No. 11
OCTOBER

ONEMA
Meetings

Treatment of wastewater, sludge and septage in small to mid-sized towns

A symposium organised by Onema and Cemagref.

The main goal of the symposium organised in Lyon, on 2 December 2010 during the Pollutec trade show, was to provide the French sanitation sector with operational tools to assist in meeting regulatory requirements and protect aquatic environments. The meeting was also an occasion to hold a debate on priorities for research and future developments, taking into account operational needs.

Local governments, State services, the Water agencies and offices, as well as sanitation-system owners and builders are currently confronted with an array of technical and regulatory challenges such as the Urban waste water treatment directive, the Water framework directive and the Grenelle environmental agreement. The overriding goal is to restore water to good status by 2015. Small to mid-sized towns must treat their wastewater, sludge and septage, and will play an essential role in meeting that goal.

Many types of sanitation systems are currently available and there are even different versions of a given type, *e.g.* planted filters. However, the information on their performance levels and scope of action has not always been sufficiently documented. Small to mid-sized towns thus find themselves at a loss to evaluate and validate sanitation projects. To provide answers to the various contracting parties (small to mid-sized towns, departmental councils, Water agencies) and funding entities, Cemagref has set up the EPNAC work group to evaluate new sanitation processes for small to mid-sized towns. The group comprises all public players in the field and is supported by Onema and the departmental councils. In addition, Onema and Cemagref work together to develop operational tools for collective (characteristics of wastewater, treatment, reuse, reclamation of by-products) and non-collective sanitation.

© Béatrice Gentil - Onema

The three types of wastewater treatment

A majority of French wastewater treatment plants have capacities of less than or equal to 2 000 IE (inhabitant equivalents[1]). In 2010, they represented almost 80 % of the 18 637 plants in France. The main types of system available are described in a reference document titled «Sanitation systems suited to small towns»[2]. If we disregard the traditional pre-treatments (screening, grit removal, grease/oil skimming), there are three types of sanitation system, 1) suspended growth, 2) attached growth on fine porous media and 3) attached growth on coarse porous media.

1 Regulations have set the inhabitant equivalent at 60 grams of biochemical oxygen demand (BOD5 per day)
2 http://www.fndae.fr/documentation/PDF/Fndae22web.pdf

ONEMA Cemagref Sciences, eaux & territoires

Aerated basin

Bruno Rakedjian,
head of the urban wastewater project at the Ecology ministry

Urban wastewater treatment directive

The 1991 Urban wastewater treatment directive is the regulatory basis for sanitation in Europe. It imposes standards for the collection, treatment and discharge of wastewater to preserve the receiving environment. France will soon be back on schedule in its work to upgrade wastewater-treatment plants, but its efforts must be pursued if it is to restore water to good status by 2015, which is the goal set by the Water framework directive. The quality of water bodies has vastly improved over the past 20 years, in terms of the parameters affected by urban wastewater, but there is still a limited number of water bodies that are significantly impacted by the wastewater discharged by small towns. The priority is to identify them and set up the measures provided for by the RBMPs and national regulations. A reduction in the impact does not necessarily require a new, high-tech treatment plant. There are other options available, such as improving plant operations, reuse of treated wastewater, addition of a tertiary treatment level, water infiltration and the creation of planted discharge zones. Towns and local governments must study all these options.

Suspended-growth systems

- *Activated sludge*

This is the primary aerobic biological process among suspended-growth systems and is now used in most treatment plants with capacities exceeding 1 000 IE. It is very effective in eliminating carbon, nitrogen and even phosphorus.

- *Natural and aerated basins*

Plants of this type have been estimated to number over 3 000. There are many significant advantages, *i.e.* ease of use, acceptance of continuous high hydraulic loading, 50 to 60 % reduction of total nitrogen and phosphorus during the summer and of pathogenic micro-organisms. However, over time and given the increases in the loads treated due to population growth in some towns, the limitations to this system have become increasingly apparent. They consist primarily of malfunctions and difficulties in achieving set quality standards for the discharged effluents. To counteract these difficulties, installations are renovated in conjunction with processes involving planted filters.
Aerated basins (photo on the left) are less common due to the high capital and operating costs. They are used only by towns that also collect industrial wastewater with the potential to modify the nutritional balance of effluents and thus encourage bulking, which is a negative factor for activated-sludge plants.

Attached growth on fine porous media

- *Filter beds*

Plants employing filter beds are dropping in numbers. The system commonly comprises primary treatment using a decanter/vertical digester, a bacterial filter bed and a clarifier. The sizing data for filter beds originated in old English-language studies and have only rarely been evaluated. The advantages are simple, but regular maintenance and low energy needs, while the disadvantages are limited nitrogen reduction and possible odours under certain conditions.

