WINERY WASTEWATER TREATMENT: PROSPECTS FOR THE SMALL CELLARS

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Summary

The liquid waste processing of cellar largely developed for the cellars of significant size. On the other hand, concerning the small structures, the phased introduction of the environmental regulation imposes the gradual installation of a device of treatment, whether it is individual or collective.
Certain systems result directly from the agro-alimentary sector. Others were developed specifically for the small cellars.
The objective of the presentation and to draw up an inventory of fixtures concerning the techniques available of water treatment used, and to consider the current prospects for research.
The intervention will relate in particular to the following systems:

- aired storage,
- evaporation,
- purification on granular support,
- planted beds of reeds.

Abstract

The treatment of winemaking wastewater widely spread for the largest wineries. One the other hand, for smaller structures, the progressive application of the environmental regulation impose the gradual set up of has purification device, individual but collective.
Some systems were directly adapted from the farm-produce industry. Other systems were specifically developed for the smaller wineries.
The purpose of the presentation is to proposes year inventory of the hand available treatment technical for winery wastewater, and to view the eventual further research opportunities.
The presentation will particularly concern the following systems:

- ventilated storage
- evaporation
- purification one granular support
- constructed wetlands

Key words: environment, effluents of cellar, durable viticultur

1. Introduction

The wine die, like any other sector, must limit the environmental impact of its activity.The rejections resulting from the presses and the cellars are likely to disturb the biological balance of the rivers in particular for the period of the grape harvest. Indeed, the organic elements resulting from the viticultural activities generate, in an aquatic environment, the development of micro-organisms which draw the oxygen dissolved with the detriment of piscicultural fauna.
The control of pollution resulting from the cellars rests on two complementary steps. Upstream, an adaptation of the development process must be implemented to reduce the polluting load and to ensure an optimal management of water. Downstream, liquid waste processing of cellar realized individually or collectively, perhaps under consideration with several techniques: evaporation, spreading, biological device.

Concerning the small cellars, if the characteristics of the effluents are rather close to that of the more significant structures, the economic constraints, the simplicity of implementation can justify specific technological developments. The objective of this communication is to establish an inventory of fixtures of the techniques available and to present the tracks of research in progress.

2 Step preliminary to the treatment

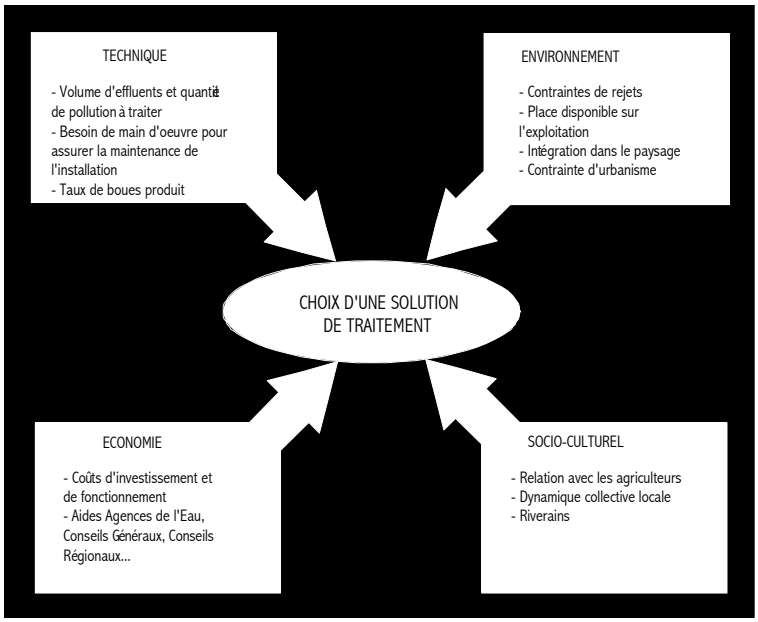
- Characterization

Variability in term of volume and polluting load is one of the characteristics of the viticultural effluents. The type of wine, the type of equipment, the sensitizing of the personnel are the principal factors of variability of the effluents.
The average composition of the viticultural effluents is as follows:

pH	4,1 to 6, sometimes 10 to 13 in period of descaling
MY	1000 to 2000 mg/l
DCO	3000 to 20 000 Mg of O2/l
Generated volume	Generated volume: from 20 to 1000 liters per hectolitre of worked out wine, including 40 to 60 % during the grape harvest

