Anaerobic Reactors
Activated Sludge Systems
Extended Aeration & Sequencing Batch Reactors
**Anaerobic Wastewater Treatment**

Anaerobic treatment of wastewater involves the breakdown of complex organic material by bacteria in the absence of oxygen from air.

The fixed film anaerobic reactors are suitable for treatment of a wide variety of complex high strength industrial wastewater discharges from industry such as food processing, dairy, ice cream production, bakery, confectionery, brewery, distillery, soft drinks production/bottling plants, and chemical/pharmaceutical industry etc.

The reactors use Patented, sintered high efficiency porous media material, PELIA® compounded from hydrophobic polyethylene and hydrophilic clay.

Use of fixed film reactor principle enables low hydraulic retention times of between 8-60 hours leading to smaller reactor sizes. The media with its extensive network of pores support a biologically active film with a variety of micro-organisms. At a reactor operating temperature range of between 30°C and 38°C the anaerobic micro-organisms breakdown the organic material in the wastewater to methane, carbon dioxide and water. The methane produced in the reactor provides a valuable heat source.

A normal process layout includes coarse/fine screen followed by equalisation tank, heat exchanger, anaerobic reactor and biogas dryer. The equalisation tank enables the hydraulic and organic loads to be evened out to a constant and continuous flow through to the reactor.

Furthermore, storage of the highly biodegradable wastewater in the equalisation tank enhances the anaerobic reactor process by breakdown of the complex organic molecules into simpler acids, sugars and alcohols through hydrolysis.

**Typical Process Flow Diagram**

*Image of a typical process flow diagram showing the various stages of anaerobic wastewater treatment.*

**Pretreatment Equipment**

*Image of pretreatment equipment.*

**Anaerobic Reactor**

*Image of an anaerobic reactor.*

**KEE anaerobic and SBR technologies are offered under licence from Herding Abwassertechnik of Germany**
Wastewater is heated, corrected for pH and then introduced into the reactor through specially designed sparge pipes.

The reactor can be an insulated concrete or fused glass coated steel tank which houses PELIA® media blocks to support an active film of biomass.

Anaerobically treated wastewater can be discharged to sewer or can be further treated aerobically using KEE Sequencing Batch Reactor, Extended Aeration, Rotating Biological Contactor or EnviroSAF Submerged Aerated Filter.

**Simplified insight into KEE Fixed Film Anaerobic Degradation**

- Total Organic Carbon = 100%
- Treatment
- 95% Biogas
- 1% Effluent
- 4% Biomass

**KEE Features of Anaerobic Reactors and PELIA® Media**

- High degradation rates - COD reduced from between 3,000-120,000mg/litre down to 300-500 mg/litre
- High and stable biomass retention with optimum bio-film conditions
- Valuable biogas production with high methane content
- Low surplus sludge production and low maintenance requirement
- Small footprint
- Structured fixed bed media with high specific surface area to volume ratio and reproducible pore size and pore size distribution
- Media with hydrophilic and hydrophobic surface components and micro, meso and macro pores for growth of full range of bacterial population
Activated Sludge Process

The activated sludge process is well established and is almost a hundred years old. It mimics natural processes that occur in soil and water to purify biodegradable wastes.

The process uses micro-organisms in the presence of oxygen to breakdown complex organic molecules to simple compounds such as carbon dioxide and water.

The oxygen can be supplied from air or pure oxygen. The micro-organisms are concentrated within the aeration tank and this reduces the time of degradation to hours instead of days in the natural state. Being a suspended growth process, the concentration of micro-organisms can be varied to match the strength of incoming wastewater and quality of final effluent required.

This process intensification enables the activated sludge plant to be smaller than those for other processes and to be operated to produce effluents of high quality. Manipulation of the biomass (activated sludge) within the process can also achieve nutrient removal.

Activated Sludge Plant treating vegetable processing effluent

Extended Aeration Technology

The Activated Sludge Process (ASP) has a number of variants in its design and layout.

Conventional Treatment includes primary sedimentation and aeration of the settled wastewater followed by final settlement of the biomass before discharge of treated effluent. This type of ASP plant requires regular removal of primary sludge as well as surplus activated sludge (Biomass).

One variation of ASP is Extended Aeration. Whole, screened wastewater is aerated in a reactor of large retention time followed by settlement of the activated sludge (Biomass) in a separate final settlement tank.

This Extended Aeration Process lends itself to modular design and produces effluents of high quality.
**KEE Features of Extended Aeration Process**

- No primary sludge production
- Low excess Activated Sludge (Biomass)
- High quality effluent
- Considerable upgrade possibilities
- Modular arrangement
- Ease of installation
- Little or no odour
- Good response to variable flow and load
- Simple operation
- Ease of maintenance

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**Schematic of Extended Aeration**

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**Sequencing Batch Reactor Technology**

SBR process is a managed form of activated sludge process where wastewater and activated sludge (biomass) are reacted over several hours in the presence of air.

