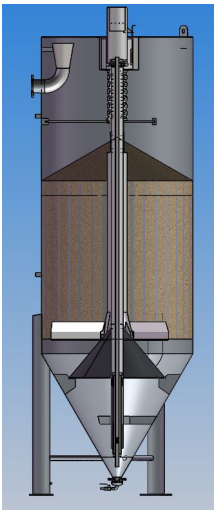
Brightwork

Product & Services Portfolio

MOVING BED (BIO)FILTRATION

Process and applications

MODE OF OPERATION



Moving bed (bio) filtration (MBF) is a mode of filtration based upon uninterrupted operations. Filter media is cleaned continuously and hence a 24/7 availability of the process is guaranteed.

Feed water flows upward through the filterbed. Filtrate is discharged at the top. Solids are retained and biomass converts organic components. Filter media (typically sand) is continuously sucked into the lower end of the airlift and transported vertically towards the sand washer at the top of the filter.

Sand is washed continuously by using a small volume of filtrate. If required, air is injected into the filterbed to create oxic conditions for the biomass.

APPLICATIONS

- **Cooling water:** *Side stream filtration*
- **Process / drinking water:** *Groundwater (bio) filtration*
  Surface water (direct) filtration
- **Waste water:** *Biological nitrification*
  Biological denitrification
  TSS removal
  BOD removal
  Phosphorus removal
  PAC / MAC removal

WASTE WATER

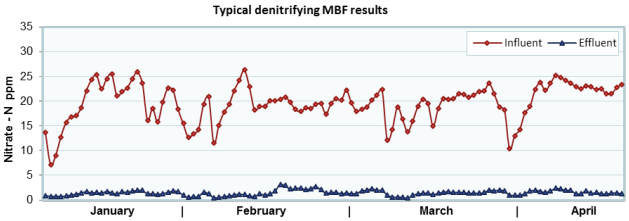
Process	Component to be removed	Typical concentration (mg/l)	
		IN	OUT
Biological nitrification/ BOD removal	NH_4^+ - N	5-20	1-5
	BOD	10-40	5-15
Biological de-nitrification/	NO_x - N	10-50	0-5
		5-10	0-1
P-removal	PO_x - P	5-10	1-2
		1-2	0.1-0.2
Suspended solids removal	TSS	40-200	10-50
		10-40	1-10

MOVING BED (BIO)FILTRATION

Biological denitrification

Denitrification is the biological process of converting nitrate and nitrite into nitrogen gas. For tertiary biological denitrification of waste water, the bacteria are using an external carbon source (e.g. methanol, ethanol, acetic acid).

Filter effluent is typically low in solids and COD; nitrate-nitrogen levels of < 5 mg/l N are achieved consistently at conversion rates of 2 - 6 kg N/(m3.d).



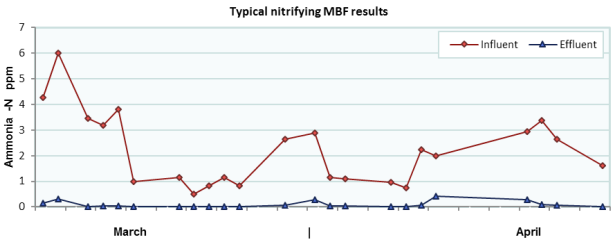
MBF for denitirification with 3,600 m³/h capacity

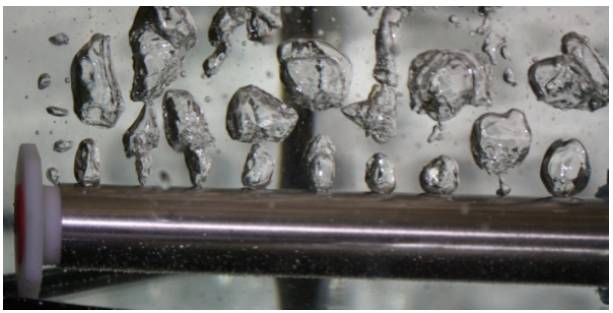
MOVING BED (BIO)FILTRATION

Biological nitrification

Nitrification is the biological process of converting ammonia into nitrate. For tertiary biological nitrification the autotrophic bacteria are using oxygen which is distributed evenly in the filter bed by means of a fine bubble aeration grid.

Filtrate ammonia levels of < 2 mg/l ammonia-N are achieved consistently, even at water temperatures as low as 5 °C.





