

WASTEWATER



Activated Sludge Treatment



Krüger's Range of Technological Solutions

For more than 40 years Krüger has been involved in the research and development of new processes based on activated sludge. This has led to a number of patented processes and control strategies all with the aim to improve and optimize the performance of wastewater treatment plants. The outcome of this development has been widely recognized and resulted in the installation of several hundreds plants all around the world based on Krüger processes.





Aktivated Sludge Treatment

As with many other biological processes, biological treatment of wastewater is based on nature's own micro organisms. Krüger's continuing research effort is directed at understanding, controlling, adapting and optimising the natural biological processes. Today we are a world leader in the field of biological nutrient removal.



The purpose of wastewater treatment is mainly to reduce one or more of the following components in the water:

- ▶ Suspended solids
- ▶ Organic compounds
- ▶ Nitrogen
- ▶ Phosphorus

This is normally done by choosing an appropriate combination of physical, biological and chemical processes. The biological processes often play a main role in achieving the desired result. The challenge is to choose the right processes and combine these in an optimum way allowing for the best treatment under the specific circumstances. This is normally a complicated task since many important factors (e.g. the wastewater characteristics, the effluent limits etc.) change

and complicate the process from case to case. Krüger's process specialists have a thorough understanding of the different processes and are able to schedule the individual process conditions allowing for a successful design of the complete treatment plant.

Biologically Processes

The biological removal of the different compounds may require different environmental characteristics. Furthermore, other conditions must be taken into account such as the rate of growth of the micro organisms, the type of micro organisms, the level and quality of substrate, the temperature and the pH. All of these conditions must be considered thoroughly before the best treatment process can be identified.

Owing to the above circumstances it is

important to have a wide range of processes to choose from in order to obtain the optimum design of each individual plant. Over the last several decades Krüger has created a diversified line of biologically processes which enable us to consistently offer the optimum design of every treatment plant.

Control and Monitoring

Significant direct benefits can be derived from computerised process control and monitoring, utilising on-line measurement of key parameters in optimising plant performance. The system usually results in considerable energy savings and frequently reduces consumption of chemicals, improves effluent quality and, not least, enhances the utilisation of the available plants capacity, so that the plant extensions can be postponed or avoided altogether.

Sludge Recirculation Systems

These plants are based on the principle that the wastewater is taken to the part of the plant that offers the best conditions. Consequently, different sections of the plant will have different conditions allowing for the total treatment. These systems can be supplied both with and without biological phosphorus removal.

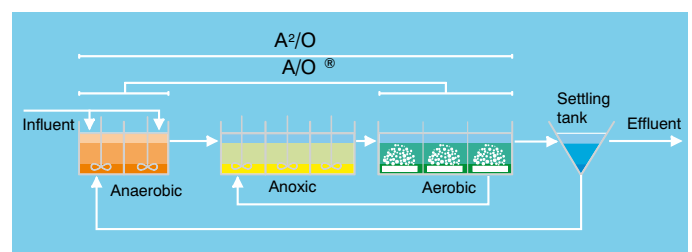
Kruger's sludge recirculation systems

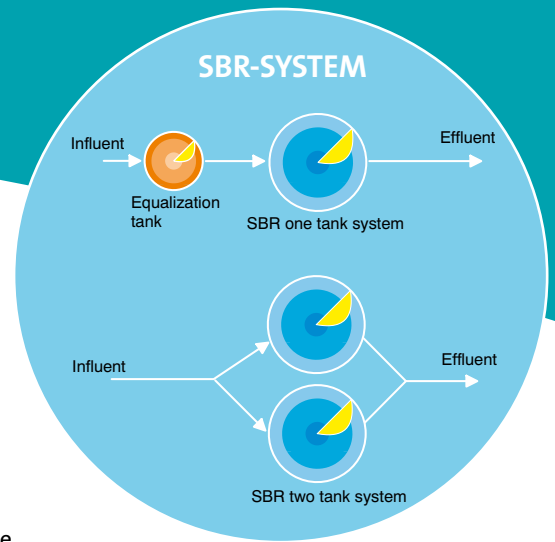
Without Bio-P	With Bio-P
AE	A/O [®]
Recirculation	A ² /O

The AE system is the simplest system allowing mainly for reduction of organic pollutants. If nitrogen removal is required, an anoxic zone with recirculation can be added resulting in a recirculation system.

If biological phosphorus removal is required the patented A/O[®] and A²/O systems can be used. The A/O[®] system was developed particularly for the purpose of biological phosphorus removal and abatement of filamentous bacteria, while A²/O removes both nitrogen and phosphorus. In their basic form A/O[®] plants comprise an anaerobic and an aerobic tank, allowing removal of organic matter and phosphorus. Nitrogen removal in A²/O plants takes place by inserting an anoxic tank between the two other process tanks.

