Optimisation of the Biological Treatment Case Studies Different types of communication systems (such as the biological or chemical processes) can be calculated within the ANCS that are often more precise than the laboratory analyser.

The optimisation strategy was switched to under dry weather conditions. Under stormy weather conditions, the optimisation yielded 15% energy savings for the WWTP. The optimisation strategy targets the control of incidents to ensure high customer satisfaction with high customer confidence. Therefore, the implemented ANCS uses intelligent machinery with genetic algorithms to optimise the processes with regards to energy consumption.

Barriers to Uptake

Legal and/or regulatory barriers: Drinking water companies must comply with the Drinking Water Directive by ensuring that the water quality of the treated drinking water fulfills the requirements of the directive. The ANN technology supports companies in complying with standards, as the system continuously monitors and steers the process based on current environmental data provided.

Economic barriers: The use of the plant for ANN optimisation alone or in conjunction with treatment plants larger plants are hence more cost efficient than smaller plants. The potential impact of ANN application can be estimated accurately and cases for a reasonable investment (e.g. with regards to the payback period) can be determined in advance.

Maintenance: Optimising is a long-term task and must not lose its importance, partly when living biological systems are involved. Therefore, maintenance is an important aspect to consider as part of ANN implementation. The systems require so-called “re-trainings”. These can be pursued either by aquatune, the operator or automatically by the system itself. The solution applied depends on several technical and economic parameters, aquatune offers attractive service level agreements that cover all possible options for ensuring ongoing maintenance.

Bargains and Solutions

OPPORTUNITIES FOR UPTAKE

- Signalling: Membrane filtration processes show very predictable behaviour. Therefore, experiences derived from research projects such as DEMEAU support the application of the ANN to a diverse range of (drinking) water treatment plants.
- Process optimisation: The implementation of ANN in WWTP makes intelligent filtration processes can enhance process productivity by 4–15%. Among existing membrane filtration plants in Europe, there is a large potential to achieve in-plant synergies with technologies.
- Flexibility: As ANCS are applicable to a multitude of technologies, the opportunities for uptake are diverse.

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The search for an optimum solution is extremely complex due to the high number of effects that simultaneously affect process quality and efficiency. For such evaluations, genetic algorithms, which are developed based on natural functionalities, have proven their effectiveness. The DEMEAU project, financed within the 7th Framework Programme for Research and Technological Development of the European Union (FP7), demonstrated possible savings in the operation of a membrane water treatment plant.
CROSSOVER

ANN-Structure: Mapping of input data (e.g. flux, temperature, Figure 1: changes in input signals cause therefore changes in the technology connects causes to effects using its algorithm- During the learning phase, the output data is compared of calculation patterns, describes how input signals derived to the system aims to optimise its target parameters. Parameters process could be a membrane filtration process, where the information to determine the optimal performance of the system is mature, its predictions are used within an algorithm as chromosomes. The GA searches the fitted solution of the optimisation problem within a defined number of generations (rounds of comparison). Chromosomes survive a generation if the set process parameters. ANCS was developed during the EU wide the set represent better results to the ANN, which programs represent the system to be optimised, than the respective code is able to identify the optimal algorithm settings for the other chromosome. Throughout the process, the chromosomes are inherited by the next generation or drop out of computation. The function of mutation and crossover simulate a non-linear thinking, adding an additional level of complexity to the selection process. The functions add new features to the process and make GA more efficient. During the optimisation process the learning phase, the operating pots can be trained for a very short time to determine the fitted chromosomes, and therefore also the optimal system settings within a system parameter range. A diagram of the process is shown in Figure 2.

Using ANNs together with a genetic optimisation algorithm, the input parameters are divided into two types of variables: constant (or disturbance) and manipulable, and are then optimised for the problem at hand. For optimisation, a target function is defined and includes the manipulable variables. The manipulable variables can be altered in a fixed range. Therefore, the data range should be defined to lie within the area of valid parameters, ensuring that the extrapolations are possible. Consideration of logical or operational barriers also will be included as barriers for the search area. Each time a greater fitness is generated, the chromosomes are decoded back to the original process settings.

OPTIMISING A TECHNICAL PROCESS

The filtration process as demonstrated in the pilot project for optimisation problems with several variables approximate the results from a pilot plant to the full scale process, many possible operating points can be tested in a very short time to determine the fittest chromosome, and thereby also the optimal system settings within a given parameter area.

The advantages of the technology increase with the complexity of the processes controlled and/or optimised. Processes in wastewater treatment plants or the purification of river water are examples for processes in waterworks. In addition, a minimum production volume needs to be considered as a prerequisite for optimisation. For the average waste water treatment plant, the minimum production volume is 20,000 population equivalents. Therefore, the advantages of the technology increase with the complexity of the processes controlled and/or optimised. Availability of data is a necessary requirement, however, as modern automation systems require sensor data for correct operation, data availability is usually not a barrier.

ANCS can be combined with many different systems of water/waste management as well as control technologies, and thus is very applicable.

SCALABILITY

Generally, ANCS can be applied to systems of all sizes. However, the size of the system influences the economic viability as time for the return of investment sizes. However, the size of the system influences the economic viability as time for the return of investment.

The efficiency increases considerably with the number of controlled or optimised parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant. The advantage of such an approach is the ability to adapt or optimise the process parameters. This is cost efficient compared to engineered solutions, due to the increased productivity of the plant.