Rigid aeration grid

MBF for nitrification with 300 m3/h capacity

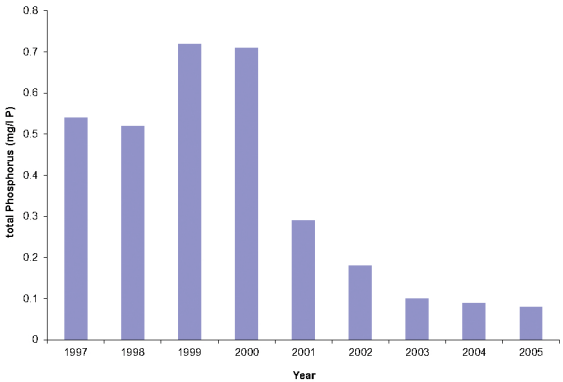
MOVING BED (BIO)FILTRATION

Phosphorus removal

Phosphorus (P) waste water effluent targets as low as 0.1 mg/l P are set for some water bodies to prevent eutrophication. MBF polishing filtration is efficient in removing both particular and soluble phosphorus.

Tertiary P-removal for water reuse

For P-removal small quantities of chemicals are required to bind P in flocs. Typically primary salts as Fe^{3+} of Al^{3+} are dosed into the feed pipeline of the MBF. Flocculation is enhanced within the filter bed due to the sand movement. As a result high removal efficiencies are achieved at lower dosing rates.



Total-P prior and after implementation of tertiary phosphorus removal

N and P-removal; Plant capabity of 1,200 m³/h

MOVING BED (BIO)FILTRATION

Aromatic carbons removal

At soil remediation and drainages ground water may be contaminated with mono- and polycyclic hydrocarbons (MAH / PAH). MBF technology is applied as a bioreactor for aerobic degradation of contaminants. The oxygen required for the biomass to grow is introduced either by pure oxygen or air supply into the filter bed.

Efficient removal at HRTs of only 10-20 minutes is achieved. Filtrate may now be discharged into surface water without further treatment.

Parameter	unity	Influent	Filtrate
Benzene	µg/l	400 - 470	0,9
Toluene	µg/l	2.0 - 3.7	< 0.1
Ethylbenzene	µg/l	18 - 26	0,1
M/P xylene	µg/l	11 - 16	0,5
Styrene	µg/l	0.1 - 0.7	0,1
O-xylene	µg/l	6.6 - 9.9	0,5
Cumene	µg/l	1.7 - 2.4	0,2
Propylbenzene	µg/l	0.8 - 1.1	0,1
135tmebenzene	µg/l	0.5 - 0.7	0,1
124tmebenzene	µg/l	5.5 - 6.8	0,4
MAH total	µg/l	450 - 540	3.0 - 20
Naphtalene	µg/l	21 - 37	< 5.0
PAH total	µg/l	23.7 - 39.7	2.8 – 7.7

Performance data of full-scale sand filtration for PAH and MAH removal

MOVING BED (BIO)FILTRATION

Process water production

Moving bed filtration is capable of handling high solids loadings and still producing a good quality effluent. Hence the technology is suitable for surface water treatment. Surface water may vary in quality: turbidity, colour, organic matter and suspended solids.

MBF may be used as a single process step avoiding the need for pre-treatment. In order to efficiently remove colloidal matter an inline dosing of flocculants is normally projected.

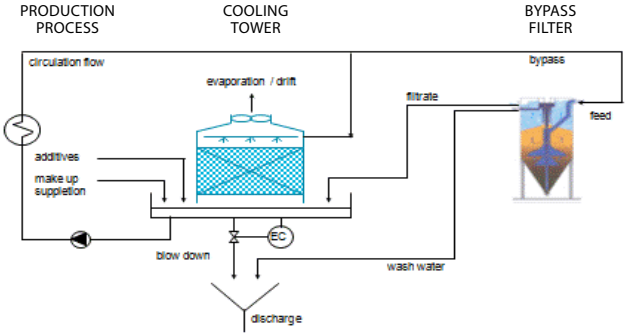
Parameter	Surface water	MBF filtrate	Criteria
Turbidity (NTU)	20-25	0.1-0.2	< 0.5
TSS (mg/l)	1-50	0,5	<1
Temperature (°C)	1-25		
Transmission (%)	30-50	> 96	
Fe (mg/l)			< 0.05
Al (mg/l)	0.05-0.60	< 0.1	< 0.1
Mn (mg/l)			< 0.05

MOVING BED (BIO)FILTRATION

Bypass filtration in cooling water systems

Open circulating cooling water systems may be optimized by bypass filtration, for which moving bed filtration is a most efficient tool. The MBF treats a small part of the warm water flow, returning from the production processes. The filtrate is returned to the cooling water circuit, while the continuously released wash water is discharged to the blow-down pit. Bypass filtration is typically handling 1 – 10% of the recirculating flow in order to be effective.