Table 1: Average characteristics of the viticultural effluents

A fine characterization imposes the use of specific materials of measurement of flow and taking away. Measurements must be carried out throughout the year, in order to have a good knowledge of seasonal variability in connection with the various stages of the development. The period of vintage, points pollution for the majority of the cellars, must be the subject of a precise follow-up (day labourers measurements).
For the small ones and average cellars, it is possible to consider a simplified follow-up established on the basis of regional average data supplemented by measurements on site.
The volume of effluents perhaps evaluated starting from the water meter. The volume of water used for the domestic activities must be deduced from total volume when the meter is not specific to the cellar.
The qualitative characterization is more problematic bus of the specific taking away, allow only one very approximate evaluation. An approach a little finer consists in storing the effluents during one day then to carry out a taking away after homogenisation.



- Selection criteria of the system of treatment

Figure 2: Factors to be taken into account for the choice of an installation of treatment (E.Proffit Source)

The installation of a system of treatment generally involves a heavy investment associated at significant cost of operation. There are not techniques of ideal or universal purification, but a whole of solutions adapted to each situation. Several factors are to be taken into account in the choice.

"Technical" Factor

The volume of rejected effluents is one of the determining factors of the capacity of the installation of treatment to be set up and strongly conditions the investment necessary (cost of storage). The composition of the effluents influences the choice of the technique and consequently the costs of operation, which forces to know well volumes and the loads to be treated.

The second technical point not to underestimate is the need for labour for the maintenance of the installation as well as necessary know-how. Indeed, in period of grape harvest and wine making, the activity is intense. It can be difficult for the exploitation to mobilize a person to deal with the installation of processing liquid waste. The rustic or completely automated solutions could consequently be preferred with those requiring a strong monitoring. The collective treatment, the provision of services, also meet this need for simplification of maintenance.

Lastly, of many processes of treatment (storage, aired, evaporation, activated sludge…) muds produce whose management must be integrated into the project. Thus, the quantity of muds produced *in fine* can intervene in the choice of the solution of treatment.

"Economic" Factor

The operation and capital costs must be studied at the time of the choice of a solution of treatment. Indeed, of low capital costs can, in certain cases, to generate high costs of operation.

"Environmental" Factor
The environmental term is employed here in the broad sense. These constraints can be separate in two groups: those of rejection and those of site, established according to cases' by regulations local, regional, national or specific to the wine die

The constraints of site are related to the place available on the exploitation to establish a solution of treatment, with the grounds possibly usable for spreading, but also with the presence of close neighbors forcing the owner to control the noises and odors generated by the installation of treatment.

Factor "Socioculturel"
Under this term, all the relational aspects are gathered revolving around an often delicate subject to approach with the residents when the medium is degraded by the effluents. If a collective treatment of the effluents is considered, it must be done by integrating the opinions of all the parts concerned with management of the file (for example: municipality, residents of the site of treatment, associations of nature conservancy…).

It is significant to stress that this factor can become limiting in the management of such a file if the relations are not clearly defined and that all the actors cannot express themselves.

- Adaptation of the development

The various stages of the development must take into account the need for reducing the volume and the polluting load of the effluents in particular with respect to the following aspects:

- Recovery and valorization of the by-products of the wine making (bourbe, dregs, tartar)
- Optimal management of the médiafiltrants and the solutions of descaling
- Optimization of hygiene (design of the installations and technologies, organization, sensitizing of the personnel)
- Suppression of the systems of cooling of musts in open circuit
- Separation of the networks (industrial, domestic, rain water)

3 Traditional techniques of treatment

Often developed for the significant cellars for several years, different technical from treatment have been able to apply to the small structures.

Evaporation
This process rests on the evaporation of the water contained in the effluents and valorization by spreading of the residues of evaporation (muds or matters dry). Two techniques can be implemented.

