

Waste Water Treatment

Project 2006

Brussels-Nord:
The new wastewater treatment plant



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1. Introduction and situation of Brussels.

A large part of the Brussels-Capital Region with about 1 million inhabitants does not have a treatment system for its wastewater.

The Brussels-North project is to provide this population with an efficient treatment system in order to preserve our water habitat.

The Senne is the natural catchment area for wastewater

The Brussels-Capital Region is part of the Senne hydrographic basin, itself being part of the Escaut basin. The Senne is at the origin of the installation of the first kets in Brussels. It has facilitated the development of craft industries and commerce since the 11th century, in such ventures as tanneries, dyeing, brewing, vinegar making and papermaking. However the river became an open drain in the 16th century and its overflows caused fatal epidemics.



The first covered drain programme was put in hand at the end of the 19th century and the river disappeared under the city.

The wastewater management plan

A wastewater management plan was put together in the 1980s to help the Senne regain its original role. The idea was to treat wastewater from the river's three sub-basins named as follows:

- the South
- the North
- the Woluwe basin, part of which is in the Flanders Region.

At the beginning of the 1990's, Brussels and Flanders regions defined a joint wastewater management plan resulting in the building of two wastewater treatment plants, one in the South of the Brussels-Capital Region and the other in the North.

The Brussels-South wastewater treatment plant

The first plant, Brussels-South, came into service in July 2000.

It is situated on the commune borders of Anderlecht and Forest.

It treats about a third of the Brussels's wastewater for about 360,000 inhabitant-equivalents.

The Brussels-North wastewater treatment plant

The wastewater from the North and Woluwe basins will be treated by the Brussels-North plant, which will have the larger capacity of 1,100,000 inhabitant-equivalents.

At the end of a tender process, the contract that included both designing and building the Brussels-North plant, and operating it for 20 years, was awarded to AQUIRIS, a group of companies lead by world leader in water services and treatment systems Veolia Water. This plant will be operational in autumn 2006.

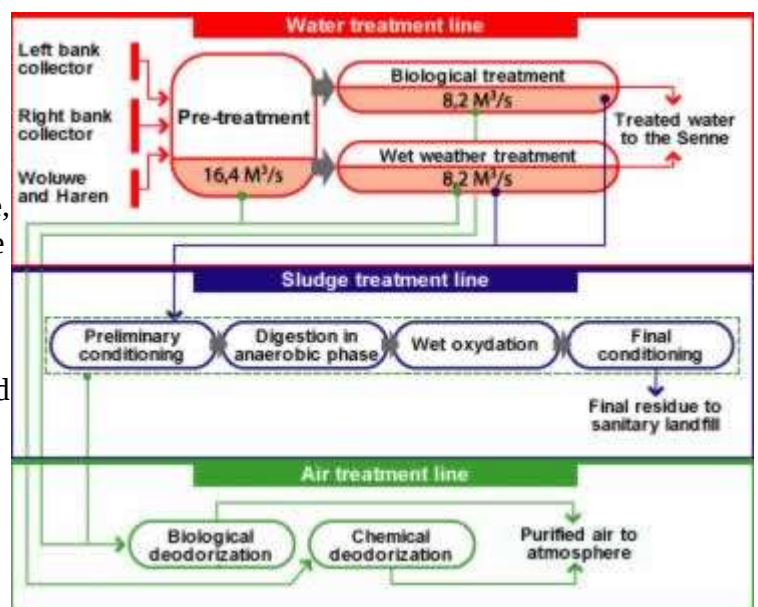
2. General principles of wastewater treatment

In modern plant, the wastewater undergoes two types of treatment. One is mechanical, that eliminates the coarse solids through screening, and other solid particles by settling and decanting. This is followed by biological treatment that removes organic pollution in the form of carbon, nitrogen and phosphorus through the action of micro-organisms (bacteria) that is naturally present in the water. This biological degradation takes place in aerating basins, with the bacteria combining as it grows to form a biological sludge.

This sludge is then separated from the treated water in large decanters called "clarifiers". The water is returned to its natural environment of the river. The separated biological sludge is mixed with sludge from the mechanical separation stage, and the mixture is then dehydrated to reduce the volume and facilitate its possible transport.

