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PHY1901 - INTRODUCTION TO INNOVATIVE PROJECTS

FACULTY - LEEMA ROSE VIANNIE

Final Review Report

WATER HARDNESSS DETECTION USING COLORIMETRIC SENSOR DESIGN

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AIM:

A new sensor design for detecting water hardness using colorimetric concepts.

BACKGROUND:

WATER HARDNESS is of great concern to both domestic and industrial users. It is caused by compounds of calcium and magnesium, and by a variety of other metals. As the concentrations of calcium (Ca^{2+}) and magnesium (Mg^{2+}) are usually greater than other alkaline earth ions (Group 2), hardness is equated to

Hardness of water = $[Ca^{2+}] + [Mg^{2+}]$

The amount of dissolved calcium and magnesium. in water determines how hard the water is. Water hardness is typically classified into four types –

- Soft (0-0.6 mmol/L)
- Moderately hard (0.61-1.20 mmol/L),
- Hard (1.21-1.80 mmol/L)
- Very Hard (≥ 1.81 mmol/L).

CONCEPTS USED:

We present a sensor that combines two well known concepts of colorimetry and complexometric to detect water hardness. Our sensor uses LEDs, Photodiodes and Voltmeter/Galvanometer. When a light is passed through a homogeneous coloured solution the solute in the homogeneous mixture absorbs some light i.e., absorbance. The absorbance is directly proportional to the concentration of solute.

A = € b c (Beer-Lambert law)

A - Absorbance

€ - Molar absorption coefficient ($M^{-1}cm^{-1}$)

b - Molar concentration (M)

c - Optical path length (cm)

The coloured solution should be a homogeneous solution so that there is no scattering of light (no Tyndall effects should be shown). Metal-ion indicators are used to give coloured solution.

MATERIALS REQUIRED:

- 250 ml Water sample (hard water)
- Eriochrome Black T (EBT- metol-ion indicator)
- Buffer Solution of ammonia and ammonium chloride at PH=10
- Blue LED
- Photodiode
- Voltmeter

PROCEDURE:

- Take a beaker fill with hard water.
- Add Eriochrome Black T (EBT- metol-ion indicator) to the hard water with buffer solution of ammonia and ammonium chloride.

EBT is a blue colour in a buffered solution, it turns red when calcium ions and magnesium ions are added. The ions involved in water hardness change the steel blue colour of EBT indicator into wine red colour.

- Blue LED is used to pass a blue light through the wine-red solution. Most of the blue light is absorbed by red solution depending on the concentration of [Ca2+] and [Mg2+] and the remaining blue light falls on the photodiode
- The photodiode absorbs photons and produces electricity that can be recorded using a voltmeter

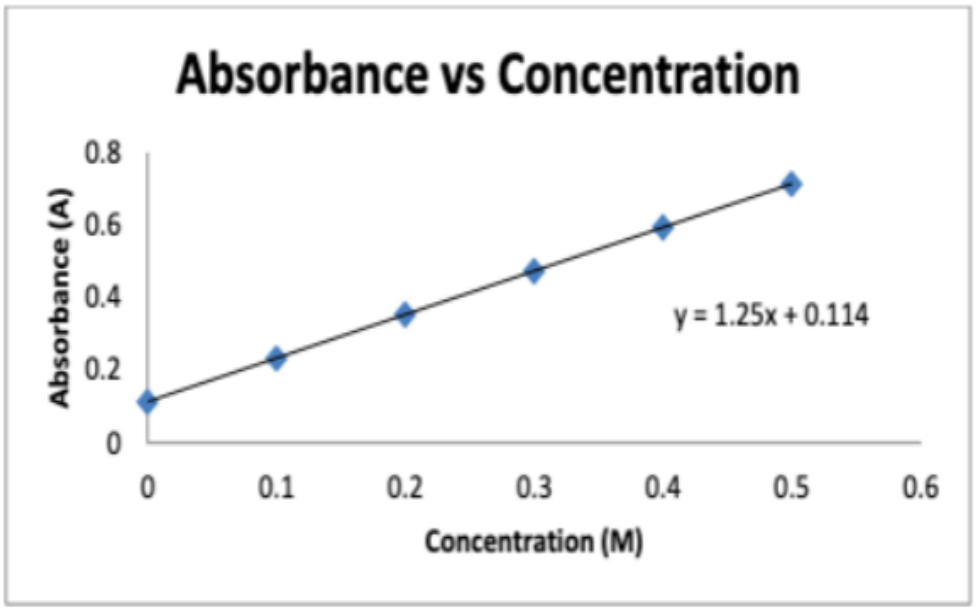
OBSERVATIONS:

When Blue light is passed through 5ml of water solution the Voltmeter reading we get is 0.50V.
When EBT buffer solution is added we get following result-

