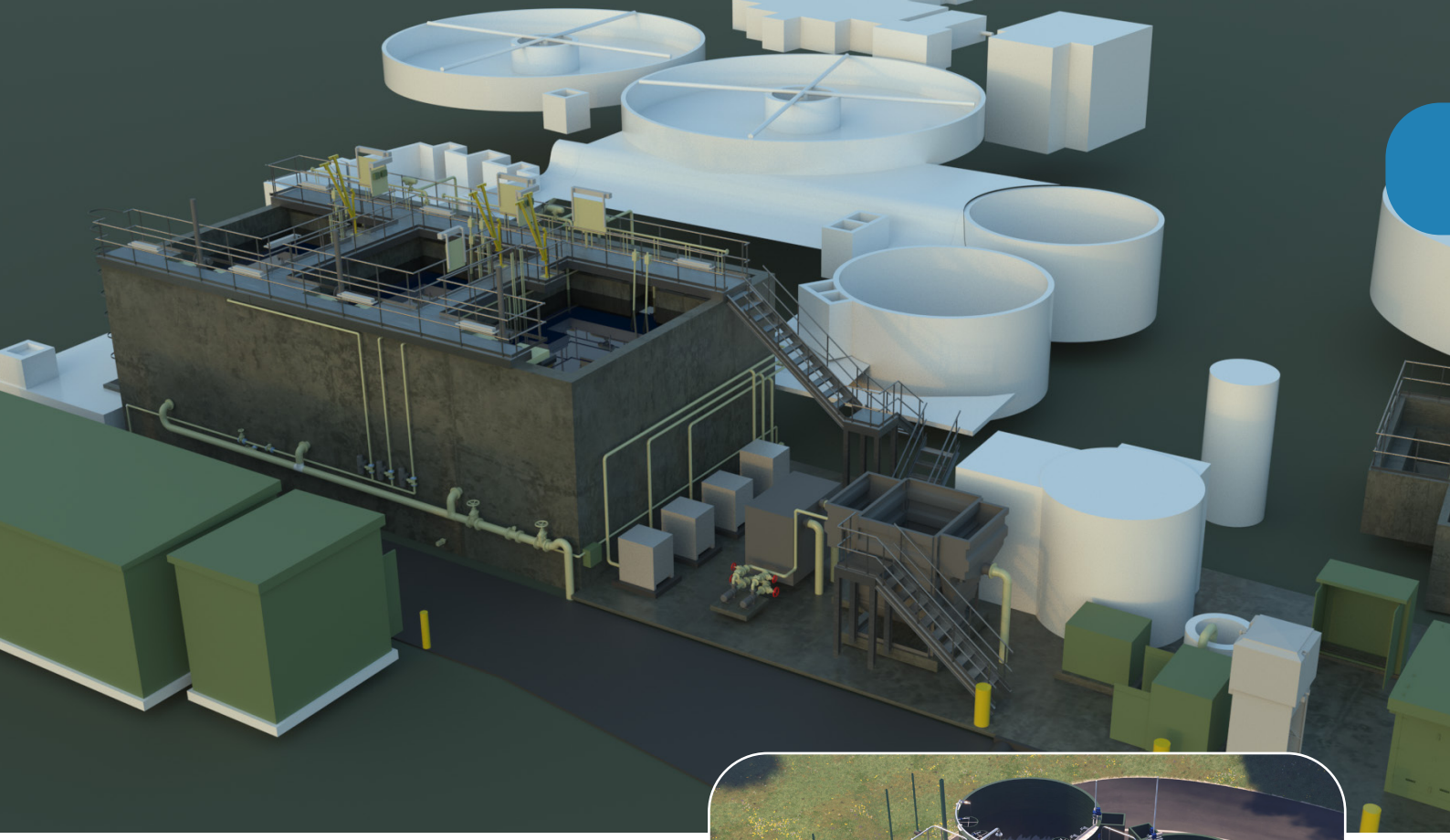
TE TECH

PROCESS SOLUTIONS

te-cyc™

Slavonski Brod WwTW, Croatia, 80,000 PE

Water and Wastewater Treatment



Hawkhurst South WwTW, UK 2285PE

te-cyc™

A reduced footprint advanced cyclic activated sludge technology with simultaneous nitrification and denitrification, and biological Phosphorus (bio-P) removal in a single treatment stage.

