OFFICE INTERNATIONAL DE LA VIGNE ET DU VIN

SCIENTIFIC AND TECHNICAL NOTEBOOKS

MANAGEMENT OF WINERY AND DISTILLERY EFFLUENTS

Group of Experts, "Technology of Wine"

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FOREWORD

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1) INTRODUCTION

If there is one sector that is in constant evolution, it surely that of the environment. Following the impulse of big worldwide conferences (Rio, Kyoto…), we are witnessing the emergence of environmental regulations that concern all sectors of activity. The industries reputed to cause the most pollution (chemistry, metal working, etc.) were the first to be subjected to this development. Now, the agro-food sector is also concerned. Likewise, wineries will not escape this trend of the end of the 20th century.

Beyond the regulatory aspects, the environment is also at stake with respect to the image of vitivinicultural procedures. Indeed, the consumer increasingly includes in his or her purchasing motives a notion of ethics, in which respect for the environment is an important component. This preoccupation with the environment includes several aspects. In the first place, an adaptation of elaboration procedures aimed at reducing the source the pollution or facilitating its treatment. In second place, residual pollution must generally be the object of a purification treatment whose performance is compatible with the characteristics of the receiving medium and with local regulations.

1.1. Characteristics of Winemaking Effluents

Pollution linked to winery effluents comes from components of the grape, must, or wine (skins, stems, earth, sugar, acids, lees, alcohol, polyphenols, yeasts, bacteria), from products of tartrate removal and cleaning, or from products used in vinification (for example, filtration media, fining agents)(1,2).

For all of these effluents, organic matter represents the main source of the pollution. Cases of pollution linked to toxic wastes can also be encountered occasionally (products used for cleaning and tartrate removal)(1,2).

1.2 Action on the environment

The organic matter in wastewater, when discharged in large quantities into a river, a pond or a lake, assures its deterioration by encouraging the multiplication of microorganisms. These consume the oxygen dissolved in the water, to the detriment of the fauna of the natural habitat. Furthermore, the nutritive elements contained in the waste (in particular, nitrogen) may favor the development of algae. These, together with suspended solids in the wastewater, limit the passage of light which is necessary for photosynthesis, a source of oxygen in the medium.

Sometimes, winemaking effluents are discharged to a network linked with a local purification station that was not originally planned with the capacity to be able to treat the extra waste during vintages (increased population of villages, fermentation wastes). In these conditions, waters may remain very loaded with organic material downstream from the station. In addition, the organic matter influx destabilizes the biological system of the station, and it can often take several weeks, or even months to re-establish the balance necessary for the purification facilities to work well again (1,2).

1.3 Measures of Pollution

A certain number of parameters permit the level of pollution of an effluent to be evaluated. The main ones are defined in the framework below.

The measurement of these parameters is an indispensable precondition to all effluent discharges.

1.4. Analysis of effluents

In the context of regulations, analyses are most often performed by an agreed, specialist laboratory, which uses standard methods recommended by the authorities of the country

At the level of the winery, the analyses often take place as routine techniques of the process.

These basic analyses are generally performed with micromethods based in the case of COD on the use of ready-to-use tubes containing pre-measured reagents, associated with a spectrophotometric measurement.

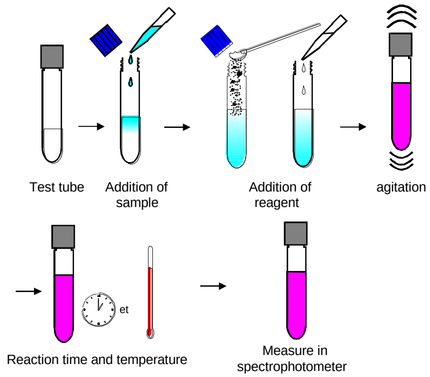

Figure 1. Micro methods of measurement
Source : LEOVIN, European Program Leonardo da vinci

1.5. Variability of effluents during winemaking

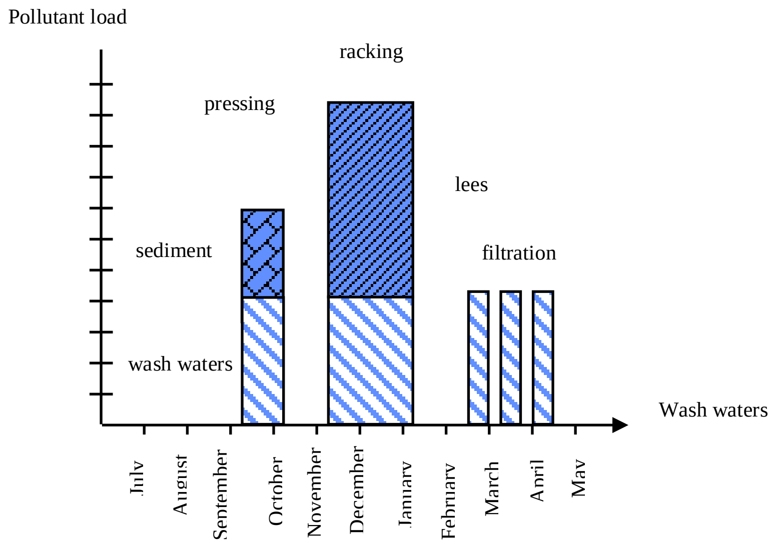

Figure 2. Example of the distribution of effluents through the year (from the example of wines of Champagne)