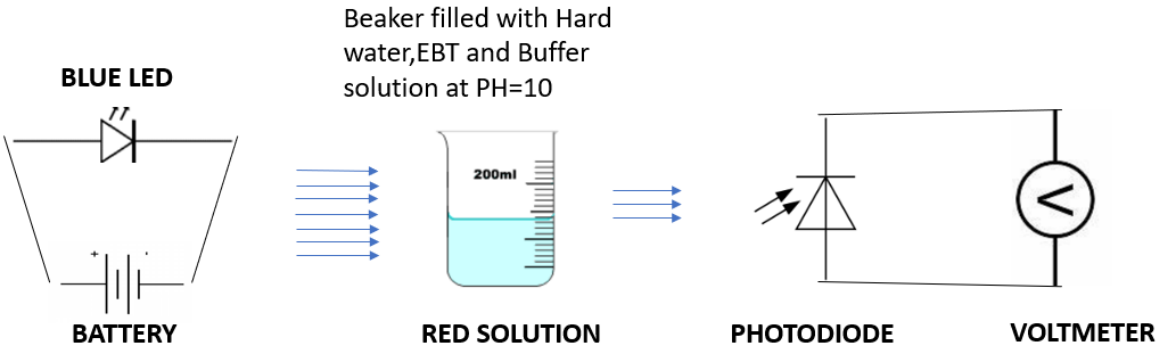
Voltmeter Reading (volts)	Transmittance
0.50	100%
0.39	78%
0.38	76%
0.40	80%
0.42	84%
0.40	80%
0.37	74%
0.44	88%
0.35	70%
0.32	64%

- Mean Transmittance=77.11%
- Absorbance=100% - 77.11% = 22.88%

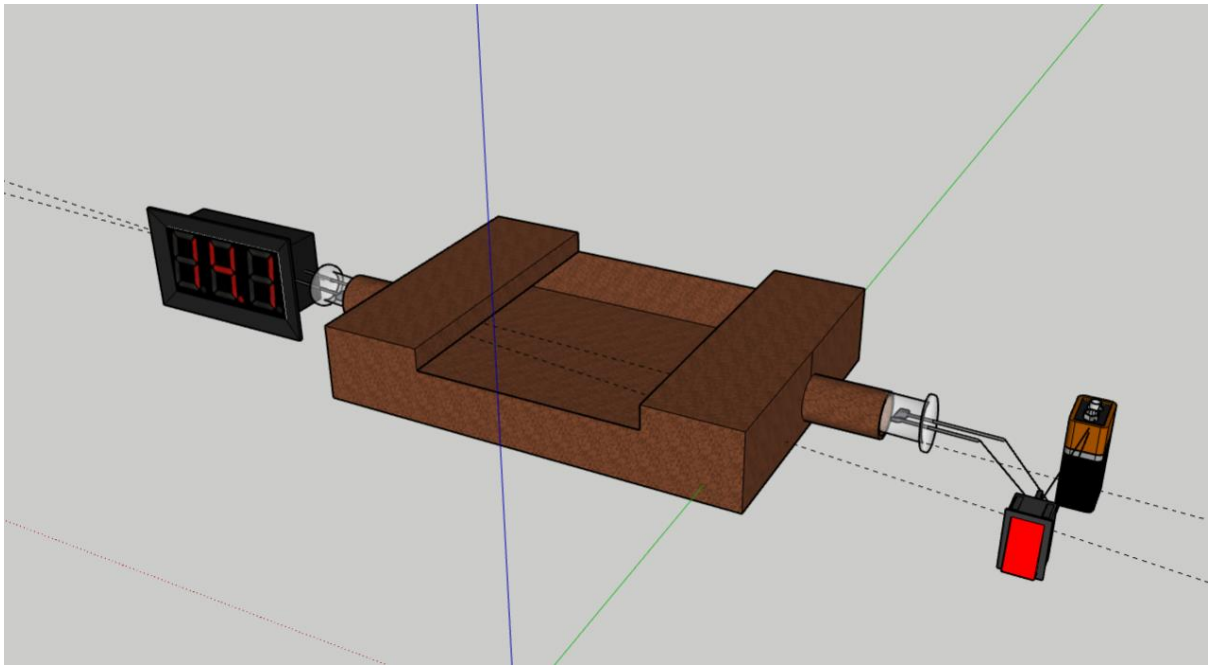
- From the table we conclude that voltmeter reading and transmittance percentage are linearly dependent on each other.
- Now we can calculate the concentration of Ca2+ and Mg2+ using the absorbance-concentration graph.
- If two solution has the same absorbance provided they are placed in the same condition they will have the same concentration of solute



SETUP:



SCHEMATIC SNAPSHOTS:



ADVANTAGES:

- Low energy costs : The device minimizes the energy consumption and man- power involved in the measurement of the hardness of water.
- Commercial feasibility : The device is easy to produce at low costs and has the potential to provide profitable business opportunities.
- Dynamic measurements possible : This device is capable of performing hardness check on the water even when the water is flowing which was not possible with the earlier models as they required water to be static in nature. Due to this it can easily be installed in homes.
- Faster Results : The device provides quick and near to accurate results minimizing the time required in the process.

PRODUCTION COSTS:

- Earlier a lot of man-power was involved in performing the titrations involved for the measurement of the hardness.
- Along with that there was also the cost of chemicals and instruments-apparatuses involved.
- Now the only major costs are the leds, photodiode, buffer solution and the metal ion indicator chemical.

SPECIFIC CONTRIBUTIONS BY THE TEAM:

YASH 20BCT0227: Setup, Testing and presentation
DEEPU 20BDS0373: Setup and Testing
JAI 20BDS0297: Report and presentation
LEKHA 20BCM0043: Concepts and Research
BASKY 20BCM0138: Concepts and Research
RANADHEER 20MIC0086: Groundwork and Miscellaneous tasks

XXX… THANK YOU …XXX