For treatment to be complete, the dehydrated sludge should be eliminated. This is done usually by recycling the dehydrated sludge as farm fertiliser, or destroying it by oxidation.

Finally, certain plants - in particular those situated in urban areas - are enclosed, and their air is treated to avoid unpleasant smells spreading to the neighbourhood.



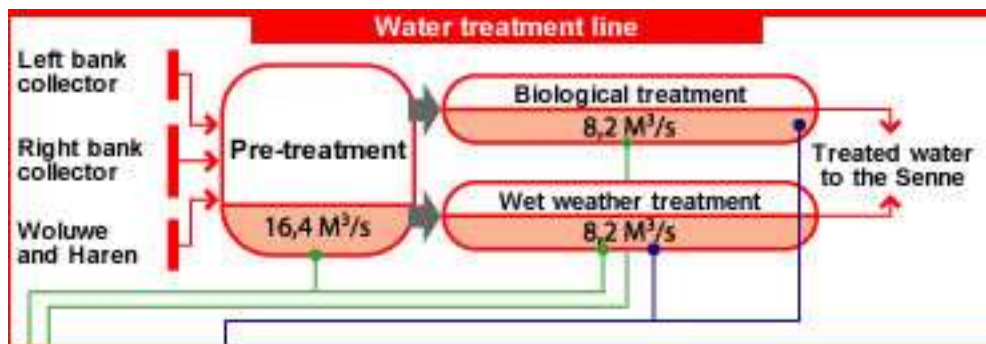
Brussels-North wastewater treatment plant

Aquiris has observed the "zero nuisance" principle in designing each of its processes:

- "Water" procedures: the AZENIT-P® biological treatment very efficiently removes nitrogen and phosphorus. The wet weather procedure uses the ACTIFLO® accelerated decanting process, which causes the rapid precipitation of material in suspension. The classic sieving/de-sanding/de-oiling pre-treatment process is used upstream of these two lines.
- "Sludge" process: this reduces sludge volume by more than 99% through completely removing any organic material present. Treatment involves two complementary procedures. One is anaerobic digestion and the other is wet process oxidation. The final residue is totally inert and can be discharged along with other harmless waste.

- "Air" process: the installations will be entirely enclosed and deodorised using two different ways. One is chemical, to be used in the sludge pre-treatment and treatment buildings - and the other is biological, for the building housing the biological treatment facility.

3. Water Treatment



a) Pre-treatment

This process includes a classic pre-treatment unit with a preliminary coarse screening followed by fine sieving for the whole of the throughput.

The separation process continues with the effluent being directed to the dry weather biological channel up to a flow of 8.2 cubic metres/sec. The excess flow is directed to the wet weather channel to a maximum of 16.4 cubic metres/sec.



b) Biological treatment

The dry weather flow is sent to grit and oil removal before being processed in 12 biological treatment channels. Each of these channels has first a biological degrading zone for phosphorus, followed by one for carbon and nitrogen (AZENIT-P® process (cfr section 6)). The effluent is then sent to basins where the treated water is clarified through decantation of the biological mud. Part of the decanted sludge is sent back to the start of the treatment process to be fed into the biomass. The clarified water is sent out to be returned to the Senne.



c) Wet weather treatment

Wet weather is characterized by a re-suspension of the solid material that had sedimented in the network through dry weather. The treatment of this sewage requires specific techniques.

The wet weather flow is first sent through a rough grit removal to eliminate particles bigger than 300 micrometres (MECTAN® process). Then it is settled using the ACTIFLO® process (cfr section 6). This rapid settling technique involves lumping the effluent together using a coagulant and then mixing it with sand. With its high density, the sand speeds up the separation out of the agglomerate in the decantation stage.



- Actiflo unit -

4. Sludge Treatment

a) Process

The principle is to break down the organic material in the sludge so as to obtain an entirely mineral final residue. This break-down process uses two complementary procedures: **digestion in anaerobic phase** and **wet oxidation**.

- **Preliminary conditioning**

After exiting the water treatment stage, the sludge is first thickened in cylindrical structures in each of the process lines, both biological and wet weather.