ROI is typically in the range of 6 – 12 months.



Specific advantages:

- improved heat transfer because of cleaner heat exchangers;
- removal of suspended solids;
- a shift of microbial activity from the cooling system to the moving bed filter;
- lower maintenance requirements and reduction of product leakages

TILTED PLATE SEPARATION

Small footprint process

A tilted plate separator (TPS) is an efficient settling technology which can be used for various applications. The TPS typically consists of modules with flat plates constructed in stainless steel or polypropylene.

Number of modules	Settling area (m^2)		Minimum required tank dimensions		
	50mm plate distance	100mm plate distance	length (m)	width (m)	depth (m)
1	22	11	3,0	1,5	3,0
2	44	22	4,5	1,5	3,0
3	66	33	6,0	1,5	3,0
4	88	44	7,5	1,5	3,0
6	132	66	10,5	1,5	3,0
8	176	88	7,5	3,0	3,0
10	220	110	9,0	3,0	3,0
12	264	132	10,5	3,0	3,0
16	352	176	13,5	3,0	3,0

The feed flow is fed into the plates at the lower end. While the feed water is flowing to the top of the TPS in between the plates the sludge is settling on the plates, sliding downwards and released at the bottom of the module. The settled water is released at the top of the module.
Each required settling area can be designed by an arrangement of a number of TPS modules. The optimum configuration will be determined on the basis of feed flow rate, solids concentration and density, settling rate, sludge volume and required effluent quality.

TPS for solids removal

TILTED PLATE SEPARATION

Process and applications

FEATURES AND APPLICATIONS

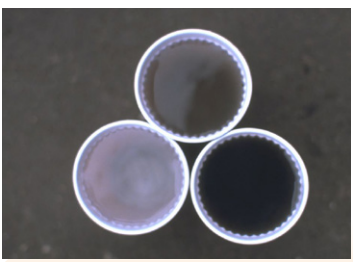
- Counter current flow conditions.
- Plate spacing: 50 – 100 mm.
- Flat plates, easy to clean.
- Plate length/width ratio > 2 for homogeneous flow distribution.
- Laminar plug flow conditions (Re < 250 and Fr > 10).
- Plate angle of 55o for fast removal of settled sludge.
- Modules for both stand-alone tanks and for (concrete) basins.
- Capacities from 3 m^3/h up to 10,000 m^3/h.

APPLICATIONS

- Waste water pre-settling of organic and inorganic solids.
- Waste water post-settling of organic and inorganic solids.
- Wash water treatment in drinking and process water treatment plants.
- Settling of surface water for process water production recycling plants.
- Primary settling in the food industry (e.g. starch separation).

BENEFITS

- Reduced space requirements.
- Reduced total installation costs.
- Lower maintenance, virtually no wear and tear.
- Improved efficiency, no short-circuiting, absence of wind current influences



TILTED PLATE SEPARATION

Wash water treatment

Water treatment works produce waste water. Sand filter backwash water is the largest wastewater stream generated, with flows varying between 1-10% of total drinking water production.

Coagulation, flocculation and tilted plate separation is an effective way to reduce wash water volumes: 100 m^3 of wash water may be split into 97 m^3 of settled water and 3 m^3 of sludge. The thickener then reduces the sludge volume to 0,7 m^3.

The typical inlet total suspended solids (TSS) concentrations are 200–300 mg/l, with outlet concentrations of around 5 mg/l and < 1mg/l Al/Fe.

The sludge is typically released at 1% dissolved solids (DS).

Tilted plate separators, using integrated coagulation and flocculation, showed to be reliable for backwash water treatment.

