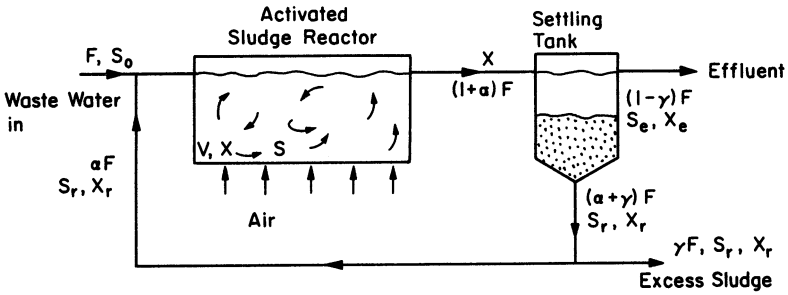

Figure 16.7. Schematic diagram of an activated-sludge unit.

mechanical agitation can be used in activated-sludge units. Mechanical surface aerators are widely used for shallow activated-sludge units. Surface aerators consist of partially submerged impellers attached to motors mounted on fixed structures. Surface aerators spray liquid and create rapid changes at the air–water interface to enhance oxygen transfer. Pure oxygen may be used for high-strength waste-water treatment. Also, stagewise operation with pure oxygen has been found to be a very effective method of waste-water treatment. The UNOX Process, first developed by Union Carbide, is based on this concept. Other forms of aeration include bubble aerators and fixed turbines similar to those we discussed in Chapter 10.

The activated-sludge system faces many uncontrolled disturbances in input parameters, such as waste flow and composition. Such disturbances can lead to system failure (less-than-adequate treatment of the waste stream). One type of disturbance is referred to as *shock loading*. A shock load indicates the sudden input (pulse) of a high concentration of a toxic compound. A CFSTR design, of course, is less affected by such inputs than a PFR design.

One response to disturbances is sludge *bulking*. A *bulking sludge* has flocs that do not settle well, and consequently cell mass is not recycled. *Bulking* sludge often results from a change in the composition of the microbial population in the treatment unit. For example, filamentous bacteria may dominate the normal floc-forming cells, leading to small, light flocs.

Various modifications of activated-sludge processes have been developed. Two examples are the following:

1. *Step feed process:* The feed stream is distributed along the length of the reactor. Such a configuration converts a conventional PFR system to more CFSTR-like behavior, which provides greater stability and more effective distribution and utilization of oxygen and oxygen transfer.
2. Solids reaeration (*contact stabilization*): In the conventional activated sludge process, the dissolved organics are quickly adsorbed onto (or into) the flocs, while the actual conversion to CO_2 and H_2O proceeds much more slowly. In contact stabilization, two tanks are used: one (about 1 h residence time) is used to promote the uptake of the organics, and the second (3–6 h residence time) is used for reaeration and the final conversion of the organic material. By concentrating the sludge before