A PHOTOELECTRIC NEPHELOMETER FOR CHEMICAL ANALYSIS

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Introduction

Chemical analysis of substances by measurement of the amount of light (i) absorbed, in case of dissolved substances and (ii) reflected, in case of suspended ones, has assumed considerable importance in analytic procedures in recent years. In a previous communication2 from these laboratories the authors described a new instrument for chemical analytic purposes by measurement of the absorbed light. The present contribution deals with a physical instrument and an outline of the procedure for the analysis of suspended substances by measurement of the reflected light.

The chief advantages of the nephelometers, i.e., instruments for chemical analysis of suspended substances by measurement of reflected light, are their convenience of operation, the large number of analyses that can be done at a time and the possibility of measuring with their aid concentrations which are measurable only with great difficulty, if at all, by gravimetric methods. However, the nephelometers do suffer from certain inherent limitations which need elimination. The dependence on the ability of the eye in the matching of light introduces a personal error in the estimations. Moreover, colour blindness, a defect not uncommonly met, dispenses with the use of the visual nephelometers. The two types (i) "constant upper end type" and (2) "constant lower end type" to which the nephelometers conform, differ in the distance that the light from the longer of the two illuminated and measured columns has to travel from the particles to the eye-piece—greater and smaller (respectively) than that from the shorter column. This variation in the distance factor, must necessarily introduce a certain amount of inaccuracy. Further, any arrangement, dispensing with the use of the plunger, which is likely to disturb the size or dispersion of the suspended particles, is desirable.

The frequent necessity of making a large number of quantitative estimations of soil and plant constituents, by the production of insoluble precipitates, has repeatedly called for simplifying the procedure so as to eliminate
the possibilities of personal error in observations, to detect more minute differences than is possible by the preceding methods and to be applicable for varied purposes. The new instrument described here circumvents some of the defects of the visual nephelometer and allows of certain additional advantages.

**Principle**

A turbid fluid possesses the property of causing a part of the light illuminating it to be deviated from its original direction and be diffused. The brightness of the light reflected, *i.e.*, opacity, is due to small particles in suspension in the liquid. The intensity of light reflected depends upon (i) the number of particles in suspension and (ii) their size.² Provided the latter is kept constant, *viz.*, by the production of suspension with uniform sized particles and comparison with an invariable standard of turbidity the intensity of the light scattered in a certain direction affords a measure of the amount of the suspended particles.

The method described here essentially consists in measuring the intensity of scattered light coming from an illuminated column of suspended substance* with the light scattered from an invariable standard of turbidity, *viz.*, frosted glass discs, with the aid of a quantitatively variable light diminution. With a view to obtaining precision in measurements, and to correct for the differences in tint in the light reflected by the suspension and standard, the measurements are made within the range of any one of the appropriately selected colour filters blue (450–510 µµ), green (520–560 µµ), and red (620–680 µµ).

From a calibration graph where the turbidity values are plotted against a series of known concentrations any observational reading may then be read off directly.

**Apparatus**

The essential features of the apparatus may readily be seen from the schematic diagrams (Figs. 1 and 2).

The source of light L is a 30 watt 8 volt "Nitra" lamp supplying an intense light which is regular and easily adjustable. Two equal beams of light from the lamp enter through the two lenses A₁ and A₂, the chambers C₁ and C₂ containing the turbid solution and the comparison standard respectively, in the form of a parallel pencil of rays square in section. The lights scattered by the suspended particles in the turbid liquid, and by the frosted

* The reaction producing the suspension should result in particles of uniform size and stability.