The sludge is conditioned with a polymer to facilitate decanting before it is guided into the structures.



- centrifugal machines -



- thickeners basins -

The sludge is then extracted and pumped into a common storage area in preparation for dehydration. This is done using centrifuges. Four treatment lines with one as back up are planned for this stage. After dewatering, the resulting residue is stored in a silo for the next stage.

- **Digestion in anaerobic phase**

Digesting the sludge eliminates the fermentable organic material that in particular generates odours.



- hydrolysis reactor -

Degradation is achieved in an anaerobic atmosphere (i.e., without oxygen) by two fermentation pathways, acidic and methanic, each of which using distinct bacteria groups.

Acid fermentation transforms the organic material into soluble compounds, essentially fatty acids and alcohol. This also produces carbon dioxide.

Methanic fermentation products mostly methane and a lesser quantity of carbone dioxid by further degradation of the soluble compounds.

Methane produced by the digestion process is recovered then stored in gasometers. It will be burned to produce vapour that to be used in the process and hot water that can be used for heating

the space.

It is planned to put a thermic hydrolysis unit upstream of the digestion stage, first to liquefy the sludge and secondly to break down the longest molecular chains. The resulting mixture becomes much more easily assimilable by the digesting bacteria - "turbo-digestion".

This thermolysis process (CAMBI®) runs at 165 °C at 8 bars pressure after the centrifuged sludge is mixed with the greases from the oil removal treatment in the biological line. Five reactors are used to do the hydrolysis.

The residue obtained, after cooling, is introduced at the digestion stages. Two structures are planned for Brussels-North, each of them equipped with a mechanical agitation system for the liquefied sludge.



- digesters -

On exiting the digestion stage, the sludge is directed to the oxidation unit.

Produced biogas is evacuated for storage in gasometers. It can be used for the production of both vapor (hydrolysis thermal and wet oxidation) and hot water (heating of the buildings).

- **Wet oxidation**

The anaerobic phase digestion process does not completely remove all organic components in the sludge. This mineralisation is achieved using a complementary oxidation process.

This is done by bringing the liquid sludge into contact with oxygen at 50 bars pressure and 250 °C, which allows higher kinetic interaction.

Two treatment lines each with an oxidising reactor are planned for the Brussels-North plant.

This process has been used for treating industrial sludge for more than 20 years, and its more generalised application for urban sludge has created the ATHOS® system (cfr section 6).

The nature of the resultant gas products from this process sets this system apart from incineration. Furthermore, this process does not produce dioxins.

- **Final conditioning**

After cooling, the reactional mixture is sent to a lamellar decanter to separate the solid and liquid parts. The liquid obtained after separation contains acetic acids, aldehydes and ketones.

All these biodegradable components will be recycled within the plant. The solid residue is dried on filter press.

b) Devolution of the final residue

The preferred destination of the residual mineral product is sanitary landfill as communal waste.

In effect the non-lixiviable nature of the compound obtained will allow permanent storage of the same sort as for incineration residue such as clinker and ash.

Since the daily discharge will be considerably less than that of a classic plant, the pollution associated with the cartage of the residue is minimised.

This residue material could also be used in infrastructure projects.

The mineral and sandy nature of the compound could allow its use as follows:

- for road under-bedding;
- for brick-making;
- as extra material in cement fabrication.



- final residue -

5. Air treatment

All the plant is enclosed within the building, and all the air is treated.



a) Chemical treatment of effluent

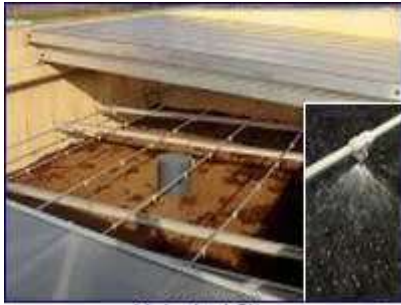
The principle of the AQUILAIR® process (cfr section 6) that is used, is to "wash" the gas with the aid of aqueous solutions to which the odorant gaseous molecules are transferred. For this to happen, the effluent runs in contra-flow through a set of towers connected in series, each containing a washing solution.

