Institute of Science and Technologie

Department of Process Engineering / First Year of Master's in Chemical Engineering

Practical Work N: 01

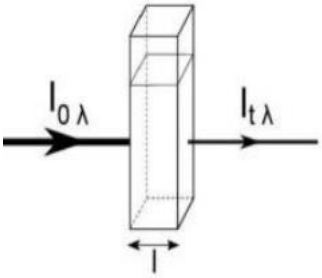
Preparation of a methyl orange solution and its spectrophotometric analysis

1- Introduction:

Molecular UV–visible absorption spectrophotometry is a very common analytical method used in laboratories. It is based on the ability of matter to absorb light radiation, in other words, on the interaction between molecules and electromagnetic radiation. The usable wavelength range corresponds approximately to the visible spectrum (400 to 800 nm) and the near ultraviolet region (200 to 400 nm). This method requires the use of a spectrophotometer and makes it possible to characterize molecules and determine the concentrations of chemical species in solution.

2- Principle of the method

When a solution is traversed by polychromatic radiation, it can reduce the intensity of radiation at certain wavelengths; it is then said to absorb this radiation. Measuring the fraction of light intensity absorbed at that wavelength makes it possible to determine the concentration of the absorbing substance in the solution under study.



3- Beer–Lambert Law:

Let us consider a solution containing a chemical species of concentration *C* that absorbs at wavelength λ. The Beer–Lambert law gives a relationship between the absorbance A_λ and the concentration *C* of the chemical species in solution.

$$\mathbf{A_\lambda = \varepsilon.l.C}$$

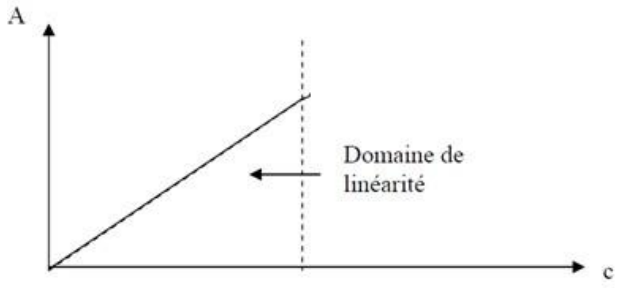
Where:

ε: the molar absorption coefficient (usually expressed in $L \cdot mol^{-1} \cdot cm^{-1}$). It is a quantity that depends on the chemical species considered, the wavelength of analysis, the solvent, and the temperature.

l: the path length of the solution crossed by the light beam (expressed in cm). Cuvettes with a path length of 1 cm are generally used.

C: the concentration of the species considered in solution (expressed in $mol \cdot L^{-1}$).

The graph representing absorbance as a function of concentration, called the calibration line (or calibration curve), makes it possible to determine the concentration of a solution from the measurement of the absorbance of solutions with known concentrations.



The correlation coefficient, R^2, and the Y-intercept of the regression line allow you to demonstrate the acceptability of the linearity of the data."

4- Work objectives:

- To understand the spectrophotometry technique.

- To understand and be able to use the relationship between absorbance and the concentration of an absorbing species in solution (Beer–Lambert law).
- To determine, from a calibration curve, the concentration of a methyl orange solution

5- Procedure:

5.1. Preparation of the stock solution of methyl orange C0C_0C0

Weigh 9.82 mg of methyl orange dye and dissolve it in a 100 mL volumetric flask by adding 80 mL of ethanol, then make up to the mark with distilled water.

5.2. Preparation of methyl orange solutions

We have an aqueous solution of methyl orange with a concentration C_0=3.10−4 mol·L^{-1}. We aim to prepare, by dilution, different methyl orange solutions with concentrations Ci.

Complete the columns of the table:

n° solution	Volume Vi of S0 introduced (mL)	Volume of water added (mL)	Total volume (mL)	Concentration Ci of the dilute orange methyl solution (mg/L or mol/L)	Absorbance A (unitless)
1	2,5				
2	5				
3	7,5				
4	10				
5	12,5				
6	15				

- Rinse a burette with the methyl orange Co solution, then fill it with the same solution.
- Add distilled water to reach the required volume (up to 50 mL).
- Prepare solutions S1 to S6 in different flasks.
- Pour the required volume of the methyl orange solution, then the volume of distilled water, put a stopper on the flask, and shake.
- Measure the absorbance of each prepared solution at $\lambda = 465$ nm.

6. Conclusion

In every lab session, it is always necessary to follow safety rules and the proper working method so that the work is well done and the lab session is better retained.

7. Lab report

After each lab session, the student must write a report including:

1. Cover page.
2. Bibliographic section.
3. Objectives and aims of the lab.
4. Materials and methods.
5. Answers to the questions.
6. Conclusion.

- Plot the curve A=f(C) on graph paper and using Excel.
- Comment on the shape of the curve and provide its equation.
- Determine the unknown concentration of a methyl orange solution using the calibration curve

Data: Methyl Orange

Its chemical formula is **$C_{14}H_{14}N_3O_3SNa$**.

Molar mass: **327.33 g·mol^{-1}**.