Test for acidic vapors using cresol red

Purpose
To determine if objects (such as cellulose nitrate) are evolving acidic vapors so that precautions may be taken to protect the object itself or others in the collections from the vapors.

Principle
Strongly acidic vapors react with certain indicator dyes to change their color. Paper impregnated with these dyes may be placed close to a suspect object and observed for a change of color in the paper. The test is recommended particularly for detecting NO_2 from degrading cellulose nitrate.

$$\text{cellulose nitrate} \xrightarrow{\text{time}} NO_2\ (g)$$

$$2NO_2\ (g) + H_2O\ (g \text{ or } l) \rightarrow \underset{\text{nitric acid}}{HNO_3\ (aq)} + \underset{\text{nitrous acid}}{HNO_2\ (aq)}$$

$$\text{acid} + \text{indicator} \rightarrow [\text{H+indicator}]^+$$

cresol red or cresol purple (red to yellow to purple)

Equipment
- filter paper or cotton string
- reagent container
- glass stirring rod
- balance (to weigh 0.001g)

Reagents and safety
- **Cresol red or cresol purple**: irritants; slight health rating
- **Ethanol** (ethyl alcohol): flammable and an irritant; slight health rating
- **Methanol** (methyl alcohol): toxic, flammable and irritant; severe health rating

Protection
Wear goggles, gloves and protective clothing when handling methanol.

Other tests to consider or confirm results
- Test for nitrate using spot test papers (p. 112)
- Test for nitrate (cellulose nitrate) using diphenylamine (p. 164).

Reference
Fenn, Julia. 1996. 'The Cellulose Nitrate Time Bomb: Using Sulphonephthalein Indicators to Evaluate Storage Strategies' in *From Marble to Chocolate: The Conservation of Modern Sculpture*, Jackie Heuman (editor) 87–92. London: Archetype.

Reagent preparation
- **0.005% cresol red solution**: add 0.005g to a mixture of 10mL methanol and 90mL ethanol.

Method of sampling
This test does not require that a sample be removed from the object. The impregnated test paper is placed near to but not touching the material being tested.

Procedure
1. Dip the paper or string in the dye solution and remove excess by tapping with a glass rod. Allow the impregnated test paper to dry completely.
2. Place the test paper or suspend the string so that they are near to but not touching the object(s) to be tested.
3. Observe for color change.

Observations and interpretation
The dye in the paper will change color if acidic vapors are present. The color change will be more intense near areas that emit more acidic vapors. Generally the color change will occur within one or two days, but some samples may take up to five days to produce a color reaction. It is best if the paper is placed beneath the material being tested as acidic vapors are heavier than air and tend to sink. If cresol red is used, the paper will change from yellow to reddish purple. In the case of cresol purple the paper changes from yellow to purple. Fresh cellulose nitrate (non-degraded) does not give a positive result with this test.

Storage and reagent shelf life
Cresol red and purple solutions are stable when stored in sealed containers in ambient conditions.

Nancy Odegaard, Scott Carroll and Werner S. Zimmt. **Material Characterization Tests for Objects of Art**. London: Archetype Books, (2nd Edition) 2007. ISBN-13: 978-1904982098