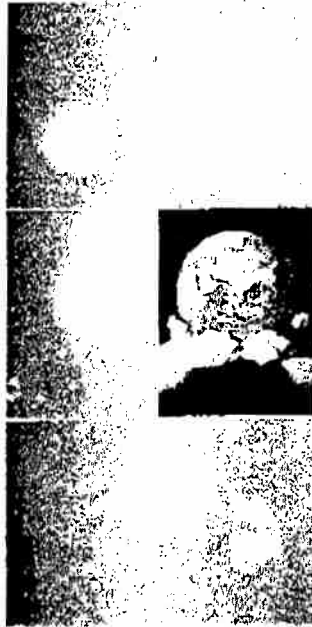


# BioShaft Water Technology - BioShaft Treatment Phases

Document received from Robert Barkwell with the request that it be reviewed before the start of SDS



## The BioShaft Treatment Phases:

### 1) Mechanical/Primary Treatment Phase:

- Delivery to the Treatment
- Screening and maceration

### 2) Biological/Secondary Treatment Phase (potented):

- Balance tank (aeration)
- BioShaft units
- Settlement tank

### 3) Tertiary Treatment Phase:

- Effluent disinfection and filtration

### 4) Sludge (inert biomass) Treatment:

- Biomass collecting tank for larger capacities >2.64 MGD (10,000m<sup>3</sup>/day)

## Mechanical/Primary Treatment Phase

The mechanical/primary treatment phase includes:

- Delivery of wastewater flow
- Automatic bar screen
- Grit removal chamber

The wastewater lifting pump set consists of two pumps, one operational and one standby. The capacity of each pump is adopted based on peak flow (2.5).

The automatic screen is installed at the inlet of the grit chamber and after the food pumps. The construction material used is cast iron, sand blasted SA 2.5 and protected with zinc epoxy thickness 45 microns and coal tar epoxy thickness .079 in. (2mm) x 8 in. (150 mm). The size of the opening between the bars is 1/2 in. (12 mm). Operation of the screen is automatic and on a 24 hour timer. The operation time may be changed via a PLC integrated in the main control panel.

The grit removal chamber is a vortex type made of HDPE, capable of handling the peak flow of the system.

Removal rate is as follows:

- 0.012 in (0.30 mm) [mesh 50] %>95
- 0.009 in (0.24 mm) [mesh 70] %>85
- 0.006 in (0.15 mm) [mesh 100] %>65

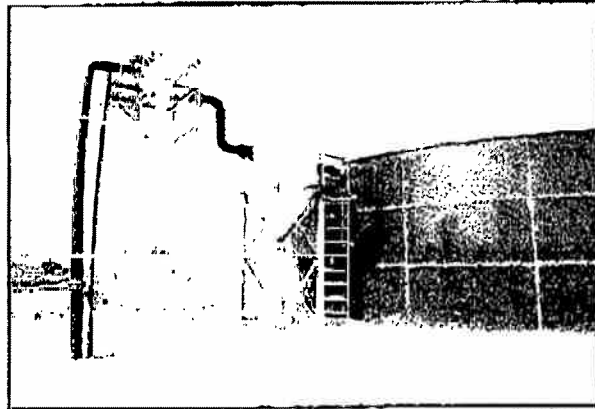


Figure 2. Primary Treatment; Screen and Grit removal chamber.

### Biological/Secondary Treatment Phase (Patented)

The biological/secondary treatment phase is shown in Fig 3 below.

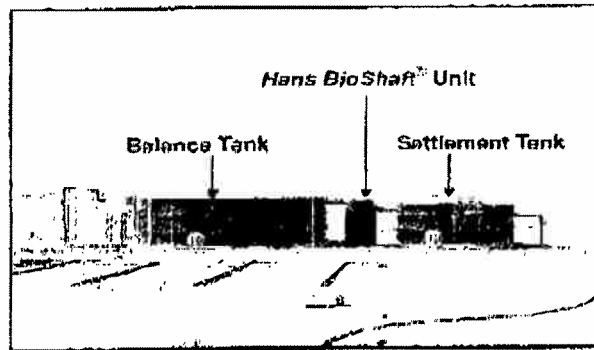


Figure 3. BioShaft Secondary (Biological) Treatment

Unlike the BioShaft System, conventional suspended growth process systems require large aeration and sedimentation volumes. With the BioShaft System, these volumes can be reduced significantly with the use of a BioShaft Unit (vertical reactor) and biomass carriers which have a high specific surface area.

