



INFORMATION ON SEWAGE TREATMENT PLANTS

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The basic principle of the process

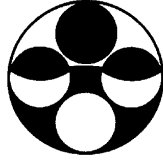
The sewage treatment process is based on a combination of the activated sludge process and the "suspended-matter/biofilm-biology". Thereby, part of the microorganisms settle down as "biofilm" on specially formed "suspended particles". "Moving-Bed-System" is the most common designation in different technical publications.

Biologically resistant, roller-shaped bodies with a diameter of about 5 mm are used as "benthic biofilm carriers". Their surface on which the microorganisms can settle is large (about 700-800 m²/m³ bulk volume) compared with the already known fixed-bed facilities, for instance RBS-units.



Biofilm Carriers

According to the aims of purification the amount of particles per m³ bulk volume and therefore the available surface can be customized and optimized for each sewage treatment plant. These suspended carrier particles with the settled microorganisms are kept back by special inverted weirs without any clogging in the different purification stages which are needed for the process.



The use of suspended carriers enables the accumulation of special microorganisms in the different process stages, like aerated and unaerated zones. In aerated stages the particles are built up a fluidized bed of carrier material and by taking off the aeration they are built up an anoxic suspended matter bed with simple filter effects after a short time. The activated sludge will be separated continuously in the final settlement tank and taken from there back into the unaerated zone where the incoming raw water and RAS (returned activated sludge) will be mixed.

The plants are equipped with different process stages and thereby with various milieu-conditions for microorganisms. This enables the plants to eliminate nitrogen and phosphorus only on the biological way as well as in large-sized sewage treatment plants.

Advantages of the process

As a result of the combination of two biological processes there are some advantages to the already known activated sludge process or fixed-bed process concerning the purification efficiency and process stability, particularly for small-sized and medium-sized sewage treatment plants. The process does in no way lack behind that of modern large-sized sewage treatment plants.

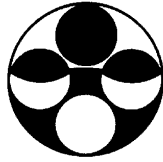
The main advantages of the process compared with the above mentioned processes are given in the following:

- Even small quantities of decentrally produced wastewater can be purified full biological the same as in large-sized sewage treatment plants. The purification contains COD and BOD removal as well as the nutrient removal (nitrogen and phosphorus), always eliminated by biological means.
- Large surface of the used carrier material caused by form and size.
- The fixed organisms within the biofilm are not washed out of the plant in case of hydraulic overloading. They do not have detrimental effects of the final settlement tank. Sewage plants which have such characteristics can be driven with higher mixed liquor concentrations as usual. This means higher a process stability.

The higher the MLSS¹-concentration the better the items as followed:

- further going wastewater purification,
 - decreased retention times,
 - higher connection values per volume (m³ biological stage),
 - smaller biological stages.
- The bioactivity of the microorganisms are kept stable also in case of underloading conditions such as low oxygen concentrations or low wastewater influent.

¹ MLSS - mixed liquor ssuspended solids



- Because of the shear-power which are caused by the aeration the "biofilm" is always thin and thereby physiological optimal for the microorganisms. Deposits on the carrier surface can be prevented.
- The supply with oxygen and nutrients for the fixed organisms is optimal.
- A special advantage is given by the fact that the population equivalent of the plant can be additionally increased without additional construction work, only by adding more particles as carrying material.
- Independent from purification aims all plants are equipped with an anoxic/anaerobic stage to increase the process stability.

This stage enables:

- pH-stabilization,
- denitrification from nitrate,
- further going elimination of phosphorus,
- degradation of BOD by nitrate respiration,
- improvement of the sludge-volume-index,
- decomposement of high-molecular organic substances to low-molecular, biologically useable compounds.
- The combination of two different biologies makes it possible to increase the load of the purification stages.

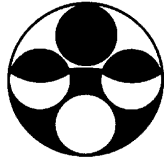
For the target "basic-purification (COD, BOD) with simultaneous stabilisation of sludge" arises the following relations:

Process/Procedure		activated sludge	fixed-bed (RBS)	EvU ^â
BOD-sludge loading	kg/kg*d	0.05	-	0.05
MLSS	kg/m ³	4.50	-	4.00
surface	m ² /m ³ _{biostage}	-	150	240 ^z
surface loading	gBOD/m ² *d	-	2.50	2.50
space loading	kgBOD/m³*d	0.23	0.38	0.80^z

Using this technology the possible connection size (PE/m³_{bio-stage}) is about twice as high as processes using the fixed-bed technology (RBS).

² according to the amount of carriers within the biostage [30%]

³ (0.05 kg/kg*d * 4.0 kg/m³) + (0.0025 kgBOD/m²*d * 240 m²/m³)



Determination of dimensions

The determination of dimensions of the sewage treatment plants are carried out according to the German ATV⁴ - guidelines and DIN⁵'s. Dimensions of benthic biofilm biology and activated sludge biology are carried out separately.

