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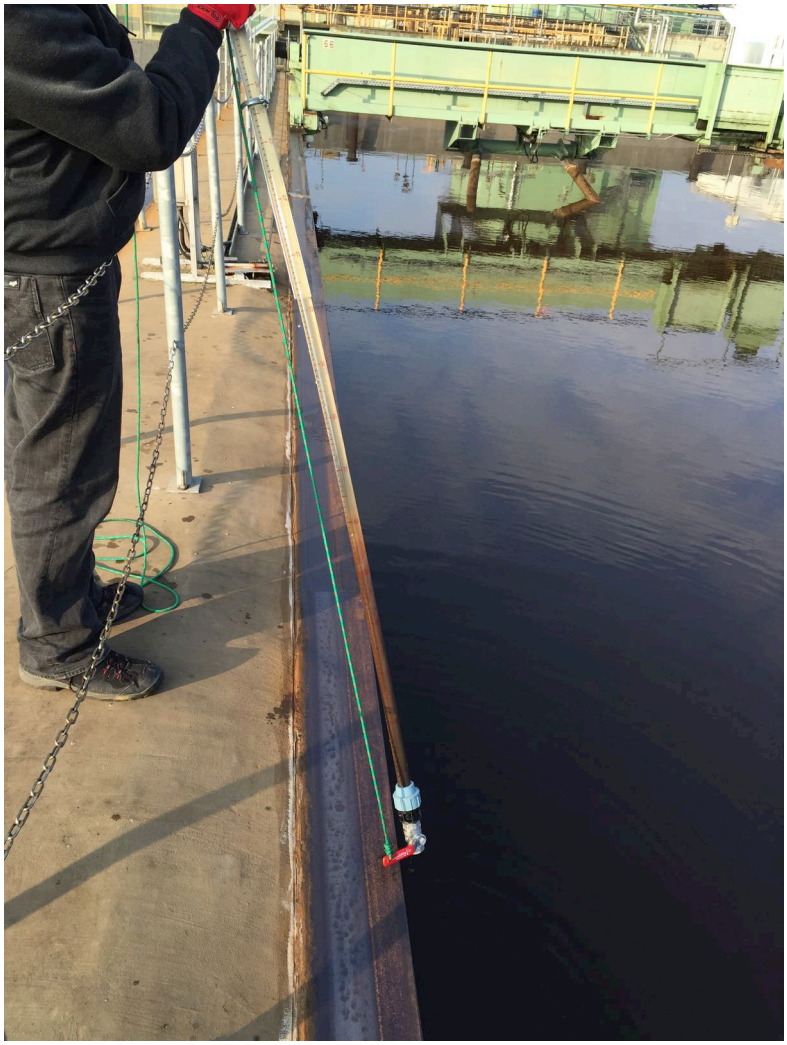
Case Study - Malatech Bioaugmentation

12 000 m3/d Chemical Industry's industrial activated sludge WWTP

Goals of bioaugmentation:

The factory has harsh, hardly biodegradable organic load in its raw influent with many inhibitory substances, and high salinity (TDS average concentration is 5 000 mg/l in the biology). Nitrogen load is also decent, so the plant has to nitrify and denitrify efficiently with the above conditions. Fluctuations of effluent parameters caused troubles in the past. The client chose Malatech Bioaugmentation to improve the resistance of the biology towards shock loads, inhibitory and toxic loads. Also, since the activated sludge had a poor settling rate, and sick structure, lowering TSS of the secondary clarified effluent caused by pin-flocs was among the main targets. In the meantime, with bioaugmentation operating cost reduction was achievable on excess sludge formation reduction, and by lowering the energy consumption of the plant.



Author: Malatech Water Ltd.

Title: Chemical industrial effluent activated sludge wastewater treatment plant optimization

The client is an international chemical manufacturer, a global player in organic chemistry, based in EU it supplies the EU market, as well as exporting overseas.

The WWTP receives multiple streams from various parts of the industry, some streams are added to the biology without pre-treatment, but streams with high COD concentrations are sent to an anaerobic digester for biogas generation, which is used for heating, and steam-drying of dewatered sludge by the plant. The digester effluent is mixed with other streams, and added to the activated sludge biology, which is a well-designed conventional continuous flow plant with 2 parallel lines, both equipped with an anoxic reactor followed by an aerobic reactor, ending with a rectangular, horizontal-flow clarifier. Internal recirculation starts from the end of aerobic reactor on both lines driven to the anoxic reactor. Sludge recirculation heads from secondary clarifiers to the anoxic basins.

