.

**Experiment**:

A standard single cassette Sonic Fog machine was chosen for these experiments. This particular unit had just returned from a four month evaluation in a customer's clean room. Over that four month period, it saw nearly daily use and no special measures or adjustments were made to the system before this evaluation. It was decided that two sets of measurements would be made, VOC airborne vapor in the clean room and secondly, measurement of vapor at the drain box. The drain box allows the collection of waste DI water from the Sonic Fog but, it also is the principal $N_2$ purge from the machine during the warm $N_2$ blow off. If volatile IPA is present you would expect to see it at the drain.

**Apparatus:**

A Spectrex SXC-20 VOC Monitor and data logger was used for all experiments. This unit showed good repeatability down to 3.0 ppm VOC content. This unit uses a semiconductor sensor measuring the ionization voltage across the sensor. This voltage is then stored in the data logger section sampling for up to 24 hours. Data points are then off loaded via RS-232 into a data management utility. The whole data set can then be viewed as a linear graph showing voltage vs. time. Later experiments showed the measurement of current to be more precise so it was chosen as the main method.

**Calibration:**

Upon receiving the unit it was determined that we would calibrate for IPA and several experiments were conducted to determine the sensitivity and repeatability of the unit. Calibration was done just before each data set was developed.

## Calibration sequence

I. A one (1) gallon (3790 ml) electro polished stainless steel airtight vessel was chosen as the sample volume container because the steel surface would not "chemi absorb" the IPA solvent. Over multiple "blank" runs this was shown to be true.

II. The curved bottom of the vessel was heated to about $70^{o}$ C to make sure that no IPA would be in the liquid state. Several tests of the hot surface were conducted to determine that no organic volatile were flashing off.

III. A glass micro syringe 0—25m liters (0.001 ml) was used to measure an exact sample of IPA. We used the exact IPA that the unit uses during water processing.

IV. This "micro sample" was carefully dispensed into the bottom of the hot S.S vessel and the lid placed over the vessel for 2 minutes.

V. The lid was then removed and the volume of air carefully stirred with a glass rod for a few seconds. Note: IPA vapor is more than twice the density of air so this stirring will mix the vapor for a uniform sample with little loss to the surrounding atmosphere.

VI. The SXC-20 sample tube was then lowered into the vessel to the center point and the maximum output recorded. Note: in addition to the data logging, the unit has a (10) LED bar graph display. This provided instant results and proved as accurate as the electrical measurement.

VII. A total of four calibration runs were made from 2 m liters to 38 m liters.

| Sample Number | LED'S | Current (mA) | IPA Sample (ppm) |
|---|---|---|---|
| 2 | 1 | 0.252 | 0.5 |
| 4 | 2 | 0.505 | 1 |
| 19 | 5 | 0.924 | 5 |
| 38 | 10 | 1.115 | 10 |

## Results:

Based on the calibration results above the Sonic Fog™ was first examined in the clean room for (5) consecutive runs. The sample point was at the machine centerline 1 inch above the top deck, at the rear deck edge. With the design of our class 100 clean room the airflow travels down from the 50% HEPA ceiling and is drawn off at the lower wall panels. The airflow accelerates as it travels to the screens at the lower wall panels. By placing the sample tube "downstream" any IPA which escapes from the chamber should be read at the back edge.

***At no point during the (5) runs did any measurement 0.5 ppm result!

***Traveling around the machine and "sniffing" the lid and surrounding gasket, at no point was a concentration of 1 ppm measured.***

*** At no point During (5) runs with the sample point at the center of the 24"x 24"x 12" deep drain box did any measurement 10 ppm results! The greatest concentration occurs during the first 90 seconds of the N2 blow off

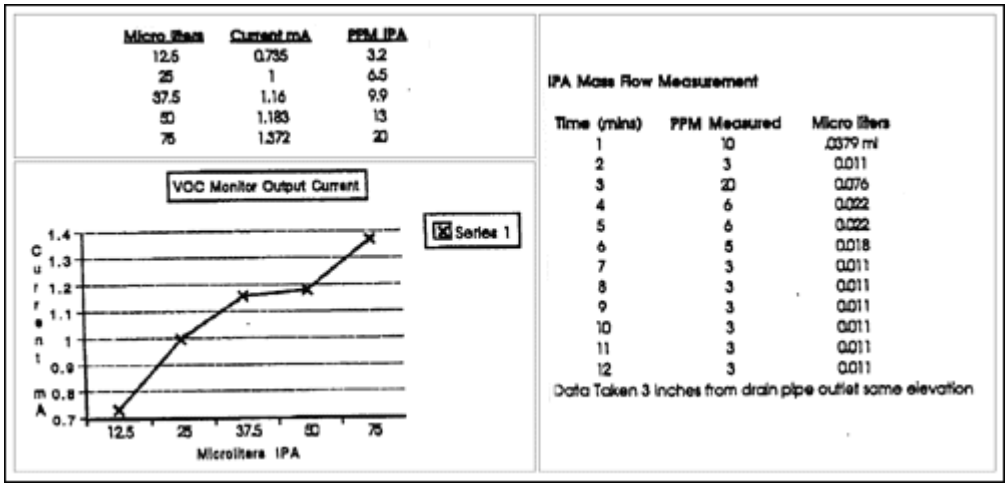
Note: The official MSDS for IPA (2-Propanol) allows for the (PEL) Permissible Exposure limit to be 400 ppm. Short term exposure (STEL) is 500 ppm

## Conclusion:

At no point during its operation does the Sonic Fog produce more than 2.5 % of the permissible exposure to IPA as reported in the EPA's MSDS Database!

### Section II Mass Balance Measurements

Several Calibration curves were developed to allow real time monitoring of the vapor loss at the drain during the whole of the Sonic Fog ™ process. Below find the curve which was used for these experiments.



| Micro liters | Current mA | PPM IPA |
|---|---|---|
| 12.5 | 0.735 | 3.2 |
| 25 | 1 | 6.5 |
| 37.5 | 1.16 | 9.9 |
| 50 | 1.183 | 13 |
| 75 | 1.372 | 20 |



IPA Mass Flow Measurement

| Time (mins) | PPM Measured | Micro liters |
|---|---|---|
| 1 | 10 | .0379 ml |
| 2 | 3 | 0.011 |
| 3 | 20 | 0.076 |
| 4 | 6 | 0.022 |
| 5 | 6 | 0.022 |
| 6 | 5 | 0.018 |
| 7 | 3 | 0.011 |
| 8 | 3 | 0.011 |
| 9 | 3 | 0.011 |
| 10 | 3 | 0.011 |
| 11 | 3 | 0.011 |
| 12 | 3 | 0.011 |

Data Taken 3 inches from drain pipe outlet same elevation

Mass Flow Vapor IPA:

Total IPA Mass = of 1-12 Volumes — 0.252m1

Total IPA Used During Cycle = 1.4 ml! mm x 2.5 = 3.5 ml's

Total loss per cycle = 0.252 ml / 3.5 ml = 7.2 %

Sonic FOG ™ IPA Process efficiency 100 **%** - 7.2 % = 92.8 %

Therefore: over 90% of the IPA Dispensed actually works at drying and lifting particles via the "Marangoni flow" effect

Total per machine VOC mass loss to the atmosphere at 30 runs per day would be:

0.252 ml x 0.79 specific gravity x 30 5.9 grams

5.9 grams / 454 grams / lbs. = 0.Ol3lbs! / day VOC loss