At present, the UK wastewater treatment industry is facing an increasing number of challenges from a variety of different drivers including regulatory obligations and increasing public awareness. Such challenges include the need for a better effluent quality with low levels of Phosphorus, ammonia and total nitrogen, as well as achieving a sustainable solution without the need for chemical dosing or a large carbon footprint. The te-cyc™ cyclic activated sludge technology from Te-Tech Process Solutions is able to satisfy these drivers in a single treatment stage. The design of the te-cyc™ process, based on more than 20 years of experience, guarantees high quality treated effluent with a reduced TOTEX when compared to traditional activated sludge and conventional sequencing batch reactor processes.

The te-cyc™ system, which can be supplied as a bespoke design or a range of standard above or below ground modular units, consists of several circular or rectangular batch reactor basins each containing an anaerobic selector zone, aeration zone, internal recycle, decant arm, and oxygen uptake rate (OUR) based aeration control system. Installing two or more te-cyc™ basins in parallel allows for continuous throughput and eliminates the need for upstream buffer tanks, mixing devices, and tertiary settling tanks, which ultimately reduces the overall site footprint by approximately 50% when compared to traditional activated sludge or conventional sequencing batch reactor processes.

Typical te-cyc™ arrangement

te-cyc™: the process consists of three distinct stages that operate on a cycle:

1 Fill/Aerate

During the fill/aerate stage water enters a single te-cyc™ basin into the aerated zone via the anaerobic selector. Throughout this fill stage, the aeration zone is continually aerated at a controlled rate and a portion of the sludge is constantly recycled to the inlet of the selector. The design of this selector and recycle rate allows for the formation of macroflocs in which simultaneous nitrification/denitrification, BOD_5 removal and biological phosphorus removal occurs. Moreover non-floc formers and filamentous microorganisms are suppressed to the best possible extent by natural selection mechanisms.

2 Settle

During the settling phase, the inlet to the particular basin is closed, the internal recycle is stopped, and the sludge formed in the previous stage aggregates as a blanket and settles to the base of the reactor tank leaving a top layer of clear treated effluent. In typical wastewater applications, the settled sludge layer has a mean biomass concentration of around 10 g/l and operational sludge volume index (SVI) of typically 60 – 100 ml/g.

Basin 1	Fill/Aerate		Settle	Decant
Basin 2	Settle	Decant	Fill/Aerate	
Basin 3	Fill/Aerate	Settle	Decant	Fill/Aerate
Basin 4	Decant	Fill/Aerate		Settle
Hour	1	2	3	4

