Planet Horizons
Technologies
Physical water treatment

PRESENTATION OF THE AQUA-4D® PRODUCT FOR THE REDUCTION OF SLUDGE PRODUCTION IN WASTEWATER TREATMENT PLANTS

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1. Introduction to the problem

The sludge management was considered as a secondary aspect of the water treatment. Nowadays sludge is the element which creates the highest operating costs and the biggest environ mental problem in a wastewater treatment plant. Increasing sludge production, combined with the new legislation restrictions being implemented worldwide, create a huge management and cost problem.

A strategy to match that fact consists in reducing the sludge production at the source. Several existing systems already have this target, but none of them has so far succeeded to become very successful.

So most wastewater treatment plants, mainly medium large sized ones, and also the newly designed ones, have still this mayor problem. It is obvious that the reduction of the production of biological sludge of a wastewater treatment plant is an important demand today in the future, thus the necessity to develop techniques able to reduce the sludge production of these plants.

Three strategies can be carried out to reduce sludge production:

- To increase the cellular death.
- To increase the maintenance energy.
- To increase biodegradability of inert and not easily biodegradable fractions.

After several studies, this last strategy seems to be the most valuable to significantly decrease the sludge production.

Other existing approaches

One of these approaches is extended aeration, in which sludge has a slow growth and is in "endogenous breathing". This system is extensive and requires great volumes of aeration tanks compared to the pollution to be treated. In the same way, the purification systems like purifying artificial marshes make it possible to obtain a very much reduced sludge production, with low operational costs, but also this system is extensive and it is only useful for small structures of a few hundreds of inhabitants-equivalents. Then there are systems like the biofiltration membranes, a technique which demands important sludge ages which consequence is a lower sludge production, with a more completed mineralization.

Existing approaches are:

- Chemical treatments:
  - Solubilisation of a part of sludge, either by ozone (O_3), or by hydrogen peroxide (H_2O_2).
  - Alkaline (NaOH) or acid (HCl) treatment allowing also a solubilisation of the organic material, often coupled with a heat treatment.
  - Oxidation by wet process. This technique makes it possible to solubilise sludge by putting them in critical conditions of pressure and temperatures.
- Physical treatments:
  - Heat treatment of sludge, with the same goal to solubilise the biomass and make it still

available.

- Mechanical treatment: centrifugation, crusher producing an important shearing.
- Ultrasound treatment: ultrasounds induce a physical stress on sludge, and partially on the lyses.

- Biochemical treatments:
  - Modification of the biological metabolism by decoupling it (addition of chemical substances).
  - Enzymatic solubilisation.
  - Modification of operating conditions by increasing oxygen concentration.

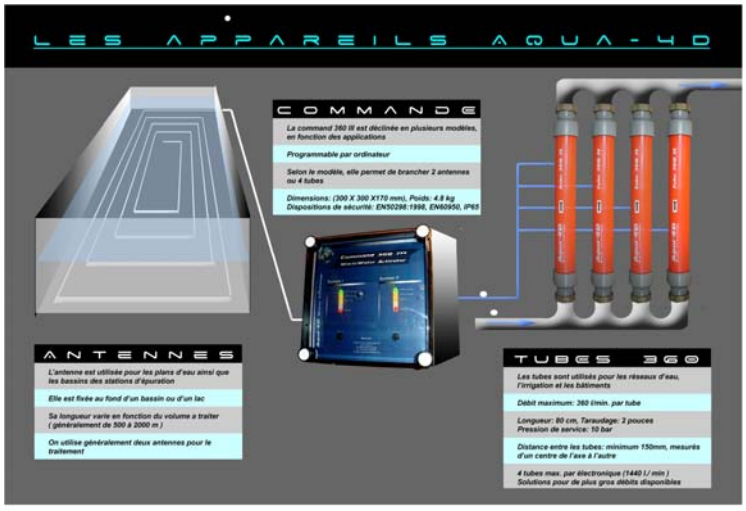
The great majority of these various treatments are technical solutions which are still at their first stage of development.

These various treatments will act differently on sludge by multiple mechanisms from solubilisation of the biomass to the modifications of the physical or biological characteristics of sludge. All of them comprise advantages and drawbacks either in term of deterioration of the quality of purification (development of filamentous bacteria, ammonia salting out, potentially production of dangerous by-products), of premature wear of the biological process (oxidation), of energy costs, or of environmental risk (problem of toxicity of the products added for the metabolism decoupling).

2. The Aqua-4D® electromagnetic treatment

After having worked many years in university research projects on this problem, the most promising alternative way to the various treatments presented in the introduction is an electromagnetic physical one. It fulfils the interest to have extremely low operating cost (very low energy consumption) and does not comprise any disadvantage compared to the others previously presented.