The choice of treatment solutions best adapted to different wineries requires a detailed knowledge of their wastes throughout their cycle of activity (4). One of the great characteristics of winemaking effluents is their seasonal nature, with the major part of the volume being produced during the harvest and during the two following months (racking procedures). The pollution induced by winemaking activity varies according to the winery and depends to a great extent on the working methods of the personnel. It depends also on the method of winemaking, on the variety of wines produced and therefore on the region where the winery is situated. The characteristics of effluents have been described for several viticultural regions: (1,4,5,6,7,8, 48, 49, 64, 65, 66).

Parameters	**Mean concentration of effluents *(*)***
VOLUME (l/hl of wine)	30 to 300
BOD5 (g/l)	1 to 20
COD(g/l)	2 to 40
SM (g/l)	1 to 4
N (mg/l)	150
P (mg/l)	50
K	300
pH	3 to 6 possibly 9 to 12 during the stages of tartrate removal

Table 1. Mean characteristics of winery effluents

(*) Winemaking effluents show great variability in their characteristics. The figures in this table are only indicative values.

1.6. Regulatory aspects

During the last three decades, the industrialized countries have become concerned with the fundamental role of the environment in the future of the planet. The treatment and/or the reduction of wastes, whether solids, liquids or gases, has been made the object of increasingly strict regulations (9). The most polluting industries (chemical, metal working,...) were the first to be addressed by the legislator due to the toxicity of their discharges.

With the goal of improving still further the quality of water and the environment, the scope of regulations has been widened notably to the agro-food industries and hence wineries themselves are made the object of regulations of varying strictness according to the country of production.

Regulations bear on several aspects, according to the country or region:

- standards for discharge linked to the type of receiving medium (aquatic, local network, soil)
- level of production of the winery

Regulatory aspects most often concern the following criteria (10 to 13):

- COD, BOD5 and SM (level in mg/l or load in kg/day)
- pH, temperature, conductivity
- level of nitrogen and phosphorus
- toxicity criteria (heavy metal content, ecotoxicity...)

In parallel with these regulatory aspects, there is often a system of financial penalties and incentives (14) possibly applied by taxes (local or regional) proportional to the level of pollution discharged and also of subsidies to wineries that implement internal management systems (aimed at reduction of pollution, reduction of water usage) and facilities of purification.

Considering the diversity of environmental laws in the different viticultural countries, it is not possible in this document to present the detail of the regulatory aspects. Further information may be obtained from the national organizations whose contact details are given in Annex 4

1.7. Environmental management

This is a voluntary movement which, although it can be "suggested" by the partners of the winery such as the distributors, is not linked to regulatory constraints.

The minimum objective to be attained in the medium term is the implementation of standards at wineries and other viticultural enterprises. In this context, environmental management could lead to a process of accreditation. The European institutions have developed the Ecoaudit movement.

At the global level, the standard ISO 14 001 gives the benefits of an international accreditation (61).

The ISO standards on environmental techniques reflect the two most common approaches in business: organization, meaning the control of processes and the product, by the management of its life cycle.

171. Principle of the standard ISO 14 001

The ISO standards dedicated to environmental management can be classified into two groups. The first group of standards propose simple models for the organization of a business which wishes to control its impact on the environment: it defines a system of management evaluated and driven by audits, which establish objectives and the means of following performance on environmental matters.

The standard ISO 14 001, the beacon standard for environmental management is part of this series. It contains specifications and a usage guide for the management system and is based on 2 major principles:

- The commitment to an environmental policy
- The establishment of an automatic improvement system for implementing this policy (continuous improvement loop).

It can be remarked that there are similarities between the quality management system (ISO 9000) and that for the environment (ISO 14 000). It is therefore wise for ISO 9000 accredited businesses to integrate the common procedures of the 2 systems in order to conserve the knowledge of the quality movement.