Secondary treated effluent flows to tertiary treatment for further TSS removal since pin-flocs continuously left secondary clarifiers keeping the secondary effluent TSS at an unacceptable high level.

The influent has high temperature throughout the year, as a result, the activated sludge is way above 20 Celsius even in wintertime. The biology is operated with a very high sludge age. Excess sludge production is very low, high reactor volumes (especially the aerobic part) compared to cumulative load give a low F/M ratio, a state close to total oxidation conditions, which combined with the inhibitory factors reducing metabolic speed of the bacteria result a very low sludge yield. The nature of the raw wastewater prevents filamentous blooms (so there is no risk because of high sludge age), moreover, the cause of the settling problem is considered to be lower filamentous count than the activated sludge structure would require for healthy settling rate, floc stability and density. Activated sludge concentration maintained in the reactors is defined by the hydraulic load of the secondary clarifiers, and kept continuously before, and after the start of bioaugmentation at 10 000-11 000 mg/l. Excess sludge is dewatered, then steam-dried before transportation.

The reason why the operator opted to go ahead with Malatech Bioaugmentation were:

- Lower fluctuations in effluent quality for COD, NH4-N, TN, TSS. The receiver of the treated wastewater is a freshwater river, which is a favoured location for anglers, and tourists.
- Increase the resistance, and tolerance of the activated sludge bacteria against shock cumulative, inhibitory, and toxic loads, as well as against high salinity, which is around 5 000 mg/l expressed as TDS in the biology
- Lower OPEX on energy consumption, and dewatered sludge production to equal the costs of biotech materials used

The biological reactors are sized well in volume for the cumulative N,P load the plant receives, even with the inhibitory factors taken into account. We opted to go ahead only with our core technology, **Bioclean TM. We expected to overcome inhibition, and increase the biology's resistance towards high salinity, toxic organic substances, and shock loads.**

Bioclean TM was dosed in the pre-treated raw wastewater stream entering the activated sludge reactors. Dosing point has been set up upstream the distribution structure. Dosage was 28 kg/d on week 1, followed by 20 kg/d on week 2, 16 kg/d on week 3, 10 kg/d on week 4. Maintenance dosage is 2 kg/d onwards.

Results:

Effluent parameters stabilized after 2 months from the start of bioaugmentation, but sludge structure needed more than 4 months to show improvement with better settling rate. The effluent TSS concentration started to drop during the 2nd month of treatment, but we needed 4-5 months to reduce pin-floc formation to a level that

was acceptable for secondary treated effluent. Since then, TSS removal at tertiary treatment operates with less cost, and higher efficiency.

Energy consumption:

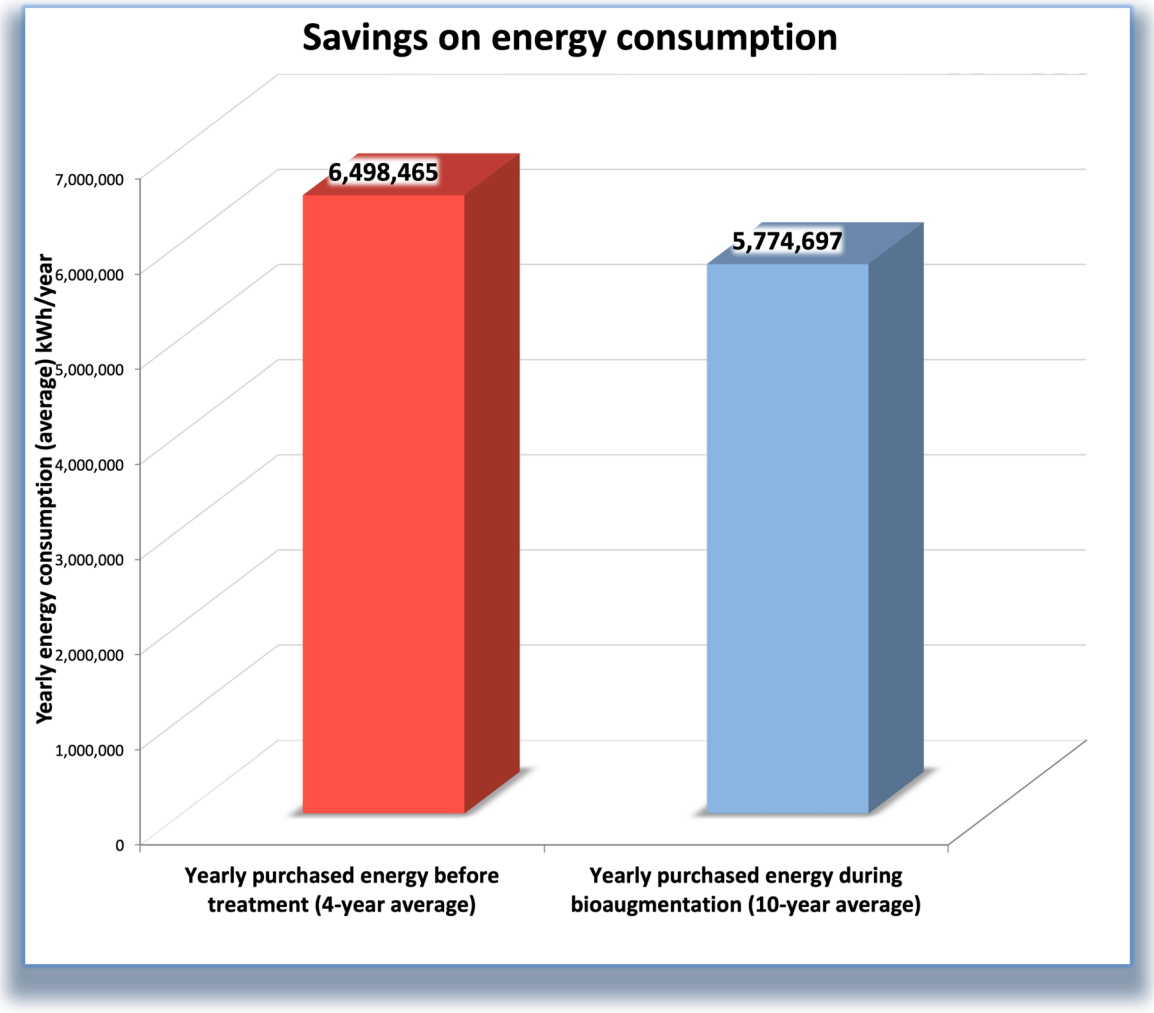
Bioclean TM bioaugmentation has a natural effect on DO utilization ability of the activated sludge. As the plant is equipped with precise DO control, the average operating frequency of the blowers dropped after the start of Bioclean TM dosage which resulted significant energy savings as shown below.

