BIOLOGICAL AERATED FILTER

ADVANCED TREATMENT PROCESS FOR MUNICIPAL AND INDUSTRIAL WASTEWATER TREATMENT
Introduction

The biological aerated filter, BAF, was a new process developed around 1990s based on conventional biological filter and filters for potable water treatment, which was applied as tertiary treatment process at first and then developed as secondary treatment process. This process has multiple functions such like SS, COD, BOD5 removal and nitrification and denitrification. The most remarkable feature is it combines biological oxidation and SS interception together in one structure, which eliminates the need for a secondary sedimentation.

Principle

The principles are based on the oxidation degradation of organisms in the bio-film growing on the filter media, the absorption and interception effect of filter media and bio-film, the food chain along the direction of flow and the denitrification reaction in the microenvironment of bio-film and the anoxic section. The bio-film forms on the filter media with internal aeration while the wastewater flows through the filter media. When the bio-film becomes mature, the organic pollutants in the wastewater can be absorbed and degraded by the bio-film thus the wastewater is purified. The aerobic bacteria and facultative microorganism grow on the surface of bio-film, the organic pollutants are degraded by microbial aerobic metabolism and the end products are H2O, CO2, NO3− and NO2− etc. Because oxygen has been consumed on the surface of the bio-film, the organisms inside the bio-film are under anoxic condition and perform anaerobic metabolism, the end products are organic acid, ethanol, aldehyde, H2S and N2 etc. The filter media itself can absorb and intercept the suspended solid matter. In addition, the sticky substances produced during the metabolism of organisms such like polysaccharides and esters can play an absorption and bridging role to cohere suspended particles and colloidal particles together and form tiny flocs; and then suspended solid matters are removed through contact-flocculation. Because of the reproduction of microbes, the thickness of bio-film increases. When the bio-film is too heavy to stick on the filter media, the surface layer of bio-film will come off from the filter media; and the pollutants absorbed on the surface of bio-film will be removed as well at the same time. As a result, the internal microbes will shift to endogenous metabolism due to lack of nutrition; and then lose its capability of steaking on the filter media and come off from the filter media with the effluents. After that, the new bio-film will grow on the filter media.
**Structure**

![Image of BIOLOGICAL AERATED FILTER structure](image)

**Product Category**

As secondary treatment or advanced treatment to remove BOD, NH\(_4\)-N, TN, SS, etc.

- Carbon oxidation aerated filter (Tank C)
- Carbon-Nitration Biological Aerated Filter (Tank C/N)
- Nitration Biological Aerated Filter (Tank N)
- Pre-denitrification Biological Filter (Tank per-DN)
- Post-denitrification Biological Filter (Tank post-DN)
- Fine-treatment Biological Aerated Filter

**Advantages**

It is applied as secondary treatment and tertiary treatment in the following kind of wastewater

- Municipal sewage
- Food processing wastewater
- Brewery wastewater
- Papermaking wastewater
- Printing and dyeing wastewater
- Upgrading of sewage and wastewater treatment plant
### Process Combination

- Single-stage Carbon-Oxidation Biological Aerated Filter (Tank C) is applied when the main pollutants in the wastewater are carbonaceous organics.

- Nitration Biological Aerated Filter (Tank N) is applied to degrade ammonia nitrogen and used to treat grey water or slightly-polluted water.

- Single-stage Carbon-Nitration Biological Aerated Filter (Tank C/N) is applied when the carbonaceous organics are required to remove and part of ammonia nitrogen are needed to be nitrified (nitrification ratio is less than 60%).

- Carbon-Oxidation Biological Aerated Filter (Tank C) and Nitration Biological Aerated Filter (Tank N) are used together to remove the carbonaceous organics in the wastewater and finish the nitrification of ammonia nitrogen (nitrification ratio is more than 60%).
• When there is a high requirement of TN removal, a combination process, Pre-denitrification Biological Filter (Tank pre-DN) + Carbon-Nitration Biological Aerated Filter (Tank C/N) can be used; and the carbon source dosing system will be installed according to the concentration of carbon source in the influent.

• When the existing activated sludge processes are required to upgrade, Pre-denitrification Biological Filter (Tank pre-DN) with external carbon source dosing or single-stage Carbon-Nitration Biological Aerated Filter (Tank C/N) with external carbon source dosing can be selected based on the quality of effluent from secondary sedimentation tank.

