

Indian Standard

METHODS OF SAMPLING AND TEST ( PHYSICAL AND  
CHEMICAL ) FOR WATER AND WASTE WATER

## PART 4 COLOUR

( First Revision )

1. Scope — Prescribes the following two methods for the determination of colour.

- a) Platinum cobalt ( visual-comparison ) method, and
- b) Spectrophotometric method.

1.1 Platinum cobalt ( visual comparison ) method is applicable to nearly all samples of potable water and is not applicable to colour measurements on water containing highly coloured industrial wastes.

1.2 Spectrophotometric method is applicable for all types of water including domestic and industrial wastes. It is generally used in case of industrial wastes that cannot be determined by platinum — cobalt method.

## 2. Platinum Cobalt ( Visual Comparison ) Method

2.1 *Principle* — Colour is measured by visual comparison of the sample with platinum — cobalt standards. One unit of colour is that produced by 1 mg of platinum per litre in the form of chloroplatinate ion.

### 2.2 Interferences

2.2.1 Very slight amounts of turbidity interfere with the determination. Therefore samples showing visible turbidity should be clarified by centrifugation.

2.2.2 The method is pH dependent. Colour of water normally increases with increase in pH value unless the coloured ion precipitates.

2.2.3 Use of filter paper may result in removal of some of the colour, leading to erroneous results. Therefore, filter paper should not be used for determination of true colour.

2.3 *Sample Handling and Preservation* — Representative samples shall be taken in clean glassware. Colour should be determined as early as possible after the collection of samples as biological activity or physical changes occurring during storage may affect the colour. Refrigeration at 4°C is recommended.

### 2.4 Apparatus

2.4.1 *Nessler cylinders* — 50 ml capacity.

2.4.2 *Centrifuge or filter assembly* — With glass fibre filters or membrane filters with functional pore sizes of approximately 0.45 µm. ( see Fig. 1 ).

### 2.5 Reagent

2.5.1 *Standard chloroplatinate solution* — Dissolve 1.246 g potassium chloroplatinate (  $K_2PtCl_6$  ) ( equivalent to 500 mg metallic platinum ) and 1.00 g crystalline cobaltous chloride (  $CoCl_2 \cdot 6H_2O$  ) ( equivalent to 250 mg metallic cobalt ) in distilled water containing 100 ml of concentrated hydrochloric acid. Dilute to 1 000 ml with distilled water. This standard solution is equivalent to 500 colour units.

### 2.6 Preparation of Standards

2.6.1 Prepare standards having colour units of 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 60 and 70 by diluting 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 6.0 and 7.0 ml standard chloroplatinate solution with distilled water to 50 ml. Use distilled water as 0 unit standard.

2.6.2 Protect these standards against evaporation and contamination by use of clean inert stoppers. The standards should also be protected against absorption of ammonia, which causes increase in colour.

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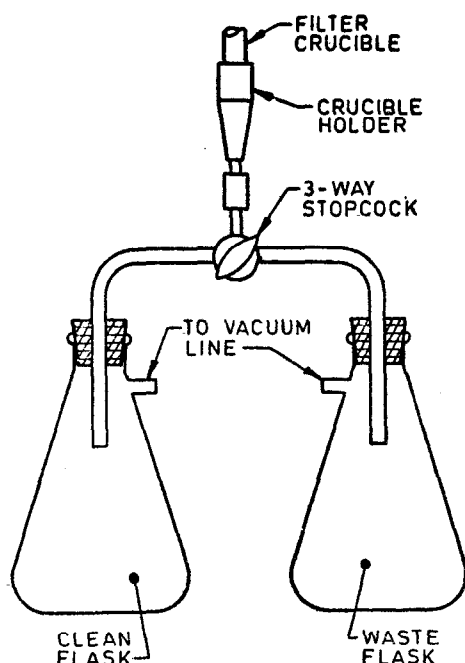


FIG. 1 FILTRATION SYSTEM FOR COLOUR DETERMINATION.

**2.7 Procedure**

**2.7.1 Apparent colour** — Observe the colour of the sample by filling a matched Nessler cylinder to the 50 ml mark with water and compare with standards. Compare by looking vertically downward through the cylinders towards a white surface placed at such an angle that light is reflected upwards through the column of liquid. If turbidity has not been removed, report the colour as 'apparent colour'. If the colour exceeds 70 units, dilute the sample with distilled water until the colour is in the range of the standards.

**2.7.2 True colour** — Remove turbidity by centrifuging or filtering sample until the supernatant liquid is clear. Compare the centrifuged or filtered sample with distilled water to ensure that turbidity has been removed. If the sample is clear, then compare with the standards as given in 2.7.1.

**2.8 Calculation** — Calculate the colour units as follows:

$$\text{Colour units} = \frac{50A}{V}$$

where

- A = estimated colour of diluted sample, and
- V = volume in ml of sample taken for dilution.

