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Case Study - Malatech Bioaugmentation

2 400 m3/d Municipal Wastewater Treatment Plant of a city with food industry (juice manufacturing) load

Goals of bioaugmentation:

1. Total Nitrogen removal enhancement due to recent authority rules 15 mg/l for final effluent, which caused trouble since the plant receives a decent amount of pre-treated effluent of a juice manufacturer with high Nitrogen load.
2. OPEX reduction by lowering energy consumption, Ferric(III)Chloride dosage, excess sludge dewatering, transportation and disposal costs

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Title: Municipal wastewater treatment plant optimization

The municipal WWTP operator client has had this **trouble-free plant** in operation 2 years after renovation. The plant has 2 parallel biological treatment lines, nearly equally sized. Both lines have fine screens, sand traps, followed by Bio-P, anoxic, and aerobic reactors, ending with 1 secondary Dorr clarifier. The plant treats the raw wastewater of a city and a few nearby villages.

The influent wastewater has higher Total Nitrogen concentration than usual municipal values since a **food industry operates in the city**, and releases their pre-treated effluent in the system. 15% of the average dry-weather influent flow is pre-treated industrial wastewater.

The plant ran trouble-free for 2 years after renovation, but **authorities lowered the effluent limit for Total Nitrogen to 15 mg/l**, which was the main reason the operator chose Malatech Bioaugmentation. **In order to make the process profitable for the operator, we placed focus on the usual OPEX reduction capabilities of our technologies to make sure the operator saves more on operating costs than spending on the maintenance dosage of the bioaugmentation materials, while meeting with new Total Nitrogen limit.**

We have targeted the 3 main factors for operating cost savings:

1. Lowering the energy consumption of the plant
2. Decreasing FeCl3 dosage significantly used for P-removal by improving the Bio-P step.
3. Decreasing excess sludge production, saving on polyelectrolyte costs used for dewatering, dewatered sludge transportation, and disposal costs.

Dosages:

Bioclean TM as our core technology has only been applied since the plant is running trouble-free, just we needed to extract the most from its biology by Bioclean TM, which has a diverse portfolio of benefits making it a sole solution for the operator's challenges.

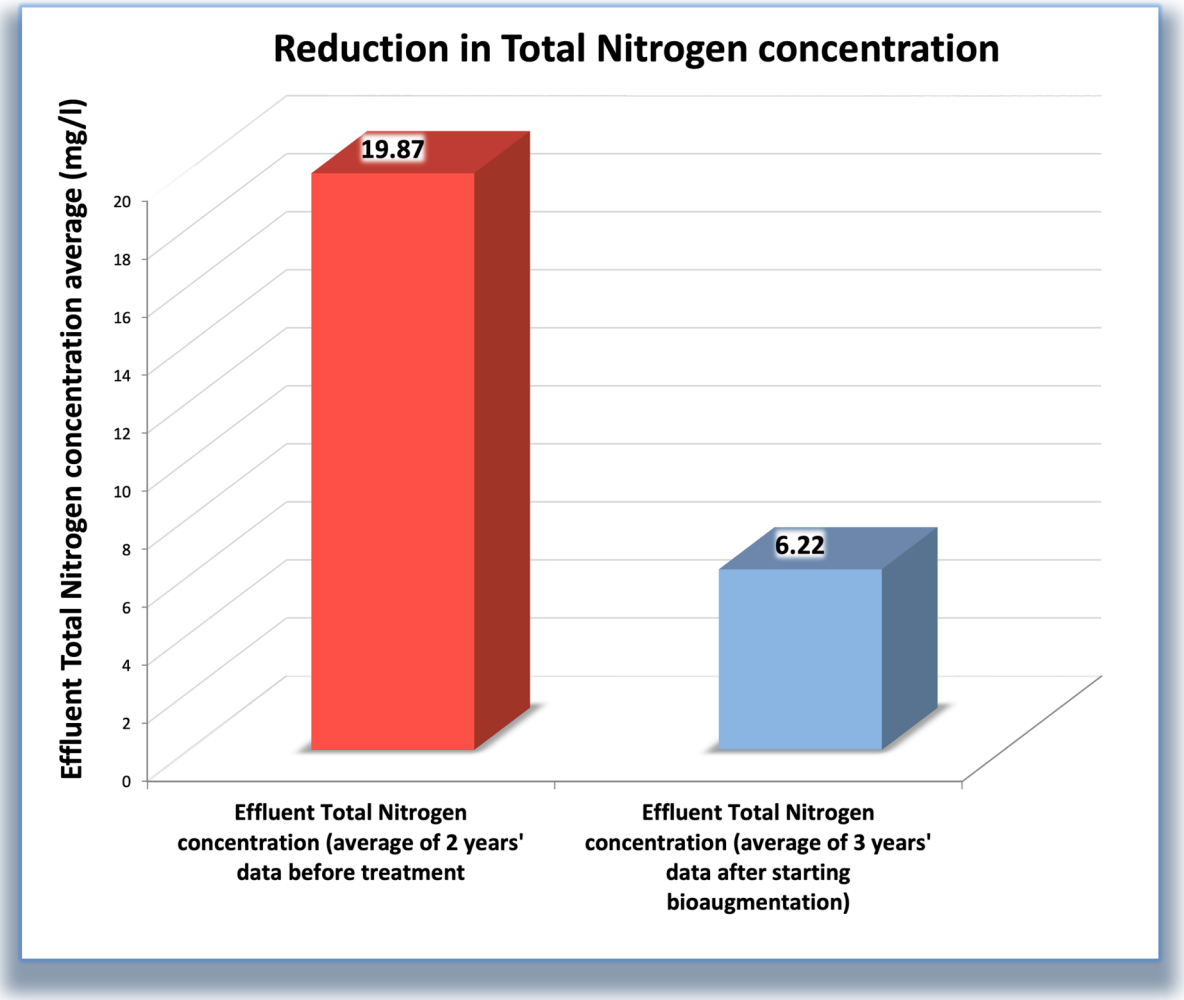
The shock dosage was 6 kg/d on week 1, followed by 5 kg/d on week 2, then 3 kg/d on week 3, and 2 kg/d on week 4. The maintenance dosage was 1 kg/d, dosed into the raw influent entering the plant before distribution.