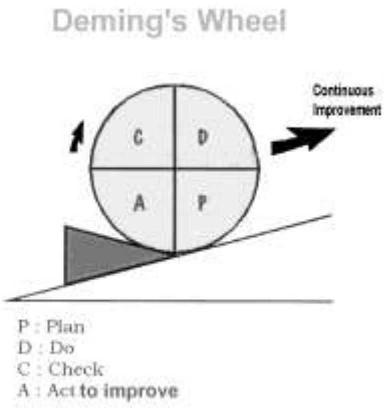

Figure 3. DEMING's wheel
Source ITV France

172. Application to wineries

With regard to the environment, each winery is an individual case. Its geographic position and size, the characteristics of its installations and the type of winemaking operations are all factors to take into account in an individualized audit. In an overall approach, the key management points are the following:

- Hygiene : optimization of cleaning operations (water economy, rational use of cleaning products);

- By-products (deposits, lees, tartrate and solutions from tartrate removal processes): recovery and value enhancement;

- Winery effluents: quantitative and qualitative monitoring and establishment of a plan for treatment (individual or associated with communal treatment);

- Wastes (packaging, filtration media, etc…) : inventory, mode of collection and of elimination;

- Energy : optimal utilization (insulation, control).

173. The Stakes

Environmental management is a global approach of the winery with regard to environmental considerations. One part concerns the management of winemaking effluents but thanks to its all-encompassing character, this movement endows the winemaking business with numerous advantages :

- The control of costs, notably by efficient management of primary materials, of energy and of wastes;
- The prevention of incidents rather than suffering them and seeking to lessen their impact;
- The knowledge of the partner institutions (banks, insurance companies, administrations);
- The strengthening of the image of the winery in regard to environmental awareness;
- The acquisition of a competitive advantage, notably in precise compliance with the regulatory aspects of export.

2) ADAPTATION OF WINEMAKING TO ENVIRONMENTAL CONSTRAINTS

During the elaboration of wine, the cleaning operations essential for the maintenance of hygiene are the source of organic and, occasionally, chemical discharges. Often, the establishment of a treatment system imposes internal controls that reduce the load of pollutants at source and decreases the volume of discharges without prejudicing hygiene, which must remain the priority preoccupation of the winemakers. To clean and yet have less significant and less polluting discharges is an objective that can be reached by taking account of the design of wineries, the organization of work and the choice of cleaning materials (17). The purification of effluents will be much easier and more economical when the load and the volume to be treated are smaller.

2.1. Planning of wineries

Wineries often have a heterogeneous layout because of the modifications and extensions that they could have undergone. The layout of wineries, often difficult to change for ancient buildings, must however be thought out for new constructions (extensions for example) so that the management and the utilization of water are facilitated (79). In spite of the constraints specific to each installation, and whatever the technique of purification envisaged, the separation of wastewater and rainwater is imperative for better control of effluent volumes.

On the other hand, the control of temperature during alcoholic fermentation is often achieved by simple flow of water, requiring between 500 and 1000 l of water per hectoliter of wine to maintain a temperature of 18°C. It is desirable in this case to separate this water from water used for cleaning and to consider recycling. Another solution to this discharge problem is the installation of either internal or external heat exchangers (18).

The coating of floors is a compromise between safety aspects (danger of falling on slippery surfaces) and the ease of cleaning, which are generally opposing concepts. According to the danger of slipping (slope, frequency of passage), it may be necessary to use non-skid type coatings that are more difficult to clean. In a more general manner, it may necessary to favor non-skid coatings despite the difficulties of cleaning. In contrast, in technical zones where few people pass, it is possible to use a very smooth surface.

2.2. Hygiene

The demands of quality, associating strictly with the notion of hygiene, must be among the priority concerns of winemakers. But in the context of these imperatives, it is possible to ensure a cleaning regime more economical of water and at the same time taking account of the organization of work, the choice of cleaning materials and the layout of the cellar.

The training and awareness of personnel, possibly linked with regular reading of water meters are preliminary measures indispensable to all policies for the optimized management of water.

In parallel, wasteful losses can be reduced by the installation of devices which stop automatically.

Several factors are involved in the optimization of the phases of cleaning :

- Type and concentration of the cleaning product
- Time of contact
- Temperature of the solution
- Importance of the mechanical effect

Thus, according to the type of cleaning to be done, it is possible to get an equivalent or even superior result, with less water, by the utilization of an appropriately adapted technique.

The use of foam guns, of washing with hot water, of suppressors and of devices with automatic cut-off, often results in a significant economy of water (18).

By way of example, the use of high-pressure washing has contributed to the development of a new cleaning process for the drains of pneumatic presses. It is based on the automation of washing by a nozzle introduced in the drains, propelled thanks to a reaction effect. In comparison with the classic process of washing of drains with rapid flow, this technique leads to a significant water saving (60 to 100 l instead of 500 to 800 l), while improving the quality of cleaning (more than 90% of the deposit eliminated as opposed to 50% for the traditional technique)(17, 19).

