METHOD # 110.1	Approved for NPDES (Issued 1978)
TITLE:	Colorimetric, ADMI
ANALYTE:	Color
INSTRUMENTATION:	Spectrophotometer
STORET No.	00082 at pH 7.6 00083 at ORIGINAL SAMPLE pH

1.0 Scope and Application

1.1 This method is applicable to colored waters and waste that have color characteristics significantly different from the yellow platinum-cobalt standard.

1.2 A working range of 25 to 250 color units is recommended. Sample values above 250 units may be determined by quantitative dilution.

2.0 Summary of Method

2.1 This method is an extension of the Tristimulus Filter Method[1]. Tristimulus values are converted to an ADMI single number color difference, of the same magnitude assigned to platinum-cobalt standards, using the Adams Nickerson Color Difference (DE).

2.2 Tristimulus values obtained by Spectrophotometric Method 204B[1] may be used to calculate ADMI values as outlined in this procedure under Calculation 9.2.

3.0 Interferences

3.1 Since very slight amounts of turbidity interfere with the determination, turbid samples must be filtered prior to analysis. The optimum filter media to remove turbidity without removing color has not been found. Membrane and glass fiber filters with functional pore sizes of approximately 0.45 µ are convenient to use. Other techniques such as centrifuging and/or filter aids may be used.

4.0 Sample Handling and Preservation

4.1 Since biological activity may change the color characteristics of a sample, the determination should be made as soon as possible. Refrigeration at 4°C is recommended.

5.0 Calibration

5.1 Standard curves must be established (as outlined in Procedure 8.3) for each photometer used, and are not interchangeable. For color values less than 250, a 5 cm cell path is recommended. Less than 5 cm cell paths may be used if calibration is performed with the shorter cell.

6.0 Apparatus

6.1 Spectrophotometer or filter photometer capable of transmission measurements using Tristimulus filters listed below:

Filter number	Wavelength of maximum transmittance in nm	Corning designation*
(1)	590	CS 3-107
2	540	CS 4-98
3	438	CS 5-70

* Available from Corning Glass Works, Optical Products Department, Corning, NY 14830.

7.0 Reagents

7.1 Standard chloroplatinate solution: Dissolve 1.246 g potassium chloroplatinate, K_2PtCl_6, (equivalent to 0.500 g metallic Pt) and (1) g crystalline cobaltous chloride, $CoCl_2 \cdot 6H_2O$, in distilled water containing 100 mL of conc. HCl. Dilute to 1000 mL with distilled water. This standard solution is defined as 500 ADMI color units.

7.2 Sulfuric acid, concentrated.

7.3 Sodium hydroxide, 10 N: Dissolve 40 g of sodium hydroxide in 80 mL of distilled water. Cool to room temperature and dilute to 100 mL with distilled water.

8.0 Procedure

8.1 Prepare two 100 mL volumes of sample by maintaining the original pH of one aliquot and adjusting the second aliquot as necessary to pH 7.6 with sulfuric acid (7.2) or sodium hydroxide (7.3).

8.2 Filter samples to remove turbidity through a 0.45 µ membrane filter, glass fiber filter or other suitable media (see interferences 3.1).

8.3 Use distilled water to set the transmittance at 100% and then determine the transmittance of the clarified sample or standard with each of the three Tristimulus filters. Calibration standards from 25 to 250 units are recommended.

9.0 Calculations

9.1 Calculate intermediate Tristimulus values for samples and standards from the transmittance data in 8.3 using the following equations:

$$X_s = (T_3 \times 0.1899) + (T_1 \times 0.791)$$

$$Y_s = T_2$$

$Z_s = T_3 \times 1.1835$

where:
T_1 = transmittance value in % using filter number (1)
T_2 = transmittance value in % using filter number 2
T_3 = transmittance value in % using filter number 3

9.2 Convert Tristimulus values to the corresponding Munsell values V_x, V_y and V_z, by the use of published tables [2, 3, 4] or the equation suggested by Bridgeman[5].

9.3 Calculate DE values for samples and standards, construct a calibration curve by plotting DE against ADMI units of standards and determine ADMI color units of samples from the calibration curve.

$$DE = \sqrt{[0.23 \times (V_{yc} - V_{ys})]^2 + [(V_{xc} - V_{yc} - (V_{xs} - V_{ys})]^2 + [0.4[(V_{yc} - V_{zc}) - (V_{ys} - V_{zs})]]^2}$$

where V_{xs}, V_{ys} and V_{zs} = the Munsell values for X_s, Y_s and Z_s respectively and V_{xc}, V_{yc}, and V_{zc} = the Munsell values for a blank solution whose Tristimulus values are X_c, Y_c and Z_c.

NOTE (1): If the photometer used is set at 100% transmittance with distilled water, the Tristimulus values for the blank are 98.09, 100.00 and 118.35 for Xc, Yc and Zc respectively. If necessary, Tristimulus values for the blank are determined as in calculation (9.1).

9.4 Report ADMI color values at pH 7.6 and at the original pH.

NOTE 2: The intermediate Tristimulus values calculated under 9.1, using the three Tristimulus filters, are used only to calculate the ADMI color value. They should not be reported as Tristimulus values or used to determine dominant wavelength, luminance and purity.

10.0 Precision and Accuracy

10.1 Accuracy data on actual samples cannot be obtained.
10.2 Precision data are not available at this time.

Bibliography

(1). Standard Methods for the Examination of Water and Wastewater, 14th Edition (1975), page 64.
2. J. Soc. Dyers and Colorists, *86*, No. 8, 354 (1970).
3. Wyszecki and Stiles, Color Science, Wiley, N.Y., 1967, Tables 6.4 A, B and C.
4. Judd and Wyszecki, *Color in Business, Science, and Industry*, 2nd Edition, Wiley, N.Y. (1963) Tables A, B and C in Appendix.
5. J. Opt. Soc. Am., Volume 53, page 499, April 1963.
6. Dyes and the Environment-Report on Selected Dyes and Their Effects, Volume (1), Sept. 1973 Appendix; American Dye Manufacturers Institute, Inc.