that BAF will be the most cost-effective alternative, but a detailed cost analysis of the alternatives has yet to be performed. Cost estimates for the project at Spanish Fork have indicated that BAF could save between 10 and 20 percent on the construction costs and between 20 and 40 percent on the operating costs. Although it is too early to present direct dollar comparisons for BAF systems versus conventional technology, BAF has certain features which should reduce costs:

- Land requirements one-fifth to one-tenth of conventional systems.
- No secondary clarifier or filter required.
- Single source of sludge.
- Simplicity of operation.

The items listed above demonstrate areas where potential cost savings may be realized with a BAF system. However, actual cost savings will depend on individual operating conditions and on further development and refinement of operating techniques with this emerging treatment technology.

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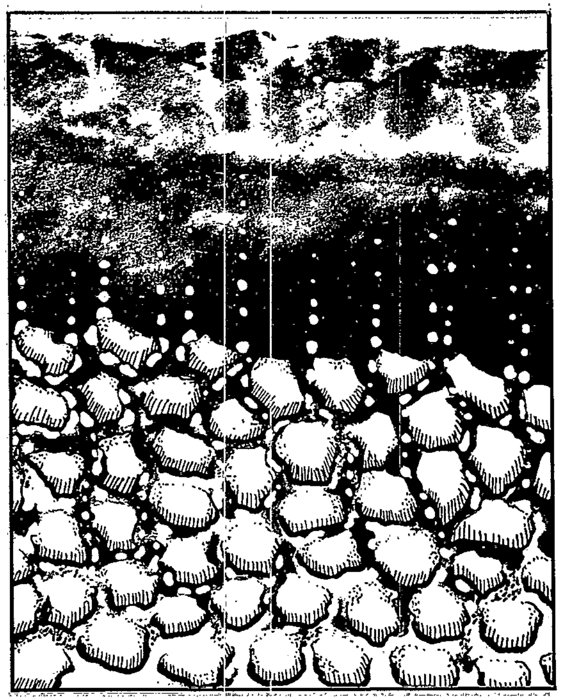
An Emerging Technology

The Biological Aerated Filter

A Promising Biological Process



The Biological Aerated Filter - A Promising Biological P

The Need for Innovative Technology

Effective wastewater treatment as a means of protecting our nation's streams continues to be an issue which warrants thorough consideration. As a result of today's spiraling construction and energy costs, the task of providing satisfactory wastewater treatment facilities is becoming increasingly complex. Thus, community officials and consulting engineers are faced with the need to modify existing treatment plants or build new facilities that are affordable, yet meet the treatment needs of the community. Although this is a critical problem for small municipalities, it is not unique to them. The problem is universal, affecting large and small communities alike.

Meeting wastewater treatment goals in today's economic climate calls for a departure from the established, or conventional, treatment alternatives. New and innovative concepts are needed to increase benefits while decreasing costs to the community. An example of this innovative technology approach is the Biological Aerated Filter. The BAF system is a relatively new advancement in biological wastewater treatment which shows potential for producing a high quality treated effluent at costs (capital and O&M) lower than those of conventional treatment alternatives.

The Process

The Biological Aerated Filter (BAF) is a down flow, high rate, fixed film, biological wastewater treatment system. The process is capable of removing both soluble and suspended organic material from the wastewater. Figure 1 is a schematic of a BAF system. Primary effluent is introduced to the BAF and flows downward through a packed bed of granular media. The media provides a surface for the growth of microorganisms which assimilate the organic matter in the wastewater. Air is introduced directly into the packed bed, countercurrent to the wastewater flow, roughly five feet below the top of