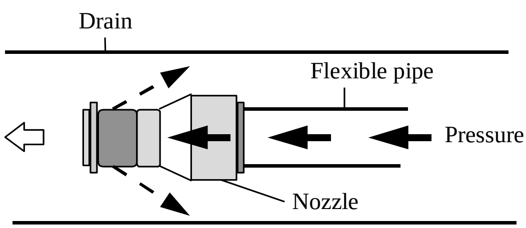

Figure 4. Working principle of the “reaction effect nozzle”
source ITV France – CIVC

2.3 Recovering and Adding Value to by-products

231 Pressing

Operations linked to pressing are the source of particularly polluting discharges, notably during a white wine vinification for which effluents generated by the production of one hectoliter of must are equivalent to the daily domestic effluent of 3 to 6 people. The recovery of the deposits of natural sedimentation or centrifugation of musts, results in a reduction by 40 to 50% of the pollutants in the discharges (1).

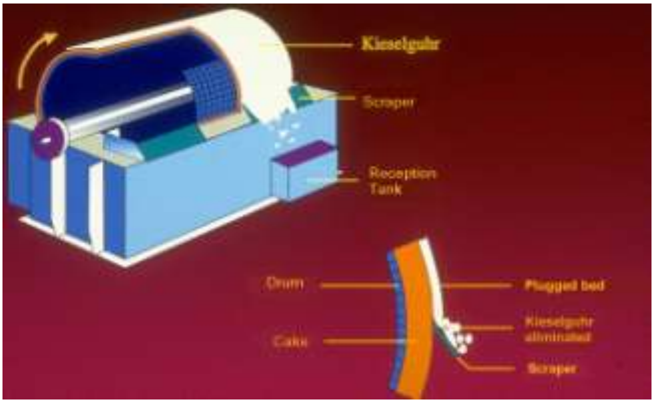

Figure 5. Principle of a rotary vacuum filter
source ITV France – CIVC

These deposits can have value recovered from them by distillation or possibly by spreading. When the legislation permits it, these can also have value recovered by the use of a filter-press, or of rotary filtration under vacuum (1).

The storage of marc can be a source of effluents rich in components with elevated COD levels by the effect of auto-pressing and leaching. This risk of organic pollution can be avoided by setting up a sealed storage area, connected to a recovery tank for the drainage waters. Value can be recovered from this liquid by distillation or spreading or it can possibly be treated by a specific purification device.

Marc is also the object of selective value recovery from its components (distillation of the alcohol, extraction of seed oil, burning of stems). An agricultural value recovery can also be considered in the context of composting.

The use of skins and pulp to complement animal feeds is a fairly common food-related value recovery method (20). The extraction of specific compounds of the marc is a new approach in the context of the human foodstuffs, in liaison especially with wine and health aspects.

232 Racking

Although more spread out over time compared with pressing, this stage of the vinification can present a significant risk of pollution. Dregs, of which the level of pollution is close to that of the initial must sediments, must be recovered. The classic value-recovery method used is distillation, possibly associated with a recovery of tartrate.

233 Tartrate removal

A fraction of the tartaric acid, a natural component of the grape, precipitates during winemaking as crystals of potassium bitartrate. These have the tendency to grow on materials in contact with wine. Their elimination usually requires the use of concentrated caustic soda. The discharge of this descaling solution represents an organic pollution source due to the presence of the bitartrate, and is toxic because of the large presence of sodium and elevated pH level (21).

Concerning new winery facilities, it is important to note that boilermakers produce several finishes of steel, some of which facilitate the removal of bitartrate crystals. The user also has the possibility to install vat washing devices that accentuate the mechanical effect and so facilitate the removal of crystals. (17,21).

Analyses	1	2	3	4	5	6
pH	12.05	12.30	12	11.9	11.95	11.6
SM mg/l	15807	2300	18780	4220	-	1096
BOD_5 mg O_2/l	50000	19900	77000	132000	67500	122000
COD mg O_2/l	121500	51000	176500	218000	120700	205900
NTK mg/l	735	266	630	735	245	420
PT mg/l	192	96	740	1000	653	1046
K mg/l	48500	20000	58750	93500	41000	78750
Fe mg/l	15.2	5.8	4.9	6.1	3.0	5.3
Cu mg/l	3.5	1.2	13.9	17.2	6.8	17.0

Table 2. : Composition of different descaling solutions. From J. ROCHARD

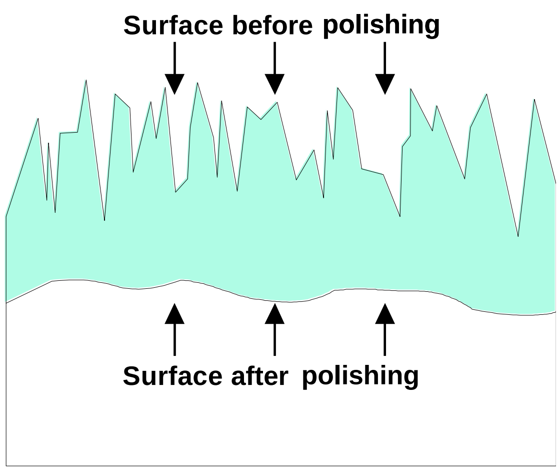

Figure 6. Microscopic view of a polished stainless steel
source ITV France – CIVC