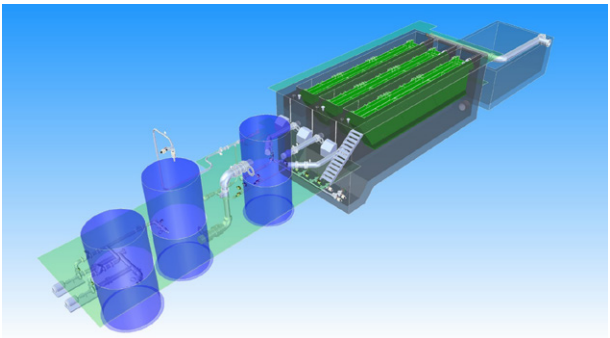
Backwash water treatment may initially be focused upon discharging waste water with low solids loadings. However wash water reuse in the primary treatment process may be an economical next step. This is carried out successfully using post filtration and disinfection.

Combined coagulation-flocculation-lamella settling

TILTED PLATE SEPARATION

Waste water treatment

In waste water treatment tilted plate separation is widely applied for both the separation of inorganic and organic solids. In biological process schemes both pre-settling and post-settling is applied.
In some cases, an appropriate conditioning of the waste water is crucial to achieve a highly efficient settling process. Conditioning may consist of pH correction, coagulation and flocculation using specific chemicals.



MeS removal in waste water treatment in a Zn refinery

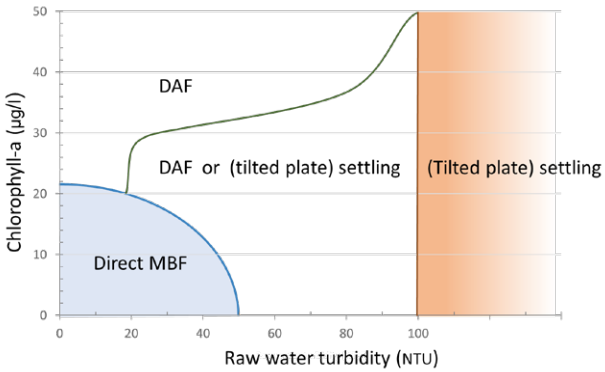
Standardized polypropylene plate pack

TILTED PLATE SEPARATION

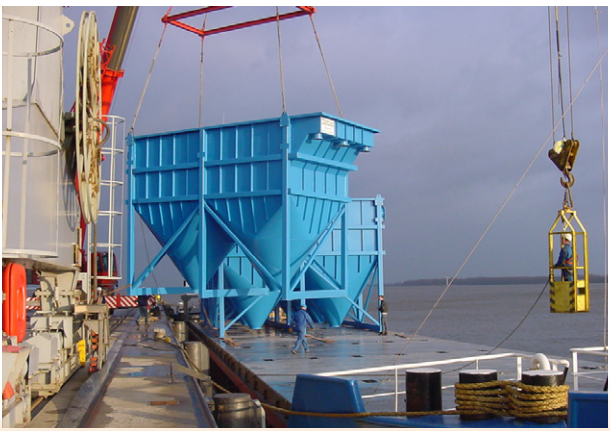
Surface water treatment

Surface water treatment for process or drinking water production requires an analysis of the feed water quality and water quality variations. With high levels of organics (expressed in chlorophyl-a) and/or high levels of inorganic solids tilted plate settling is the right choice.

A well balanced mixing of chemicals, coagulation and flocculation upstream of the tilted plate separation in function of actual flows, temperature, solids load is important to achieve good settling results.



Process selection vs surface water quality



Coagulation – hydraulic flocculation – tilted plate separation of surface water for process water production
(river Elbe, Germany, capacity: 1,200 m³/h)

PELLET REACTOR TECHNOLOGY

Chemical enhanced crystallization

Controlled chemically enhanced crystallization of a variety of components in water and waste water with often reuse of valuable pellets. The process is based upon high rate fluidized bed flow conditions, such as:

- Softening
- Fluoride removal (CaF_2 5- 7 kg-F/(h.m^2 reactor))
- Phosphate removal ($Ca_3(PO_4)_2$ or $Mg_3(PO_4)_2$)
- Manganese removal

If required, the carry over in the supernatant from the pellet reactor may be treated efficiently in a moving bed filtration stage, which is typically fed by gravity.