**2.9 Report** — Report the results in whole numbers as follows:

Colour Units	Record to Nearest
1 to 50	1
51 to 100	5
101 to 250	10
251 to 500	20

**2.10 Precision and Accuracy** — Data not available.

**3. Spectrophotometric Method**

**3.1 Principle** — Colour characteristics are measured at pH 7.6 and original pH of the sample by obtaining the visible absorption spectrum of the sample on a spectrophotometer. The percent transmission at certain wavelengths is used to calculate the results which are expressed in terms of dominant wavelength, hue, luminance and purity.

### 3.2 Apparatus

**3.2.1 Spectrophotometer** — Having 10 mm absorption cells, a narrow (10 mm or less) spectral band and an effective operating range from 400 to 700 nm.

**3.2.2 Filtration system** — Consisting of following ( see Fig. 1 ):

- a) Filtration flasks, 250 ml with side tubes ;
- b) Crucible holder;
- c) Micrometallic filter crucible, average pore size 40  $\mu\text{m}$ ;
- d) Calcined filter aid ( celite 505 or equivalent); and
- e) Vacuum system.

**3.3 Sample Handling and Preservation** — Since biological activity may change the colour characteristics of a sample, the determination should be made as soon as possible. Refrigeration to 4°C is recommended.

### 3.4 Procedure

**3.4.1** Take two 50-ml samples and bring to room temperature. Use one sample at original pH value and adjust pH of other sample to 7.6 by use of suitable volume of concentrated sulphuric acid or sodium hydroxide so that not more than 0.5 ml acid or alkali is used. Remove suspended material by centrifuging. Treat each sample separately by thoroughly mixing 0.1 g filter aid in a 10-ml portion of centrifuged sample and filtering the slurry to form a precoat in the filter crucible. Direct the filtrate to waste flask of filtration system. Mix 40 mg filter aid in a 35-ml portion of the centrifuged sample. With the vacuum still on, filter through the precoat and pass the filtrate to waste flask until clear, and then direct the clear filtrate flow to clean flask by means of three-way stop-cock. Collect 25 ml sample for measurement of transmittance.

Note — In case a larger volume of acid/alkali is required for pH adjustment, determine the exact quantity required and use the appropriate dilution factor.

**3.4.2** For determination of light transmittance characteristics clean 10 mm absorption cells with detergent, rinse with distilled, filtered water and fill the cell with filtered water. Determine the transmittance values ( in percent ) for the sample at each of the visible wavelength values given in Table 1. For fairly accurate work take readings at 10 ordinates marked with an asterisk, and for increased accuracy at all 30 ordinates. Set the instrument to read 100 percent transmittance on the distilled water blank. Make all determinations with a narrow spectral band.

TABLE 1 SELECTED ORDINATES FOR SPECTROPHOTOMETRIC COLOUR DETERMINATIONS

Ordinate No.	Wavelength, nm		
	X	Y	Z
1	424.4	465.9	414.1
2*	435.5*	489.5*	422.2*
3	443.9	500.4	426.3
4	452.1	508.7	429.4
5*	461.2*	515.2*	432.0*
6	474.0	520.6	434.3
7	531.2	525.4	436.5
8*	544.3*	529.8*	438.6*
9	552.4	533.9	440.6
10	558.7	537.7	442.5
11*	564.1*	541.4*	444.4*
12	568.9	544.9	446.3
13	573.2	548.4	448.2
14*	577.4*	551.8*	450.1*
15	581.3	555.1	452.1

( Continued )

TABLE 1 SELECTED ORDINATES FOR SPECTROPHOTOMETRIC COLOUR DETERMINATIONS — *Contd*

Ordinate No.	Wavelength, nm		
	X	Y	Z
16	585.0	558.5	454.0
17*	588.7*	561.9*	455.9*
18	592.4	565.3	457.9
19	596.0	568.9	459.9
20*	599.6*	572.5*	462.0*
21	603.3	576.4	464.1
22	607.0	580.4	466.3
23*	610.9*	584.8*	468.7*
24	615.0	589.6	471.4
25	619.4	594.8	474.3
26*	624.2*	600.8*	477.7*
27	629.8	607.7	481.8
28	636.6	616.1	487.2
29*	645.9*	627.3*	495.2*
30	663.0	647.4	511.2
<i>Factors when 30 ordinates used</i>			
	0.032 69	0.033 33	0.039 38
<i>Factors when 10 ordinates used</i>			
	0.098 06	0.100 00	0.118 14

\*Insert in each column the transmittance value in percent corresponding to the given wavelength. Where limited accuracy is sufficient, only the ordinates marked with an asterisk may be used.

### 3.5 Calculation

3.5.1 Tabulate the transmittance values corresponding to wavelengths shown in col X, Y and Z, in Table 1. Add each of transmittance columns and multiply the tables by the appropriate factors (for 10 or 30 ordinates) shown at the bottom of the table to obtain tristimulus values X, Y and Z. The tristimulus value Y is the percent luminance of the waste.

