

TEST METHOD

Special light tubes for photocatalytic air purification are inserted into a 1-liter reactor chamber inside a 4-liter gas cell used for gas concentration analysis. The air cleaning light tubes are made from two parts as described in U.S. Patent 6,336,998. A fiberglass sleeve coated with anatase TiO₂ is attached around a UV-A spectrum type light tube. The lamp used in the reactor is rated at 10 Watts, 330-mm long with tube diameter of 25-mm.

The VOC under test is injected with air into the reactor chamber. The test environment is room temperature and humidity. The flow rate through the gas cell and reactor chamber is 6 liters per minute. This flow rate provides a retention time of 10 seconds inside the 1-liter photocatalytic reactor.

VOC sample concentration is measured using FTIR spectroscopy, a method applicable to most organic gases. The optical path length of the gas cell is 4 meters. A long path length is required to accurately measure infrared absorption by a small gas concentration.

By measuring VOC gas concentration as it enters the photocatalytic reactor and again as it exits the reactor after 10 seconds, a rate of decomposition is determined. Since only one reactant is involved, the reaction is of the first order according to the laws of chemical kinetics.

The rate of a first order reaction is described by the equation $\{ e^{-kt} \}$ where; **e=2.718**, **t** is time in minutes, and **k** is the **time constant of decomposition** (with units of min⁻¹). The value **k** is measured for each subject VOC gas exposed to the photocatalytic reactor.

TEST RESULTS

Test results are presented in Table 1 for several VOCs that are known as toxic irritants in low concentration. Some are even carcinogenic. The measured *Time Constant (k)* determines the time required to decompose any initial gas concentration in half (50%). These values, listed in Column 3 of Table 1, simplify the efficiency of the photocatalytic light tubes in their ability to decompose many toxic VOC gases.

Table 1

VOC	Decomposition Time Constant (min ⁻¹)	Time to 50% Concentration (mins)	OSHA PEL 8-hr AVG (ppm)	PRODUCT USES
Acetaldehyde	0.1708	4.00	200	a federal hazardous air pollutant from incomplete combustion
Acetic Acid	0.2418	2.75	10	vinegar, drugs, dyes, plastics, fibers
Benzene	0.0651	10.75	1	gasoline, carpet glue, textured carpet, furniture wax
Butylacetate	0.3123	2.25	150	paint, print inks, adhesives
Dichloromethane	0.0185	37.50	25	spray shoe polish/water repellant, spot removers, wood floor or panel cleaners
Methanol	0.0702	9.75	200	gasoline additives, wood alcohol
Methyl ethyl ketone	0.2894	2.50	200	artificial leather, lubricating oils, paint removers, adhesives, cleaning fluids
N-hexane	0.1100	6.25	500	gasoline, type correction fluids, and aerosols in perfumes and cleaners
P-dichlorobenzene	0.0528	13.25	75	moth repellents, room deodorizers
Pyridine	0.0753	9.25	5	paint and rubber preparation
Tetrahydrofuran	0.3426	2.00	200	PVC food wrap, adhesives, lacquers, inks, fat oils, and non-vulcanized rubber
Toluene	0.1795	3.75	100	gasoline, paint thinner and remover
Trimethylamine	0.1105	6.25	10	agricultural chemicals, herbicides and insecticides

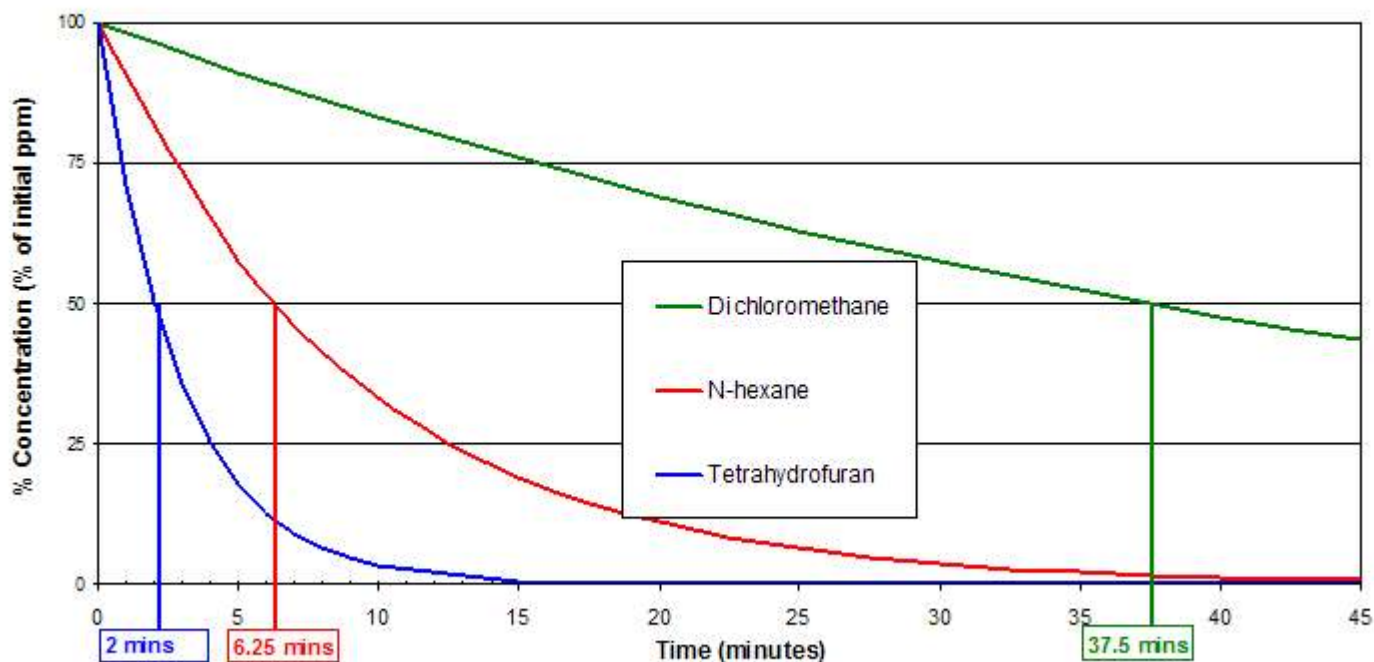
Notes to Table 1:

- The VOC names printed in boldface also appear in Figure 1. Columns shaded in gray are reference information.
- OSHA PEL** defines the Physical Exposure Limit as a time weighted average during an 8-hour work shift set by the Occupational Safety and Health Administration of the U.S. Department of Labor www.osha.gov.

TESTING FOR VOC DECOMPOSITION RATES

The decomposition rates for three VOC gases are plotted in Figure 1. The time required to decompose to 50% concentration varies from 2 minutes to 37.5 minutes for the selected VOC gases. Two of the gases can be totally decomposed in 15 to 45 minutes. The red decomposition curve (for N-hexane) is typical of most VOC gases.

Figure 1 - VOC Decomposition
at room temperature and humidity



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