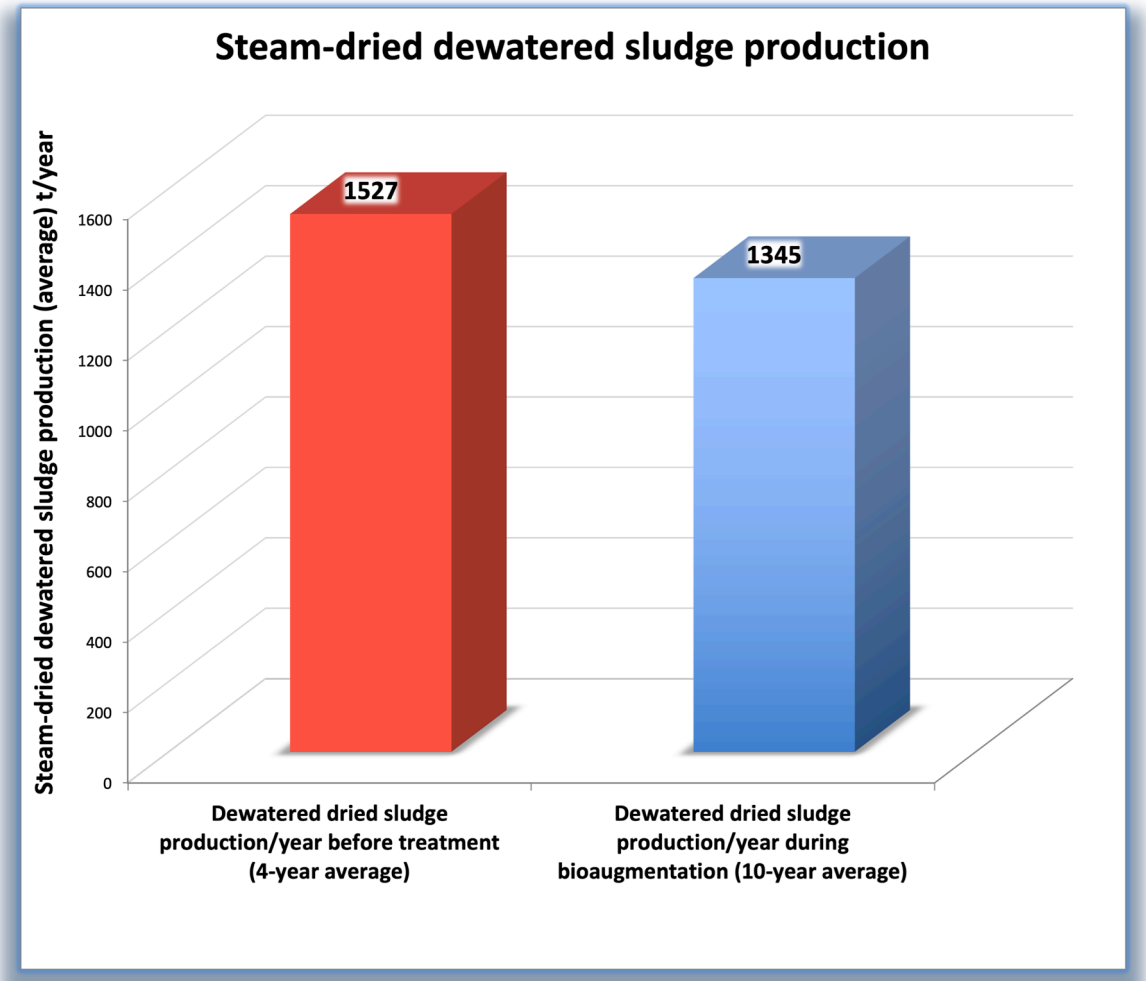
Dewatered sludge production:

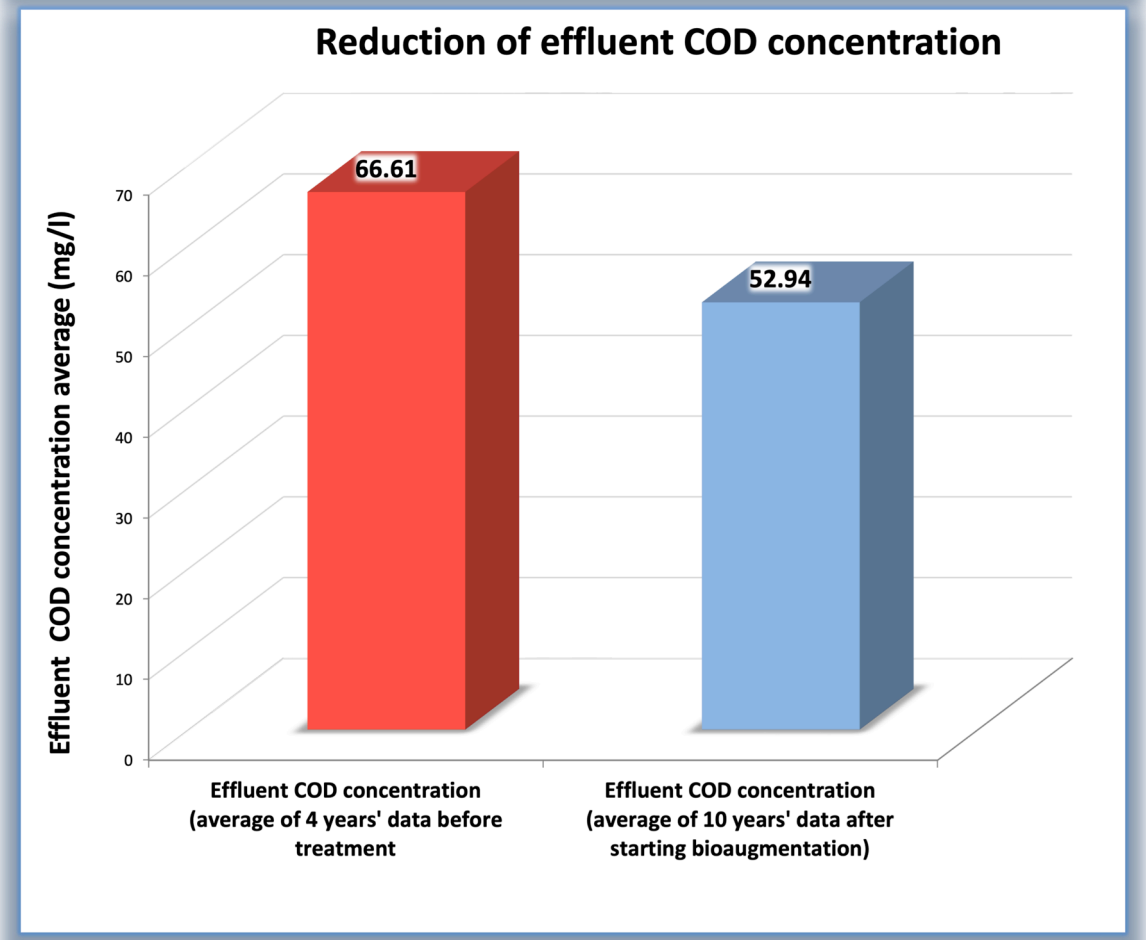
Bioclean TM also has a mentionable impact on excess sludge production. While reducing the yield of the activated sludge bacteria, operators of WWTP's naturally experience a drop in the monthly dewatered sludge production which is another major factor of cost-savings for bioaugmentation with Bioclean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

