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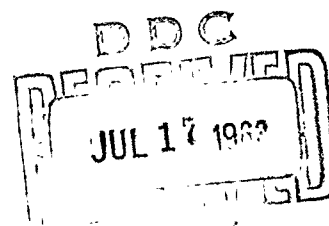
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ULTRAVIOLET DEGRADATION OF PAINTS FILMS

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U. S. NAVAL CIVIL ENGINEERING LABORATORY

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ULTRAVIOLET DEGRADATION OF PAINT~~/~~ FILMS

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by

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ABSTRACT

A cell has been built to contain the gaseous degradation products from coating films and paint films placed on the inner surface of the cell and then exposed to ultraviolet radiation. These products may be identified by their infrared spectra. The cell has been used to identify the degradation products of linseed oil and an alkyd resin. It may be used to measure the protective qualities of various pigments in vehicles by comparison of degradation rates of vehicle only with degradation rates of complete paints.

INTRODUCTION

One of the many factors affecting the service life of a paint film is its resistance to the deteriorative effects of ultraviolet light. The organic part of the film is subject to greater or less damage depending on its composition and on the protective properties of the pigment it contains. The exposure of the paint to direct sunlight is, of course, important. The paint on the south side of a building is more severely attacked than that on the north.

The purpose of this work is to investigate some of the details of decomposition of paint films by the ultraviolet radiation in sunlight. Clear unpigmented films are being studied first. Subsequently, the protective qualities of pigments and other ultraviolet absorbers will be studied.

METHOD

The cell shown in Figure 1 is constructed of a quartz tube closed at either end by windows of IRtran II.¹ A stopcock is sealed into the side of the cell body to permit filling the cell with various atmospheres, such as pure oxygen, or to evacuate it. Except for the use of quartz, necessary for transparency to ultraviolet radiation, and the use of IRtran II windows for resistance to weather during outdoor exposure, the cell is the usual 10 centimeter gas cell. Its diameter is 5 centimeters.

With the windows removed, the inside of the cell is swabbed with a very thin coating of the resin to be studied. The film is allowed to dry, the windows are installed and sealed with amalgamated lead rings. The cell is attached to a vacuum line and pumped out for several hours at about 5 millimeters pressure to assure freedom from volatile materials. A blank spectrum is run before irradiation after the cell has stood for several hours to assure that no slow evolution of vapors has occurred.

The cell is then irradiated with ultraviolet light from a mercury or carbon arc. It is placed so as to get maximum radiation through the quartz tube. A current of air from a blower is used to keep the cell cool.

The infrared spectrum between wave number 625 and wave number 4000 is run on a Beckman IR7 at high resolution. Figure 2, formic acid vapor, was run at an effective band width (resolution) of 0.7 wave number and 5 times scale expansion. The region covered by this spectrum is wave number 1070 to wave number 1130.

¹ Eastman Kodak Company proprietary infrared transparent glass.

RESULTS

When a linseed oil film was studied by the method described above, CO_2 , CO, and formic acid were found to be degradation products. This is in agreement with the work of Crecelius et al.²

A soybean alkyd resin containing 32.2 percent phthalic anhydride was coated on the inside of the cell body. After exposure to the radiation from a carbon arc in an Atlas Weatherometer Model DMC-HR for three hours, peaks in the infrared spectrum were found at wave number 1106, 1778, 2890, 2940 and 2960. These peaks³ represent formic acid 1106, formaldehyde 1778 and C-H stretching vibrations 2890, 2940 and 2960, from hydrocarbons such as methane. Two experiments out of six have shown some evidence of isobutane. Water, CO and CO_2 , were also identified. A portion of the spectrum of formic acid vapor is shown in Figure 2. This was not found in the linseed oil experiment. Diatomic molecules such as O_2 , N_2 , H_2 have no infrared spectra. If formed they would not be detected by this method.

CONCLUSION

The method was shown to be capable of identifying the degradation products formed during ultraviolet irradiation.

FUTURE WORK

The effect of pigments and ultraviolet absorbers on rate of degradation will be studied in future work. A cell will be exposed to sunlight outdoors and to mercury or carbon arcs.

