NOTES
Gravity Flow System for Continuous Culture Feed

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There are innumerable varieties of devices available for the supply of fluid media to continuous culture systems. The unit presented here offers the advantage of being an inexpensive system with a high degree of reliability. No moving parts or pumps are required, and functional models can be constructed from routine laboratory ware.

The primary problem with gravity flow or "drip" systems has been their dependence upon some kind of restricted orifice for control of the feed rate. Such orifices tend to clog from the debris in the medium. Variations in the room temperature with corresponding expansion and contraction of an adjustable orifice unit also cause definite changes in flow rate through the system. A partial solution to this problem was supplied by H. A. Jannasch (Arch. Mikrobiol. 45:323, 1963), who used the simple device of a length of one plastic or rubber tubing in place of the orifice. Such a system then depends on restriction of flow by surface resistance and interaction between the fluid and the walls of the tubing. Thus, it is possible to use tubing up to 2 or 3 mm in diameter, provided a sufficient length is employed.

To develop a complete gravity flow system, we devised a simple "self-feeder" to maintain a constant static pressure head. When this was combined with the constant effects of resistance to flow and gravity, a system with remarkably uniform flow was provided, a system from which a variety of adaptations can be made. As may be seen in Fig. 1, we employed about 2 to 4 meters of tubing (0.01 mm in inner diameter) with approximately 30 cm of pressure head. Other combinations of tubing length, diameter, and pressure head can be employed to give the desired flow rate. However, from our experience, it is questionable that feed tube diameters much below that which we have indicated will be satisfactory.

Under the conditions listed above, the retention time of the medium in the tubing is less than 5 min, but, from earlier studies (R. B. Parker, Biotech. Bioeng., in press, 1966), it is known that this is sufficient to allow some oxygenation of the medium. Where such anaerobic conditions are required, it may be necessary to use stainless steel 21- to 24-gauge needle loom in place of the plastic tubing. An air vent at the top of the reservoir is required in order to compensate for volume loss as the medium is fed through the system. Where removable connections are desirable, standard taper fittings have been used for convenience and maintenance of sterility during assembly of the system. The one critical dimension in construction of the glass, constant-level reser-

![Diagram of gravity flow system](http://aem.asm.org/)

FIG. 1. Gravity flow system for continuous culture feed.

ervoir is the diameter of the air line, which in this specific example is 16 mm. Smaller diameters offer enough surface tension to hold water in the tube, which leads to a waterlock of the air line and a very erratic flow to the constant-level reservoir.

With proper design we have found hourly variations in volume output of this system to be less than 3% and 6-hr variations less than 1%, at flow rates near 10 ml/hr.

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