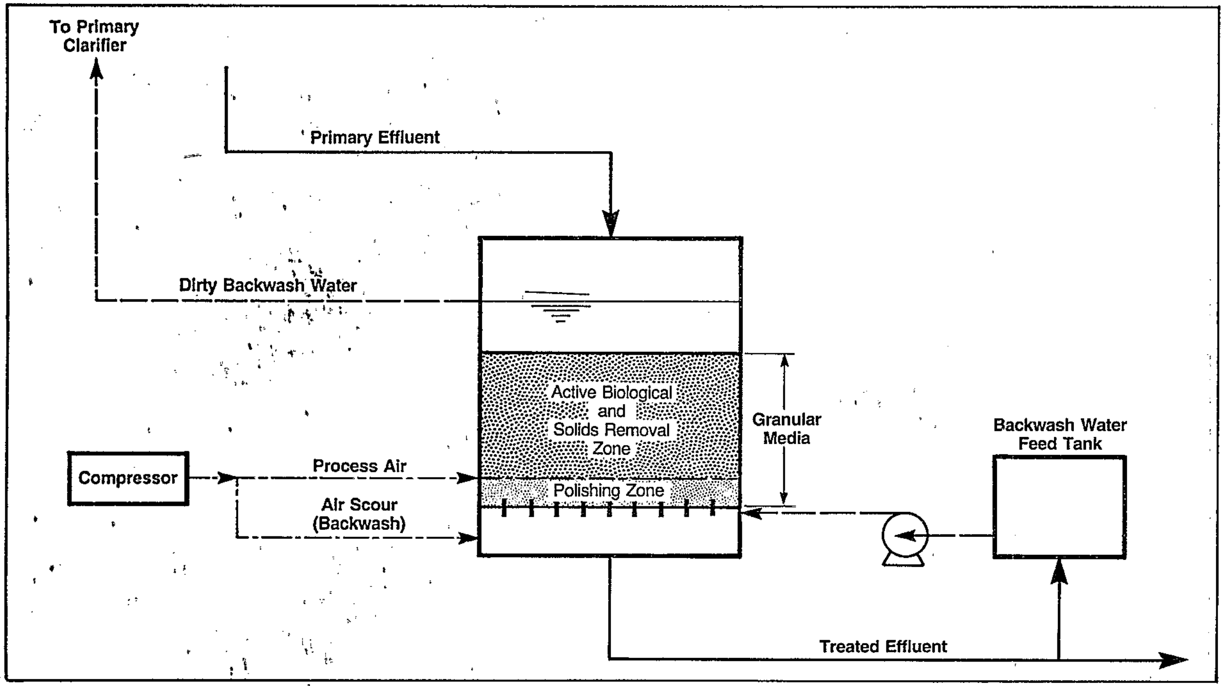


Figure 1 Biological Aerated Filter

the bed. This provides oxygen for biological growth. BOD absorption/oxidation and solids filtration are accomplished in the upper portion of the bed. The bed volume below the level of air injection is undisturbed and serves as a polishing zone for the removal of suspended solids. This may eliminate the need for a separate secondary clarifier.

Excess biological growth and trapped suspended solids are removed from the bed by periodic backwashing of the entire media with treated effluent. Air is introduced to the bottom of the bed during the backwash cycle to scour excess solids from the media. The dirty backwash water is removed from the BAF system by siphon and returned to the primary clarifier.

Operational Experience
The BAF system was developed and is patented by OTV of Paris, France. EIMCO in Salt Lake City, Utah, has exclusive marketing rights for the patented BAF system in the United States. The present BAF design technology and expected performance is based on OTV pilot plant studies, results from a full scale 0.5 MGD system built at LeHavre, France, in 1978, and recent EIMCO pilot work in Salt Lake City. The facility at LeHavre was built to treat primary effluent and provide high quality water for industrial use. It has been reported that this plant has consistently produced effluent BOD_5 and suspended solids of less than 10 mg/l.

While most of the operating experiences with the BAF process have occurred in France, pilot tests have recently been conducted in Asheville, North Carolina and Park City, Utah and are currently being run at Spanish Fork, Utah and Salt Lake City, Utah. These tests were and are being conducted with domestic wastewater after primary clarification. OTV has conducted pilot plant tests on industrial wastewater sources. However, high strength wastewaters require recycling of treated effluent to reduce BAF influent concentrations to acceptable levels.

Typical design parameters of the BAF are summarized in Table 1. Specific ranges and values for organic loading rates for BOD removal and nitrification have been developed by the manufacturer. These loading tables are proprietary and are not available for public distribution. Present design of BAF systems is based on limited research and development and operational experience. The Salt Lake City project is being run by the University of Utah and is a demonstration project supported by EPA- ORD to obtain third party information and to study process feasibility and optimization.

Effluent Quality	
BOD_5	10-20 mg/l
Suspended Solids	10-20 mg/l
Dissolved Oxygen	0.5-2.0 mg/l
Removal Efficiency	
BOD_5	80-96 percent
Suspended Solids	85-96 percent
Bed Depth	5-6 feet
Organic Loading Rate	140-350 lb. BOD_5/day 1000 cu. ft. of media volume
Detention Time	30-80 minutes
Sludge Production	0.4-0.7 lb./lb. BOD_5 removed
Air flow	2-5 scfm/ft^2