² Mechanism of Linseed Oil Film Degradation, S. B. Crecelius, Alexander, A. L., Kagariße, R. E., NRL Rpt 4802. (1956).

³ R. H. Pierson, Fletcher, A. N. and Gantz, E. S., Anal. Chem. 28, 1218 (1956)

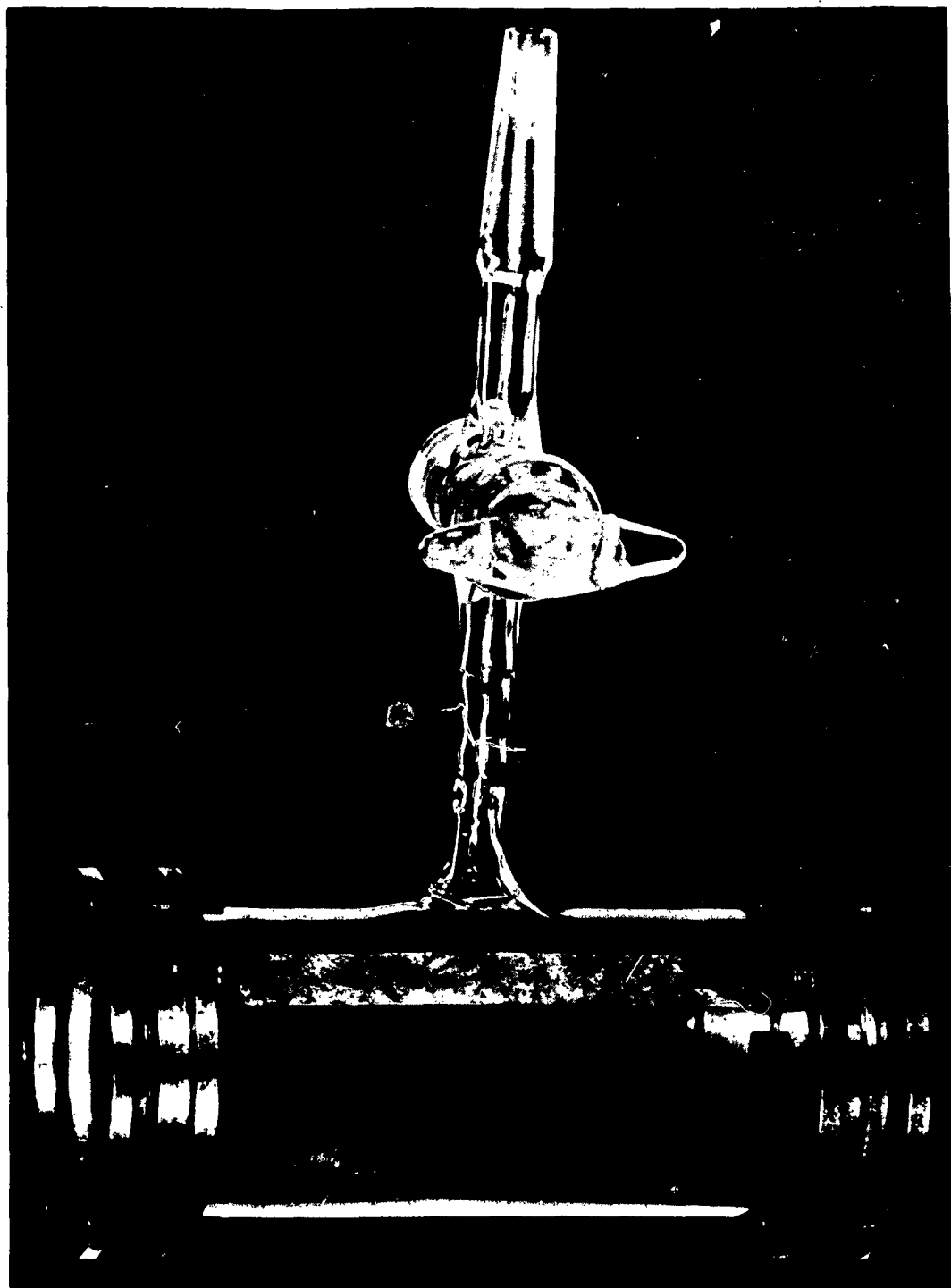


Figure 1. Quartz bodied gas cell.

