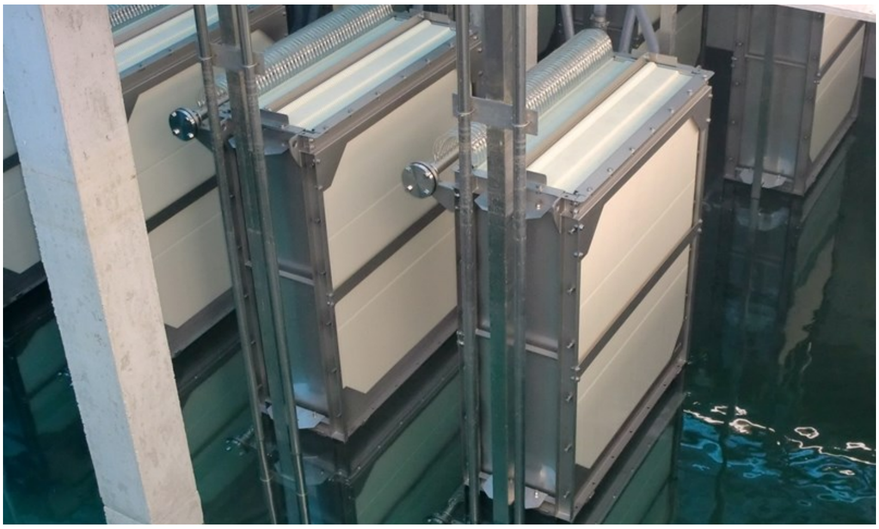
COMMISSIONING OF A MEMBRANE BIOREACTOR WASTEWATER PLANT

Helping Arenales del Sol assess operational strategies with calibrated modelling

The coastal region of Alicante, Spain, is a popular destination for visitors during the summer and winter touristic seasons. It is therefore essential that its wastewater treatment plant (WWTP) – Arenales del Sol – is equipped with the capability to provide high quality treatment to greatly variable seasonal sewage inflow. One of the challenges that Arenales del Sol WWTP faced was having a suitable seeding procedure which could reduce the start-up time for its large membrane bioreactor (MBR) system. To address that, we simulated the start-up phase of a flat-sheet MBR system of the WWTP in WEST. The simulation proved the effectiveness of the proposed solution of dosing molasses, available at no cost, to dramatically shorten the period necessary to attain the optimal mixed liquor suspended solids (MLSS) concentration.

USING A MATHEMATICAL MODEL TO ASSESS SPECIFIC OPERATIONAL STRATEGIES

The Arenales del Sol WWTP combines biological treatment with nutrient removal along with a submerged MBR system fitted with flat sheet ultra-filtration membranes, which has an average treatment capacity of 10 MLD. Commissioning a relatively large MBR plant that is to operate under highly seasonal inflows and yet is able to deliver high quality effluents appeared to be a challenge. The solution called for the use of a mathematical model, where specific operational strategies could be assessed upfront.



Flat-sheet membrane modules. © DHI / PROINTEC

CLIENT

PROINTEC, for EPSAR (Entitat Pública de Sanejaments D'Aigues Residuals)

CHALLENGE

- Highly variable sewage inflow due to touristic nature of the region
- Need for a suitable seeding procedure capable of reducing the start-up time for a large MBR system
- Creation of a custom operations and maintenance manual that covers a variety of possible scenarios

SOLUTION

Development of a calibrated model of the WWTP in WEST to select the ideal start-up procedure among a variety of possible operation modes.

VALUE

- Up to 40% reduction in start-up time, compared to conventional seeding
- Assessment of several realistic seasonal scenarios, in view of a significant reduction in energy consumption for aeration costs

LOCATION / COUNTRY

Alicante, Spain

SOFTWARE USED

WEST

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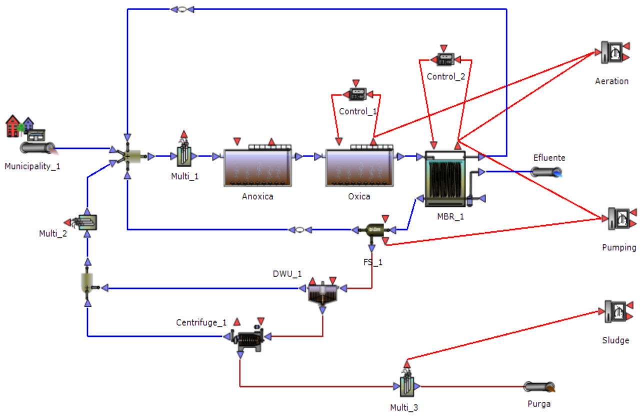
DRAMATICALLY REDUCED START-UP TIME

Flat sheet MBR systems (FS-MBR) deliver better performances at high concentrations of solids (MLSS) in the range of 12 g/l. Sludge seeding in biological and MBR tanks is thus a challenge for medium to large municipal WWTPs.

