BILJEŠKE NOTES

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An Attachment to the Beckman Model DU Spectrophotometer for Precise Measurements of Turbidity*

Gj. Deželić

Laboratory of Physical Chemistry, Faculty of Science, and Department of Applied Biochemistry, »Andrija Štampar« School of Public Health, Faculty of Medicine, University of Zagreb, Zagreb, Croatia, Yugoslavia

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The experimental performance of turbidity measurement by transmission technique is in principle the same as the measurement of extinction. Therefore commercial spectrophotometers can be conveniently used for determining the turbidity of moderately and strongly turbid media (up to 0.5 $cm.^{-1}$ with cells of 10 cm. path length) if some precautions are taken. The main advantage of their use is the fact that particle sizes or molecular weights can be obtained directly without any calibration of the apparatus.

The errors occuring generally in transmission turbidity measurements were discussed by other authors[1,2]. The main problem in such measurements is the prevention of the light scattered at small angles to enter the detector, a requirement more important as particle size increases. In the apparatus of Heller and coworkers[3,4] this is avoided by using a light beam of small diameter and keeping the cell at a large distance from the detector (small solid angle of the light beam seen by the detector). In the construction of Gumprecht and Sliepcevich[5] there is a lens — pinhole arrangement as a regulator of the solid angle. In our construction we followed the first suggestion.

The geometry of the usual spectrophotometers does not admit any precise turbidity measurements when particle diameters are greater than 150 mμ (*e. g.* with the Beckman DU photometer using 10 cm. cells and performing measurements in the same manner as in the absorption measurements the error may amount up to 30%[1]). For that reason some authors used specially built instruments[3,4]. A simpler and cheaper way to remove instrumental pitfalls is to adapt an already existing apparatus by introducing some changes in the geometry of the optics of apparatus. The first description of a turbidimetric assembly built in connection with a commercial spectrophotometer, which eliminates the errors discussed by Heller and Tabibian[1], has been made by Bateman and coworkers[6]. This assembly was used in combination with the Beckman DU spectrophotometer whose crystal quartz entrance and exit windows were removed.

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The device described in this note follows closely that of Bateman *et al.* The main difference and its advantage is in leaving the original arrangement of the Beckman apparatus unchanged (quartz windows not removed), what permits the diversified use of the spectrophotometer when combined with other attachments. Because of this advantage and since Bateman *et al.* did not go into detailed description of their modification, we believe that publication of this note is warranted. As with Bateman construction, our modification is also built from inexpensive parts and requires only a very limited amount of shop work.

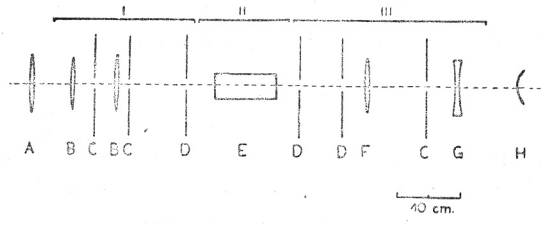

Fig. 1. Schematic view of the attachment for measurement of turbidity. A — Beckman exit lens, B — biconvex lenses of 5 cm. focal width, C — circular stops of 2.5 mm. in diameter, D — circular stops of 3 mm. in diameter, E — cell, F — biconvex lens, G — biconcave lens, H — Beckman phototube.

A schematic view of our construction is given in Fig. 1. The whole device consists of three separate parts. The first one (I) serves for obtaining a nearly parallel light beam strictly defocused. The light beam emerging from the Beckman silica exit lens (A) is of a rectangular shape. After passing through the condensor consisting of two simple lenses (B) of a focal width of nearly 5 cm. and several circular stops (C,D), the beam is transformed into a circular one, defocused and weakly divergent. The cell compartment (II) is the original Beckman accessory for cells of 10 cm. path length (E). The third part (III) has

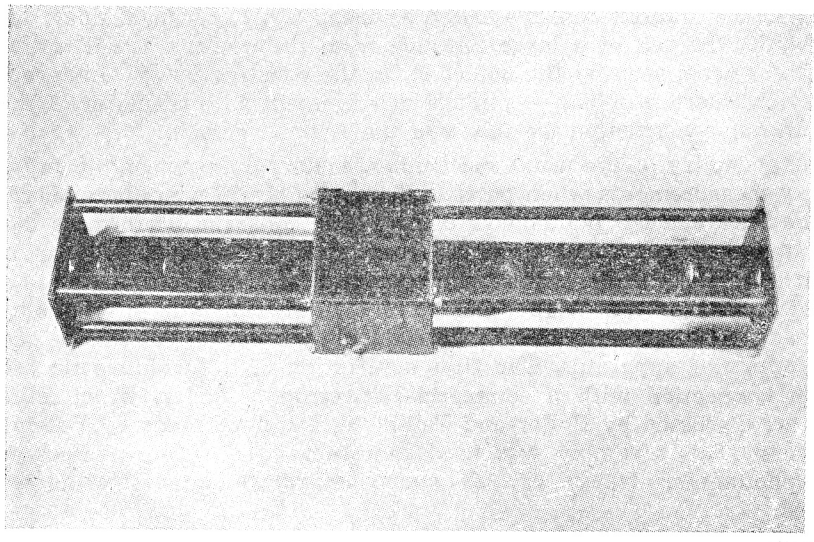

Fig. 2. Inner view of the attachment.

