A Note on Nephelo-Turbidimetric Analysis

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ABSTRACT

The article describes here some of the aspects of scattering of light and its applicability in Nephelo-turbidimetric analysis.

Keywords: Scattering of light, Nephelometry, turbidimetry

INTRODUCTION

Red colour of sun at sunset, blue color of sky during day time, and haziness of solution are some key manifestations to conclude the phenomenon of scattering of light (SOL) occurring irrespective of medium. In technical sense, an ideal scattering can be defined as "the phenomenon where beams of light when impinges with particulate matter change in its direction of propagation from one to multiple planes without changing net radiating power or energy". In general aspects, light scattering can be categories into following two types an elastic and an inelastic scattering each envelops a distinct bounce back phenomenon of waves when it comes in contact with particulate matter. Scientifically, elastic scattering involves light absorption by a particle followed by its transmission without change in radiant energy however transmittance of radiation with change in energy is an inelastic type of light scattering. Universally scattering of light is none an independent phenomenon however depends upon numerous factors such as number of particulate matter present in a medium including their dimensions as well as wavelength of light that interact with them. Rayleigh & Tyndall scattering are some exemplifications of elastic scattering, former involves interaction between particles smaller in dimension compared to wavelength of light while later involves interaction of larger particle compared to wavelength of light. Instrumental analytical technique that measures the extent of elastic scattered of light when it comes in contact with particulate matters present in solution is known as nephelo-turbidimetric analysis.

PRINCIPLE

Nephelometry and turbidimetry are distinct class of instrumental techniques that rely on the phenomenon of scattering of light (SOL) by particulate matters present in the solution. It is an universally accepted fact that when a beam of light is passes through two dissimilar medium there is difference in intensity of incident and transmitted light among i.e. in transparent medium the intensity of incidence beam of light is same as that of transmitted beam while the medium containing suspended particles the intensity of transmitted beam of light is lesser than incident beam due to interaction between particulate matter and beam of light. It is noteworthy to pinpoint that in both the cases there is no effect on radiating power of light beam. If a sensitive photodetector is placed on other side of medium the net change in intensity of incidence to transmitted beam of light is thus recorded. Nevertheless, if all the parameters are kept constant extent of reduction in intensity of beam reaches to photodetector relates concentration of particles responsible for scattering. On the basis of dimension as well as extent of particulate matter present in the medium the different angles with respect to incident and scattered beam is selected for measurement for example in nephelometric analysis power of scattered beam of light is measured at an angle 90 degree to incidence beam while in case of turbidimetry power of scattered beam of light is measured at an angle 180 degree to that of incidence beam.

CHOICE BETWEEN BOTH THE TECHNIQUES

Choice between nephelo or turbidimetric methods depends upon following two parameters

Scattered radiation intensity vs incidence radiation intensity: In case medium to be analyzed contains high concentration of particulate matter turbidimetry is choice over nephelometry while just opposite is true for very dilute solutions containing fewer particulate matter, leading to least scattering hence nephelometry is choice over turbidimetry.

Size of particulate matters: Nephelometry is choice in case where particles suspended in medium are of smaller dimension since they scattered light at right angle to incidence beam, this is the reason why nephelometric measurements are done usually at an angle of 90-degree to collimated beam while in case of particle of larger dimension, scattering of light in this case to such a extent is somewhat difficult, hence turbidimetry is preferred and measurements for same are done at an angle of 180-degrees.

FACTORS AFFECTING SCATTERING OF LIGHT IN SOLUTION

1. Order and rate of mixing of substance within solution.
2. Agitation of solution containing particulate matters.
3. Temperatures of solution as it affect solubility of component present in it.
4. Viscosity of medium.
5. Presence or absence of electrolyte or protective colloid.
6. Concentration of solution.
7. Number of particulate matter suspended.
8. Dimension of particulate matter.
9. Wavelength of radiating beam.
10. Refractive index of medium.

