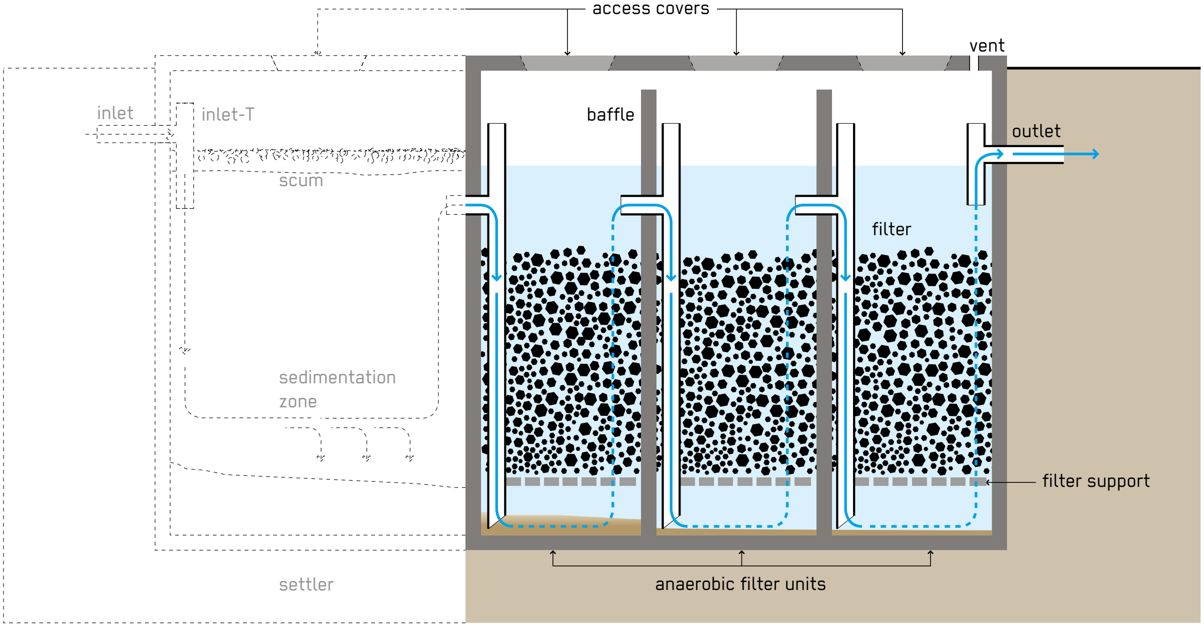
Anaerobic Filter

Phase of Emergency	Application Level / Scale	Management Level	Objectives / Key Features
Acute Response * Stabilisation ** Recovery	* Household ** Neighbourhood City	* Household ** Shared ** Public	BOD reduction
Space Required	**Technical Complexity**	**Inputs**	**Outputs**
** Medium	** Medium	Blackwater, Greywater	Effluent, Sludge



An Anaerobic Filter (AF) can efficiently treat many different types of wastewater. An AF is a fixed-bed biological reactor with one or more filtration chambers in series. As wastewater flows through the filter, particles are trapped and organic matter is degraded by the active biofilm that is attached to the surface of the filter material.

This technology is widely used as a secondary treatment in black or greywater systems and offers more effective solid removal than Septic Tanks **(S.13)** or Anaerobic Baffled Reactors **(T.2)**. The treatment process is anaerobic making use of biological treatment mechanisms. Suspended solids and biochemical oxygen demand (BOD) removal can be up to 90 %, but is typically between 50 % and 80 %. Nitrogen removal is limited and normally does not exceed 15 % in terms of total nitrogen.

