A SIMPLIFIED MULTICHAMBER GRADIENT MIXER

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A previous report[1] described a mixer capable of producing an almost infinite number of systematically variable gradients, simple or compound, for use in chromatography. It comprised a ring of nine serially connected cylindrical chambers, the contents of which were stirred magnetically or by rotating paddles as liquid flowed from one to another to maintain hydrostatic equilibrium in response to the removal of liquid from one end of the series. The shape of the gradient was determined by the concentration initially introduced at each position, and any number of different solutes could be given independent gradients in the emerging liquid. This communication presents a more compact version that is simpler and less expensive to construct, although identical in its theoretical aspects. In the new design, nine rectangular chambers are arranged linearly, and mixing is accomplished by the oscillation of a line of stirrers in a manner similar to that of a windshield wiper.

Fig. 1 provides end and top views of a mixer constructed of Lucite and capable of holding 1200 ml. The sides and ends of the tank are 1/4 in. thick, the bottom 3/16 in. Eight partitions of 1/8 in. Lucite divide the interior into chambers measuring

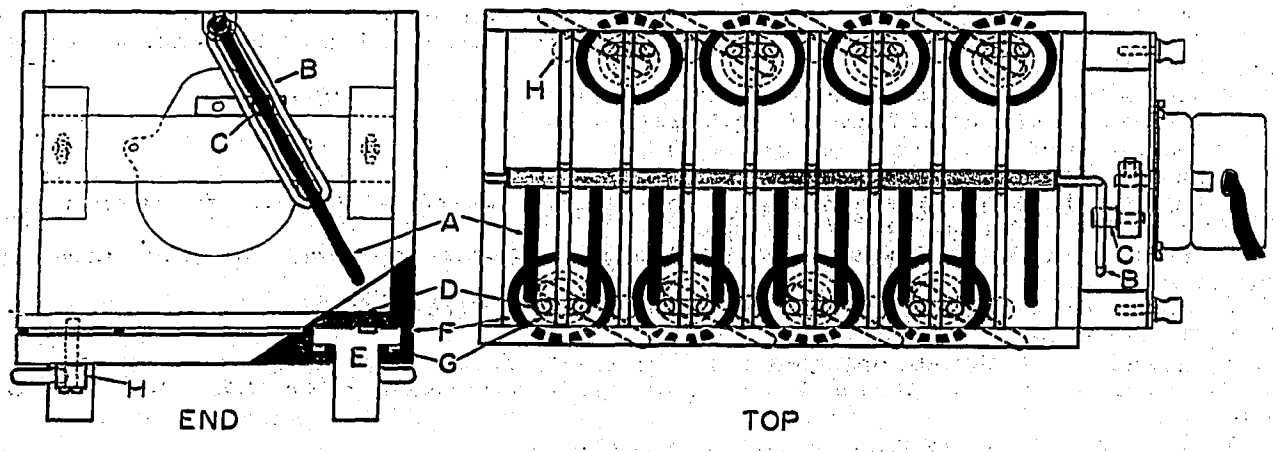

Fig. 1.

10 × 10 × 1.5 cm. The stirring unit is a comb-like assembly of nine Lucite rods (A), 1/8 in. in diameter, mounted in a 1/4 in. rod that is supported at its ends by inserts of 3/32 in. stainless steel wire that rest in 1/8 in. slots in the end walls of the tank. One of these inserts extends beyond the end of the tank and is bent and soldered to

form a flat loop (B) in a plane perpendicular to the axis of the 1/4 in. rod. Within this loop moves a brass sleeve (C), rotating freely on a steel pin fixed to a steel arm, which is in turn attached to the shaft of a 60 r.p.m. Cramer double torque (60 in. oz. at 1 r.p.m.) synchronous motor. As the motor shaft turns, the pin moves in a 1.5 in. circle, imparting a back and forth motion to the stirring assembly. A marked difference between the forward and backward speeds prevents the building up of sizable waves and aids mixing by causing a vertical circulation of the liquid in the direction, at the bottom of the chamber, of the more rapid motion. The 1/8 in. stirring rods used in this model have proved adequate for mixing 1 *M* NaCl with water, but liquids differing greatly in density will require the use of paddles instead of rods. Paddles would be needed, also, for larger mixers. In such cases the stirring unit can be cut as a single piece from a sheet of Lucite.

Entrance and exit holes (D) are 3/16 in. in diameter and are located at opposite ends of the floor of each chamber. The Teflon stopcock plugs (E) are 1 in. in diameter, with 1/2 in. shanks. Off center channels, 3/16 in. wide and 1/16 in. deep, in the flat, upper surfaces of the plugs connect exit and entrance holes of adjacent chambers when the stop-cocks are in the open position. In the closed position only one of the holes of a given pair remains connected with the channel. The rounded ends of each channel, corresponding also to the positions of the holes, are centered on radii of the Teflon plug 120° apart. Neoprene "O" rings (F), 1 in. in diameter, prevent leakage to the exterior. The plugs are supported in a 3/8 in. Lucite plate and are pressed against the holes in the bottom of the tank by 1/2 in. "O" rings (G) that are compressed by tightening the ten screws (only one is shown) that fasten the stopcock assembly to the tank. These screws pass through the centers of the sections of 5/8 in. Lucite rod that serve as stops (H) for the stopcock handles. The tank is covered with a 1/8 in. Lucite plate (not shown) containing one or more holes to accommodate a glass or plastic outlet tube (see ref. [1]). A leveling bubble should be mounted on the top surface of the cover and two small Lucite studs on its bottom surface to fit into diagonally opposite corners of the tank. A 1/2 in. steel rod fastened along the bottom of the stopcock plate provides a means of mounting the apparatus on a vertical supporting rod.

The mixer can be constructed with fixed channels instead of stopcocks, in which case the holes are stoppered with removable plugs while the chambers are being filled[1]. However, this will result in a significant loss in operating convenience.

SUMMARY

An improved design for a nine chambered variable gradient mixer, employing a single oscillating stirrer unit and easily made stopcocks, is described.

REFERENCE

[1] E. A. PETERSON AND H. A. SOBER, *Anal. Chem.*, 31 (1959) 857.