Results:

Total Nitrogen removal:

Bioclean TM has a massive impact on denitrification, it boosts Nitrogen removal both in anoxic, as well as in the aerobic reactors by its unique microbes with high simultaneous nitrification-denitrification (SND) capabilities. By enhancing the floc structure, the more compact, better settling, dense flocs are able to carry out intrafloc denitrification more efficiently in the aerobic reactors. The combination of the 2 processes results a significant drop in effluent Total Nitrogen concentration at every Bioclean TM bioaugmented plants. As the result shows, **we have decreased effluent TN by nearly 70% compared to the reference period**. Influent TN remained at the same level before, and during bioaugmentation, 60-95 mg/l in average.

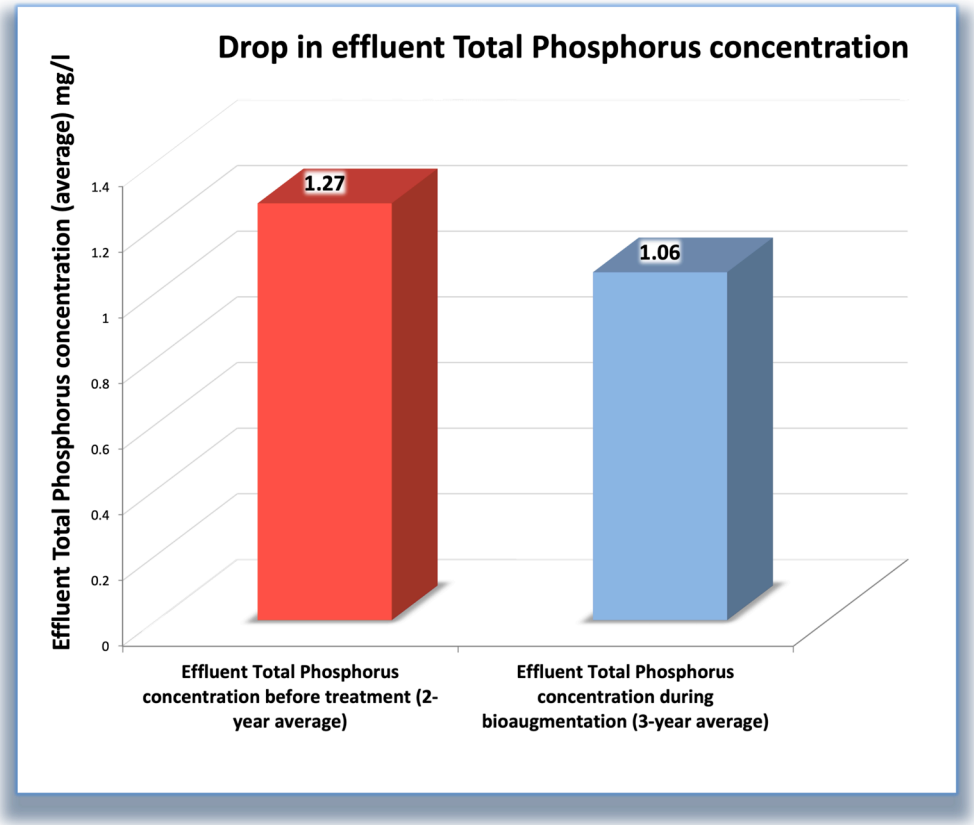
TN removal has always been an Achilles point for this plant since the juice manufacturer's load increases influent TN. The renovated plant is very well-designed, all reactors, as well as mechanical, and electrical parts are fine, the plant is capable for biological N,P nutrient removal.