Table 1 Typical BAF Design Ranges

Advantages
The BAF system is capable of producing a high quality treated effluent, equal to or better than 20 mg/l BOD_5 and 20 mg/l suspended solids for most domestic wastewaters. The process can also be operated to achieve high levels of nitrification, although this operating mode will require lower loading rates and a larger system for the same flow. Since filtration is achieved in the lower portion of the filter, the BAF system eliminates the need for a secondary clarifier and filter in cases where an effluent with low suspended solids is required. This can substantially reduce the capital and operating

costs. Another feature of the process is the reduced land requirement. The system requires substantially less space than most conventional systems (approximately one-fifth the area for conventional activated sludge systems). EIMCO markets the BAF process in modules which makes staged construction of the project very practical for small to medium sized facilities. A BAF module assembly marketed by EIMCO is shown in Figure 2. One additional feature of the process is that the operator does not have to be concerned with as many operating parameters as with most conventional systems such as activated sludge. This allows the system to be micro-processor controlled, thus simplifying operation.

Limitations

One of the major limitations of the BAF process is the lack of full-scale operational experience in the United States. Caution must be used for design situations that deviate significantly from OTV's and EIMCO's data base. The BAF process does not lend itself to retrofitting into an existing treatment system except for combining it with an existing primary clarifier. There is little benefit to combining the BAF process with an existing trickling filter or activated sludge system. For large BAF systems (greater than 10 MGD), the economies of scale are not as favorable as other systems because as the size of the project increases, the unit costs per volume do not reduce at the rate that they do for systems such as oxidation ditches, aerated lagoons, and others. The suppliers of the BAF system are currently marketing only systems capable of handling flows equal to or greater than 0.5 MGD. Thus, the BAF process may not be suitable for flows under 0.5 MGD.

Costs

Since the BAF system is relatively new in the United States, reliable cost information is currently not available. In the project at Park City, it appears

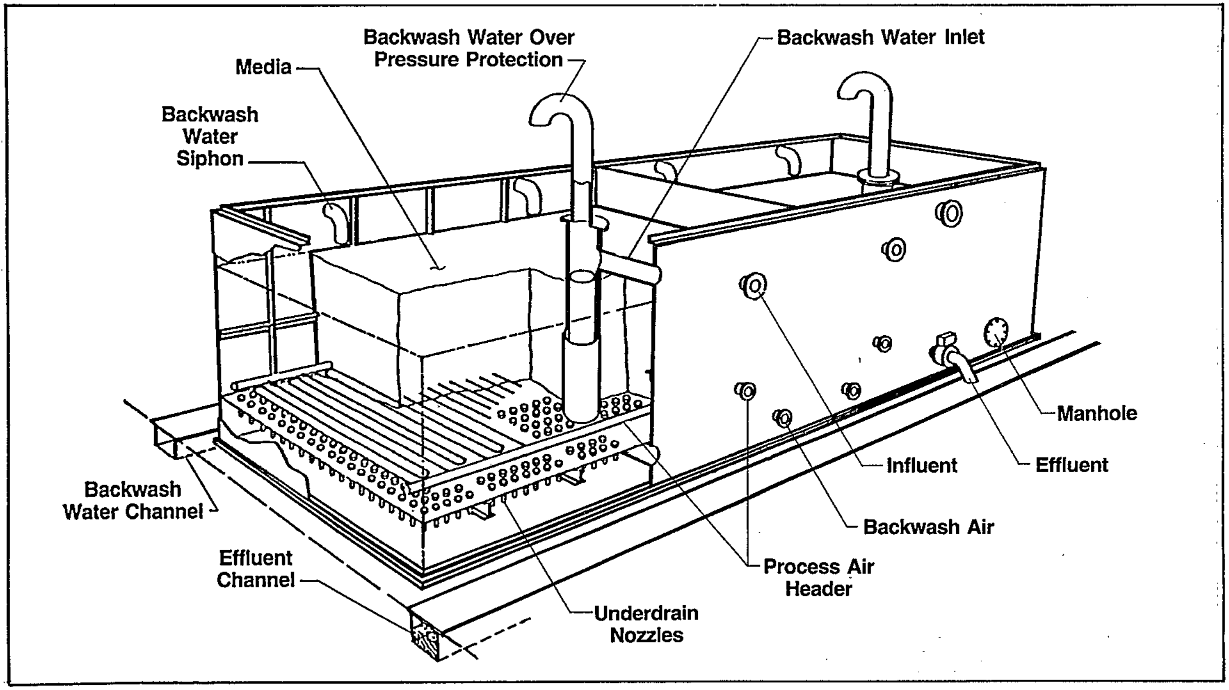


Figure 2 BAF Module Assembly