

Physical Analysis of Water

2.1 Potability of Water

(1) Principle

Colour is determined by visual comparison of the sample with known concentration of coloured solutions. Comparison also may be made with special, properly calibrated glass colour disks. The platinum-cobalt method measuring colour is the standard method, the unit of colour being that produced by 1mg platinum/L in the form of the Chloroplatinum ion.

(2) Chemicals Required

Potassium Chloroplatinum (K_2PtCl_4), Cobaltous Chloride ($CoCl_2 \cdot 6H_2O$), Concentrated HCl.

(3) Materials Required

Nessler tube (50ml), pH meter, Aluminium foil, measuring cylinder (50ml), graduated pipette.

(4) Preparation of Stock Solution

Dissolve 1.246g potassium Chloroplatinum (equivalent to 500mg metallic Pt) and 1.00g crystallized Cobaltous Chloride (equivalent to about 250mg metallic Co) in distilled water. Carefully add 100ml concentrated HCl and make up the volume to 1litre (1000ml) with distilled water. This stock solution gives a colour value of 500 colour units.

(5) Preparation of Standards

Prepare standards having colour value of 5, 10, 15, 20, 25, 30, 25, 40, 45, 50, 55, 60, 65 and 70 by diluting 0.5, 1.0, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5 and 7.0ml of the stock solution with distilled water. Label each tube and cover with aluminum foil to protect from evaporation and contamination.

(6) Pre-Treatment of Sample

Even a slight turbidity in sample may cause deviation of apparent colour (colour due to suspended matter and other substances in the solution) from the original colour (colour from which turbidity has been removed). Therefore, removal of turbidity is necessary before putting samples into experiment. The pretreatment includes removal of turbidity by centrifugation or filtration. While centrifuging, the sample, it should be kept in mind excessive centrifugation or centrifugation at high speed may alter results.

(7) Procedure

- Take 50ml of the sample in a nessler tube.
- Hold the standard tubes vertically above white surface and match the colour of the sample with that of the nearest colour of the standard. Record the value.
- If the colour exceeds 70 units, dilute sample with distilled water in known proportions until the colour is within the range of the standard.
- Measure pH of each sample.

(8) Calculation

$$\text{Colour (unit)} = \frac{A \times 50}{B}$$

Where,

A = estimated colour of a diluted sample,

B = Volume of the sample taken for dilution in ml,

50 = Total volume taken for reading,

(Comment= Drinking water usually shows colour unit below 20.)

2.2 Turbidity

(1) Introduction and Principle

Turbidity of water can be accurately measured for any water sample that is free from debris and rapidly settling coarse sediment with the help of an instrument called 'Nephalo-turbidimeter'. The method is based on a comparison of the intensity of light scattered by a standard reference suspension under the same condition. The higher the intensity of light, higher the turbidity. Formazine polymer is used as the primary standard reference suspension. The turbidity of a specific concentration of formazin suspension is defined as 4000NTU (Nephalo Turbidity Unit).

(2) Reagent

Hydrazine Sulphate, $(\text{NH}_2)_2\text{H}_2\text{SO}_4$, Hexamethylene tetramine $(\text{CH}_2)_6\text{N}_4$, Distilled water.

(3) Apparatus

Nephalo turbidimeter, Sample tube (made of colour free glass), 100ml volumetric flask, measuring cylinder.

(4) Stock Solutions

Solution I: Dissolve 1.0g hydrazine sulphate in distilled water and dilute to 100ml in a volumetric flask.

Solution II: Dissolve 10.0g hexamethylene tetramine in distilled water and dilute to 100ml in a volumetric flask.

Composite solution: In a flask, mix 5.0ml solution I and 5.0ml solution II. Let stand for 24h at 25 ± 3 °C. This solution is 4000NTU suspension. Transfer stock suspension to an amber glass or other UV-light-blocking bottle for storage. Make dilution from this stock suspension. The stock suspension is stable for upto 1year, if properly stored.

(5) Procedure

- Switch on the nephalo-turbidimeter and keep 15minutes to warm up.
- Set nephalo-turbidimeter to 100 using 100 NTU standard suspension (Standard solution of 50, 10 or more than 100 NTU can be used as per the level of turbidity of the sample).

- Shake the sample thoroughly and let the air bubbles subside.
- Take the sample in a nephalo-turbiditymeter tube and find out the value.
- If the turbidity of the sample exceeds 100 NTU, the sample can be diluted further with distilled water (rather than using other standard suspension) so that its turbidity can be read within 100NTU.
- Note down the reading.