- *Rotating biological contactors*

There is a large number of plants using rotating biological contactors (photo on the right at the top) due to the highly diversified offer. Treatment of organic matter and nitrogen is good if load levels and sizing rules are strictly observed.

Rotating biological contactors

Attached growth on coarse porous media

The most common technique employs planted filters. Today, the plants most often used are reeds (see below).

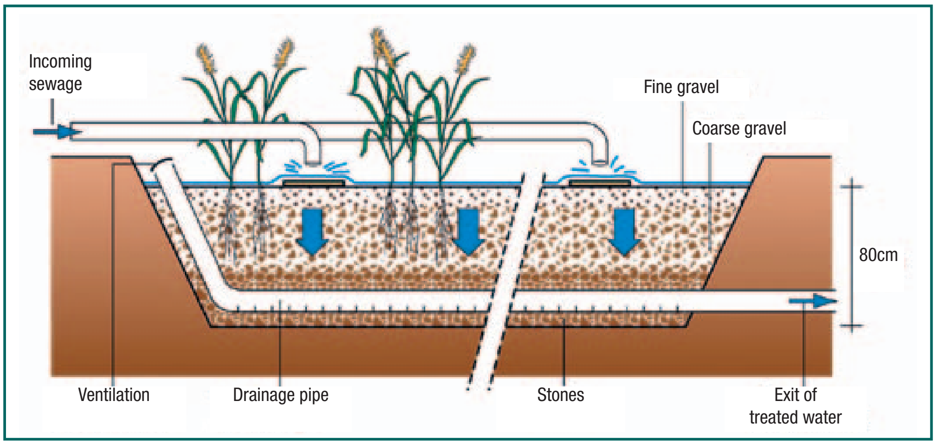
Planted filters, an up and coming technique

Research on reed-bed filters was launched by Cemagref in the 1980s (photo below). This method was initially developed to handle the sewage of small to mid-sized towns and was then expanded to treat sludge and septage from non-collective sanitation systems. The reeds are not active components in eliminating pollutants, but they create a favourable environment for bacterial flora because their stalks and rhizomes assist in oxygenating the filter. They also improve effluent infiltration and make for a better looking system.

Planted filters for wastewater treatment

A number of configurations exist. The standard version, vertical-flow filters planted with reeds (drawing page 3), comprises two in-series stages, each made up of two or three parallel-connected filters.

Reed-bed filter



Cross-section of the first stage in a vertical-flow filter planted with reeds (RMC water agency).

The total size of the system is 2 to 2.5 square metres of filter per IE. Each first-stage filter receives an irregular flow of untreated wastewater. The goal is to ensure an even supply of wastewater to all parts of the filter and good oxygenation of the filter. These supply phases alternate with rest phases.
This first stage is intended to retain any suspended matter and to mineralise all organic matter. The wastewater is treated by the biomass that develops in the filter. The second stage continues treatment of the nitrogen.

Recycling in a single-stage, reed-bed filter

Standard reed-bed filters need a large amount of space. This requirement may cause difficulties in terms of the necessary land or funds. To reduce the size of systems, Cemagref started a research project on recycling the effluent through a single-stage, reed-bed filter. Trials were carried out for 18 months in an 800 IE treatment plant, with variable hydraulic and organic loads. The treatment results for organic and suspended matter were satisfactory, with reductions of approximately 90 %. Results may be less than satisfactory if the concentrations at system input are very high. For nitrogen, 100 % of the effluent must be recycled to achieve satisfactory results.

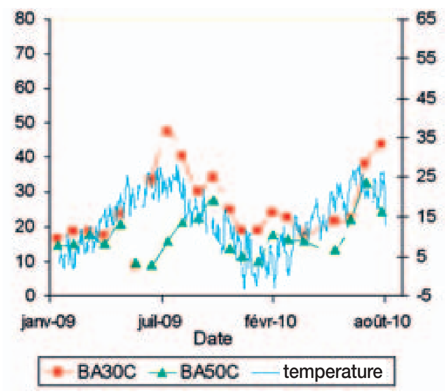
Sludge and septage treatment

Septage from non-collective sanitation and sludge are an increasing concern for local governments. In view of using reed-bed filters for this problem, Cemagref has carried out research on pilot units (scale models) comprising drying beds planted with reeds (photo page 4) and in a full-scale treatment plant at Andancette (Drôme department). The three-fold goal is to 1) determine bed-sizing rules for given sludge qualities, 2) define input strategies to ensure a high-quality final product and 3) determine the impact of weather conditions on system sizing and management.

