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A simple constant head device

Throttled gravity flow from a reservoir is a common means of feeding eluent to chromatographic columns. If the head is great enough, the variation in flow rate caused by lowering of the liquid level in the reservoir is not serious. However, in applications such as gel filtration, when gels with high molecular weight exclusion limits are employed, a high head is likely to compress the gel bed so that required flow rates cannot be maintained. In these cases, when a low head is desirable, some form of constant head device is required to maintain a reasonably constant flow of eluent.

The Mariotte bottle (after the seventeenth century French physicist, EDMÉ MARIOTTE) is probably the most widely used constant head device but has some disadvantages. The most serious of these are sensitivity to ambient temperature changes and a tendency to surge at low flow rates and low liquid level. (See CUTLER[1] for description).

The device depicted in Fig. 1 and described in the legend has been found to be

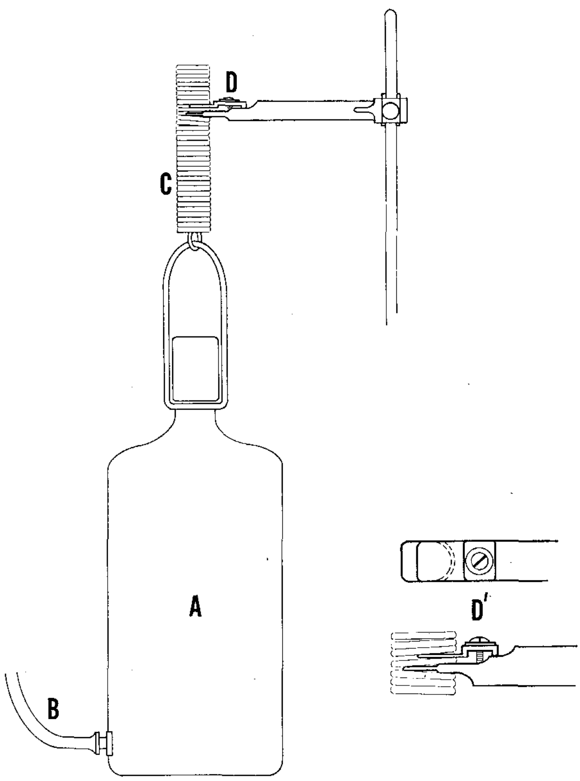

Fig. 1. Constant level reservoir: (A) reservoir with wire yoke for suspension; (B) flexible outlet tube; (C) suspension spring; (D) suspension clamp. D′ is a detail of the suspension clamp showing the groove in the lower part that serves to hold the spring in position during adjustment.

capable of maintaining a constant head $\pm$ 1 mm when assembled from readily available springs and bottles. If required, even this small variation could be reduced by refinements such as the use of an accurate cylinder as a reservoir and protection from drafts which might cause oscillation.

The spring used should be long enough and strong enough so that its elastic limit is not approached when fully loaded. The strength and length should also be such that the extension by the required load is somewhat greater than needed. The adjustment required to maintain a constant head is made at the suspension clamp. The length of spring required to match the spring extension to changes in liquid level in the suspended reservoir is first approximated by clamping an appropriate coil. Fine adjustment is then made by rotating the coil through the loosened clamp. The adjustment can also be used to compensate for solution density. Tension springs of this type are normally wound with tightly packed coils and the weight of the empty reservoir may not be enough to cause any extension. In such a case, the spring must be pre-stretched beyond its elastic limit sufficiently to slightly loosen the coils.

The outlet tube should be small and flexible with a freely suspended loop of sufficient length to accommodate the vertical movement of the reservoir; 1/16 in. I.D. by 1/8 in. O.D. vinyl tube has been found satisfactory for most applications. During calibration the tube should be suspended as it will be in use so that compensation will be included for the varying length of tube supported by the spring as the liquid level changes.

As an example, when a 1 gal. polyethylene bottle with a bottom outlet was chosen as a reservoir, it was determined that the liquid level fell 6 cm when 1 liter (1 kg) of water was withdrawn from the cylindrical portion. A spring that extended 7.5 cm/kg (0.056 in. wire, 7.5 in. long, 9/16 in. coil diameter) was then selected from the assortment available at a local hardware store. The ratio of the extension required (6 cm/kg) to the extensibility of the spring (7.5 cm/kg) multiplied by the length of the spring (7.5 in.) then gave 6 in. as the first approximation of the portion of this spring required to maintain a constant level. Final adjustment was then made by filling and draining the reservoir with the buffer to be used as eluent.

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1 W. G. CUTLER, *Am. J. Phys.*, 27 (1959) 185.

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