Three treatment lines, each with two towers, will be installed at Brussels-North:

the first of the two towers will have an acid wash;

the second will have a basic wash.

b) Biological treatment



- biological filter -

The ALIZAIR® process (cfr section 6) used is a biological deodorising process that uses biofiltration techniques.

The principle is to pass the gaseous effluent across a bed of bacteria where the malodorous molecules are degraded through oxidation. The bed is continually sprayed with a mixture of water and nutritional elements to maintain bacterial activity.

The water being sprayed absorbs the products of oxidation as it passes through the bacteria bed. It is then sent to the biological facility for treatment. The choice of filtration

material depends on the composition of the effluent.

6. Details of some process

a) Actiflo

Ballasted coagulation/ flocculation and lamella settling

Ballasted clarification for a very high rate and compact process

Actiflo™ is a compact process that operates with microsand (Actisand™) as a seed for floc formation. Actisand™ provides surface area that enhances flocculation and also acts as a ballast or weight to aid a rapid settlement.

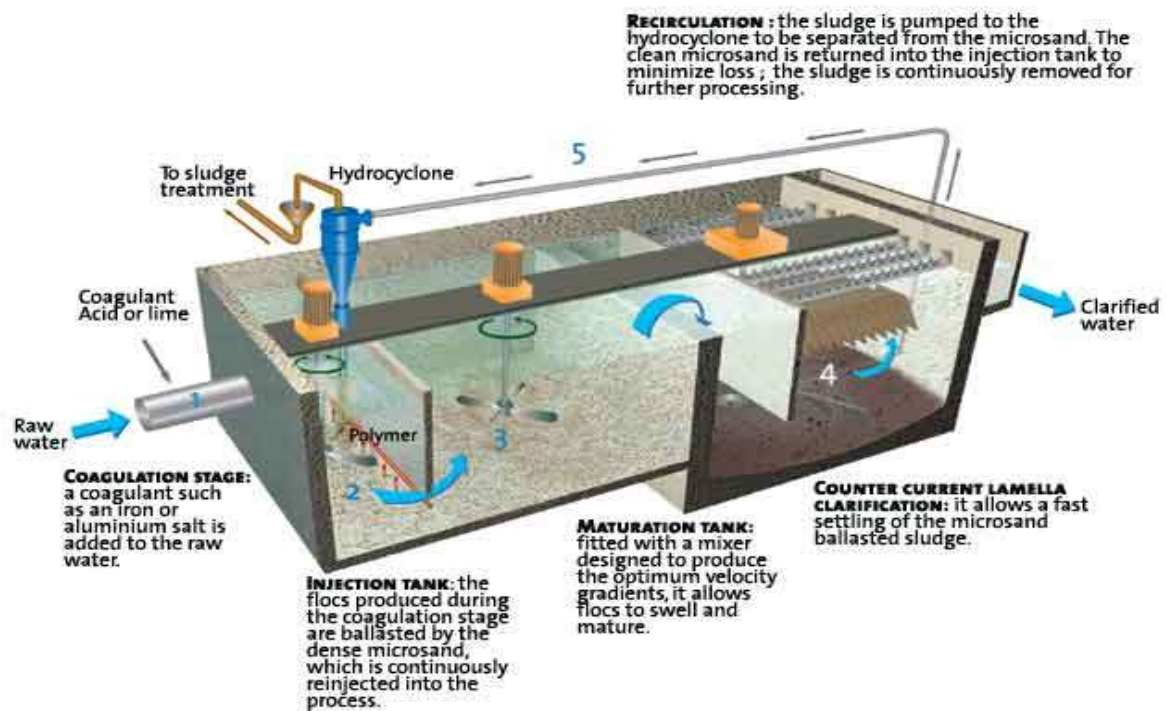
Actiflo™ is recommended for:

- surface water clarification,
- industrial process water production,
- wastewater treatment,
- storm flow water settlement.

Compactness displaying its true potential

The microsand ballasted flocs display unique settling characteristics, which allow for clarifier designs with very high overflow rates and short retention times.

These designs result in footprints that are 5 times smaller than classic lamella clarifier or dissolved air flotation (DAF) and up to 20 times smaller than conventional clarification systems.