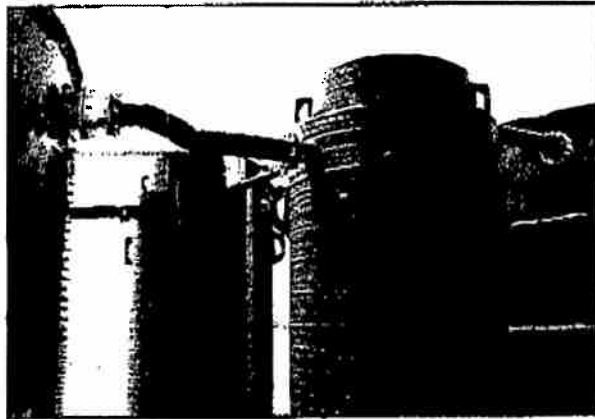


Figure 4. BioShaft Unit Technology: The BioShaft Unit enables the balance tank to operate at high biomass content rates significantly higher than conventional activated sludge systems.

The application of a large number of biomass carriers instead of sedimentation by surface aeration has an exceedingly positive effect on the efficiency and size of the required equipment, enabling the balance tank to be operated at high biomass content .93-1.87 lb/ft<sup>3</sup> (15-30Kg/m<sup>3</sup>) compared to the conventional aeration process sludge content .16-.19 lb/ft<sup>3</sup> (2.5-3 Kg/m<sup>3</sup>). Aeration is provided using highly efficient membrane diffusers resulting in much higher oxygen transfer per unit volume. This allows a purification degree up to 97 percent.

The balance tank receives the flow after the screen, half of the balance tank is aerated to ensure that the biomass is properly oxygenated and the other half acts as a buffer area. The balance tank is constructed from glass fused steel sheets or any other approved material and is equipped with the aeration system which is comprised of two types of fine bubble diffusers membranes: vertical and disc type. The membrane material is ethylene/propylene rubber compound (EPDM). The proposed membranes are highly resistant against wastewater, ozone, weathering, aging, heat and most chemicals. The proposed IFU membranes feature the following characteristics:

The proposed IFU membranes feature the following characteristics:

- Endure a wide variety of wastewater compositions;
- Resistant against acids and alkalis;
- Have great elasticity, lasting for many years;
- Withstand temperature up to 300 degrees F (150 degrees C);
- Fine bubble diffuser 0.039-0.157 in. bubble size (1 – 4 mm bubble size)

The buffered wastewater flows from the balancing tank towards the BioShaff units. Please see Figure 6.

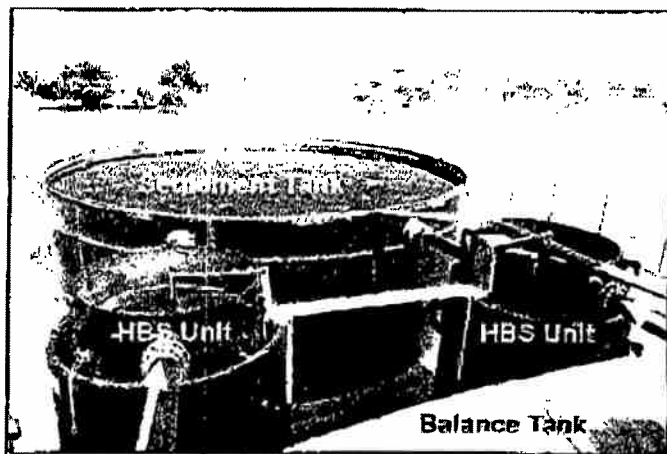


Figure 6. Flow of the BioShaff System

The wastewater enters the BioShaff unit where it flows through the biological aeration filter chamber containing the hollow plastic media (biomass carriers). See Figure 6. The unique design of the biomass carrier results in anoxic decomposition, which takes place on the inner surface (hollow area), while on the outside of the carrier's corrugated surface, the process is aerobic. This ensures a very high level of sewage purification at great speed.