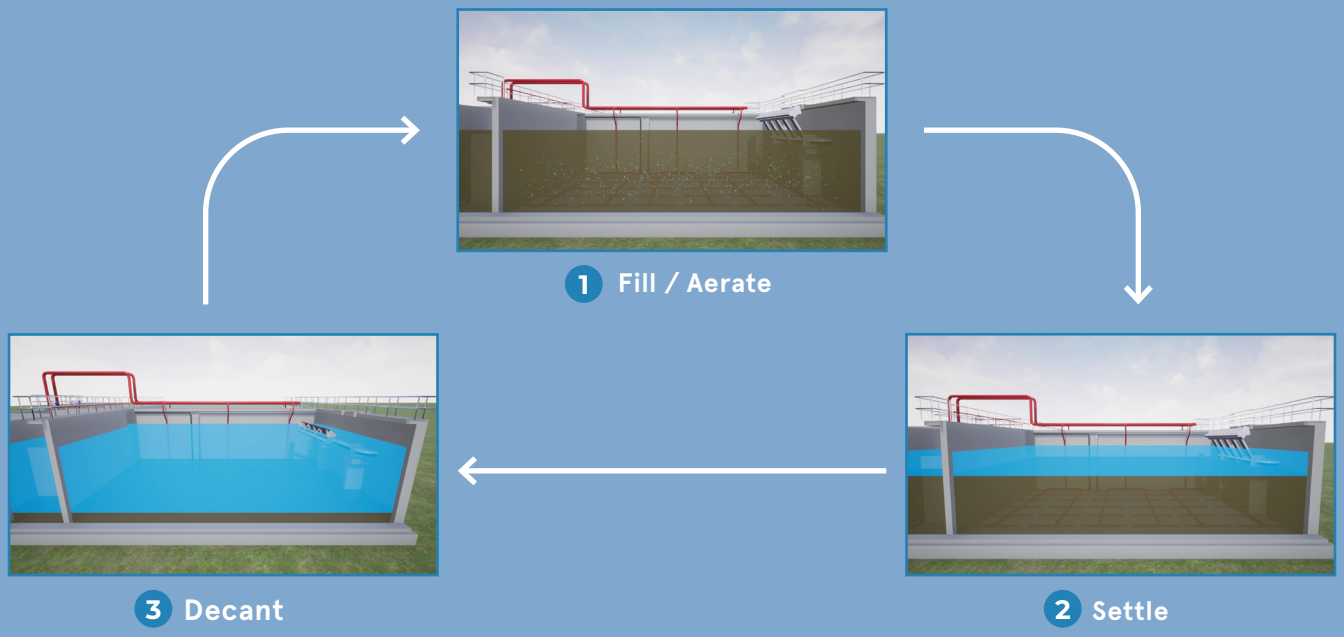
Typical cycle sequence

3 Decant

In the decant phase, the mechanically driven weir decanter moves from the top water level to the bottom water level to remove approximately one third of the reactor volume which will be clear treated effluent. The decant arm also features all-side scum guards which prevent floating solids from discharging into the decanter. At the end of the decant phase, the decant arm is returned to its parking position. Towards the end of the decant phase, a portion of the settled surplus sludge at the base of the reactor based is discharged. The rate at which the decanter is lowered and, hence, the rate of treated wastewater discharge, can be varied during the decant phase.

This cycle is typically 4 hours duration for dry weather flow and is repeated continuously. Having multiple reactor basins in parallel, with their cycles out of phase with each other, means that the total system can handle continuous flow without the need for an upstream buffer tank.

The flow and aeration control systems are designed with dry weather flow and wet weather flow operating protocols as standard, with maintenance cycles available with 3 or more parallel reactor basins. The transition between cycles, whether automatic or manual, is done via the PLC system without affecting the continuity of the plant operation.



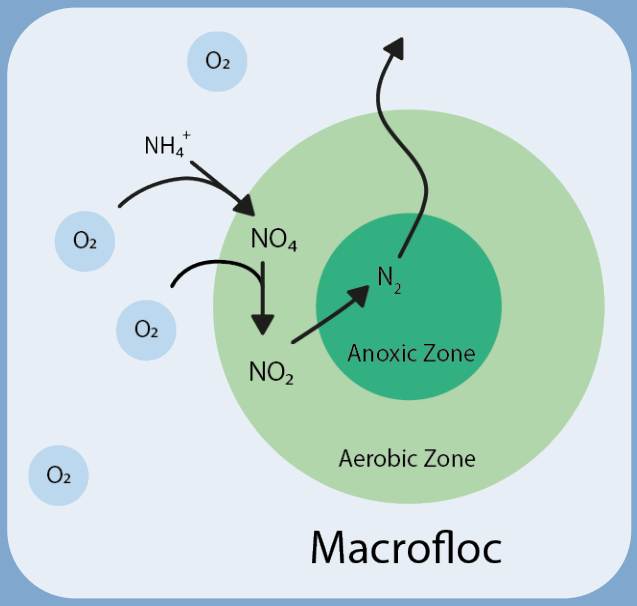
Typical te-cyc™ process cycle

OUR (Oxygen Uptake Rate) Control

The OUR control system is particularly applicable to biological nutrient removal. It uses only a measurement of the dissolved oxygen within a reactor basin to determine the actual oxygen uptake rate of the biomass available. In doing so, the required duration of the fill/aerate cycle and the rate of aeration to achieve complete nitrification and BOD/COD removal are calculated and implemented. Employing the control system prevents over-aeration of the reactor basin and creates energy savings. On average the energy required for plants using OUR control is 27% less than those without, and compared to traditional ASP and SBR processes, the energy requirement of the process is on average around 70% less.

Macrofloc Formation

The anaerobic selector zone and internal recycle of the te-cyc™ system allows for the formation of so-called "macrofloc" in which extracellular polymeric substances (EPS) produced by the floc forming microorganisms under stress conditions act as a "glue" between the microorganisms. The enhanced size of these macrofloc means that each floc contains an external aerobic zone and an internal anoxic/anaerobic zone during the aeration phase of the process cycle. This means that both nitrification and denitrification occur simultaneously within the same reactor zone and cycle phase, reducing both the required reactor volume and overall cycle time when compared to traditional ASP or SBR processes.