(6) Calculation

$$\text{Turbidity (NTU)} = \frac{A \times (B+C)}{C}$$

Where,

A= NTU reading in diluted sample,

B= Volume of distilled water,

C= Sample volume taken for dilution in ml.

(7) Precautions

- Shake the sample thoroughly before measuring. Do not allow sample to stand for long time to remove air bubbles.
- Hydrazine sulphate is a carcinogen, avoid inhalation, ingestion and skin contact. Formazin suspensions may also contain residual hydrazin sulphate.

2.3 Temperature

(1) Introduction

Turbid water absorbs more sunlight and hence the temperature of water increases.

(2) Apparatus

Alcohol or mercury thermometer with 110 °C as maximum graduation.

(3) Procedure

- Record the surface temperature by holding the thermometer upright in the surface.
- Rerecord the water temperature immersing the bulb of the thermometer in it.

See that the bulb is completely immersed in water.

- Observe the mercury or alcohol column and note down the reading in Celsius when the reading becomes constant.

(4) Precautions

- Do not expose the bulb of the thermometer to direct source of heat or sunlight while taking the reading.
- It is important to take temperature reading at the same time of the day and season, if the readings have to be composed over a period.
- Take minimum and maximum temperature and mention it in your record if temperature is measured over a period of time i.e. Day, Month, etc.

Note: Conversion of temperature

$$^{\circ}\text{C} = \frac{(^{\circ}\text{F} - 32.0)}{1.80}$$

$$^{\circ}\text{F} = (^{\circ}\text{C} \times 1.80) + 32.0$$

Where, F = degree Fahrenheit.

2.4 Dissolved Solids

(1) Principle

The solids represent the portion of a water sample, which is not lost upon evaporation. Solids include dissolved organic matter, particulate organic matter, dissolved inorganic substances except gases and the CO₂ contained in bicarbonate and particulate inorganic substances.

The Total Solid (TS) concentration represents dissolved and particulate organic and inorganic matter. It is determined by evaporating a raw water sample, weighing the residue and expressing the weight of the residue as mg/L in the sample.

The Total Volatile Solid (TVS) concentration is measured by determining the weight loss upon ignition of the residue from the TS analysis. It is also expressed as mg/L in the water sample and is an estimate of dissolved and particulate organic matter.

To measure the Total Dissolved Solids (TDS) concentration, a sample is

filtered to remove the particulate matter, the filter is evaporated and the residue weighed. It indicates the mg/L of dissolved organic and inorganic matter in a sample.

When the residue from the TDS analysis is ignited and the weight loss determined, one may obtain the Total Volatile Dissolved Solids (TVDS), which is expressed as mg/L of the dissolved organic matter in a sample.

(2) Apparatus

Porcelain dish/glass beaker, oven or bunsen burner, analytical balance and dessicator, glass fibre filter, funnel and muffle furnace.

(3) Procedure

a) TS and TVS

- Weigh a glass beaker or a porcelain dish. This is initial weight (w_1).
- Take a known volume of the water sample in the weighed dish or beaker.
- Evaporate the sample to dryness at 103°C to 105°C for 24h in an oven. If an oven is not available, heat the beaker on a bunsen burner using a sand bath or directly, until the water evaporates and a residue is left behind.
- Cool the container in a dessicator if available or make air cool. Weigh the container and record the reading. This is the final weight (w_2).

b) Calculation of TS

$$\text{TS in mg/L} = \frac{\text{Final weight } (w_2) - \text{Initial weight } (w_1)}{\text{Volume of the sample taken}}$$

For TVS, the sample processed for TS can be further treated as follows:

- Place the evaporating dish (porcelain dish) in a muffle furnace at 550°C for 30 minutes.
- Cool in a dessicator and weigh. This is w_3 .

c) Calculation of TVS

$$\text{TVS in mg/L} = \frac{\text{Final weight } (w_2) - \text{Initial weight } (w_1)}{\text{Volume of the sample taken}}$$

d) TDS and TDVS

The procedure is same as TS and TDS. But the sample is to be filtered before

measuring TS.

TDS can be used as a measurement of Salinity in brackish or sea water and expressed as g/L (equivalent to parts per thousand, ppt). However, one has to be careful for that measurement of TDS gives all dissolved solids including salts and other organic/inorganic materials in water.