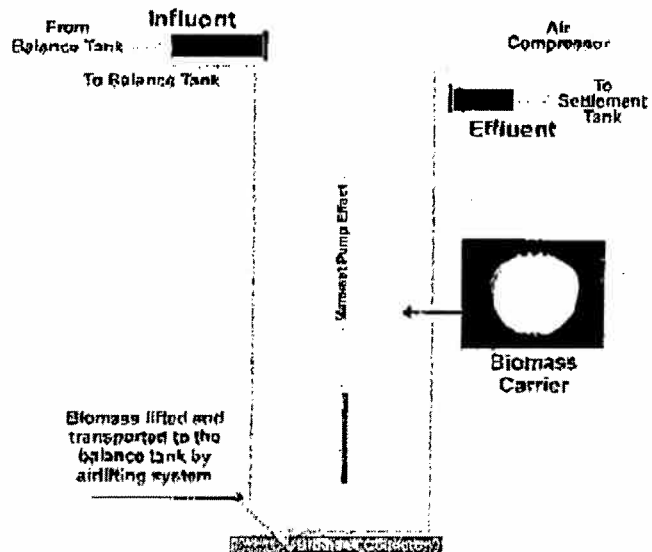


Figure 6. BioShaff Unit Cross Section

The oxygen demand for the decomposition process is provided by the central air

lift aerator shown in Figure 7. The air is supplied by a compressor and is dispersed by a special maintenance free membrane diffuser providing an enormous number of micro bubbles which saturate the sewage with oxygen and simultaneously force the sewage up to the surface.



Figure 7. Top of BioShaft Unit

This oxygen-rich fluid then passes back down through the aeration chamber in intimate contact with the carriers. Because the biomass carriers (See Figure 8) have a relative density less than unity they will always try to rise towards the surface, but are constantly forced downward under the pressure of the aerated sewage. These two forces ensure that there is constant upward and downward motion of the carriers within the aeration chamber.

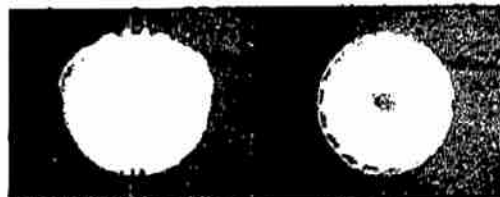


Figure 8. Biomass Carrier - 1 in (2.54cm) diameter

Collision between the carriers occurs, removing the excess microbial biomass by means of the down current. This self-cleaning feature will protect the biological filter against any possible clogging and makes the unit virtually maintenance-free.

Treated water flows to the final sedimentation compartment in the BioShaft unit where suspended particles sink down to the bottom of the tank. This active biomass is then transferred back to the balance tank at periodic intervals by the airlift system which eliminates the need for sludge pumps. Purified water rises up the outer compartment of the BioShaft unit to the outlet and flows to the settlement tank and polishing before discharge. Any remaining biomass settles to the bottom of the settlement tank and will be periodically skiffed back to the balance tank.

The BioShaft treatment technology has a particular and vital advantage over more traditional processes as the matter in the BioShaft Unit is converted into a highly active biomass which is rich in oxygen. As described above, the biomass in both the BioShaft unit and the settlement tank has a noted tendency to settle, unlike activated sludge which normally floats on the surface. This active, oxygen rich, biomass containing large numbers of highly active bacteria from both the BioShaft unit and the settlement tank is air lifted back to the balance tank where it will initiate the decomposition process. The recycling of the biomass in the process leads to the digestion of sludge in the waste water. Since sewage has only a 2 to 4% solid content, the quantities of accrued insoluble solids (sludge) will be minimal; hence the balance tank will require emptying much less frequently than a balance tank of a conventional plant.

Odors are eliminated due to the absorption of large quantities of oxygen in the system which converts odorous gases into dissolved chemicals.

The BioShaft unit is designed and constructed based on the following codes and standards:

	BS 4994: 1987	

Design Code	CS-1	
HDPE	DIN 8075	Shell material
Pressure	Atmospheric	Operating
Pressure	Atmospheric	Design
Inspection & Test	BS 4894:1987	Manufacturer's QC ISO 9001 Design & Build Certificate No. FM 01067
Nozzles	PN 10 to BS 4504	6 in (150 mm)

**Tertiary Treatment Phase**

Final treatment of the effluent is handled through polishing filters, and finally disinfected via chlorination units or UV sanitizers to complete the process.