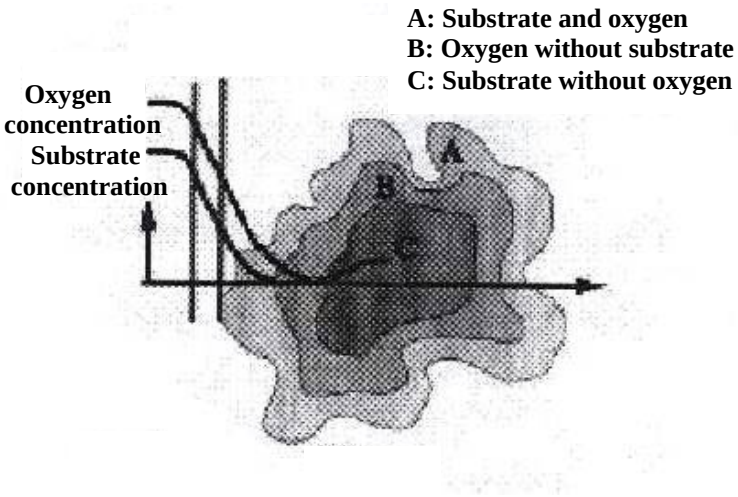
Our device is composed of a programmable command unit which generates a combination of frequencies (taking into account resonance frequencies and the mathematic ratios of biologic systems), with the possibility to regulate the intensity, the pulsation and the shape of the emitted signals. These signals are then diffused either using tubes containing copper coils or using transmitting antennas laid out in the basin, form and shape depending on the individual situation.



3. The chosen way to decrease sludge production

It's known that it is possible to reduce the activated sludge production of a wastewater treatment plant by increasing the oxygen concentration in the aeration tank. With this intention, it is considered that the oxygen diffusion and the substrate in the floc are limiting factors. The floc, constituted by micro-organisms, exopolymeric substances and water (pore water, "close" water and linked water), is divided into three zones:

- The zone A around the floc where oxygen and substrate are not limiting.
- The zone B where just oxygen is available.
- The zone C, in anaerobic conditions where there is a cell hydrolyse and substrate production.



Increasing the oxygen concentration in the medium increases the volume of the floc which is oxygenated and decreases the concentration of substrate in the centre of the floc, what results in a reduction in the sludge production. The reduction in substrate concentration in the medium has the consequence that this last is limiting and by this fact the oxygen concentration increases inside the floc. Thus there is a larger active fraction of the floc and a stronger biodegradation of the inert biomass present at the centre of the floc.

Thus one of the frequencies chosen for our electromagnetic treatment was the resonance frequency of oxygen. We do not send molecular oxygen as it is the case with the aeration tank but we send directly into the medium the "electromagnetic signature" corresponding to oxygen. As we know from quantum physics, we can describe things as waves or particles, by knowing that all is finally vibration. With our approach, the advantage is that this signal is retransmitted to the whole sludge and penetrates much easier into the flocs; which allows as just described an significantly higher reduction of the sludge production.

In parallel it is also possible to reduce the production of the activated sludge by stressing it electromagnetically. This stress leads to increase the maintenance energy of the micro-organisms (catabolism) to the detriment of the growth and storage phases (called mucilage). The increase of their breathing leads to a greater consumption of substrate without producing sludge. Moreover, the micro-organisms can react to the stress by secreting exoenzymes which will solubilise the solid substrate. This allows to improve the access of the biomass to the substrate and to increase its diffusion within the floc. The main advantage of our electromagnetic approach is that we can stress the micro-organisms without risking their life and without adding often toxic and expensive chemicals.

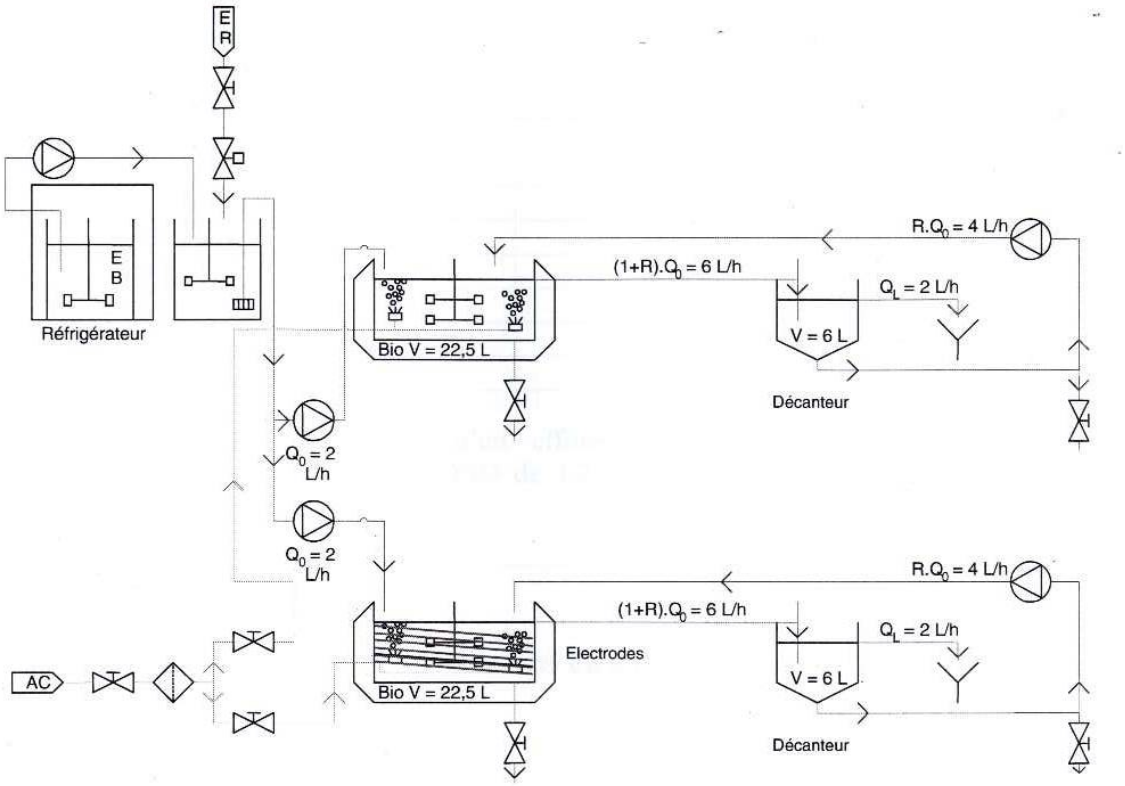
4. Engineering school results:

The reduction of the sludge production was highlighted in March 2006 by the ESIGEC (Higher School of Engineers of Chambéry). The test was carried out on a pilot with 2 lines in parallel, one in reference and the other equipped with our system (scheme of the pilot below).

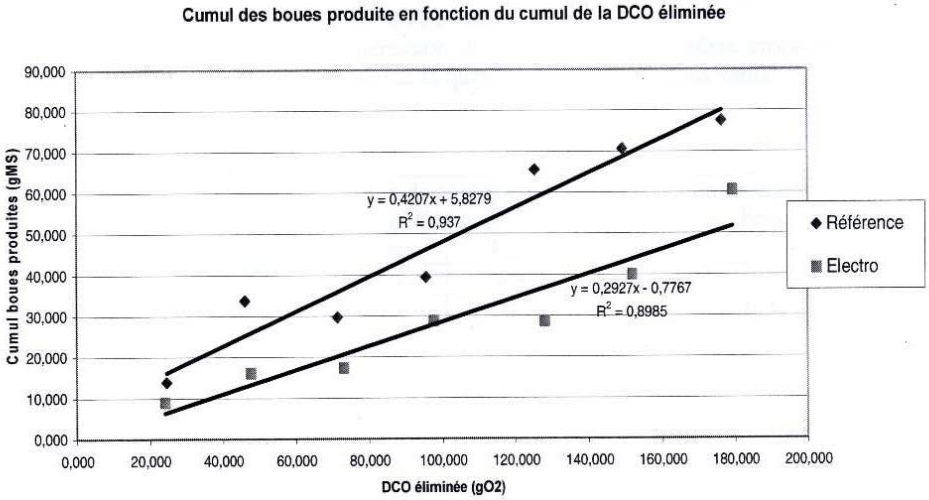
Each line included an aeration tank with activated sludge and a decantation basin. The installation functioned with weak loads. The effluent to be treated was obtained by dilution of a synthetic effluent prepared at the laboratory.

The sowing of the aeration tanks was carried out with sludge of the municipal wastewater treatment plant of Le Bourget du lac (50'000 inhabitants).

The follow-up of the pilot and the analyses were carried out over a period of 1 month, once the 2 lines stabilized.



The following graph presents the cumulated sludge production according to the eliminated COD. We note a clear reduction of the production on the line treated with our electromagnetic device.



The following table recapitulates the various results obtained. We see a very significant difference with the supernatant of the decantation basin (50%), the supernatant is much less turbid in the line treated with our electromagnetic device. But the most important corresponds to the sludge produced where we can note a reduction of the sludge production of about 30% with our treatment, which lead to more thorough tests but which was already very promising for a first test on a pilot scale.

	Taux de conversion (gMV / g O_2)		Réduction de la production de boue
	Référence	Electro	
Surverse	0.0026	0.0013	50 %
Extraction	0.3053	0.3088	0 %
Boues produites	0.4207	0.2927	30 %

The tests with this pilot go on and the last results obtained on a period of 2 months are always in the direction of a clear reduction of the sludge production (at least 15%).

5. Conclusion

With our electromagnetic treatment we can use in a combined way the two most interesting strategies with the aim to reduce the sludge production; without any risk neither for the quality of the water treatment nor for the operating conditions of the plant. Moreover, operating costs are almost inexistent since the necessary power is only a few watts; it is the precise frequencies and shapes of the emitted signals which is important and not its intensity. Thus the emitted waves do absolutely not present any danger to the people nor cannot disturb other installations.

The results obtained so far are all very promising, because a reduction of the sludge production of 15 to 30% is very significant and the savings made with such a lowering of the sludge produced allows a rapid return on investment.

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