Design Considerations: Pre-Treatment **(PRE)** is essential to remove solids and solid waste that may clog the filter. The majority of settleable solids are removed in a sedimentation chamber sequenced before the AF. Small-scale, stand-alone units typically have an integrated settling compartment, but primary sedimentation can also take place in a separate Settler **(T.1)** or another preceding technology (e.g. Septic Tank **(S.13)**). AFs are usually operated in upflow mode because there is less risk that the fixed biomass will be washed out which would reduce treatment efficiency. The water level should cover the filter media by at least 0.3 m to guarantee an even flow regime. The hydraulic retention time (HRT) is the most important design parameter influencing filter performance. An HRT of 12–36 hours is recommended. The ideal filter should have a large surface area for bacteria to grow, with large pore volume to prevent clogging. The surface area ensures increased contact between organic matter and the attached biomass that effectively degrades it. Ideally, the material should provide between 90–300 m^2 of surface area/m^3 of occupied reactor volume. The connection between chambers can be designed either with vertical pipes or baffles. Accessibility to all chambers (through access ports) is necessary for maintenance. The tank should be vented to allow for controlled release of odorous and potentially harmful gases. Where kitchen wastewater is connected to the system, a grease trap must be incorporated into the design before the Settler.

Materials: An AF can be made of concrete, sand, gravel, cement, steel, as well as fibreglass, PVC or plastic, and thus can be found as a prefabricated solution. Typical filter material should ideally range from 12 to 55 mm in diameter. The size of materials decrease from bottom to top. Filter materials commonly used include gravel, crushed rocks or bricks, cinder, pumice, shredded glass or specially formed plastic pieces (even crushed PVC plastic bottles can be used).

Applicability: AFs are not suitable for the acute response phase because the biological environment within the AF takes time to establish. The AF is more suitable for the stabilisation and recovery phases and as a longer-term solution. The neighbourhood scale is the most suitable, but the AF can be implemented at the household level or in larger catchment areas and/or public buildings (e.g. schools). Even though AFs are watertight, it is not recommended to construct them in areas with high groundwater tables or where there is frequent flooding. Alternatively, prefabricated modules can be placed above ground. AFs can be installed in all climates, although efficiency will be lower in colder climates. Pathogen and nutrient reduction is low in AFs; if high effluent standards are to be achieved, an additional treatment technology should be added (e.g. ABR **(T.2)**, Constructed Wetland **(T.6)**, Waste Stabilisation Ponds **(T.5)**).

Operation and Maintenance: An AF requires a start-up period of six to nine months to reach full treatment capacity as the slow growing anaerobic biomass first needs to be established on the filter media. To reduce start-up time, the filter can be inoculated with anaerobic bacteria, e.g. by spraying Septic Tank sludge onto the filter material. The flow should be gradually increased over time. Scum and sludge levels need to be monitored to ensure that the tank is functioning well. Over time, solids will clog the pores of the filter and the growing bacterial mass will become too thick, break off and eventually clog pores. When efficiency decreases, the filter must be cleaned. This is done by running the system in reverse mode (backwashing) or by removing and cleaning the filter material. AF tanks should be checked from time to time to ensure that they are watertight.

Health and Safety: Effluent, scum and sludge must be handled with care as the effluent contains pathogens. If the effluent will be reused in agriculture or directly used for fertigation, it should be treated further. Alternatively it can be discharged appropriately. Full personal protective equipment must be worn during desludging and cleaning of the AF.

Costs: Capital costs of an AF are medium and operational costs are low. Costs of the AF depend on what other Conveyance and Treatment technology it is to be combined with, and also on local availability and thus costs of materials (sand, gravel, cement, steel) or prefabricated modules and labor costs. The main operation and maintenance (O & M) costs are related to the removal of primary sludge and the cost of electricity if pumps are required for discharge (in absence of a gravity flow option).

Social Considerations: Usually, AF treatment systems are a well-accepted technology. Because of the delicate ecology in the system, awareness raising among the users on eliminating the use of harsh chemicals is necessary.

Strengths and Weaknesses:

(+) Low O & M requirements and costs
(+) Robust treatment performance and resistant to sudden loads of organic material or flow increases
(+) No electrical energy is required
(+) High reduction of BOD and solids

(−) Low reduction of pathogens and nutrients
(−) Requires expert design and construction
(−) Removing and cleaning the clogged filter media is cumbersome
(−) Long start-up time

→ **References and further reading material for this technology can be found on page 193**