This removal is much more efficient than ordinary washing when achieved with hot water, and performed quickly after the racking of the vat. With regard to chemical descaling, it is also possible to recycle caustic soda solutions. This is done by putting a container for spent caustic soda at the user's disposal. This is then sent after descaling to a center specializing in the recovery of tartar. The profitability of the recovery is only foreseen where the collector receives a descaling solution rich in potassium bitartrate. The concentration is generally followed by density or tartric conductivity (22).

234. Clarification techniques

The use of filter media in alluvial filtration techniques is the source of organic pollution during the wash cycle. The filtration media also produce a quantity of suspended solids likely to impair the transfer of effluent by plugging or choking of pipes.

New materials produced on the market and named “ecological filters” permit the recovery of the filter cake in the form of pelletable paste. The partial drying of filtration media is obtained by the use of a nitrogen gas.

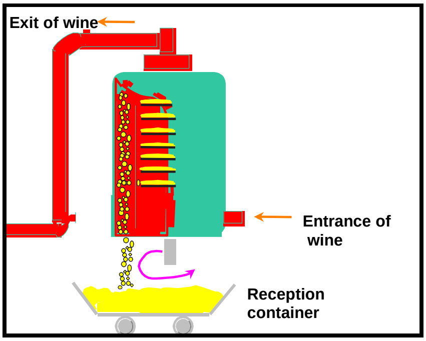

Figure 7. Working principle of an alluvial “ecological filter”
Source ITV France-CIVC

Another technique is also envisaged, based on the use of a regenerable adjuvant (65).

The paste is usually eliminated from the filtration plates by centrifugal force. These materials present an increased cost in the order of 20 to 30% compared with classic filters, but this extra investment is often made up for by a reduction of the wine loss.

Separation techniques using centrifugation and tangential filtration avoid the difficulties of management of filtration media. However, the cleaning waters, rich in organic matter and possibly detergent and disinfectant, must be able to be integrated in the purification strategy of the winery.

3) PRETREATMENT STEPS

Technologies for the treatment of winery effluents are based on the classical procedures used in the agro-food sector. However, the seasonal character of the wastes, the heterogeneity of the procedures both with regard to the fashion of production (from the cottage industry to the very industrial approach) and to the geographic position (urban or rural) justify a very varied range of techniques for purification treatments.

Every winery is an individual case. Therefore, there are no universally applicable treatment schemes. A technique corresponds to an optimal choice for a given situation. Again it is necessary to have determined all the elements linked to the specificity of the cellar.

3.1. Pre-study

This must integrate at the same time a quantitative and qualitative knowledge of the effluents with a precise knowledge of the variability during a production cycle, an estimation of the reduction of the pollution resulting from the establishment of internal measures and an understanding of local problems (legislation, relational context with the regional local administration and the local environment). The definitive choice must lean on the technico-economic aspects associated with the investment but also with the functionality, for which it is desirable that the constructor commits to performance objectives.

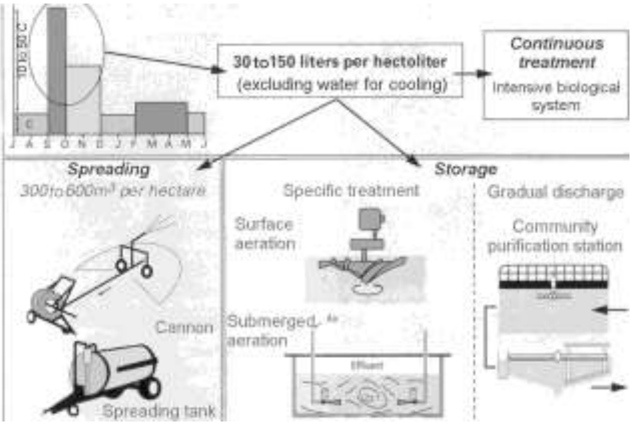

Figure 8. Main schemes for the treatment of winery effluents
ITV source France-CIVC

3.2. Economic aspects

321. Analysis criteria

The procedures for treatment of vinicultural effluent currently available to wineries are numerous and impose a choice. Some may be eliminated immediately because they are not adapted to the climatic conditions or to the immediate environment of the winery. Once the first sorting is done, the definitive choice must be made according to the price of the process. If the cost of the investment affects the decision, the cost of using and of maintaining the process should not be overlooked. Expenses linked to auto control systems, sometimes required by the legislation, must also be taken into account in the economic study (29, 50).