The technique of natural evaporation can be used in the areas where the annual hydrous deficit is significant. The effluent to be evaporated is stored, after cleaning, in tight basins low depth (about the height of the clear evaporation annual of the place is approximately 400 mm

in the Mediterranean zones) and whose total surface is calculated according to the volume of annual rejection.
Evaporation can be optimized by a sequential pulverization of the effluent on alveolate panels, standard honeycomb, on high specific surface. The effluent streams along the cells and form a film on the mesh, which proportionally increases the potential of evaporation on the surface of the basin.
An alternative of traditional evaporation utilizes a recirculation on a support of compost which intervenes under greenhouse, leading to final to the volatilization of the totality of the effluent. The compost enriched out of organic matter, is developed by amendment.

Spreading
The liquid waste processing by spreading on arable lands rests on the capacities épuratoires system ground – micro-organisms – plants: it ensures the filtration of the suspended matter, fixing then the degradation of the organic matter and the use by the plants of the released biogenic salts.

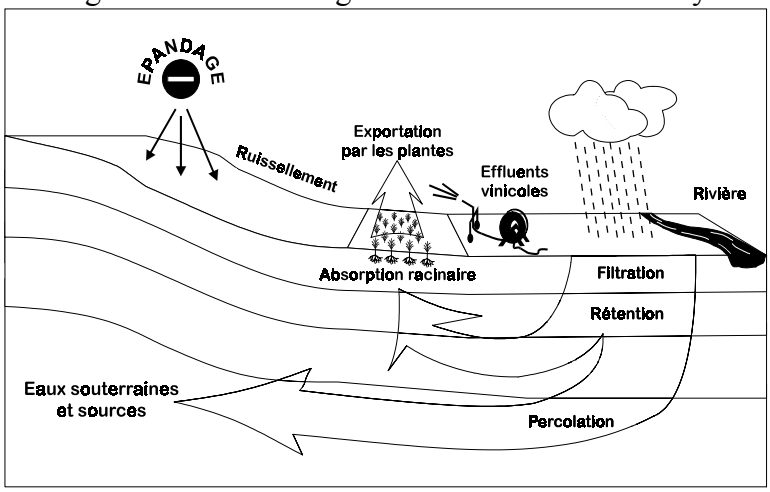
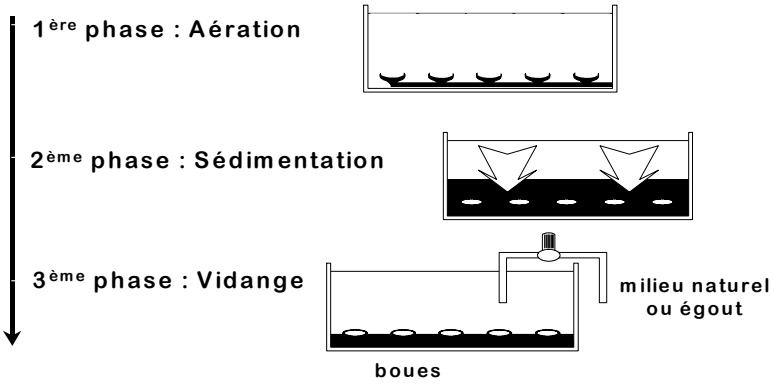


Figure 3: general diagram of spreading
(Source ITV France-CIVC)

To be effective with respect to the environmental protection, spreading must be reasoned and managed well.It is indeed essential to adjust the volume of effluents to the physicochemical characteristics of the ground and the capacities of export of biogenic salts by the cultures. A study preliminary to spreading must thus be carried out, aiming characterizing the effluents of the establishment considered, selecting pieces likely to receive spreadings (slope lower than 7%, distances compared to the dwellings, river and collectings, etc…) and at studying the agricultural grounds and the context (cultures installation, average rotations, outputs, work of the ground).

Aeré storage
This technique is an alternative of the biological processes (activated sludge, lagunage). It is often used in the cellars for which the seasonal character is particularly marked. Its implementation rests on a system by batch.
The following operations are carried out in the same tank:

- Storage after cleaning of the whole of the effluents of the vintage;



- Sequential ventilation and mixing;
- Decantation of formed muds.

