A Rapid and Simplified Method for Determining Ozone and Other Image Degradation Oxidants in Air

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Extended Abstract

It is now well known that pictures stored in circulating air are subject to degrading oxidants, especially ozone, that attack the dyes or pigments present in the image. This new perception is the result of many field observations and the testing by many manufacturers to explain why accelerated tests on images were under predicting life expectancy.

It is also well known that expansion of industrialization, on a global scale, the increased burning of fossil fuels and the proliferation of vehicles of transportation in many new countries that have advanced economically, are creating atmospheric pollution that results in marked increases in ozone and other related oxidants on a world wide scale.

So much for our understanding of the causes; this has sparked a great interest in methods that can quickly monitor atmospheric conditions and determine changes that influence image degradation and may allow better quantification between cause and effect.

Some of the current accepted methods for quantifying ozone or other oxidants, rely on expensive lab instruments, or costly and slow Drager tubes for field use. Since it is not feasible to sample air and transport in to labs for measurement, without incurring changes during transport, we have developed an alternate chemiluminescent method.

Chemiluminescent methods are fast, sensitive and today easy to carry out in the field with small portable instruments (luminometers).

New molecules are available that have increased both sensitivity and convenience to various mediums. We have worked with a new material, commercially available from biotech supplier, Capricorn Products Inc., called AcriGlow 301™. The molecule is a water soluble derivative of 9-acridinecarboxylic acid, with good stability in water and is converted to the chemiluminescent by-product, 9-acridine-percarboxylic acid in the presence of trace quantities of peroxyde. To make optimum use of this chemistry we have developed a method that facilitates its use in the field and provides for the capture of oxidants in air.

The method begins with the sampling of air from a source of interest, by drawing into a gas syringe containing a buffer and a proprietary fluorinated surfactant, resistant to oxidation. The gas sample is shaken in the syringe to dissolve the oxidizing gases, such as ozone, peroxyde or oxides of nitrogen, and injected into the reading tube of a portable luminometer. The activating AcriGlow molecule is injected before or immediately after the buffer/dissolved gas sample and readings are taken minutes later. Since the photon flux, from the chemiluminescent reaction builds gradually readings can be taken at various time intervals, until a maximum signal is observed. This will occur in less then 15 minutes, but with low concentrations of oxidant in less the 5 minutes. Since chemiluminescent signal is temperature dependent, it is best to do readings at 20°C. or above.

The output readings are in arbitrary photon counts per unit of time and are converted to concentration by doing a calibration with known concentrations of gases. Using small commercial ozone generating sources, such as quartz/UV tubes, calibration may be carried out using sampling syringes and using the principle of systematic dilution to generate concentration series. Similarly peroxide concentrations can be generated to do calibration series.

Using this information, sample images were placed in atmospheres of different gas concentrations and stored for various periods of time, temperature and humidity to observe image degradation. Image degradation was observed both visually and then measured with a small densitometer.

Data will be shown that the simplified chemiluminescent method and the use of the new acridine molecule allows detection of oxidant species such as ozone and peroxide down to the parts per billion range and can be used to correlate with observed image degradation as concentration of gases increase. The method is fast, simple to use and inexpensive. This has the virtue that many measurements can be made, in atmospheres of varying concentration, in the field to better understand how images react and find ways to improve image stability.

This method was developed to encourage more field measurements and get better correlation with real life environments to determine conditions for improved image stability.

Biography

Peter H. Roth is president of a small technology consulting firm that contracts with clients to solve practical development or manufacturing problems in areas of imaging, coating, electrical conducting polymers and system analysis. He has training in chemical engineering from City University of NY., and graduate degrees in physical chemistry and solid state physics from Northeastern University, Boston. His experience covers more then 40 years with Polaroid Corp. in the design, development and reduction to commercial manu-facture of complex imaging systems for both the amateur and industrial and medical imaging. After leaving Polaroid Mr. Roth started a small consulting business and is an operating partner and director in a small electronics firm that develops proprietary technology for the fabrication of complex electronic printed circuits.

His clients are both large and small companies that required rapid, economical solutions to special problems. He has done work involving complex coatings, biotechnology development, electrical coating formulations, electrophotochromic systems, complex polymer formulation, solving wetting phenomena in fluids and designing fluids requiring complex rheological properties. He has numerous US and European patents and papers on colloid chemistry, image stability, design of stable image receptor surfaces. In all areas of activity special emphasis is placed on developing practical and economical solutions rather then impractical abstractions.