It is necessary to keep in mind that in the period of vintage, the availability of personnel is restricted. More basic systems may then be preferred to sophisticated processes requiring increased control and surveillance. The optimization of purification systems very often complicates the progress of the installation and increases its price. This intensification of the process is often necessary when the available land is limited (urban situation).

Procedures	Investments [1][2]	Running costs
Individual aerated storage	24 Frs. /hl (3.66 euros)	1 Fr. /hl (0.15 euros)
Two-stage biological treatment by activated sludges	57 Frs. /hl (8.69 euros)	4.2 Frs. /hl (0.64 euros)
Methanisation (anaerobic biological treatment)	4.28 Frs. /hl (0.65 euros)	2.05 Frs. /hl (0.31 euros)
Continuous aerobic biological treatment by activated sludges	3.42 Frs. /hl (0.52 euros)	2.71 Frs. /hl (0.41 euros)
Biological aerobic treatment at the 1st stage (yeasts)	6.03 Frs. /hl (0.92 euros)	
Physico-chemical treatment by forced evaporation	0.60 Frs. /hl (0.09 euros)	0.20 Frs. /hl (0.03 euros)

Table 3. Investment and the running costs of some purification processes used in French wineries, after J.D HERING 1995, (51).

(1) the investment cost has an amortization period of 10 years

(2) the prices are given excluding any subsidy and are normalized to one hectoliter of wine. They are given to illustrate the variability that one can observe according to the problems faced in each situation.

In certain cases, financial aid may be available. The mechanisms by which this is given are very variable according to countries or regions.

These grants enable the cost of direct investment to be reduced as well as possibly those of subsidiary developments (discharge networks, water economy, by-product management, etc.).

322. Implementation strategy

The considerations prior to investment must also include the implementation strategy for individual or collective treatment. In certain cases, this choice is linked directly to the local legislation: prohibition of discharge into the local network or on the contrary, strong incentives for cellars to participate in a mixed collective treatment.

When this alternative exists, several aspects must be taken into consideration:

- Financial aspects: mixed management should theoretically lead to an economy of scale from which the winery should benefit. But on the contrary, vinification doesn't have the control of the work flows that can sometimes lead to more favorable cost-benefits. Moreover, the calculation of the respective contributions of the urban and vinicultural sectors is often difficult, since the characteristics of the 2 types of effluents are so different (level of pollution, quantities produced at different times of the year).

- Management of purification: collective treatment avoids the constraint of monitoring at the level of the winery for the part that is linked to the system. On the other hand, the adaptation of winemaking processes (to achieve water economy, by-product management), often integrated in national legislation or the contract of connecting to the treatment system, must generally be envisaged whatever the approach adopted. For individual systems, management is linked closely to the level of intensification and automation of the process.

- Responsibility of the winery: In the context of individual or collective management, the party producing the effluents generally assumes the responsibility associated with a possible negative effect on the natural habitat. However, individual management can result in a more direct implication of the winery compared to a mixed management system, especially in the event of a malfunction in the purification system.

3.3. Safety

Winemaking activities present particular risks when personnel are instructed to enter into tanks. The release of carbon dioxide during fermentation is a phenomenon well known by practitioners, despite which accidents occur all too frequently. On the other hand, the risk of methane and hydrogen sulfide formation in waste water storage tanks is less well understood by wine professionals.

All entry into tanks used for winemaking effluents can therefore present a danger. This is why, in order to avoid accidents, it is essential:

- to have a good knowledge of the risks;
- to purge the atmosphere of the tank with a ventilation system;
- to be accompanied at all times by a person remaining outside the tank.

Risks of accidents

Three major risks of accident are present in a tank used for storage or treatment of wastewaters:

- explosion, caused by the presence of methane and hydrogen sulfide. When these flammable gases are mixed with air, the simple presence of a flame, of a spark or of excessive temperature can start an explosion;

- asphyxia, linked to a reduction of the quantity of oxygen, because of the presence of other gases from chemical reactions or fermentations. Below 18% of oxygen, air becomes asphyxiating, and produces a characteristic progression of symptoms, from acceleration of the pulse to loss of consciousness and death;

- poisoning, due to the presence of certain gases such as hydrogen sulfide, carbon dioxide... that are produced by the fermentation of residual organic matter in the tank.

The purification of the atmosphere in the tank will be achieved with a centrifugal fan by blowing in clean air that pushes the polluted air toward the exit of the tank. This system should operate for a sufficiently long time so that the air in the tank is completely renewed before the entrance of the personnel: the time of purging must correspond to at least 6 times the volume of the vat.

In the case of a prolonged stay in the tank (to do repairs for example), ventilation must be maintained during the entire period.