Rapid, flexible and performant

Actiflo™ is a very high-rate clarifier exclusively developed and patented by Veolia Water Solutions & Technologies.

- **In drinking water applications**, its removal efficiency exceeds 90% for turbidity, colour, algae or arsenic;
- **In wastewater applications**, it consistently produces high quality water, even in varying raw water conditions, with removal efficiency:
 - > higher than 90% for total suspended solids (TSS), colloidal matter, total phosphorus, heavy metals and faecal coliforms,
 - > of 60% for BOD and COD.

Depending on the application, the following upflow velocities are consistently achieved:

- drinking water: 40-80 m/hr.
- process water: 50-100 m/hr.
- highly loaded industrial effluents or municipal wastewater : 50-100 m/hr.
- primary treatment of wastewater or storm flow treatment : 100-150 m/hr.

For applications requiring a high turn down ratio, Actiflo™ can also operate with microsand recirculation at a high overflow rate and without microsand at a rise rate lower than 20 m/hr. The microsand is simply stored in the process at low flows until it is required again. In this configuration, Actiflo™ then becomes a conventional lamella clarifier (Actiflo™ Duo).

Major process benefits

- High treatment efficiency ; removal rate of turbidity > 90%
- Very small footprint compared to conventional clarifiers; suited for restricted spaces and easy retrofit of existing plants
- Reduced civil engineering
- Flexible: reacts quickly to changing raw water quality; provides consistently high quality effluent
- Very short start-up time < 10 minutes
- The sludge produced can be thickened and dewatered easily
- Can be entirely automated and remotely controlled
- Minimum equipment to maintain, all easily accessible 15 years of operating experience with more than 300 Actiflo™ references worldwide
- Prefabricated package plants (1 000 to 10 000 m³/d per unit) which can be combined for larger flow rates

b) Aquilair

Physical and chemical deodorisation

Aquilair™ is a physical and chemical de-odorisation process developed by OTV, a subsidiary of Veolia Water Solutions & Technologies. This process entails the transfer of odorous gaseous molecules to a liquid phase.

Principle

The Aquilair™ process chemically treats dirty air in a counter flow system with aqueous solutions. This takes place in wet scrubbers operating in series. Within the scrubbing towers, an inert material enhances the contact between the gas and the liquid.

Depending on the properties of the component to be removed, a neutralising agent (base or acid) is added to the treatment water to accelerate gas-liquid transfer and therefore the treatment efficiency. The addition of an oxidising agent accelerates this transfer process on the one hand, and regenerates the wash water on the other, while modifying the absorbed molecules.



Performance

- Aquilair™ is designed to treat highly concentrated gaseous effluents that may have concentration of odorous components as high as 100 mg/m³.
- This highly reliable technique achieves treatment levels in excess of 99%, ensuring the total absence of odour-induced pollution.
- The characteristics of the packed bed (properties, specific surface area, volume, height) are designed to optimise the gas-liquid contact time as well as the transfer of molecules.

c) Azenit P

Nitrogen and phosphorus removal



Biological treatment of wastewaters for nitrogen and/or phosphorus removal by activated sludge.

Simultaneous removal of nitrogen, phosphorus, COD, BOD and SS including a bacterial selector and regulation of oxygen consumption. Azenit™ can be position in the process line either after pretreatment or after primary treatment.

d) Alizair

Biological deodorisation

The collection and processing of wastewater often involve the production of unpleasant smells.

Because of the absence of air and more particularly of oxygen, wastewater when it is collected becomes septic and can be extremely malodorous, sometimes directly at the network level and usually on arrival in the wastewater treatment plant.

At the treatment plant level, the storage and treatment of the sub-products resulting from the treatment of wastewater (sludge, scum, etc) can also release strong smells.

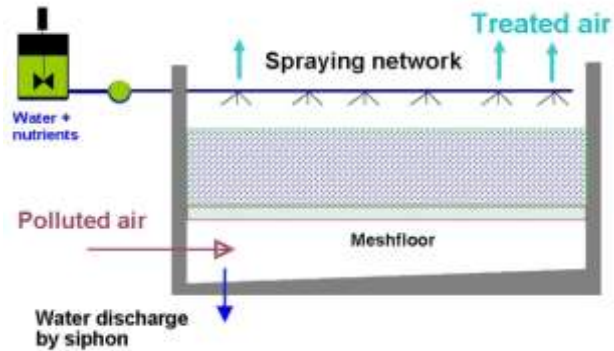
In the wastewater treatment plant, the nuisances are mainly related to the presence of sulphur compounds already partially formed in the network and, at a lower degree, to the presence of nitrogenous compounds.