the purpose of the elimination of stray light, multiple scattering and corona effect. The biconvex (F) and biconcave (G) lenses give an image of uniformly distributed intensity onto the phototube. It is obvious that in this construction the measured values of turbidity practically does not depend on the variation of the spectrophotometer slit width. The divergence of the beam within the cell amounts to 1.2^0 of the half angle. The solid angle of the cone of scattered light seen by the detector, defined by the planar angle[1] ω, is 0.83^0. Fig. 2 is a photograph of the attachment (the covers of the compartments are taken off). The whole device (about 70 cm. in length) can be easily inserted between the monochromator and phototube unit. Fig. 3 shows the attachment mounted on the Beckman spectrophotometer.

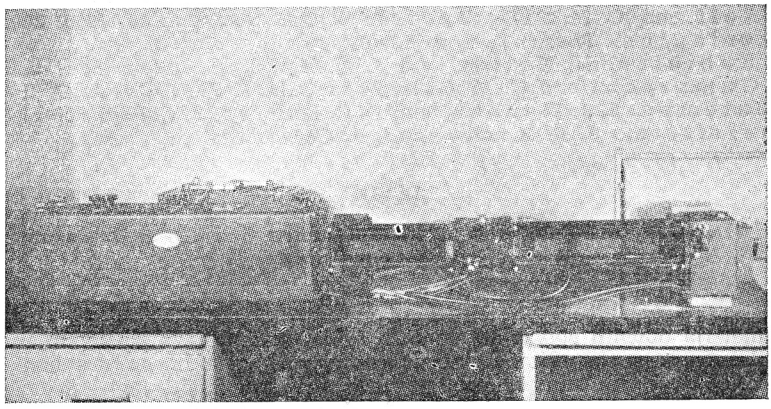

Fig. 3. The attachment mounted on the Beckman DU spectrophotometer.

Because of the great decrease in the intensity of light reaching the phototube, it is much more convenient to work with the photomultiplier attachment, although the normal blue sensitive phototube can be also used (in the later case greater slit widths must be applied resulting in light of less monochromacy). The absence of stray light, multiple scattering and corona effect was proved. For this purpose the cell walls must be blackened.

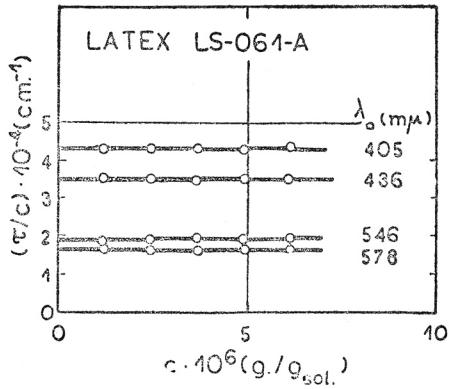

Fig. 4. Dependence of specific turbidity τ/c *versus* concentration c for Dow monodisperse polystyrene latex LS-061-A of 365 mμ in diameter.

This device showed as very satisfactory in use. The specific turbidity of monodisperse polystyrene latexes practically did not depend on the concentration [7], a fact in agreement with findings of other authors[4,6]. A typical plot is given in Fig. 4, representing one series of measurements on monodisperse polystyrene latex of 365 mμ in diameter. A full report of these measurements is given in Ref. 7.

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IZVOD

Dodatak Beckmanovom spektrofotometru tipa DU za precizna mjerenja mutnoće

Gj. Deželić

Geometrija običnih spektrofotometara nije pogodna za precizna mjerenja mutnoće, jer se javljaju eksperimentalne pogreške, koje u nekim slučajevima mogu biti i prilično velike. Razni autori opisali su izvore tih pogrešaka kao i principe, prema kojima treba konstruirati aparate za dobivanje ispravnih rezultata u mjerenju mutnoće.

Detaljno je opisana jednostavna i prilično jeftina naprava, koja se montira na Beckmanov spektrofotometar tipa DU i daje pouzdane rezultate. Prednost te naprave pred drugim sličnima jest u mogućnosti brze montaže i skidanja, što omogućuje upotrebu spektrofotometra i u druge svrhe.

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