Figure 4: General diagram of ventilated storage (Source ITV France)

Time necessary to the treatment varies according to the laid down objectives of rejection, according to whether the rejection is carried out in a network of cleansing (approximately 15 days) or in the natural environment (30 to 40 days), and with the type of installation (one or more tanks of storage and the activity of the cellar).

This technique can be implemented individually or collectively. The collective treatment, generally associated a transport of the effluents, makes it possible to ensure the purification of the effluents of the small cellars which do not have place sufficiently to implement individual systems.

Mixed collective treatment

The rejection of the viticultural effluents in a network of communal cleansing constitutes the solution of the treatment simplest to implement for the establishments of small size. However, as for the Installations Classified for the Environmental protection, the connection of the viticultural establishments of small size can be carried out only under certain technical conditions.

The station of purification must be sufficiently oversize to accept viticultural effluents. Several configurations are possible according to the annual distribution and the percentage of load due to the viticultural effluents.

- If the viticultural activity presents a strong saisonnality, the station of purification comprises a buffer storage upstream basin of ventilation and is slightly oversize to absorb the quantities stored over a few months.
- If the viticultural activity is more constant throughout the year, the solution lies in an oversizing of the station of purification proportional to the viticultural quantities of effluents to purify.

The correction of the pH, the storage of volumes over a few hours, the control of the rejections are some of the conditions which can be requested from the cellars before their connection.

4 Purification on granular support

Principle

These techniques gathered under name cultures fixed on fine support, initially found their applicability in the domestic water treatment worn. Their general principle rests on a filtration percolation on a support in which develops a purifying biomass that it is advisable to maintain in aerobic conditions (A. LIENARD). The principal characteristics concerning domestic worn water are as follows:

- Application of small quantities of organic matter which constitutes the substrate of the bacteria on the useful surface area of the granular supports (often less 50g of DCO/m²/j) so that their initial permeability is not reduced too much by the development of the micro-organisms in intergranular porosity.

- Alternate food of at least 2 filter solid masses in parallel for sparing phases of rest during which the biomass decrease and where is reconstituted the oxygen stock.

- Food by covered, with strong flow during a short time, to distribute the best possible effluents on the filter solid mass in service.

- When their operation is optimal, the filter solid masses are placed in hydrous condition of not-saturation free volumes in intergranular spaces are thus occupied alternatively by gases resulting from the processes of degradation for the periods of operation (mainly of CO2) and will be gradually replaced by air, richer in oxygen, during periods of rest.

The application of these processes to the effluents of cellar owes integrer specificities of the wine sector compared to the domestic treatment

- Point pollution in period of vintage
- Content of DCO of the effluents generally ranging between 5 to 20 g/litre (1 to 1.5 g/litre for the domestic effluents)

These specificities generally impose implementation an adapted

- Preliminary pretreatment (aerobic system or anaerobe) allowing to lower the DCO to a level close to 1 to 1.5 g/litre
- Recirculation contributing by passage successive on the solid mass to a progressive lowering of pollution

Implementation

Several systems are developed in the viticultural sector:

Filter sand

The device generally consists of a whole of filter solid masses furnished with sand a thickness of approximately 70 cm. Each filter is used in alternation for one period from 3 to 4 days followed by one week of rest.

The capacities of purification measured on domestic water are approximately 60 G of DCO/m²/jour (LIENARD A.).

This device was developed for the viticultural effluents in treatment of completion after a device of ventilated storage.

Filter gravillonaire with recirculation

After aerobic treatment in two successive tanks during 7 days a total average residence time, the purification of completion intervenes on a pozzolana solid mass sprinkled by 4 asperseurs. This solid mass is gradually naturally colonized by a fixed biomass. Compared to a filter on sand, pozzolana has a more significant potential of fixing of micro-organisms, but the residence time of the effluent during the percolation is shorter what justifies a recirculation.