Flow diagram of the A/O[®] and A²/O process





Bio-Denitro®

The **BIO-DENITRO®** is a unique process developed by Krüger in the 1970s. Since then the process has been adopted worldwide on more than 300 plants with capacities of up to 750,000 PE. The process is based on the principle that the treatment is performed in the activated sludge tanks where the wastewater is admitted. The systems are operated by sequentially alternating the flow and the process conditions in the reaction tanks allowing for the total treatment. This results in an extremely flexible and cost effective design.

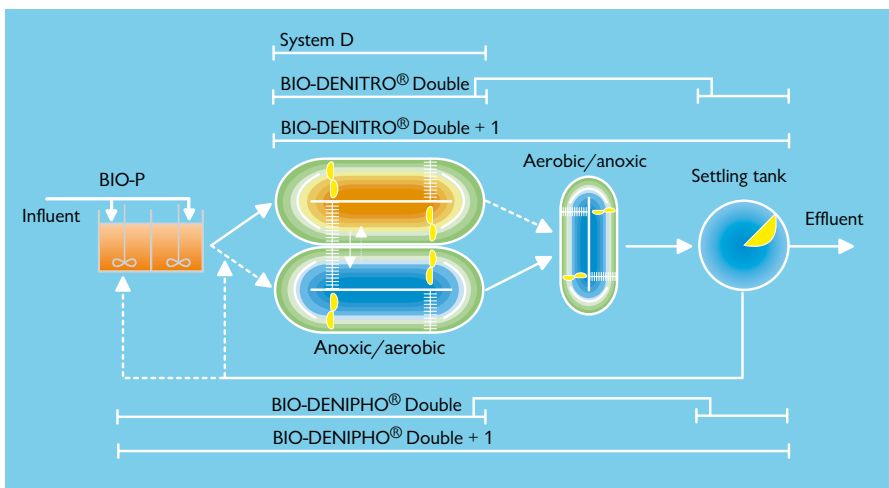
The **BIO-DENITRO®** process is available in systems both with internal and external settling. The systems with internal settling are based on a novel combination of a Continuous Sequence Batch Reactor (CSBR) and the **BIO-DENITRO®** process. The systems with external settling include one or more final clarifiers. In this design, the process can be extended with a Bio-P system allowing for biological phosphorus removal. This process is called **BIO-DENIPHO®**.

Krüger's systems based on the **BIO-DENITRO®** process

No. of process tanks	Internal settling tank	External settling tank	
		Without Bio-P	With Bio-P
2	System D	BIO-DENITRO® – Double	BIO-DENIPHO® – Double
3	System T	BIO-DENITRO® – Double+1 BIO-DENITRO® – Triple	BIO-DENIPHO® – Double+1 BIO-DENIPHO® – Triple
4	System Q	BIO-DENITRO® – Quattro	BIO-DENIPHO® – Quattro

In its basic form the **BIO-DENITRO®** plant consists of two identical process tanks and a settling tank. However, the system is available with up to four reaction tanks resulting in both higher flexibility and better effluent quality.

Flow diagram of some of the processes based on **BIO-DENITRO®**



Sequencing Batch Reactor (SBR)

The Sequencing Batch Reactor (SBR) is also part of Krüger's product range. An SBR system is a very simple system where the entire treatment is carried out in the tank where the wastewater is admitted. The SBR system is characterised by being a batch process with discontinuous influent and effluent from each tank.

Normally, the SBR system is made as a one or two tank system. In the one tank system an equalization tank is needed in front of the SBR system.





Aktivated Sludge Treatment



Advanced Controlling

Since the loading conditions of a wastewater treatment plant are constantly changing, the controlling of the plant is critical in order to continuously obtain the optimum treatment. Krüger's systems based on the BIO-DENITRO® process are extremely flexible which allows for the plants to be adjusted to the specific conditions.

To continuously maximise the plant's efficiency Krüger has developed STAR (Superior Tuning and Reporting). By adding the STAR system to the plant an instant on-line control of the plant is obtained. The on-line instruments provide direct feedback to the computerised control system. Instant knowledge of the biological process performance in the tanks is secured and the treatment process can immediately be adjusted accordingly. The result is a treatment plant working at its optimum at all times.

If STAR is incorporated into the design of the plant from the beginning, the volume of the process tanks can be reduced by 15-25%.



Example of the result of improving the controlling of a wastewater treatment plant