Total Phosphorus removal:

The complex Bioclean TM solution's other key strength could also be demonstrated: massive enhancement of Biological Phosphorus removal. **Bioclean TM has a decent positive impact on both poly-Phosphate formation, and excess Phosphate uptake**. Since both treatment lines are equipped with Bio-P reactors, we have only needed to eliminate one hindering factor: Nitrate inhibition. The Bio-P reactors receive the recirculated sludge from the secondary clarifiers, and that caused some issues in the past. Since insufficient N-removal rate, the mixed liquor entered the secondary clarifiers with high Nitrate concentration on both lines. It meant that the recirculated sludge contained high amounts of Nitrate, which caused a fluctuation in Bio-P removal. Operator had to equalize by adding excess amount of Ferric(III) Chloride to keep effluent TP below 2.0 mg/l.

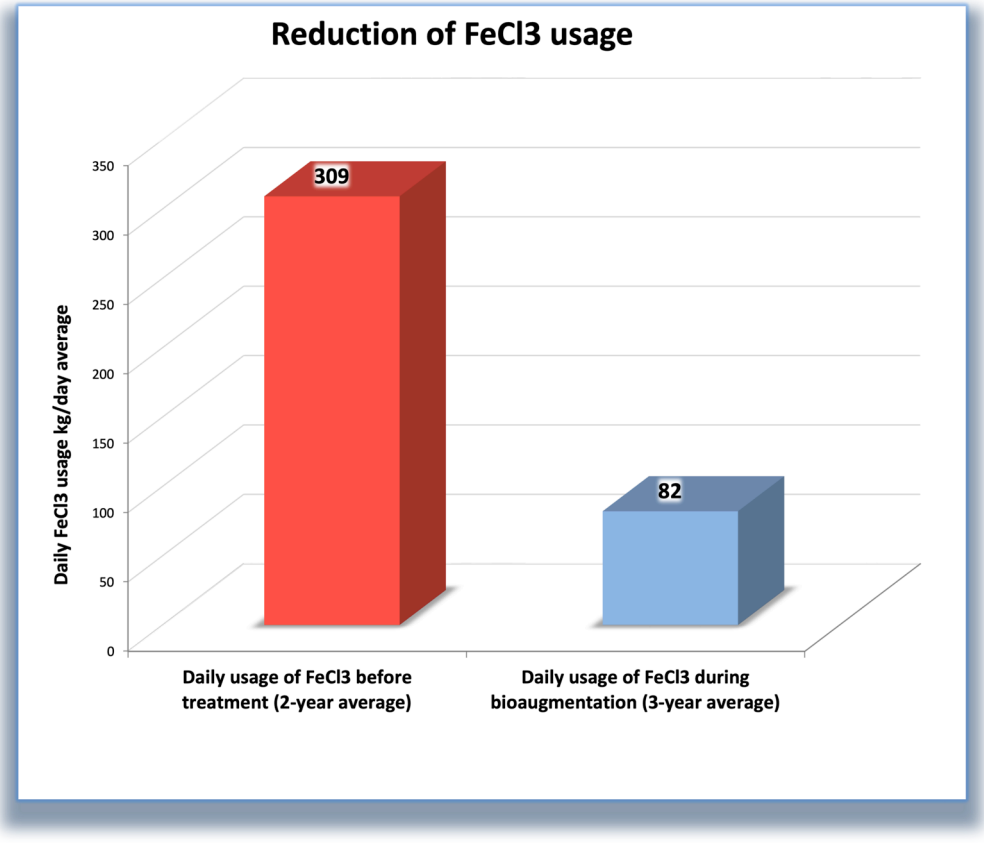
As it is shown on the diagrams below, we lowered effluent TP concentration despite a massive reduction of FeCl3 usage. But as it is clearly visible from the graph, because of the fluctuating industrial load, Nitrate inhibition could not be fully excluded. Usually Bioclean TM results way below 0.5 mg/l effluent TP concentrations for well-functioning WWTP's equipped with Bio-P removal step even without any metal salt addition. Here it is definitely not the case.



