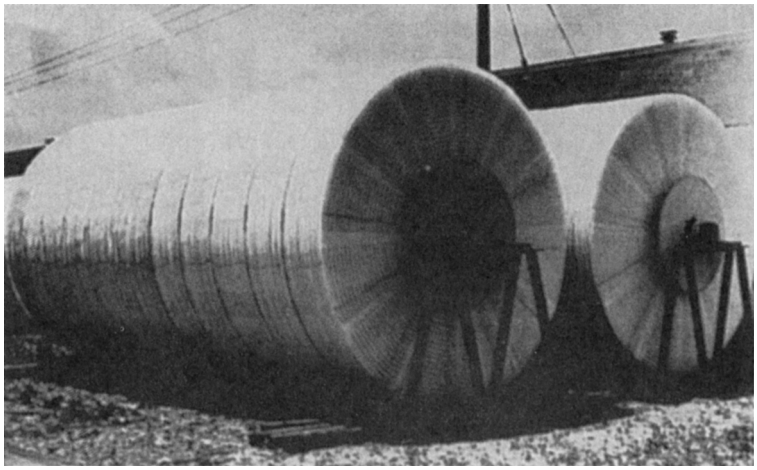

Figure 16.9. Styrofoam disks used in RBC units (Biosystems Division, Autotrol Corporation). (With permission, from E. D. Schroeder, *Water and Wastewater Treatment,* McGraw-Hill Book Co., New York, 1977, p. 306.)

biofilm. The design equations for RBCs are similar to those used for trickling biological filters (TBF). RBCs are more compact and efficient than trickling-bed systems.

Oxidation ponds provide another inexpensive alternative to activated-sludge and trickling biological filter operations. Oxidation ponds are shallow (2 to 4 ft deep) waste-treatment reactors closely resembling natural aquatic ecosystems. Bacteria and algae grow in the same pond in a symbiotic relationship. Bacteria oxidize organic compounds by utilizing oxygen produced by algae and produce CO_2; algae utilize CO_2 produced by bacteria and produce oxygen by photosynthesis for bacterial consumption. Such ponds require large land areas, are less efficient than many other techniques, and may have adverse environmental side effects. Toxic or hazardous materials may collect in the sediment without degradation, creating a long-term problem.

Anaerobic digestion (or biological treatment) is usually used to treat solid wastes and excess sludge produced in aerobic waste-treatment processes. Particulate waste material removed by screening or sedimentation in primary waste treatment and biomass (concentrated sludge) produced in activated-sludge units are degraded under anaerobic conditions to produce methane. Anaerobic digestion is a slow process compared to aerobic processes; typical residence times are 30 to 60 days. The microbiology and biochemistry of anaerobic digestion are very complicated. However, the major steps involved in this process are as follows:

1. *Solubilization of insoluble organics:* Waste material may contain large amounts of solids made of cellulosics (papers, agricultural wastes), starches (potato waste), and other complex insoluble organic chemicals. Solubilization of these compounds by acid or enzymatic hydrolysis (cellulases, amylases, glucoamylases, lipases, proteases) is the first step in anaerobic digestion. These compounds are not readily utilizable by microorganisms, and their hydrolysis is essential for effective microbial digestion.