5 Devices of beds plants of reeds.

Principle

This technique takes as a starting point the the operation of a ground in wetland (marsh). The device generally consists of 2 or 3 beds in series. Each bed comprises a height of fine gravels (2 to 8 mm) which is used as support with the development of the reeds (reeds)
This technique associates at the same time:

- Development of an intense underground microbial activity thanks to the support effect of aggregate and the network racinaire
- Transfer of oxygen by the air parts of the reeds towards the roots contributing to aerobic, more or less intense underground mechanisms according to the design of the bed
- Assimilation of the degraded organic matter contributing to the development of the air parts.

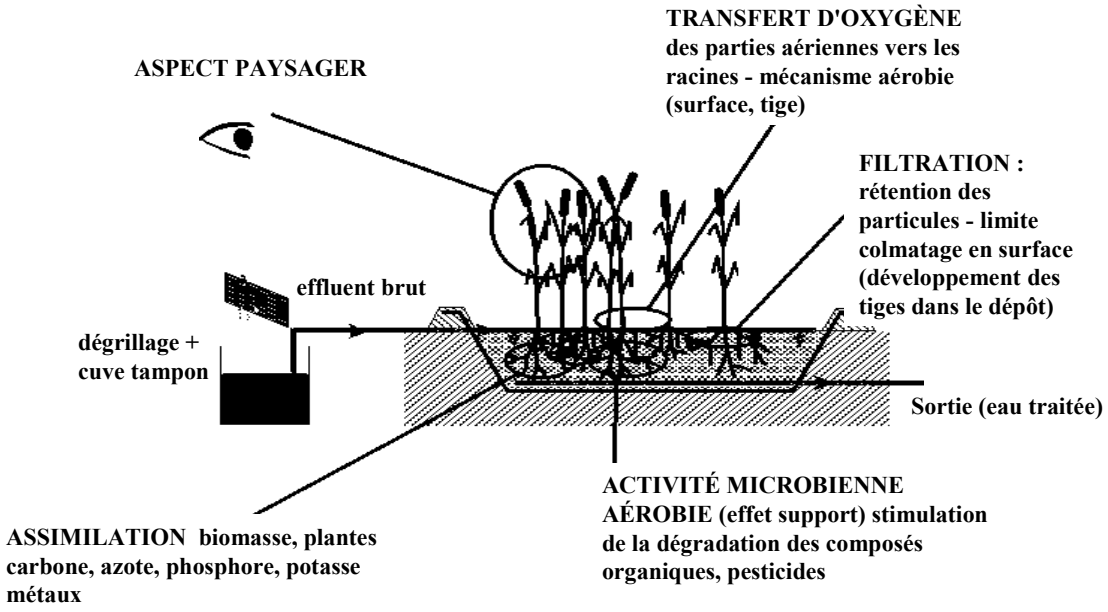


Figure 5: Principle of operation of a device of planted bed of reeds

From a practical point of view, the contribution of the effluents is carried out uninterrupted (horizontal system) or by batch (vertical system). On the surface, contrary to the filters on traditional granular support, the permanent movement of the reeds related to the action of the wind avoids the phenomenon of filling per formation of a ring of flow around the stems.

- Traditional uses

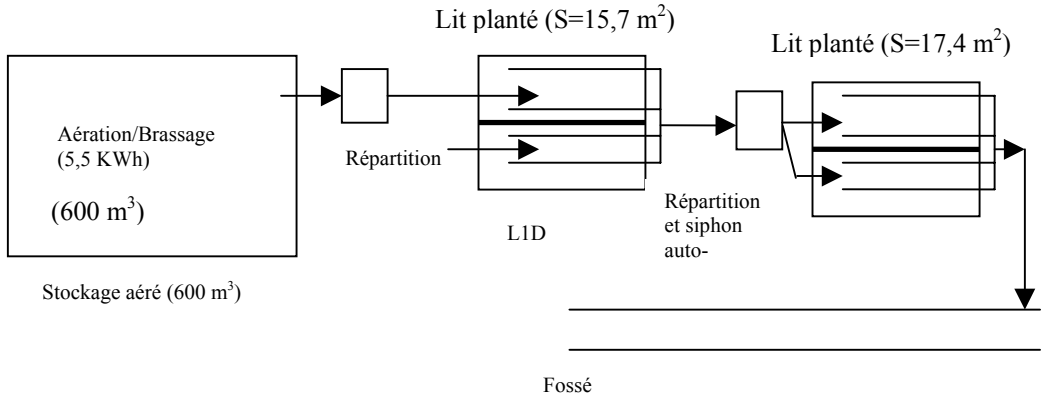
The use of the planted filters is recognized since many years for purification of domestic worn water; the technology transfer towards the viticultural die is easily possible since one places oneself under organic conditions of characteristics (1 to 2 G of DCO per liter) and of rate/rhythm of food (spread out rejection) close to the domestic effluents. Beyond the characteristics épuratoires, the motivation of the cellars to invest in this type of process, also relates to aesthetic integration and the ecological concept of the device. This process is used in France by ten cellars which have, for the majority of them, is the subject of a follow-up by ITV France or the National Group Technical "Effluent viticultural".