Savings on operating costs:

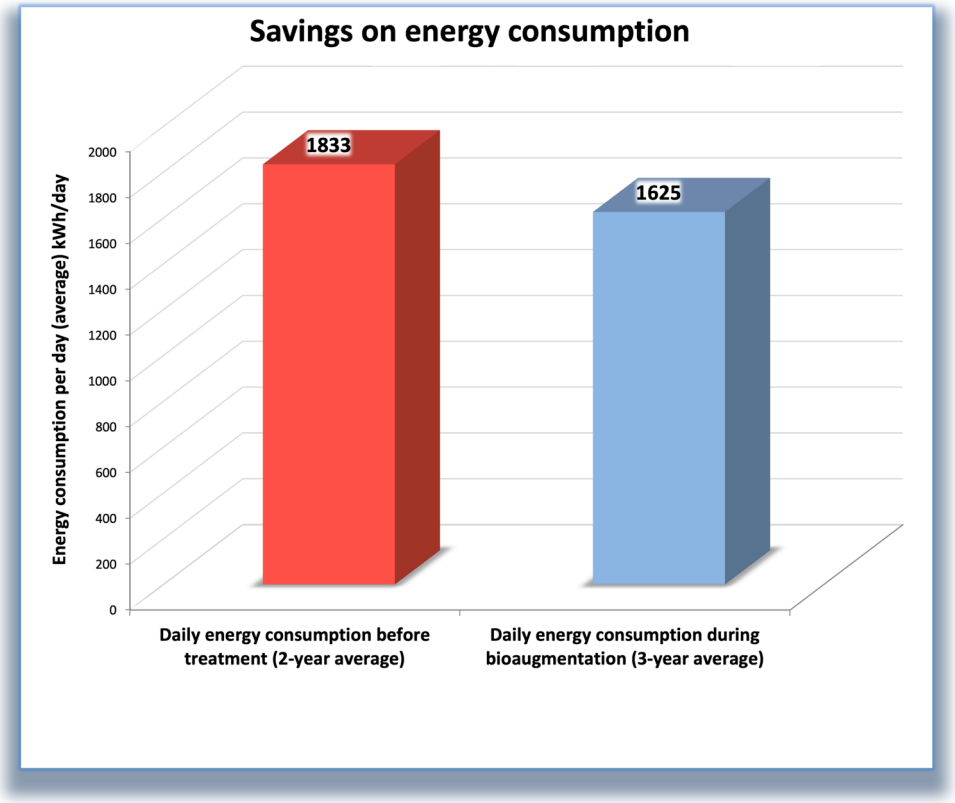
Ferric(III) Chloride dosage:

The operator doses FeCl3 (41 m/m%) for aiding TP removal to reach effluent TP below 2.0 mg/l. Before bioaugmentation the daily average was 309 kg/day. After the start of bioaugmentation when operators started to see effluent TP concentrations dropping, they decided to subsequently reduce the dosage. 82 kg/d dosage was kept for safety reasons, since the periodic Nitrate inhibition in the Bio-P reactors still occurred, the duration and the extent significantly decreased though.



Energy consumption:

Bioclean TM bioaugmentation has a natural effect on DO utilization ability of the activated sludge. As the plant is equipped with precise DO control, the average operating frequency of the blowers dropped after the start of Bioclean TM dosage which resulted significant energy savings as shown below. 2-year average data before treatment have been compared to 3-year data of bioaugmentation, while the daily cumulative load has remained nearly the same.



Filamentous blooming control, foaming, sludge settling rate:

Since the raw wastewater contains high concentration of easily biodegradable COD, and the plant is equipped with full-BNR functions, the activated sludge operates with higher filamentous count normally. The problem is that the dominant species contain Microthrix parvicella, which causes heavy foaming during wintertime. **Bioaugmentation with Bioclean TM provided a healthy control of Microthrix, prevented excess foaming, sparing a lot of interaction, and headache for the operator. Activated sludge structure improved, and better settling rates dominated since the start of bioaugmentation:**

Activated sludge settling volume	After 30 mins	After 60 mins	After 90 mins	After 120 mins
Winter (2-year average before treatment)	910	800	900	480
Winter (3-year average during bioaugmentation)	750	650	820	440
Summer (2-year average before treatment)	880	620	660	480
Summer (3-year average during bioaugmentation)	660	450	410	300

Dewatered sludge production:

Bioclean TM also has a mentionable impact on excess sludge production. **While reducing the yield of the activated sludge bacteria, operators of WWTP's naturally experience a drop in the monthly dewatered sludge production** which is another major factor of cost-savings for bioaugmentation with Bioclean TM.