The dimensions of the benthic biofilm biology is carried out according to the ATV-guidelines A 122, A 135 and the DIN 4261, part 2, as well as on the basis of results reached in a pilot plant supported by the Federal Ministry of Research and Technology as part of a research and development project over a period of two years.

At the surface determination it is estimated an usable particle-surface of about 950 m²/m³ bulk volume, the effective surface where the microorganisms can settle is approx. 1200 m²/m³ bulk volume.

According to the purification aims the BOD₅ surface-loading is calculated as followed:

purification target	BOD₅ surface-loading
1. high-rate biology	= 8.0 gBOD ₅ /m ² *d
2. basic purification ⁶ without nitrification	6.5 gBOD ₅ /m ² *d
3. improved basic purification with nitrification (10 mg/l)	4.5 gBOD ₅ /m ² *d
4. basic purification with nitrification (5 mg/l)	3.5 gBOD ₅ /m ² *d
5. basic purification with nitrification and denitrification and Bio-P-removal	3.0 gBOD ₅ /m ² *d

The dimensions of the activated sludge biology as well as the primary and secondary clarification is carried out according the ATV-guidelines A 131 and M 208.

Our sewage treatment plants with further going purification are equipped in flow direction of the waste water with the following stages:

1. anoxic denitrification stage,
2. anaerobic acidification stage (biological phosphorus stage),
3. intermittent aerated nitrification/denitrification stage (moving bed).

⁴ Abwassertechnische Vereinigung e.V.

⁵ Deutsche Industrie Norm

⁶ COD and BOD₅-removal



All stages are filled with a different required amount of carrier material according to the calculation. The activated sludge will be separated continuously in the final settlement tank and taken from there back into the denitrification zone where raw water and RAS will be mixed.

When passing this zone, the nitrate is reduced to gaseous nitrogen and released into the atmosphere. As a result of this nitrate-respiration parts of organic substance (BOD_5) is already eliminated by using bonded oxygen.

On bigger plants there are an internal activated sludge recycle.

Application areas of the technology

All of our sewage treatment plants are able to ensure that municipal wastewater as well as organic polluted industrial wastewater can be purified according to the required effluent standards. Therefore, the biological stage will be designed depending on the purification targets with different loadings (as already shown in "Determination of dimensions").

As a result of the enrichment of specialized microorganisms (within the biofilm and the activated sludge) the process is suitable particularly for the elimination of heavily degradable organic substances as well as for nitrification and denitrification processes.

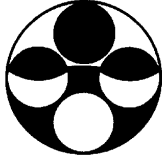
If required biological processes can be combined with physical and/or chemical purification processes. The main application of our plants is established on the field of municipal sewage water treatment in small-sized up to large-sized treatment plants.

Possible applications in detail:

- Purification of wastewater at decentralized sites (small towns, villages, recreation settlements, trading areas) for which the connection to central plants would result in high costs.



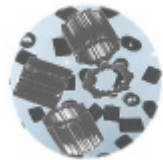
- Temporary solutions for sites which later on will be connected to central plants.



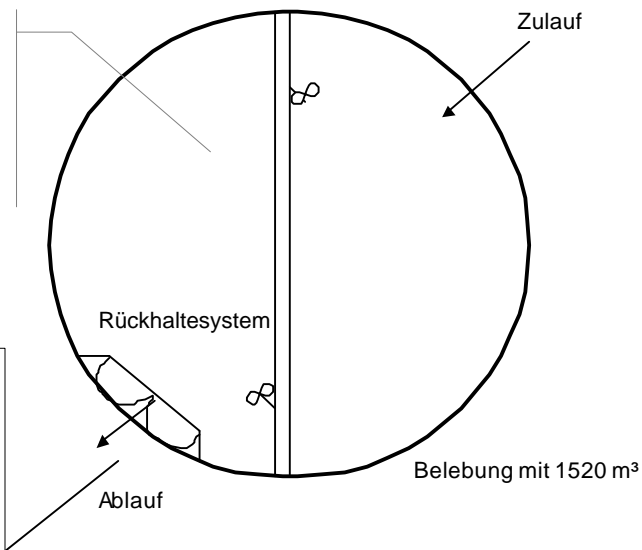
- Reequipping and modernization of mechanical and partially biological sewage treatment plants.

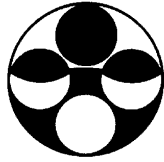


- Sewage purification in ecologically sensitive catchment areas of water storage reservoirs, lakes, small streams with a low waterlevel, drinking water areas.
- Sites with discontinuous wastewater flow (trading areas, holiday centres).
- Treatment or pre-purification of organically contaminated industrial wastewater, leachates, night soil and slurry. The treatment should meet the water quality required of water bodies.
- Sites with high demands on the purified water (nitrification).
- Low cost modernization (3rd purification stage) or capacity increase within the main structure of well preserved sewage treatment plants.