Pre-denitrification process for system upgrade with external carbon source dosing

Single-stage denitrification process for system upgrade with external carbon source dosing
Crucial Parameters for the Design of Deep-Bed Biological Aerated Filter

<table>
<thead>
<tr>
<th>Type</th>
<th>Function</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon-Oxidation Biological Aerated Filter (Tank C)</td>
<td>Degrade carbonaceous organic material in the wastewater</td>
<td>Hydraulic load surface (m³/m²·h)</td>
<td>3.0~10.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Volume Load (kgBOD/m³·d)</td>
<td>2.5~6.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydraulic Retention Time (min)</td>
<td>40~60</td>
</tr>
<tr>
<td>Carbon-Nitration Biological Aerated Filter (Tank C/N)</td>
<td>Degrade carbonaceous organic material in the wastewater and nitrate part of ammonia nitrogen</td>
<td>Hydraulic load surface (m³/m²·h)</td>
<td>1.5~4.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Volume Load (kgBOD/m³·d)</td>
<td>1.2~3.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nitration Load (kgNH₄-N/m³·d)</td>
<td>0.4~0.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydraulic Retention Time (min)</td>
<td>70~100</td>
</tr>
<tr>
<td>Nitration Biological Aerated Filter (Tank N)</td>
<td>Nitrate ammonia nitrogen in the wastewater</td>
<td>Hydraulic load surface (m³/m²·h)</td>
<td>3.0~12.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nitration Load (kgNH₄-N/m³·d)</td>
<td>0.6~1.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydraulic Retention Time (min)</td>
<td>30~45</td>
</tr>
<tr>
<td>Pre-denitrification Biological Filter (Tank pre-DN)</td>
<td>Utilize the carbon sources in the wastewater to de-nitrate</td>
<td>Hydraulic load surface (m³/m²·h)</td>
<td>8.0~10.0 (including back-flow)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Denitrification Load (kgNO₃-N/m³·d)</td>
<td>0.8~1.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydraulic Retention Time (min)</td>
<td>20~30</td>
</tr>
<tr>
<td>Post-denitrification Biological Filter (Tank post-DN)</td>
<td>Utilize the external carbon source to de-nitrate</td>
<td>Hydraulic load surface (m³/m²·h)</td>
<td>8.0~12.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Denitrification Load (kgNO₃-N/m³·d)</td>
<td>1.5~3.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydraulic load surface (min)</td>
<td>15~30</td>
</tr>
<tr>
<td>Fine-treatment Biological Aerated Filter</td>
<td>Degrade the carbonaceous organic material and nitrate ammonia nitrogen in the effluent of two-stage sewage treatment plant</td>
<td>Hydraulic load surface (m³/m²·h0)</td>
<td>3.0~5.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Denitrification Load (kgNH₄-N/m³·d)</td>
<td>0.3~0.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydraulic load surface (min)</td>
<td>30~45</td>
</tr>
</tbody>
</table>

Note: The main design parameters of denitrification filter are shown in the denitrification deep bed filter sample of our company.

General Operating Parameters

The thickness of filter media: 2.0~4.5 m
Size: 7.5×9.0×7.9 m (L×W×H)
Max. SS of influent: 60 mg/L
Separate air backwashing intensity: 12~16 L/m²·S
Separate water intensity: 4~6 L/m²·S
Air intensity: 12~16 L/m²·S
Separate water backwashing intensity: 8~12 L/m²·S
Backwash frequency: 24~72 hr
### Removal Rate

<table>
<thead>
<tr>
<th>Sewage type</th>
<th>Main process</th>
<th>Parameter</th>
<th>Removal rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Municipal sewage</td>
<td>pretreatment + biological filter</td>
<td>SS</td>
<td>75–98</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BOD₅</td>
<td>80–95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>COD₅</td>
<td>80–90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NH₄-N</td>
<td>80–95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TN</td>
<td>50–80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TP</td>
<td>40–80</td>
</tr>
<tr>
<td>Industrial wastewater</td>
<td>pretreatment + biological filter</td>
<td>SS</td>
<td>75–98</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BOD₅</td>
<td>70–90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>COD₅</td>
<td>70–85</td>
</tr>
</tbody>
</table>

Note: Different kinds of pretreatment methods can be applied before the biological filter treatment unit according to the inlet water quality, outlet water requirements, process flow, etc.

### Properties of Filter

- The effective particle size: $1.7 \sim 3.35 \text{ mm}$
- Specific Weight: $\geq 2.6 \text{ g/cm}^3$
- Coefficient of Uniformity: $\leq 1.35$
- Moh’s hardness: $> 6$
- Acid solubility: $\leq 3\%$
- Thickness: 1.83m (2.44m)

### BAF Specific Aerator

- Water Depth: 4.5m
- The air flow rate: 0.23-0.43m³/h
- Oxygen utilization ratio: $\geq 22.3\%$
- Friction Loss: $\leq 2600 \text{ Pa}$
- Oxygenation capability: $> 0.2 \text{ /m}^2$
- Installation spacing: 100-200mm
Advantages

- Higher concentration of organisms and organic load
- Simple process with good quality of effluent
- High capability of surge load resistance
- High oxygen transfer efficiency
- Bio-film forms easily and quick commissioning
- Reasonable structure of flora
- Short hydraulic retention time and smaller volume of tank and footprint
- Low infrastructure investment, low operation cost and energy consumption

SafBon specialists have vast expertise and experience ranging from engineering to building and commissioning, and from investment to operation.

Please feel free to contact us for support!

KW1 International Environmental Treatment Gmbh
Auengasse 8, A-9170 Ferlach, Austria
Tel. : +43 4227 3266
Fax : +43 4227 3449
E-mail: office-at@kwi-intl.com
Web: www.kwi-intl.com