It is possible to use gas detectors. They enable the verification of the quality of the atmosphere after ventilation. These devices only give rapid and localized indications of the levels of O2, CO2, H_2S, flammable gases… They don't allow the application of security rules to be dispensed with.

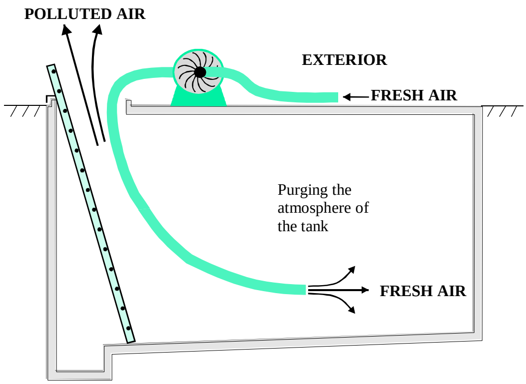

Figure 9. Ventilation of a storage tank
Source ITV France - CIVC

3.4. Sieving

This operation is often an indispensable prerequisite to the implementation of a purification system. It enables the elimination of the solid elements such as stems, seeds and skins that contribute to the blockage of pipelines or the deterioration of pumps.

The main criteria in the choice of different processes are as follows (26):

- Hourly output to be treated;
- Concentration of coarse elements in the effluent to be treated;
- Fineness of the sieving process desired;
- Possibility to place a sieve in the water flow (directly in the sewage discharge channel);
- Constraint of maintenance of different materials;
- Risk of odors;
- Geographical position of the cellar (risk of frost).

341. Settling Tank

During transfer to one tank or between several tanks, suspended solids deposit progressively according to their size by the simple effect of gravity. The raw water is thus partially rid of the coarsest particles. However, in practice, the efficiency of these tanks proves to be very limited. Indeed, the periods of discharge take place at the time of peak activity in operations, an inconvenient period for the maintenance of these settling basins (emptying). Moreover, the sugar-rich effluents during the vintage period ferment quickly, which impedes the sedimentation of suspended matter. The presence of these tanks can also encourage multiplication of various insects such as drosophila, which are vectors of the acetic inoculum. In addition, in the case of insufficient maintenance, there is the risk that some putrid odors may develop to become a nuisance to the neighborhood.

342. Basket-sifter

These baskets, constructed from stainless steel or plastic, are generally positioned in peepholes or at the level of water discharge points. These economic devices nevertheless require regular surveillance and cleaning in order to avoid the loss of efficiency by clogging and overflow. The mesh of these baskets is generally sized between 5 and 20 mm.

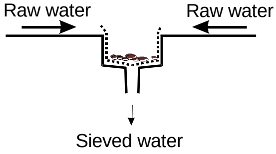

Figure 10. Principle of a basket sifter
Source - Leovin, European Leonardo da vinci Program

343. Tilted static sifter

The concept of this device approaches that of a toboggan whose flooring is replaced by transverse strips. The wastewaters carrying solids flow down the length of these strips, whose spacing is sufficiently small to prevent the passage of solid matter. A Spacing between the strips of 0.5 mm to 1mm seems best adapted to winemaking effluents. The grid in certain models includes several slopes, which enables optimization of solid matter removal.

The main advantage of such a device is the absence of moving parts, which facilitates the maintenance and increases the robustness of the system.

Daily washing with water under high pressure is necessary in order to avoid the clogging of the grid. The unblocking of the grid in certain models is sometimes assured by a system of brushes, vibrators or a pipe containing water jets to wash the grid.

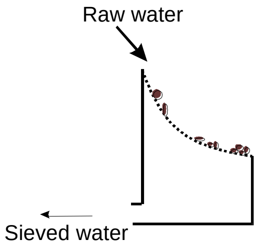

Figure 11. Principle of a tilted static sifter
Source - Leovin, (European Leonardo da vinci Program)

- Dynamic processes: these permit the treatment of higher outputs but require more significant investment. The self-cleaning devices need little maintenance.

344. Rotary sifter

This device is composed of a metallic drum grid that retains solid particles. There are two types of equipment:
- In the first, the effluent flows from the outside of the drum to the inside and the solids are retained on the periphery;

- The second functions in the opposite way, the raw effluent arriving at the center of the sifter and being directed toward the outside. The progression of the solid elements is assured at the interior by a slight slope or by an advancement screw.

The unblocking of these devices is generally assured by brushing or by washing from lateral rails.

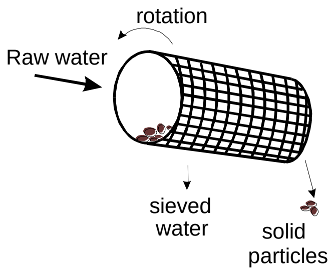

Figure 12. Principle of a rotary sifter
Source: Leovin, European Leonardo da vinci Program

345. Self-cleaning sifters using the wastewater current

This device is composed of claws, the spacing of which defines the fineness of the sifting. The continuous rotation of combs enables the coarse elements to be raised from the raw effluent discharge pipeline, with the water current. This principle avoids the need to achieve a raising of the raw water.