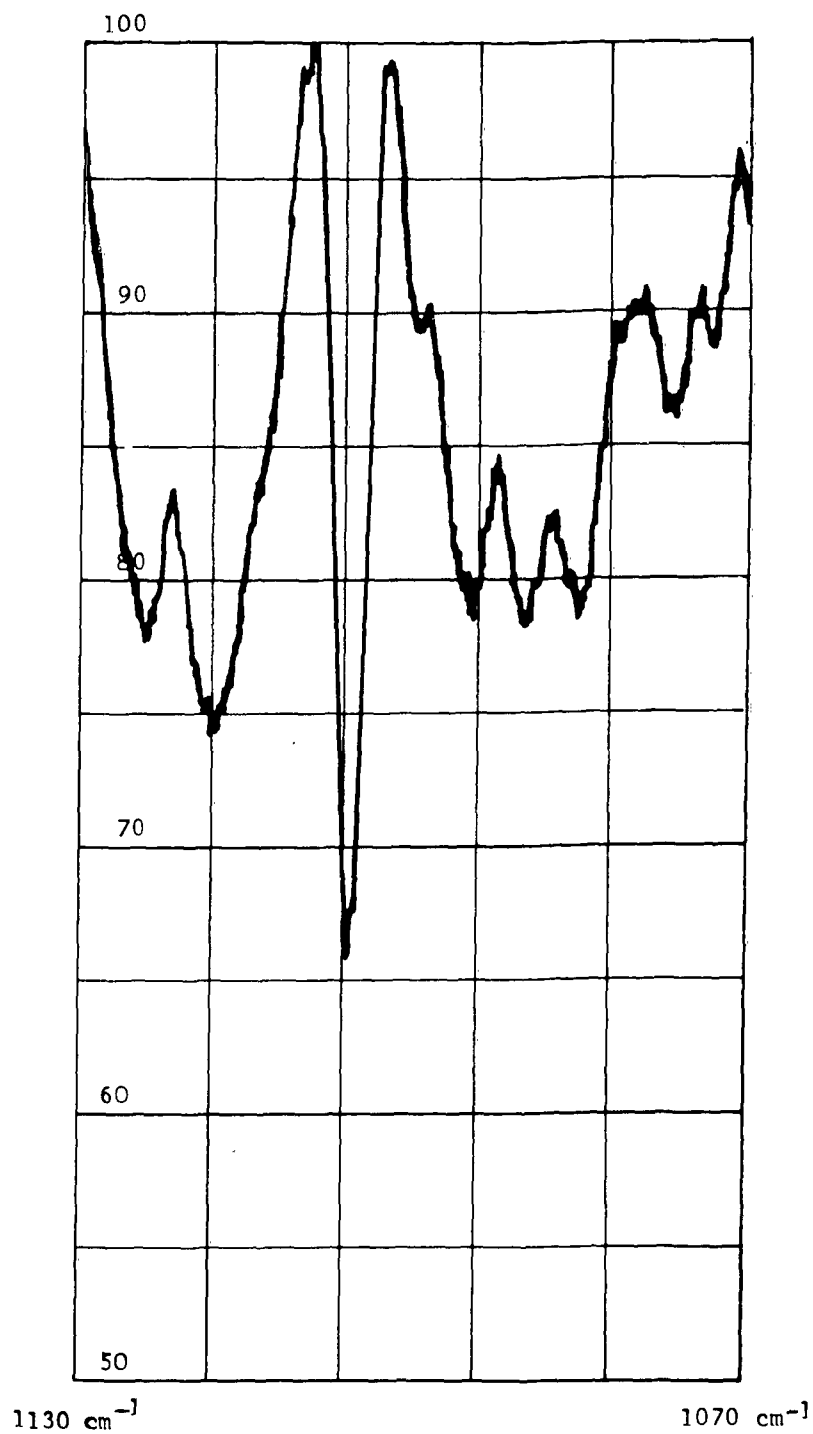


Figure 2. Formic acid vapor.