The air is stopped and the mixed liquor in the reactor is allowed to settle; this removes the need for a separate settlement tank.

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**Typical SBR Cycle**

- **1. Filling Stage**
- **2. Mixing Stage**
- **3. Aeration / Mixing Stage**
- **4. Settling Stage**
- **5. Drainage Stage**
  - clear water removal
  - excess sludge removal

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**Decanter**
After a short settling period the clarified treated effluent is discharged via a specially designed decanter. The decanter follows the liquid level down enabling only the clear treated effluent to discharge whilst the biomass continues to settle. Once the treated effluent is emptied the reactor is available to treat a further batch of wastewater. As the process operates on a batch treatment principle and the operations are sequenced, the system is known as sequencing batch reactor or SBR.

On small installations a single reaction tank can be utilised with an upstream balancing tank to cater for flow variation and sequencing of the operations. With larger flows two or more reactors can be used and this would remove the need for an upstream balancing tank. The KEE SBR can also be fitted with patented sintered hydrophobic and hydrophilic bio-block media (optional) and this makes the KEE SBR particularly versatile for use with a large variety of wastewater characters. This bio-block media allows a wide variety of bacterial population to establish in the biomass in high concentration.

The whole SBR process is fully automated and PLC controlled for efficient performance. The settling characteristics are improved and sludge bulking is almost unknown in the SBR process.

**KEE Features of SBR Technology**

- Single or multiple reactor tanks option
- Operations sequence and aeration phase are PLC controlled
- Anoxic aerobic phase for BOD removal, nitrification and denitrification.
- Up to 95% BOD reduction
- Simple operation and maintenance requirement with reduced sludge production
- Versatility with a variety of wastewater characters through use of high efficiency hydrophobic and hydrophilic structured media blocks (optional)
- Optional Porous Patented Media offering highly active and captive biomass
- Optional Porous Media provides support and anoxic conditions for bacterial population

Typical schematic flow diagram of single reactor SBR
The KEE SBR process is a compact yet adaptable system proven to produce high quality effluent from Municipal and Industrial wastewater. The reactor tanks can be prefabricated from glassfibre reinforced polyester for small flows and steel or concrete for larger flows. They can be installed above or below ground, depending on site conditions, and have a small footprint with low environmental impact.

Applications can include treating biodegradable wastewater from industries such as food processing, chemical/pharmaceutical industry and isolated facilities such as schools, colleges, leisure complexes, hotels, nursing homes, public houses, housing developments etc. which are not able to connect to public sewer.

**Industrial Wastewater Disposal Options**

Process industries tend to generate a large amount of wastewater and this is often highly polluted. Disposal options include discharge to public sewer or on-site treatment prior to discharge to sewer or a watercourse.

Public Sewers are convenient for disposal of wastewater if they are nearby. Quantity, strength and character of wastewater need to be considered and Authorities consulted for discharge to sewer. If approval is granted and the wastewater meets the criteria set, then sewer disposal would be an obvious choice, but this comes at a cost. High COD (Chemical Oxygen Demand) and suspended solids would lead to high costs and reducing these parameters can make significant savings. Partial or full on-site treatment would bring about cost savings, but need to be justified.

It is always advisable to carry out an evaluation of the processes involved in core business to identify sources of waste. An audit would help reduce waste and disposal costs and quantify flow rates, organic loads and characterise the wastewater to optimize the design of any on-site treatment plant.

The KEE Group can offer design, installation and operation of on-site treatment plant. Their technologies include anaerobic digestion, aerobic processes including RBC and Submerged Aerated fixed film systems, extended aeration and SBR activated sludge processes, complemented with physical and physio-chemical processes. KEE also have a team of experienced process engineers and project engineers capable of delivering solutions to suit.
Other technologies, systems and services offered by the KEE Group.

Wastewater Treatment Solutions

- **Rotating Biological Contactor (RBC) Wastewater Treatment Systems**
  - NuDisc® Single Piece Packaged RBC Treatment Plants
  - Modular Packaged RBC Treatment Systems
  - Large Diameter RBCs for site erection

- **Submerged Aerated Filters**
  - Single Piece EnviroSAF Systems
  - Modular Packaged EnviroSAF Treatment Systems
  - Large EnviroSAF in on-site constructed concrete tanks

- **Activated Sludge Systems**
  - Extended Aeration (EA)
  - Sequencing Batch Reactors (SBR)

- **Anaerobic Reactors**
  - Industrial Wastewater Treatment

- **Settlement Tanks and Packaged Pumping Stations**
- **Custom made composite GRP covers and enclosures**

Treatment Plant Service

- **Service, Maintenance and Operations**
- **Replacement parts and associated products**

Telephone 0800 389 0457 for more information on these and other products and services developed and offered by the KEE Group.

Distributed by:

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In keeping with the Company policy of continuing research and development, KEE Process reserve the right to alter specifications and dimensions without prior notice.

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