- Treatment of completion

The planted filters can constitute a stage of completion of the water treatment after one of the traditional biological processes (activated sludge, aired storage…). Their role is then rather comparable with that of the sand filters; they are fed with waste water, after separation of muds.

Their performances épuratoires, comparable with those obtained with the planted filters used in domestic treatment, make it possible to reach values of DCO in the rejection lower than 125 mg/l for concentrations in entry of filter of about 1 g/l. Their presence makes it possible to guarantee the conformity of organic matter and the suspended matter concentrations before rejection in the natural environment.

Figure 6: Device of planted bed associated a aeré storage



- Treatment of muds

A second application directly derived from the experiments in the domestic field relates to the treatment of biological muds. Those are taken in the decanter for the continuous systems, or in the basin after draining of the water purified for ventilated storages. They are deposited in successive layers on the surface of the planted filters which leave percoler water that they contained; this water is returned in the basin of ventilation for treatment.

In addition to this dehydration, the plants allow a degradation and a stabilization of muds which reduces the final volume of the product and its olfactive harmful effects. The installation itself diffuses only few odors, probably thanks to the presence of the vegetable cover which limits the displacement of the masses of air.

The end product obtained, rather near to a compost, is extracted by clearing out, on average the every 5 to 10 years, and is the subject generally of a valorization by spreading on arable lands.

- Direct handling of the effluents

The principal characteristics of the viticultural effluents are, in comparison with domestic worn water, a strong organic load, an acid pH and an unequal distribution in the year with a peak marked in autumn, particularly for the small cellars.
The first experiments of purification with planted filters show that the pH is not really a limiting element. Indeed, since they are fed with an effluent of relatively constant composition, the plants manage to adapt and carry out purification to it. On the other hand, the organic load and its unequal distribution throughout the year are much more problematic since they imply very significant surfaces of filtration if one takes as bases dimensioning the ratios used in the domestic sector. Tests carried out in various cellars could show the limits of this technique, applied in direct handling, during the grape harvest. On the basis of this report, we designed a device equipped with a significant storage capacity allowing to ensure a recirculation of the effluents by sequence on the planted beds.

