Apparatus for Conditioning Unlimited Quantities of Finished Waters for Enteric Virus Detection

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An apparatus has been developed, constructed, and tested for conditioning unlimited quantities of finished waters for enteric virus detection.

The potential occurrence of enteric viruses in treated potable water supplies is of major concern to many environmental health officials (2). Critical examination of water supplies for the presence of viruses, however, requires a quantitative approach. Moreover, adequate viral assessment of drinking water supplies also requires that large quantities of at least 100 gal (378.5 liters) be sampled (3). Furthermore, in the not-too-distant future, some microbial indicator system or minimal treatment standards may have to be established in order to assure that drinking water is virologically safe. As part of a continuing effort to develop such criteria or standards, a study on the occurrence of viruses in drinking water in the United States has recently been initiated by the Water Supply Research Laboratory.

In initiating viral studies of drinking water, the immediate problem was technological, i.e., how to conveniently sample large quantities (100 gal or more) of water. This note describes the design characteristics of a water sampling apparatus for conditioning unlimited quantities of finished water in a flow-through system. The apparatus principally consists of ancillary component parts set up to control pH and ionic concentration of the water before the water passes through the selected viral adsorbent.

Details of the requirements for virus adsorption and elution from various adsorbents have been published previously (1, 4–8). Efficiency of virus adsorption has been shown to be enhanced by controlling pH in the range of 3.5 to 4.5 and by the addition of cations, i.e., Mg2+ or Al3+ at predetermined concentrations. In addition, sodium thiosulfate or other chloride neutralizing chemical should be constantly added to the water sample to prevent viral inactivation. The apparatus, as described, systematically (i) adds the necessary chemicals at the desired concentration, e.g., thiosulfate is added via one dosing pump, and HCl and cation are added via the other dosing pump, (ii) measures water sample volume, and (iii) mixes all additives before the water is delivered to the virus adsorbent. A diagrammatic view of the apparatus is shown in Fig. 1. The component parts consist of (i) a pressure relief valve, (ii) a household water meter, (iii) a standard pressure gauge, (iv) 5-gal (18.9-liter) chemical additive containers, and (v) a hydraulic pressure-driven fluid proportioner containing two dosing pumps and a mixing chamber (model M14, manufactured by Johanson & Son Machine Corp., Clifton, N. J.). The apparatus is connected to the selected virus-adsorbent holder for virus concentration. Any one of a number of effective virus adsorbents, e.g., Millipore nitrocellulose membranes, AA Cox M-780 epoxy-fiberglass filters or K-27 fiberglass depth filters may be used (4–6). All component parts are commercially available at a reasonable cost. The angle iron, two-wheeled dolly carrier can be readily constructed by any competent welder.

The apparatus can be effectively operated at as little as 20 psig of water pressure, a pressure below the standard faucet pressure. We generally adjust the pressure relief valve to prevent pressure from rising above 60 psig. Effective virus concentration studies with membrane filters have been conducted at flow rates of 1 to 2 gal (ca. 3.8 to 7.6 liters)/min. Therefore, a 100-gal sample can be processed in 50 to 100 min. Chemicals are dosed into the water sample through the fluid proportioner to produce the final desired concentration. For convenience, we use a dilution factor of 1:100 although the proportioner dosing pumps can be easily adjusted to produce 1:29 to 1:1,280 dilutions. The fluid proportioner motor also will deliver approximately 10 gal/min with 100 psig regulated pressure. Since the proportioner dosing pumps are driven by the water flow, the pre-
determined dilution rate of chemical additives is not affected by changes in flow rate.

We have conducted many virus recovery experiments by using the water-conditioning apparatus. Measurements of the filtrate water periodically throughout the many experimental runs indicated that the water-conditioning apparatus effectively and predictably controlled pH and the ionic strength of the water at the desired levels. We have extensively tested the flow-through system by using Millipore filters and fiberglass microfilters as selected virus adsorbents. In quantal virus seeding experiments conducted with coxsackievirus type B1, coxsackievirus type A9, reovirus type 1, and poliovirus type 1 at virus inputs of 100 infectious units (TCID₅₀ or plaque-forming units) per 100 gal, virus was recovered with 100% reliability when 100 gal were sampled. In quantitative virus recovery studies using poliovirus type 1 (strain Lsc 2ab), recoveries have ranged from 25 to 50% with virus inputs of 16 to 50 plaque-forming units per 100 gal when 100 gal were sampled.

We feel that the apparatus satisfies not only the logistics but also the scientific requirements for conditioning extremely large quantities of water for enteric virus detection. Consequently, a need is filled for those who are planning to monitor large volumes of water for the presence of viral agents and for those who are investigating and evaluating materials as potential viral adsorbents.

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