The sulphuric compounds that form the majority of the concentrations in the foul air from the pre-treatment, and the thickening and dewatering of the sludge offer the highest olfactive thresholds. The nitrogenous compounds (ammonia, amines) are mainly present in the sludge treatment rooms.

To prevent the propagation to the surroundings of the odours produced in the treatment works, and to provide a healthy and safe environment to the operation personnel, all risks of releasing malodorous gas are minimized by using a biological odour removal system, called Alizair™.

Technical Details

Alizair™ is a biological deodorisation process (bio filter) that uses the bio-filtration technique. This process involves biological oxidation of odorous compounds in a liquid phase. It is particularly well suited to the treatment of gaseous effluent that is generally encountered in sewage / sludge treatment works and is designed to handle very high air flow rates. Alizair™ achieves very high filtration rates and ensures almost full removal of malodorous compounds.



Alizair™ is an air flow bio-reactor lined with a support material that is either mineral (e.g. Biodagene™) or organic (peat, compost). The flow of air to be treated rises in the bio-reactor. A perforated floor supports the material while allowing air to evenly penetrate the material and the spray water to run out.

The air is fed into the bioreactors by centrifugal fans. Malodorous compounds are bio-degraded during filtration via specific bacteria fixed onto the support material. The composition of the air to be treated and the features of the plant determine the choice of support material to be used and the nature of the added nutrients.

Spraying the surface of the filter with raw water maintains a constant relative humidity in the bed, provides the nutrients needed for the bacterial activity and ensures evacuation of biological oxidation products such as sulphates.

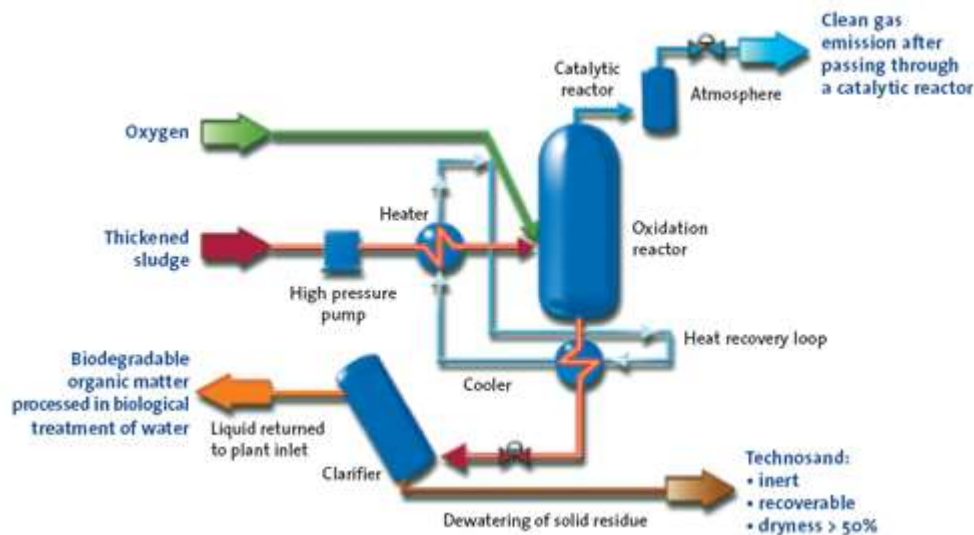
The spray water recovered at the bottom of the reactor is either recirculated or returned to the inlet works.

e) Athos

Reducing overall sludge production

The Athos™ process is based on the principle of hydrothermal oxidation (HTO), a process of oxidation in liquid phase that involves heating an effluent to a high temperature (250 to 300°C) and high pressure (70 to 150 bar) in the presence of an oxidising gas (air or oxygen).