INSTRUMENTATION

Any photometer (visual or photoelectric) can be a turbidimeter without modification. However for greater sensitivity, a blue filter can additionally be employed in the instrumental layout design. The same instrument as describes above can also be used nephelometer however in this case the instruments should have suitable provision for adjusting source and detector at a right angle to each other.

***Radiation source*:** Generally an ideal source for nephelo-turbidimetric measurement must be sufficient intense and monochromatic so that photometric error if any can be substantially be minimized. Mercury arc lamp or Laser light are some of the commonest radiation sources used in nephelo-turbidimetric analysis however later is advantageous owing to its capability of emitting monochromatic beam compared to tungsten lamp, which exceptionally emits polychromatic light beam.

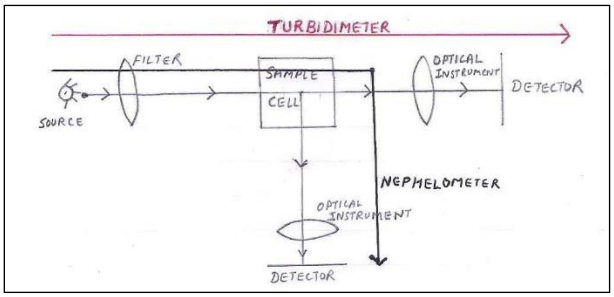

Figure 01: Components of Turbidimeter (straight line) & Nephelometer (line bent at right angle)

***Filters*:** Filter aid-up in selecting particular wavelength of light to be worked upon. Generally as per the feasibility of analysis colorimeter with blue filter (530nm) is a turbidimeter while fluorimeter with a visible secondary filter is nephelometer.

***Sample cell*:** Cuvette or sample cells are used to hold the sample under interest and are generally made up of transparent glasses; geometrically may either be cylindrical or rectangular in shape with a path length of 1-cm. Sometime special cells measuring light scattering at different angles 45, 90, 135-degree also employed in nephelo-turbidimetric analysis.

Detectors: On the basis of nature of study to be done, the position of detector with respect to source has to be selected for example in case of turbidimetric analysis the detector is placed inline arrangement (180-degree) with respect to source of radiation however in case of nephelometry the detector is adjusted at an angle 90-degree to source of light. In general photovoltaic cells and phototubes are suitable for turbidimetric analysis while sensitive photomultiplier tubes are ideal for nephelometric determination.

CONCLUSION AND APPLICATIONS

Nephlo-turbidimetric method no doubt is an ideal inexpensive technique used for multi-facet

measurements some of which are precisely discussed below;

1. Determination of particle size present in suspensions.
2. Determination of average molecular weight of polymer in solution.
3. Measurement of atmospheric pollutants.
4. Determining concentration of solute in solution.
5. Growth of bacterial cell in a liquid nutrient medium.
6. Turbidimetry and nephelometry has numerous applications in water treatment plants, sewage work, steam generating plant, beverage bottling industry, in pulp and paper manufacturing, petroleum refining and pharmaceutical industries.
7. Determination of carbon dioxide, sugar products and clarity of citric acid juice.
8. Determining end point of precipitation titration.

↓ REFERENCES

1. Watson D.G., Pharmaceutical analysis; Churchill Livingstone, Edinburgh; 1999.
2. Helmut G, Alex W.; Basic Principles of Chromatography; Wiley-VCH; Weinheim; 2001; Edn 1, 173-197.
3. Beckett A.H., Stenlake J.B.; Practical Pharmaceutical Chemistry; CBS Publisher; New Delhi; 2005
4. Skoog D.A., Holler, F.J., Nieman T.A.; Principles of Instrumental Analysis; Harcourt Brace & Co.; 1998.
5. Jeffery G.H., Bassett J., Mendham J., Denny R.C.; Textbook of Quantitative Chemical Analysis; Longman Scientific & Technical; 1989.
6. Sharma, B.K.; Instrumental methods of chemical analysis-Introduction to analytical chemistry; Goel Publishing House; 2000.