3.5.2 Calculate the trichromatic coefficients X and Y from tristimulus values X, Y and Z by the equations :

$$X = \frac{X}{X + Y + Z}$$

$$Y = \frac{Y}{X + Y + Z}$$

Locate the point (X, Y) on one of the chromaticity diagrams shown in Fig. 2 and determine the dominant wavelength and purity from this diagram. Determine the hue values from dominant wavelength value according to the ranges given in Table 2.

TABLE 2 COLOUR HUES FOR DOMINANT WAVELENGTH RANGES

Dominant Wave Length Range nm	Colour Hue
400 — 465	Violet
465 — 482	Blue
482 — 497	Blue green
497 — 530	Green
530 — 575	Greenish yellow
575 — 580	Yellow
580 — 587	Yellowish orange
587 — 598	Orange
598 — 620	Orange red
620 — 700	Red
400 — 530 <sup>c</sup>	Blue purple
530 <sup>c</sup> — 700	Red-purple

Note — See Fig. 2 for significance of 'C'.

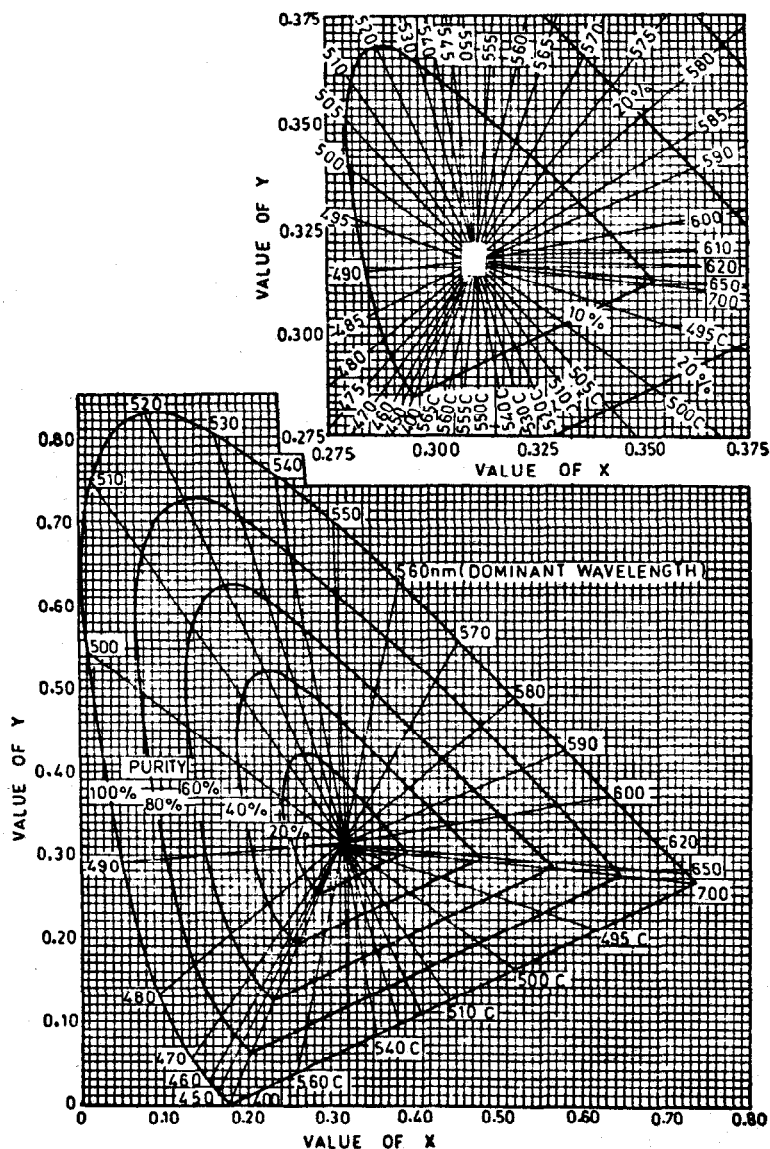


FIG. 2 CHROMATICITY DIAGRAM

**3.6 Report** — Report the colour characteristics at pH 7.6 and at original pH in terms of dominant wavelength (nm to the nearest unit) hue (for example, blue, blue green, etc) luminance (percent to the nearest tenth), and purity (percent, to the nearest unit). Mention the type of instrument (that is the spectrophotometer), the number of selected ordinates (10 or 30) and the spectral band width.

### EXPLANATORY NOTE

Colour in water may be due to inorganic ions, such as iron and manganese, humus and peat materials, plankton, weeds and industrial wastes. The term 'colour' is used to mean true colour, that is, the colour of water from which turbidity has been removed. The term apparent colour includes not only the colour due to substances in solution but also that due to suspended matter. Apparent colour is determined on the original sample without filtration or centrifugation.

This method supersedes 5 of IS : 2488 (Part 1)-1966 'Methods of sampling and test for industrial effluents : Part 1' and 5 of IS : 3025-1964 'Methods of sampling and test (physical and chemical) for water used in industry'