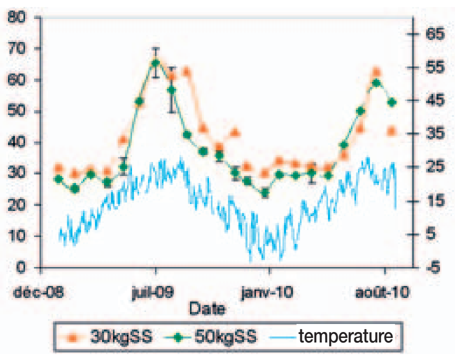
A number of key points must be observed to ensure high system performance:

- control input loads, *i.e.* 25 to 30 kg of dry matter per square metre per year during the start-up phase and up to 70 kg max. during normal operation;
- set up a sufficient number of beds, six minimum, to provide sufficient time for operating and rest times;
- treat percolates by recycling them back to the system input or setting up specific treatment, prior to discharging them to the natural environment.

Correct system operation (correct loading, frequency of bed rotations, etc.) can also be measured by the percentage of dry matter in the sludge



Change in percentage of dry matter at the end of rest periods, for beds receiving activated sludge
BA30C = 30 kg load of dry matter
BA50C = 50 kg load of dry matter



Change in percentage of dry matter at the end of rest periods, for beds receiving septage (30 and 50 kg loads of suspended solids [SS])

Céline Lagarrigue and Fabien Abad,
Urban and industrial pollution and public water and sanitation services - RMC water agency

Planted discharge zones

Planted discharge zones are one of the new sanitation systems that have made great strides over the past few years. The number of existing or planned systems has increased. Local governments are attracted by their «natural look», integration in the landscape and contribution to biodiversity. Their operation may, at first glance, appear simple and highly effective, but a number of complex mechanisms are brought into play by these systems. Their actual value in terms of treatment results must still be evaluated.
Today, the goal is to study the basic mechanism involved in these systems in order to consolidate our knowledge on a number of aspects and thus enable the various stakeholders to better understand these systems and justify any funding by the water agencies. Subsequently, the goal will be to create guidelines promoting good practices for the creation of planted discharge zones.

Pilot units for treatment of sludge and septage

and septage. The percentage of dry matter is a key factor in the quality of the final sludge. Minimum values of 15 % and 25 % have been set for activated sludge and septage respectively.
The highest levels are reached during the summer (graph page 3), which is consequently the best time to empty the system.

Prospects for research and innovation

The meeting ended with a round table focussing on participants in the sanitation sector and on operational needs. Speakers included a local government (Grenoble) and a representative of local governments (French association of rural mayors), the Ecology ministry, the RMC water agency, water companies (Lyonnaise des Eaux, Saur and Veolia) and an association representing the technical departments of departmental councils (ANSATESE).

A number of current topics were discussed, including sustainable management of the environment, funding of local governments, new contaminants, progress in sanitation systems, ecological engineering, etc. In all cases, the social and economic aspects were examined and must be built into all new projects.

The partnership launched in 2008 between Onema and Cemagref produced technical solutions that are ready for immediate, operational use by participants in the sanitation sector in France. The partnership will be pursued with a number of new public and private partners in view of preserving water resources and aquatic environments, developing innovation and assisting decision-makers.

Daniel Villessot,
Scientific director at Lyonnaise des Eaux / Suez Environnement

New approaches to the energy needs of sanitation systems

The average, total energy consumption required by a sanitation system to discharge treated water to the natural environment and for any additional treatment on residues (sludge and other screenings) is 0.23 kWh/person/day. The increase in energy costs have led system managers to check that the energy consumed by the main processes (aeration, mixing, pumping, sludge treatment) does not exceed that required to ensure discharge quality.
Further research on energy and sanitation systems led to the question whether it would not be possible to recover the energy in warm wastewater with a high organic-matter content, before treating the water. The calculations showed that the potential recoverable energy amounted to 0.37 kWh/person/day. Quite naturally, our research turned to the means to recover the energy in wastewater and sludge, as well as other forms of renewable energy, and the result today is «carbon neutral» treatment plants, such as the AQUAVIVA plant in Cannes.

For more information…
Symposium proceedings:
http://www.onema.fr/Colloque-Pollutec-2010

Meeting organisation:

Stéphane Garnaud, Onema, scientific officer for water and sanisation

Alain Héduit, Cemagref, Research director and member of the Onema scientific council

ONEMA Meetings

Publisher: Patrick Lavarde
Coordination: Véronique Barre, Research and development department, Claire Roussel, Information and communication department.
Authors: Stéphane Garnaud, Research and development department
Editorial secretary: Béatrice Gentil, Information and communication department.
Translation: Cabinet Bartsch
Layout design: Eclats Graphiques
Production: Accord Valmy
Printed on paper from sustainably managed forests by Panoply
Onema - 5 Square Félix Nadar - 94300 Vincennes
Document available at:
www.onema.fr/IMG/EV/cat7a.html