



**Figure 6.17.** Typical laboratory setup for a turbidostat. (With permission, from D. I. C. Wang and others, *Fermentation and Enzyme Technology*, John Wiley & Sons, Inc., New York, 1979, p. 100.)

pump is activated and fresh medium is added. The culture volume is kept constant by removing an equal amount of culture fluid. The turbidostat is less used than the chemostat, since it is more elaborate than a chemostat and because the environment is dynamic. Turbidostats can be very useful in selecting subpopulations able to withstand a desired environmental stress (for example, high ethanol concentrations), because the cell concentration is maintained constant. The selection of variants or mutants with desirable properties is very important (see Chapter 8).

A plug flow reactor (PFR) can also be used for continuous cultivation purposes. Since there is no backmixing in an ideal PFR, fluid elements containing active cells cannot inoculate other fluid elements at different axial positions. Liquid recycle is required for continuous inoculation of nutrient media. In a PFR, substrate and cell concentrations vary with axial position in the vessel. An ideal PFR resembles a batch reactor in which distance along the fermenter replaces incubation time in a batch reactor. In waste treatment, some units approach PFR behavior, and multistage chemostats tend to approach PFR dynamics if the number of stages is large (five or more).

### 6.4.3. The Ideal Chemostat

An ideal chemostat is the same as a perfectly mixed continuous-flow, stirred-tank reactor (CFSTR). Most chemostats require some control elements, such as pH and dissolved-oxygen control units, to be useful. Fresh sterile medium is fed to the completely mixed and aerated (if required) reactor, and cell suspension is removed at the same rate. Liquid volume in the reactor is kept constant.

Figure 6.18 is a schematic of a simplified chemostat. A material balance on the cell concentration around the chemostat yields

$$FX_0 - FX + V_R\mu_g X - V_R k_d X = V_R \frac{dX}{dt} \quad (6.64)$$