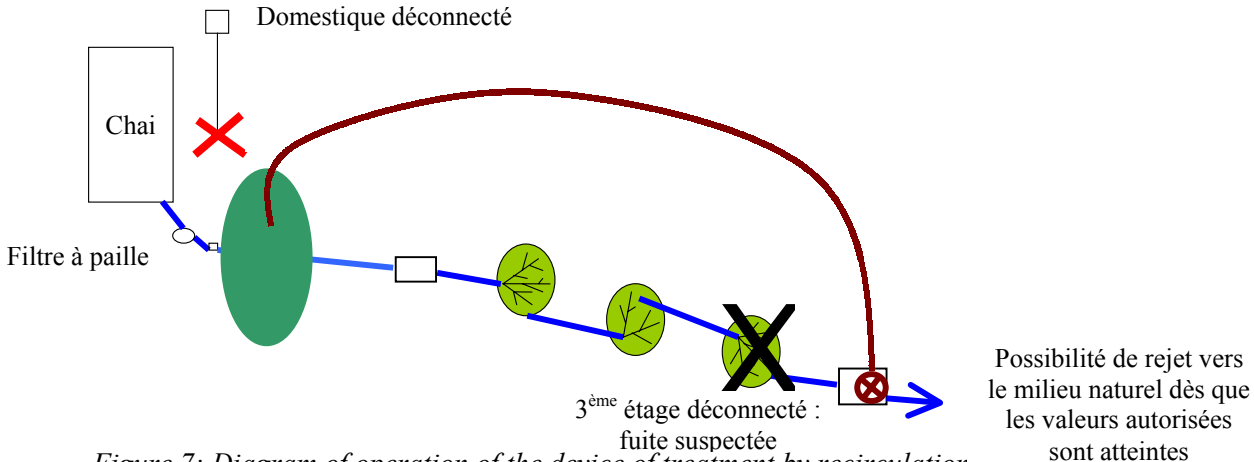
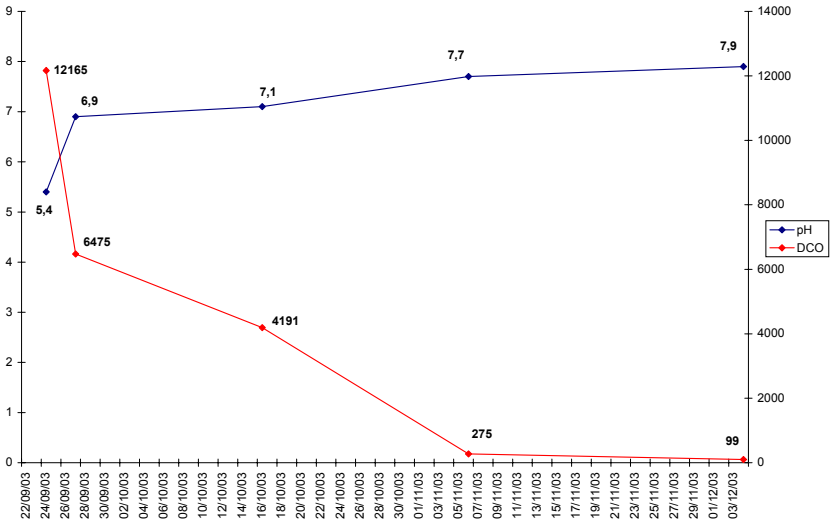


Figure 7: Diagram of operation of the device of treatment by recirculation
Source: Labaronne-Citaf – Living room Toilets

This principle was tested in a small cellar of Bordeaux which vinifies approximately 600 hl annually. The device is composed of vertical planted filters of a total surface of 27 m² and of a tank of storage of 40m3. A system of car-syphon makes it possible to carry out a discontinuous food of approximately 300 liters the every 30 to 40 minutes (either 10,8 to 14,4 m3 per day).

The effluent is recovered downwards in a tank of 1m3 equipped with an automatic pump of reassembly (system of float) towards a flexible tank of storage of 40m3



Graph n°8: Evolution of the pH and the DCO during the treatment

The results (graph n°8) are very encouraging. Indeed, starting from an initial DCO of approximately 12,5 g/litre, a content lower than 300 mg/l (limit of rejection usually imposed) was reached after 6 weeks of recirculation. This treatment was prolonged to reach
99 Mg after 11 weeks.
The evolution of the pH which passed from 5,4 to 7,9 testifies to the biological activity (degradation of the acids).
This process-pilot is under development in connection with a manufacturer what will make it possible during next campaigns to validate the industrial aspects (cost, consumption of energy, constraints of follow-up, etc.)

CONCLUSION

A "durable" approach applied to small and average exploitations justifies to treat effluents, in order to limit the environmental impacts on the aquatic environments. Parallel to the diversity of the traditional methods, various tracks of research aim at an adaptation of the processes to the specific constraints of the cellars (investment, cost of operation, facility of follow-up). In complement of these technical constraints, are added concerns in particular related on the aesthetic integration of the installations, the consumption of energy and becoming muds. The devices of planted beds, in the course of experiments, fall under a development prospect potential for the cellars.

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