We therefore decided to use WEST primarily to simulate and optimise the seeding phase of the plant, so as to reach a high MLSS concentration in the shortest time possible while ensuring the process integrity (that is, reducing filamentous bacteria, foaming, EPS formation, and so on).

High energy consumption is one of the major drawbacks when using MBR technology. As such, another practical use for the WEST model was to explore various operations and maintenance (O&M) strategies, aimed at achieving a highly stable water quality as well as energy optimisation.

The plant layout consists of an anoxic zone, an oxic zone and the membrane tank. Fine bubble aeration of the oxic chamber was modelled through the KLa parameter, which is regulated through a PI control loop.



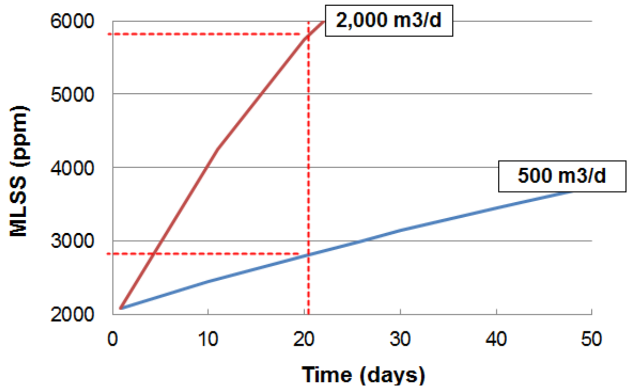
WEST layout of the Arenales del Sol WWTP. © DHI / PROINTEC

The use of a calibrated model in WEST enabled us to optimise the seeding strategy of an MBR system. The time required to attain the high MLSS concentrations necessary to start-up a FS-MBR is reduced by 40% as a result.

MODEL-BASED OPTIMISATION OF SEEDING PHASE

During commissioning, the pre-existing WWTP required at least 1,500 m3/d of wastewater to ultimately guarantee sufficient irrigation of nearby crops. The new MBR plant could only receive 500 m3/d of water, equivalent to 1/8 of the design flow. This posed serious difficulties in achieving the target MLSS concentration of 7 g/l required for the FS-MBR within a reasonable time frame.

The WEST simulation indicates that in three weeks – the acceptable start-up time – an MLSS concentration of only 2.8 g/l could be attained with the available flow rate. With a larger inflow, such as, 2,000 m3/d, and over the same time period, concentrations of nearly 6 g/l would be reached.



Simulated MLSS concentration at 500 m3/d and 2,000 m3/d of influent flow. © DHI / PROINTEC

Another factor resulting in such long start-up times was the low COD concentration as compared to the design values (900 ppm versus 1,500 ppm). Microbiological analyses and further wastewater characterisation confirmed that the low biomass growth yield was not due to cell growth inhibition.

Since it was not possible to operate at higher flow rates, the hypothesis was formulated such that external organic matter will be added in precise intervals. This would allow the desired MLSS concentration to be attained in a limited time period.

The WEST simulation confirmed that increasing the flow rate to 1,000 m3/d and adding molasses from a nearby candy factory at 1 kg COD/l would ensure that 6,000 mg/l MLSS will be reached in just 21 days – at hardly any additional cost to the operator except transportation cost.

POTENTIAL ENERGY CONSUMPTION REDUCTION

The WEST model aptly predicted the MLSS evolution and the biologic removal of organic matter and nitrogen in the MBR. It can be applied in operational strategy studies to reduce energy consumption for aeration without compromising effluent quality. It can also be useful when compiling an O&M manual for a wide range of process conditions. This enables the operator to choose the best operational strategy at any given time, while providing estimated energy consumption indicators for every scenario.

CLIENT TESTIMONIAL

> *The application of WEST has allowed us to shorten the commissioning period. With WEST, we can demonstrate to the operating personnel how the system works. We have gained certainty in our own tasks.*
>
> *Héctor Rey Gosálbez - Chemical Engineer - PROINTEC*

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