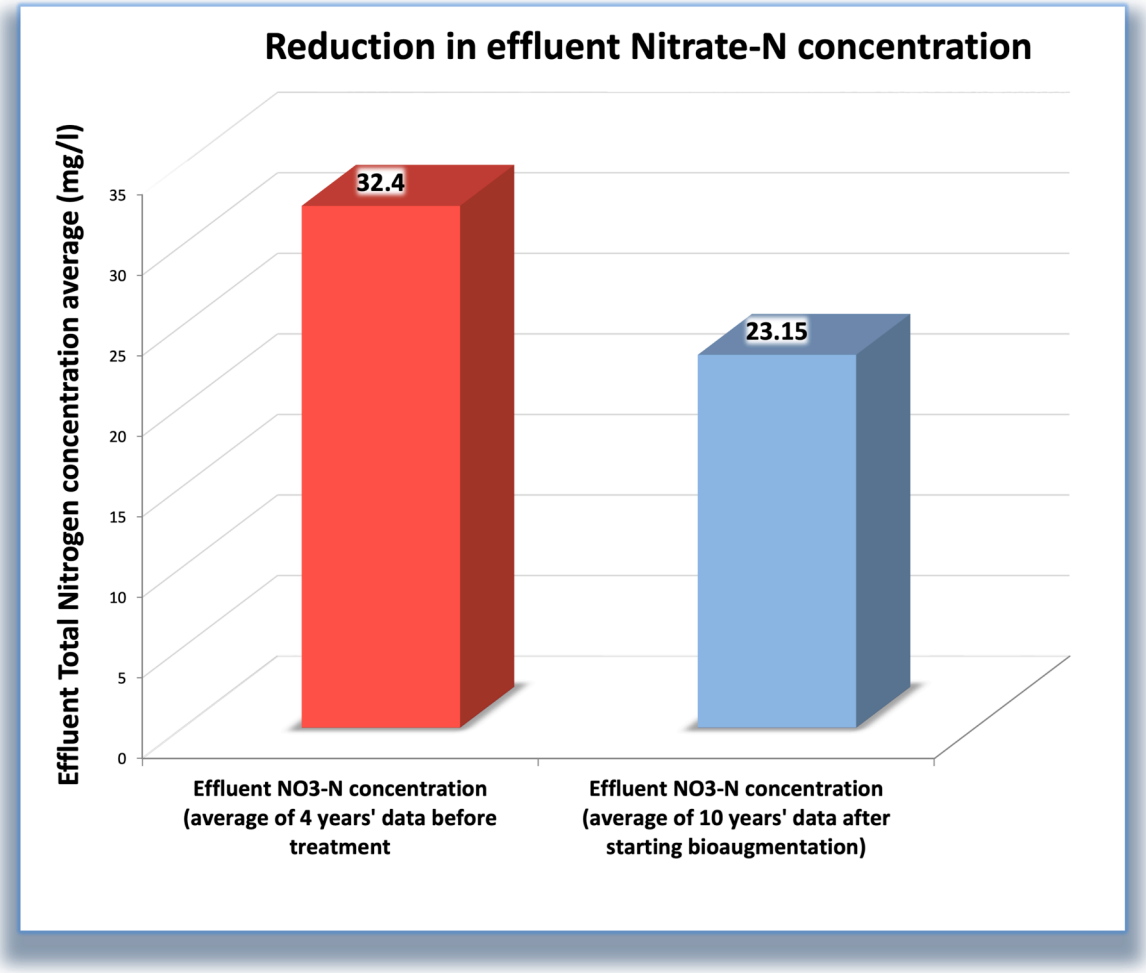
Nitrogen removal:

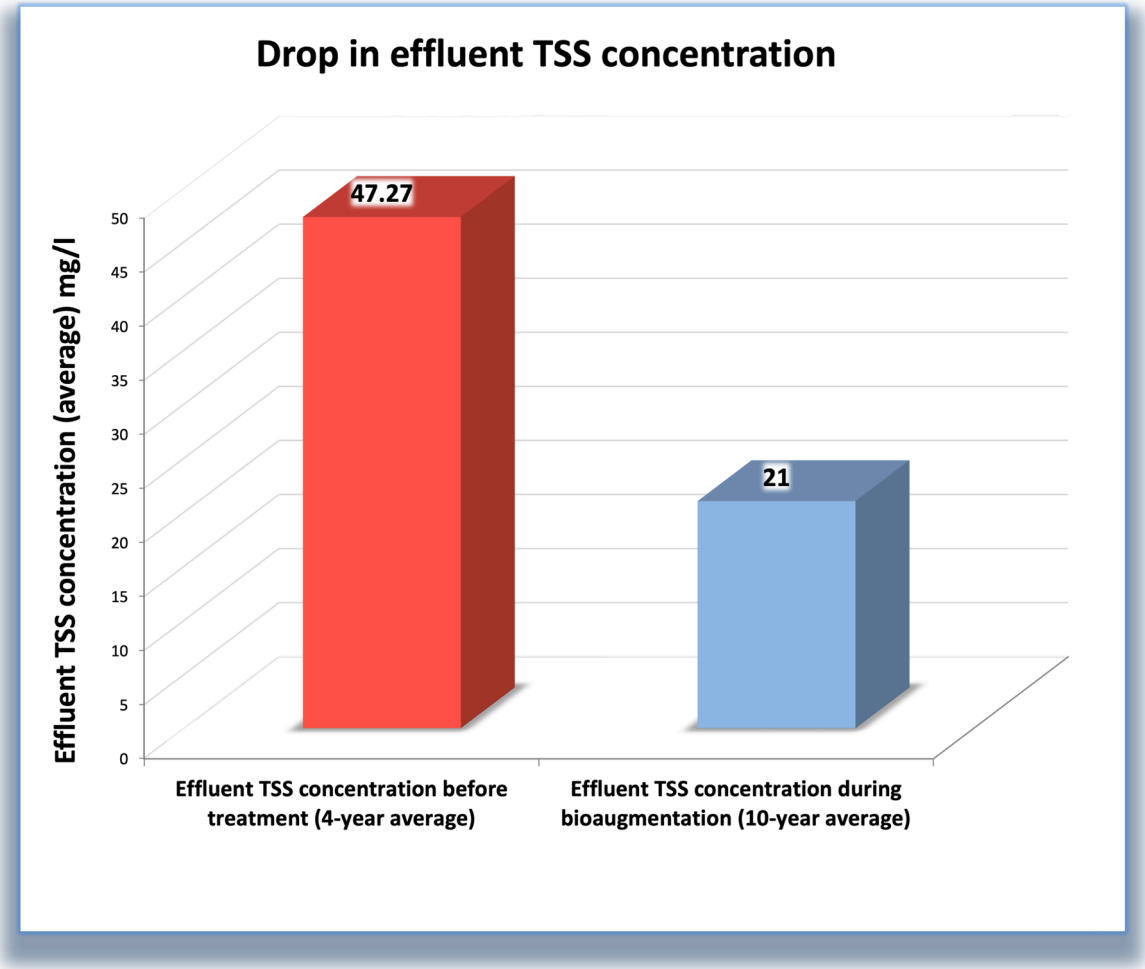
Bioclean TM has a massive impact on denitrification, it boosts Nitrogen removal both in anoxic, as well as in the aerobic reactors by its unique microbes with high simultaneous nitrification-denitrification (SND) capabilities. By enhancing the floc structure, the more compact, better settling, dense 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. Achieved results are summarized below.