Nitrification & denitrification pathways

Case study: Grossarl (Austria)

The Grossarl plant in Austria gives a good indication of what the latest te-cyc™ design can achieve in UK conditions. The 18,000 PE, 3,440m³/d (DWF) plant was built in 2004 as an upgrade to an existing two-lane activated sludge plant. Two new te-cyc™ lanes were built and brought online either side of the existing lanes, and then the two existing activated sludge lanes were easily converted into two further te-cyc™ lanes, creating a four lane system all whilst keeping the site operational. The total volume of the four reactor basins is 5,200m³ with a footprint of 1130m².

Grossarl's influent consists of a mixture of domestic and industrial wastewater with typical water quality values shown below. Also shown in table 1 are the design influent and average effluent qualities for 2014. Even during the coldest month, January, when the water temperature is below 8°C, high levels of biological nutrient and BOD_5/COD removal are still achieved.

Enhanced Bio-P Removal

The anaerobic selector zone provides the perfect conditions for the growth of polyphosphate accumulating organisms (PAOs) within the macroflocs. The mechanism for removal begins with the PAOs releasing all of the polyphosphates contained within them in the selector zone and then uptaking a greater amount of phosphate from the surrounding bulk liquor within the aerated zone. This is the so-called luxury uptake cycle for enhanced biological phosphorus removal. The phosphate-rich organisms are then periodically removed with the settled sludge during the period of sludge wasting in the decant phase. Under favourable conditions the te-cyc can provide treated effluent phosphorus concentrations of less than 1 mg/l P without the need for chemical dosing.

Amble WwTW, UK, 15,000 PE

Markse WwTW, UK, 140,000 PE

Worldwide/UK Installations

There are currently more than 500 te-cyc™ plants installed worldwide, with capacities ranging from 200 to 1,200,000 PE, and treating a wide variety of wastewater types in a range of climatic conditions.

Wastewater types:

- Domestic Wastewater
- Food and Beverage Industry
- Paper Industry
- Textile Mills
- Pharmaceutical and Chemical Industry
- Petrochemical Industry
- Landfill Leachate

In the UK and Ireland, there are several te-cyc™ plants that were all built in the early 2000s with the application of carbonaceous removal only. The continuous development of the te-cyc™ process incorporates advanced features, such as simultaneous nitrification/denitrification and enhanced biological phosphorus removal, which are ideally suited to the UK population growth drivers and to meet tightening discharge consents

te-cyc™ Grossarl Influent and Effluent Data

Parameter	Design Influent Load (kg/d)	Average Influent Concentration (mg/l)	Average Effluent Concentration (mg/l)
DWF	3,440 m^3/d		
WWF	9,900 m^3/d		
BOD_5	6,480	218.6	4.7
COD	14,200	574.6	30.8
SS	4,400	347.8	5.23
Total P	**150**	**7.0**	**0.84**
Total N	**1,100**	**46.6**	**6.63**

Grossarl WwTW, Austria, 18,000 PE

Compact | Cost Effective | DfMA | Resilient | Innovative | Sustainable | Flexible

Summary

The te-cyc™ has had great success worldwide with over 500 installations and is ideally suited to meet the requirements of the UK wastewater market.

te-cyc™ Advantages:

- Continuous throughput allowing for elimination of buffer tank leading to ca. 50% reduction of plant footprint compared to conventional ASPs
- Anaerobic Selector designed for:
  - Formation of macroflocs for simultaneous nitrification and denitrification
  - Formation of PAOs for enhanced bio-P removal
  - Suppression of bulking sludge forming bacteria
- Excellent effluent quality guaranteed - BOD:SS:TN:TP of < 10:10:10:1 mg/l
- Capital savings of around 10-20% when compared to conventional ASPs
- Energy savings of around 75-85% when compared to conventional ASPs

Of course, not all wastewater treatment sites are equal; therefore the te-cyc™ process and cycle design can be adapted to:

- Nutrient removal or removal of BOD_5/COD only
- Simultaneous sludge stabilisation
- Nitrification at very low temperatures
- Enhanced biological phosphorus removal
- With or without primary settling tanks

Jelutong WwTW, Malaysia, 1.2million PE

Cork WwTW, Ireland, 450,000 PE

Tychy WwTW, Poland, 89,100 PE

Contact Us

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