$MgCO_3$	$FeCO_3$	$Co(OH)_2$	$Zn_3(PO_4)_2$	PbS
$NiCO_3$	Ag_2CO_3	$CaSO_4$	$FeAsO_4$	As_2S_3
$CaCO_3$	$PbCO_3$	$BaSO_4$	$BaCrO_4$	CuS
$BaCO_3$	$CdCO_3$	$Ca_6Al_2(OH)_{12}(SO_4)_3$	SnS_2	HgS
$SrCO_3$	$HgCO_3$	$KMgPO_4$	SnS	$CaMoO_4$
$MnCO_3$	$Zr(OH)_4$	NH_4MgPO_4	Sb_2S_3	$CaSiO_3$
$CuCO_3$	$Cr(OH)_3$	$FePO_4$	ZnS	CaF_2
$ZnCO_3$	$Al(OH)_3$	$Mg_3(PO_4)_2$	CdS	MgF_2
$CoCO_3$	$Fe(OH)_3$	$CA_3(PO_4)_2$	NiS	Na_3AlF_6

Variety of components

Pellet reactors

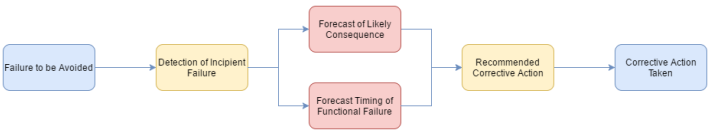
MONITORING AND CONTROL

Sand-Cycle

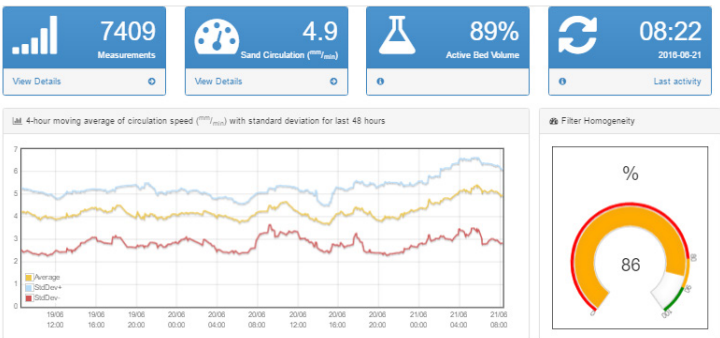
Sand-Cycle is an IT-based smart monitoring tool for optimising the operation of MBFs. Radio frequency identification (RFID) tags, as small as sand grains, are applied in the filter bed to monitor the movement of media. Field data are transmitted to a server via GPRS. The server converts raw field data into relevant outputs using dedicated algorithms.

Sand-Cycle can monitor the homogeneity of sand circulation rate, "dead" zones in the filter bed, sand migration from one filter cell to another during operation and sand loss.

The solution is suitable for implementation in any type of MBF. It is a tool for optimising O&M through predictive analytics and for facilitating real time filter control under variable operating conditions. Sand-Cycle provides options for advanced filter control, delivering improved performance.



'Predictive analysis'



Sand-Cycle dashboard

Sand-Cycle.com

SYSTEM ENGINEERING

Quality Manufacturing

Regular feedback from our clients and licensee partners allows us to optimize our systems. Furthermore, pilot plants and scientific research and development is executed to enlarge the fields of applications and hence the possibilities for broadening the product-market-combinations.

All components are manufactured in the Netherlands according to the highest quality standards.

Our products are highly standardized by combining mechanical engineering know-how and thorough process knowledge and expertise.

Surveys and spare parts

Our process know-how and reactor design expertise is directly available to our clients and partners.

Trouble shooting, piloting, servicing, standardized design packages and process optimization is part of our daily work. Reference plants and large data sets form the basis of our know-how and know-why of operating plants are used to support our design activities.

TEMPORARY EQUIPMENT

Rental and pilot plants

Both for pilot plants and temporary capacity issues we have available various assets and the possibility to quickly mobilize plants. In this way, we are able to offer our clients tailor made solutions based upon standardized equipment.

REFURBISHMENTS

Plant turn-overs

Our team is very experienced in refurbishing existing plants in order to restore process functionalities. Executed activities are:

- Field surveys of the operations of existing assets
- Plant turn-overs, exchanging MBF internals, washer components, airlifts, filter sand and/or lamella packs.
- Mechanical refurbishment of existing components.
- Replacement of spare parts
- Process conversions, e.g. conversion of a solids removal plant into a biological filter plant

Brightwork

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