

**Application Level:**

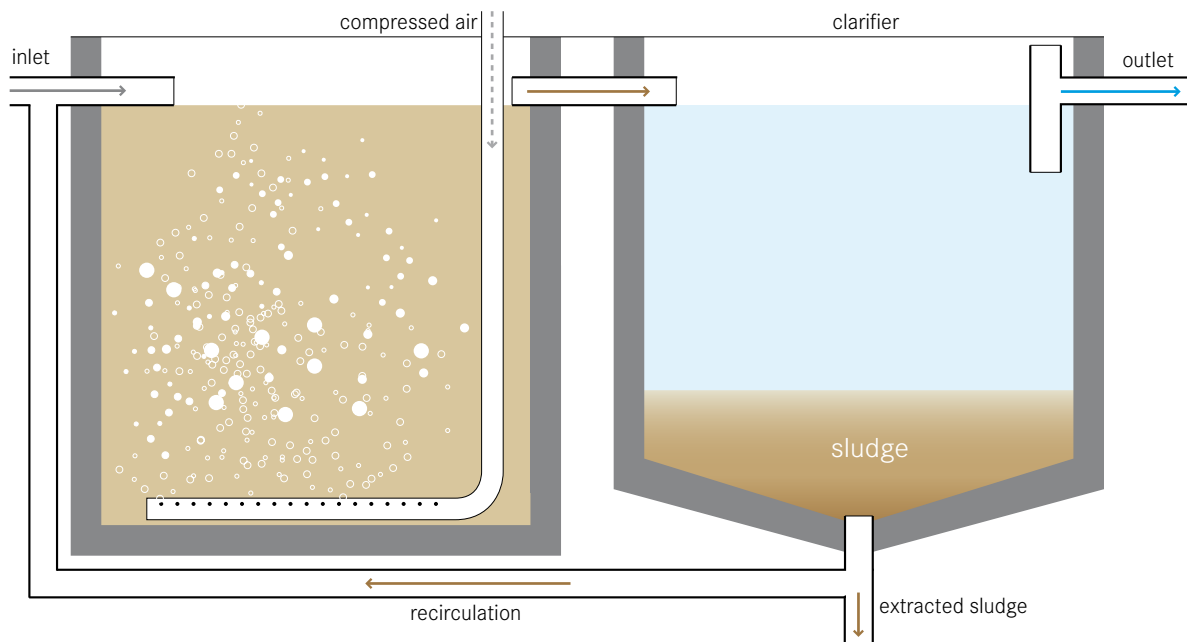
- Household  
 Neighbourhood  
 City

**Management Level:**

- Household  
 Shared  
 Public

**Inputs:**  Effluent  Blackwater  
 Brownwater  Greywater

**Outputs:**  Effluent  Sludge



**An activated sludge process refers to a multi-chamber reactor unit that makes use of highly concentrated microorganisms to degrade organics and remove nutrients from wastewater to produce a high-quality effluent. To maintain aerobic conditions and to keep the activated sludge suspended, a continuous and well-timed supply of oxygen is required.**

Different configurations of the activated sludge process can be employed to ensure that the wastewater is mixed and aerated in an aeration tank. Aeration and mixing can be provided by pumping air or oxygen into the tank or by using surface aerators. The microorganisms oxidize the organic carbon in the wastewater to produce new cells, carbon dioxide and water. Although aerobic bacteria are the most common organisms, facultative bacteria along with higher organisms can be present. The exact composition depends on the reactor design, environment, and wastewater characteristics.

The flocs (agglomerations of sludge particles), which form in the aerated tank, can be removed in the secondary clarifier by gravity settling. Some of this sludge is recycled from the clarifier back to the reactor. The

effluent can be discharged or treated in a tertiary treatment facility if necessary for further use.

**Design Considerations** Activated sludge processes are one part of a complex treatment system. They are usually used after primary treatment (that removes settleable solids) and are sometimes followed by a final polishing step (see POST, p.136). The biological processes that occur are effective at removing soluble, colloidal and particulate materials. The reactor can be designed for biological nitrification and denitrification, as well as for biological phosphorus removal.

The design must be based on an accurate estimation of the wastewater composition and volume. Treatment efficiency can be severely compromised if the plant is under- or over-dimensioned. Depending on the temperature, the solids retention time (SRT) in the reactor ranges from 3 to 5 days for BOD removal, to 3 to 18 days for nitrification.

The excess sludge requires treatment to reduce its water and organic content and to obtain a stabilized product suitable for end-use or final disposal. It is important to consider this step in the planning phase of the treatment plant.

To achieve specific effluent goals for BOD, nitrogen and phosphorus, different adaptations and modifications have been made to the basic activated sludge design. Well known modifications include sequencing batch reactors (SBR), oxidation ditches, extended aeration, moving beds and membrane bioreactors.

**Appropriateness** An activated sludge process is only appropriate for a Centralized Treatment facility with a well-trained staff, constant electricity and a highly developed management system that ensures that the facility is correctly operated and maintained.

Because of economies of scale and less fluctuating influent characteristics, this technology is more effective for the treatment of large volumes of flows.

An activated sludge process is appropriate in almost every climate. However, treatment capacity is reduced in colder environments.

**Health Aspects/Acceptance** Because of space requirements and odours, Centralized Treatment facilities are generally located in the periphery of densely populated areas. Although the effluent produced is of high quality, it still poses a health risk and should not be directly handled. In the excess sludge pathogens are substantially reduced, but not eliminated.

**Operation & Maintenance** Highly trained staff is required for maintenance and trouble-shooting. The mechanical equipment (mixers, aerators and pumps) must be constantly maintained. As well, the influent and effluent must be constantly monitored and the control parameters adjusted, if necessary, to avoid abnormalities that could kill the active biomass and the development of detrimental organisms which could impair the process (e.g., filamentous bacteria).

#### Pros & Cons

- + Resistant to organic and hydraulic shock loads
- + Can be operated at a range of organic and hydraulic loading rates
- + High reduction of BOD and pathogens (up to 99%)
- + High nutrient removal possible
- + Can be modified to meet specific discharge limits

- High energy consumption, a constant source of electricity is required
- High capital and operating costs
- Requires operation and maintenance by skilled personnel
- Prone to complicated chemical and microbiological problems
- Not all parts and materials may be locally available
- Requires expert design and construction
- Sludge and possibly effluent require further treatment and/or appropriate discharge

#### References & Further Reading

- Crites, R. and Tchobanoglous, G. (1998). *Small and Decentralized Wastewater Management Systems*. WCB/McGraw-Hill, New York, US. pp. 451-504.  
(Comprehensive summary including solved problems)
- Ludwig, H. F. and Mohit, K. (2000). *Appropriate Technology for Municipal Sewerage/Excreta Management in Developing Countries, Thailand Case Study*. The Environmentalist 20 (3): 215-219.  
(Assessment of the appropriateness of activated sludge for Thailand)
- von Sperling, M. and de Lemos Chernicharo, C. A. (2005). *Biological Wastewater Treatment in Warm Climate Regions, Volume Two*. IWA Publishing, London, UK.  
Available at: [www.iwaterwiki.org](http://www.iwaterwiki.org)
- Tchobanoglous, G., Burton, F. L. and Stensel, H. D. (2004). *Wastewater Engineering: Treatment and Reuse*, Metcalf & Eddy, 4<sup>th</sup> Ed. (Internat. Ed.). McGraw-Hill, New York, US.  
(Detailed design information)