Athos™ is a new process combining HTO with biological treatment, which mineralises the organic matter in the sludge under moderate conditions of temperature (235°C) and pressure (45 bar) in the presence of pure oxygen.



Technical details

With less than an hour retention time in the reactor, the Athos™ process results in :

- High mineralisation (less than 5% organic carbon content in the solid residue);
- Easily biodegradable liquid that can be returned to the biological treatment process (equivalent to ~ 25% total COD* in the sludge);
- Continuous and safe oxidation, under continuous mixing;
- Phase separation between gas and inorganic sludge.

Features & Benefits

The Athos™ process complies with all regulations on the disposal of wastewater treatment sludge whilst remaining cost effective. It benefits from the technological expertise and track-records of the Veolia Water Solutions & Technologies Group, the world leader in the treatment of urban and industrial effluents.

An environmentally friendly process

Athos™ is a clean technology : all the sludge components are recycled, recovered or discharged to the natural environment with no adverse effects.

- **Final result** : a concentrate of inorganic matter (technosand) accounting for only 1% to 2% of the quantity of initial liquid sludge ;
- **Possibility of recycling** the technosand for building materials ;
- **Stabilisation of the heavy metals** in the solid residue in a non-leachable form (inert waste) ;
- **Zero emissions of polluted fumes** nor harmful by-products (nitrogen oxides, dioxins, furans) ;
- **Reduction of the greenhouse effect** (50% drop in CO2 emissions compared with incineration) ;
- **Destruction of toxic and malodorous** (hydrogen sulphide, mercaptan, etc.) and **organic micropollutants**.

A cost-effective thermal process

Operating costs are reduced by:

- **Moderate operating conditions** (temperature and pressure, limited O₂ consumption) ;
- **Reducing the dewatering stage** (restricted only to the inorganic fraction of the sludge), with no chemicals addition.

A flexible process

Athos™ provides high operational flexibility :

- **Treats all types of thickened sludge** ;
- **Possibility of adjusting** retention time, temperature and the O₂/organic pollution ratio ;
- **Advanced automation.**

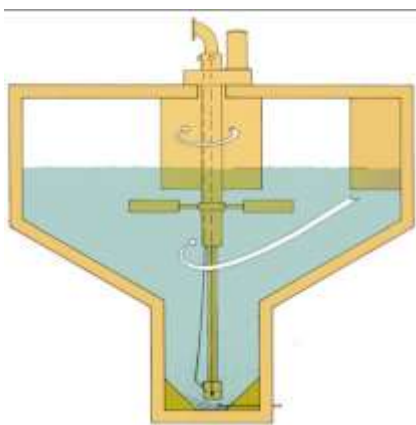
A compact process

Thanks to its compact design, Athos™ can be fully integrated into the wastewater treatment plant and provides continuous sludge processing, as well as its by-products treatment.

f) Mectran

Grit removal design

Grit is a source of problems in wastewater treatment facilities, which causes wear and tear on mechanical equipment, decreases the effective treatment volume in basins, causes pipe blockages and generally increases operating costs.



Prior to the introduction of conical vortex grit chambers, grit removal systems were usually designed to remove 70-mesh particle size at a water velocity of 1ft./sec. This objective was met provided that the flowrate remained constant.

The **Mectan®**'s circular construction sets itself apart from other systems by its *sloped transition section* between the upper chamber and the central grit collecting well. *All similar equipment on the market, at present, are modifications of our basic design. This is where we leave the others behind.*

Features & Benefits

- Compact size results in low excavation and civil works costs.
- Retrofittable into existing plants.
- Energy efficient with low cost maintenance.
- Simple mechanics and minimum mobile parts.
- No moving parts subject to wear located under water.
- Reliable simple design.
- Efficient operation on a wide range of flowrates.
- Constant velocity assisted by only two paddles.
- Low $\frac{1}{4}$ " head loss.
- Sloped transition and rotating motion eliminates accumulation of grit in the chamber under all conditions.
- Full accessibility to grit collecting well.

7. Conclusion

After all, Brussels will have the best Waste water treatment plant and will finally correspond to the demand of European union about waste water.

March 2007 : Plant start-up. 20-year operating period begins

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