Biofilm carriers





Because of the generally long and expensive transport distances to larger sewage plants we offer a plant for the decentralized treatment of night soil.

Retention-system for the carrier material

A main part of our technology is a special system for the retention of the relative small carrier particles. The retention is ensured by a hydraulic system (dived walls/weirs/sieves or combined systems) and the characteristics of the particles.

The principle of our retention system is mainly based on special characteristics of the carrier material. All particles have the same uplift-speed caused by the specific weight and the defined shape. The biofilm-thickness is reduced by the predominating shear-power in the aerated zone and thereby, there are no changes of the specific weight at all.

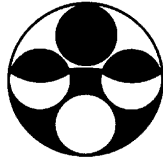
The retention in the aerated zone is ensured by the installation of two walls with a defined distance to one another at the crossing between aerated zone and final settlement tank.

To ensuring the retention of the particles in situations of hydraulic overloads as well as in ordinary situations of high turbulences in the aerated zone the wall-distance is fixed according to the uplift-speed of the particles and the downstream-speed of the wastewater. Thereby, the particles are always kept back in the aerated zone of the plants.



Purification results of the process

The process has been intensely investigated in a plant with a population equivalent of about 200. The investigation was carried out over a period of several years and supported by the Federal Ministry of Research and Technology as part of a research and development project.



The results underlined that with optimum process design and load the monitoring values of large sewage treatment plants can be reached just by biological elimination processes.

The following average elimination efficiencies were attained with the pilot plant over a period of two years:

	Influent [mg/l]	Effluent [mg/l]	Degradation [%]	min. requirements [mg/l]
BOD ₅	579	5	99	20
COD	1164	57	95	75
P _{total}	15,5	0,9	40	2,0
o-P	9,2	0,7	92	-
NH ₄ -N	76	3,0	96	10
N _{total}	78	15	81	18

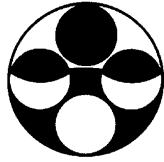
For comparison the minimum requirements for sewage treatment plants of size 5 (>1.000.000 PE) are given in the last column of the table.

The following average elimination efficiencies were attained during the summer and winter period:

Parameter [mg/l]	Effluent		min. requirements ⁷
	summer	winter	
BOD ₅	5.0	5.0	15
COD	49	65	75
P _{total}	0.8	0.9	1.0
NH ₄ -N	3.0	4.0	10
N _{anorg} -N	14	17	18

The TÜV-Umwelttechnik Sachsen (Technical Organization for Environmental Monitoring) has investigated the same pilot plant within a half-year period:

⁷ minimum requirements for sewage treatment plants of size 5 (>1000.000 PE)



wintertime/springtime

Parameter	Influent	Effluent	Degradation
	[mg/l]	[mg/l]	[%]
BOD ₅	598	8	99
COD	1088	53	95
NH ₄ -N	70	2.4	97
NO ₃ -N	1.2	11.0	-
NO ₂ -N	0.4	1.4	-
N _{total}	71.8	14.8	79
o-P	9.2	0.9	90
P _{total}	13.3	1.0	92

springtime/summertime

Parameter	Influent	Effluent	Degradation
	[mg/l]	[mg/l]	[%]
BOD ₅	493	6	99
COD	1073	44	96
NH ₄ -N	91	< 2.0	98
NO ₃ -N	1.2	10.1	-
NO ₂ -N	0.2	0.8	-
N _{total}	92.4	12.9	86
o-P	10.2	1.3	87
P _{total}	15.3	1.3	92

We have already designed and constructed some plants with furthergoing effluent requirements since the last years.

Program for sewage treatment plants

Fully biological small sewage treatment plants acc. DIN 4261, part 2, and ATV A 122, 135

- for domestic waste water in concrete and reinforced plastics,
- up to 20 PE primary settlement incl. sludge store, biological stage and secondary settlement are installed in one round concrete tank,
- For higher connection sizes up to 200 PE the we are offering round concrete containers - primary settlement and sludge store as well as biological stage and secondary treatment are installed in separate concrete tanks different sizes.

Container and compact sewage treatment built in concrete and steel



- For connection sizes > 200 PE we are offering different plants in concrete and steel as well as round combination-tanks and rectangular-tanks.
- All plants can be designed for higher purification targets (Nitrogen and Phosphorus).

Plants equipped according to the SBR-principle

- parts of microorganisms can settle as a bentic-biofilm on carriers with a specific weight of > 1.0 g/cm³,
- oxic suspended or moving bed of carriers by operation of aeration,
- anoxic/anaerobic bed by take off the aeration,
- By combination of the activated sludge process and the biofilm process the concentration of biomass can be increased without increasing the reactor volume.