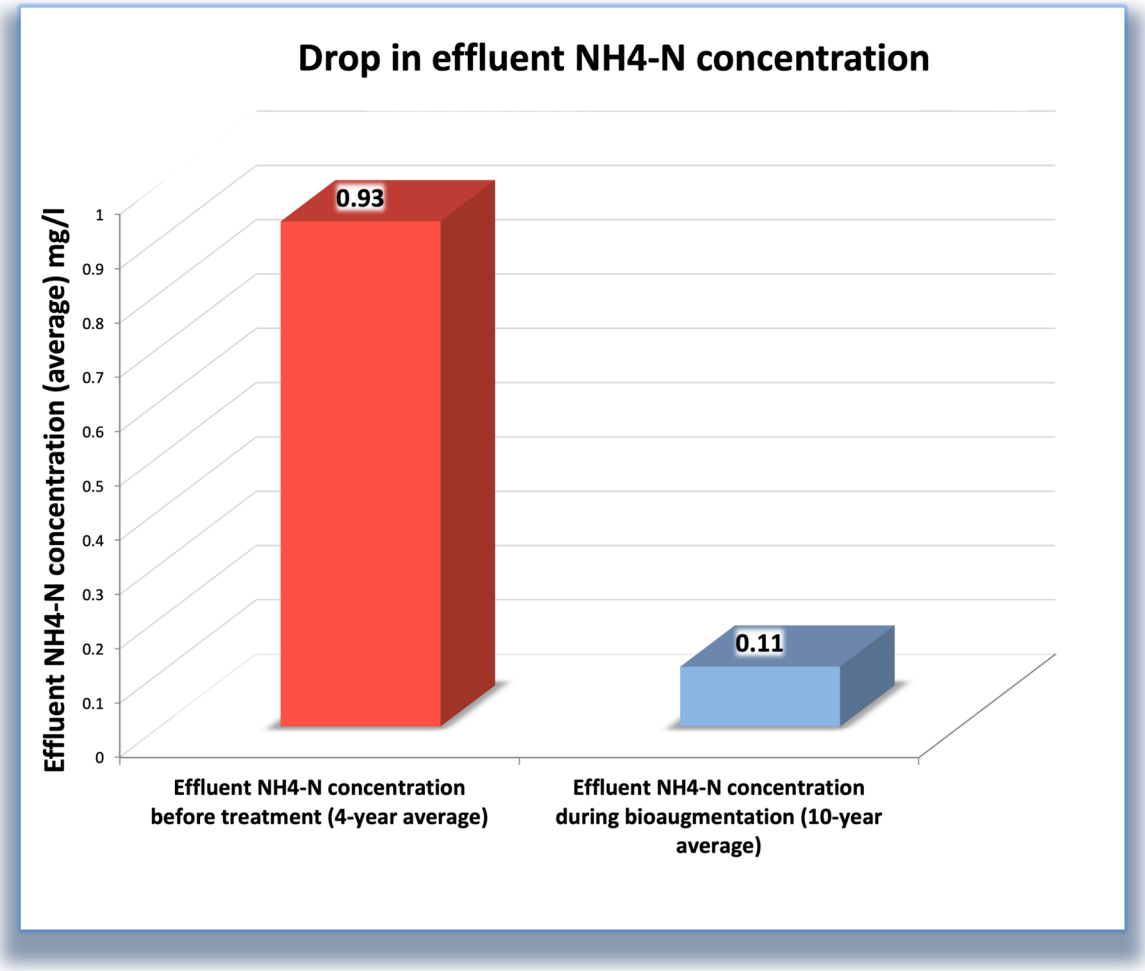


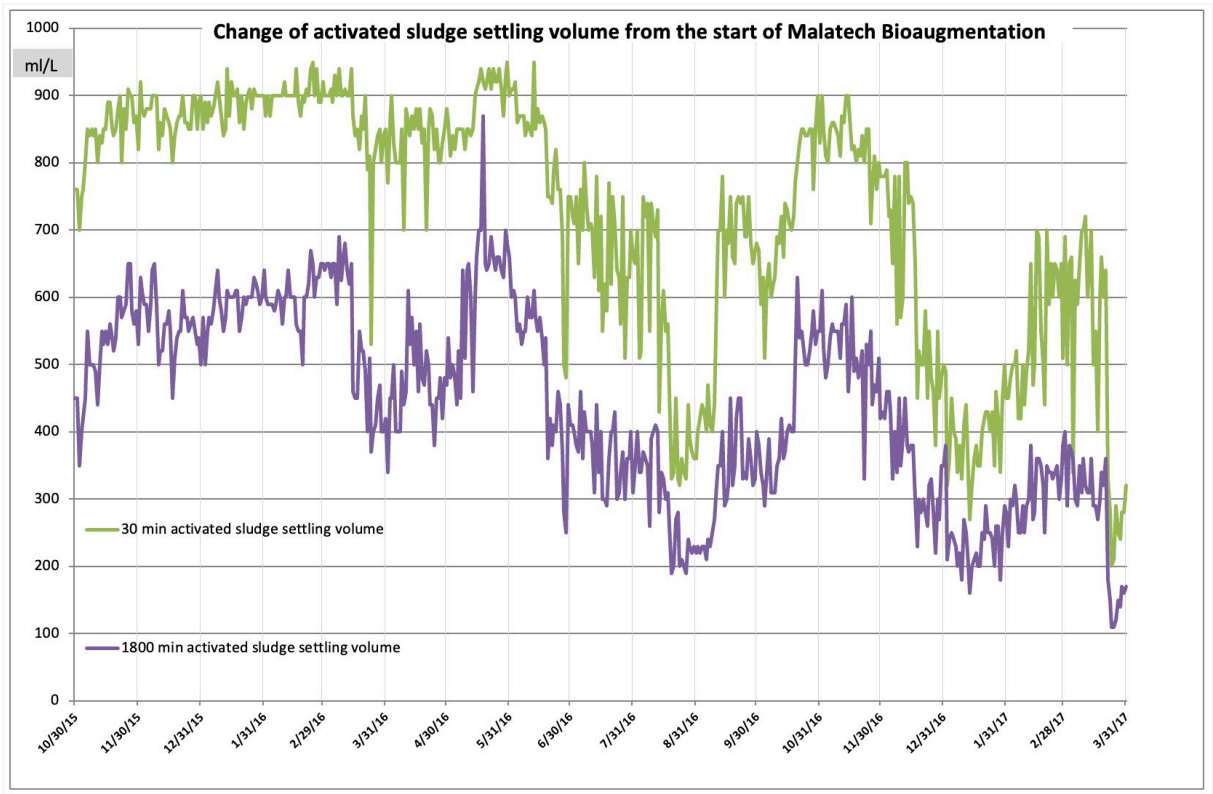

Steam-dried dewatered sludge production
Steam-dried dewatered sludge production (average) t/year
0
200
400
600
800
1000
1200
1400
1600
1527
1345
Dewatered dried sludge production/year before treatment (4-year average)
Dewatered dried sludge production/year during bioaugmentation (10-year average)


Reduction of effluent COD concentration
Effluent COD concentration average (mg/l)
0
10
20
30
40
50
60
70
66.61
52.94
Effluent COD concentration (average of 4 years' data before treatment
Effluent COD concentration (average of 10 years' data after starting bioaugmentation)


Reduction in effluent Nitrate-N concentration
Effluent Total Nitrogen concentration average (mg/l)
0
5
10
15
20
25
30
35
32.4
23.15
Effluent NO3-N concentration (average of 4 years' data before treatment
Effluent NO3-N concentration (average of 10 years' data after starting bioaugmentation)


Drop in effluent TSS concentration
Effluent TSS concentration (average) mg/l
0
5
10
15
20
25
30
35
40
45
50
47.27
21
Effluent TSS concentration before treatment (4-year average)
Effluent TSS concentration during bioaugmentation (10-year average)


Drop in effluent NH4-N concentration
Effluent NH4-N concentration (average) mg/l
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0.93
0.11
Effluent NH4-N concentration before treatment (4-year average)
Effluent NH4-N concentration during bioaugmentation (10-year average)


Change of activated sludge settling volume from the start of Malatech Bioaugmentation
ml/L
1000
900
800
700
600
500
400
300
200
100
0
30 min activated sludge settling volume
1800 min activated sludge settling volume
10/30/15
11/30/15
12/31/15
1/31/16
2/29/16
3/31/16
4/30/16
5/31/16
6/30/16
7/31/16
8/31/16
9/30/16
10/31/16
11/30/16
12/31/16
1/31/17
2/28/17
3/31/17