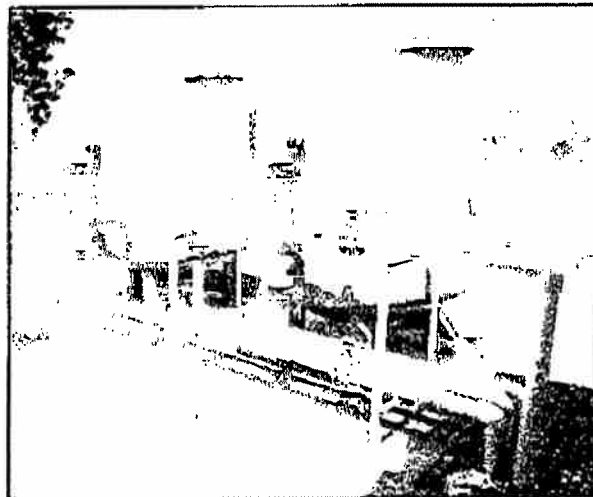


Figure 8. Filtration

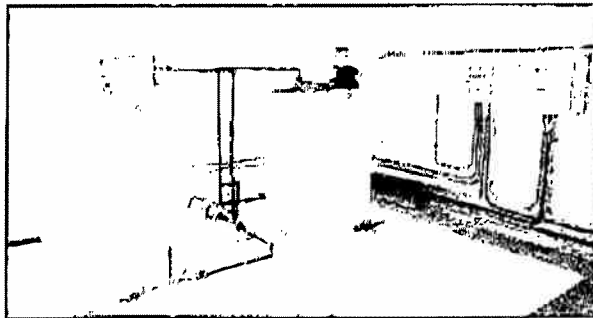


Figure 9. Chlorination

**Sludge (inert biomass) Treatment:**

The patented BioShaff system's attached growth process results in the virtual elimination of sludge and the associated sludge components found in conventional active sludge waste water treatment systems (i.e. sludge drying beds, collection and disposal). However, for larger capacity designs greater than 2.64 MGD (10,000m<sup>3</sup>/day), a biomass collecting tank will be furnished to collect the inert biomass that may be infrequently collected at the bottom of the balance tank.

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## BioShaft Benefits

A BioShaft plant has many advantages over a traditional sewage treatment plant. Some unique benefits include:

- **Minimal Sludge:** Traditional Wastewater treatment produces a byproduct called "Sludge". First this Sludge has to be treated and then it must be hauled off & disposed of. A BioShaft plant virtually eliminates Sludge.
- **Minimal Odor:** The amount of odor produced by the system is negligible. So the system can be run closer to housing areas, therefore reducing the size the land required for a plant.
- **Less Land Required:** The BioShaft accelerates the process and therefore a BioShaft Plant does not have to be as large as an Active Sludge Plant.
- **Lower Initial Investment:** It costs less to manufacture.
- **Lower Operational Costs:** It takes less personnel to operate.
- **Lower Energy Costs:** Energy costs are drastically reduced due to the minimal amount of electromagnetic parts.
- **Lower Maintenance Costs:** The reduced amount of electromagnetic parts also drastically lowers the cost of maintenance.

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**Technology Comparison:**

Process	Attach growth process	Activated sludge process	Separation process
Capital Investment	Competitive	Standard	Not competitive
Cost & Efficiency	Low (very simple with high efficiency)	High	Very high
Required Area for Sewage Treatment Plant	Less than others (less aeration area, less sedimentation area, less sludge treatment required)	Large	Large
Sludge Treatment	Minimal Required	Required	Required
Energy Consumption	Low (only air pumps). 0.004-0.006 KW-hr/gal (1-1.6KW-hr/m <sup>3</sup> )	High (air pumps and large number of mechanical motors required), 0.011-0.015 KW-hr/gal (3-4 KW-hr/m <sup>3</sup> )	Very high (air pumps and large number of mechanical motors required) - up to 0.026 KW-hr/gal (7 KW-h/m <sup>3</sup> ), ref Stefan Geizler, Aachen University Chemical Engineering Institute
Maintenance & Cleaning Process (Chemicals)	Maintenance free self cleaning process	Maintenance needed - sludge removal and chemical treatment of sludge.	Intensive maintenance and chemicals required for flushing and cleaning membranes
Replacement of Major Items	No replacement	Replacement of electromechanical parts (ie, sludge pumps, recycling pumps, gears, etc)	Membrane replacement periodically
Possibility of Expansion	Unlimited	Limited	Limited
Operating Cost	Low (air compressor only, no electromechanical equipment, low number of personnel required)	High (air pumps and large number of mechanical motors required, large number of personnel required)	High (air pumps and large number of mechanical motors required, large number of personnel required)
Maintenance	Very low (no mechanical equipment only standard compressor)	High	High
Construction Possibilities	Above and underground	Above ground and some of them can be erected under ground (with limited capacity)	Some of them can be erected under ground (with limit capacity)
Relocation of the Sewage Treatment Plant	Possible	Not possible	Not possible

**Technology Comparason**

Population Limit	No limits	No limits	No limits
Landscape Disturbance	Low	High	High
Odor	Negligible	Present	Low
Water Effluent Quality (BOD/TSS)	Tertiary 10/10ppm (10/10 mg/l)	Secondary - requires filtration to reach tertiary quality 30/30 ppm (30/30 mg/l)	High quality 5/5 ppm (5/5 mg/l)