Sewage treatment plants for industrial waste water, night soil and leachates

- For the partly purification or purification acceptable for the receiving water bodies we are offering special plants for the treatment of night soil, organic polluted industrial waste water and leachates.
- If required biological processes are combined with chemical and physical purification processes.

Re-equipment and modernization

- The biofilm process is suitable particularly for the re-equipment of mechanical sewage treatment plants.
- The installation of different process stages (anoxic, anaerobic) into well preserved tanks or basins is often relatively easy to realize.

Packaged sewage treatment plants



Sewage Plant - 500 PE



Sewage Plant - 5,000 PE

Packaged sewage treatment plants

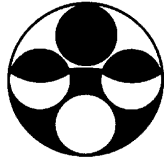




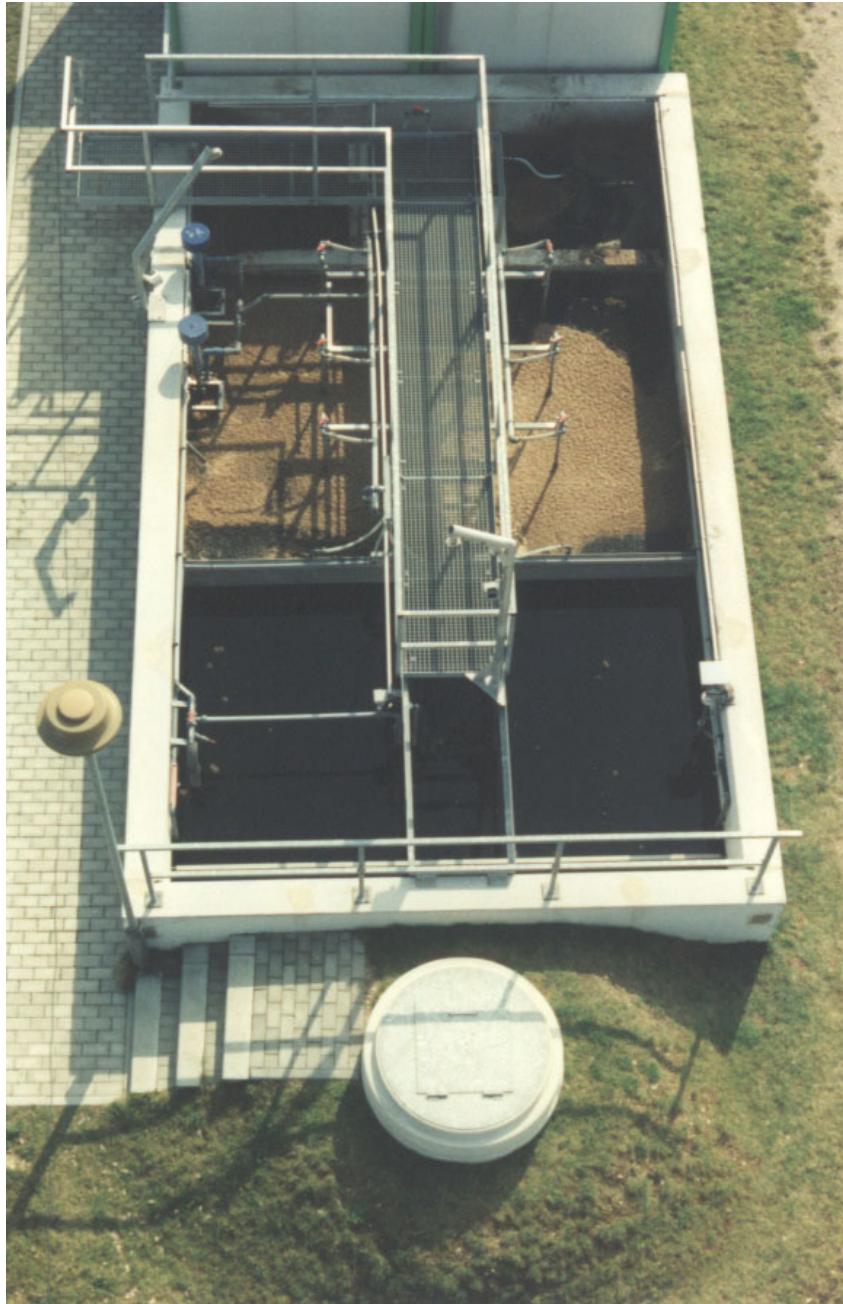
Transport Packaged Plant

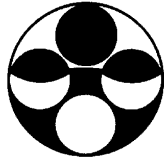


Sewage Plant - 800 PE



***Sewage treatment plants
1,000 PE - concrete version***





***Sewage treatment plant
40,000 PE***



biostage - aerated zone



biostage - intermittent aeration