4) EXTENSIVE TREATMENT PROCEDURES

4.1. Spreading

The treatment of effluents by spreading on agricultural land rests on the purifying capacities of the soil - microorganisms - plants system: it assures the filtration of suspended matter, the fixation followed by the degradation of organic matter and the utilization by plants of the mineral elements liberated.

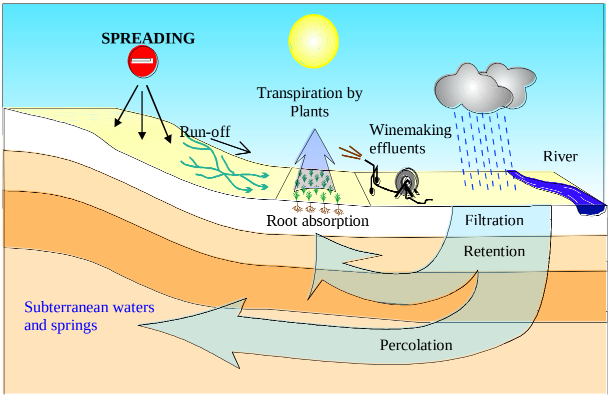

Figure 13. Schematic of the principle of spreading
Source ITV France-CICV

To be efficient with regard to the protection of the environment, spreading must be justified and well managed (19, 68, 80). It is indeed indispensable to adjust the volume of effluent to the physico-chemical features of soil and the capacity of the plants cultivated for use of mineral elements (23, 80). A survey must be done prior to spreading, therefore, aimed at characterizing the effluents of the establishment considered, to select pieces of land appropriate for spreading (slope lower than 8%, distances from dwellings, water courses and wells, etc...) and to study soils and the agricultural context (plants being cultivated, rotations, average outputs, working of the soil).

On the other hand, spreading can represent a supplementary irrigation source rather than a method of purification. Thus, in California (6), effluents must be treated before being used for irrigation of vineyards (by drip or by spraying). In South Africa, some wineries and distilleries perform spreading in semi-arid zones, in spite of some difficulties for vegetation to adapt to the acidity of spread effluents (24). In Australia (25, 66), most wineries perform spreading after correcting the pH and short storage (<7 days) of the effluents, but some establishments do a pretreatment to improve the quality of water before spreading, possibly enabling the reuse of water within the winery.

In agricultural spreading, sieved effluents are stored in a buffer basin whose capacity varies according to the winery and can then be spread either by spraying with the help of stationary or mobile jets, or by a muck spreader tank towed by tractor.

Spreading by spraying is economically feasible when the spreading field is close to the winery. The installation, set up after a study of hydraulics, must include a pump of appropriate pressure, a system of accounting for the volumes spread, a network of fixed pipelines (buried or otherwise), and one or several spray jets, according to the size of the spreading area. Two types of jets may be used: fixed or mobile and automatically driven (28). Facilities for spreading by spraying entail a significant investment but have a small running cost and require little manual labor, even though a daily inspection must be undertaken.

Spreading by muck spreader is a simpler technique to operate but requires more manual labor than spraying. The main criteria in the choice of the muck spreader are the volume, the number of axles, the type of tires, the internal coating of the muck spreader, the rate of output, and the power of tractor required (28). The necessary investment is relatively small, but running costs are high and the distribution of effluents is not uniform. In addition, larger buffer storage must be provided because of climatic uncertainties. Nevertheless, it is possible to call upon specialized service providers in this area or upon agriculturists already possessing the necessary equipment, which allows the personnel of the winery to dedicate themselves mainly to the vinification. In this case, collective spreading can be considered.

4.2. Evaporation

This process is based on the evaporation of the water contained in effluents and recovering value from the process by spreading the evaporation residues (sludges or dry matters). Two techniques can be put into operation.

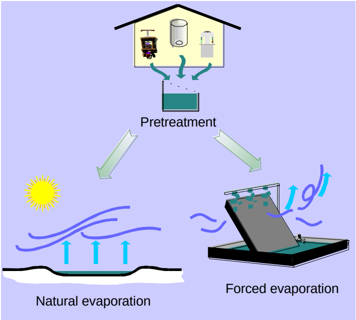

Figure 14. Principal of treatment by evaporation
Source - Leovin, European Leonardo da vinci Program

421. Natural evaporation

This technique can be used in regions where the annual water deficit is important. The effluent to be evaporated is stored, after sieving, in waterproof, shallow basins (the net annual level of evaporation would be about 400 mm in Mediterranean zones) whose total surface is calculated according to the annual volume of discharge. To avoid infiltration into the soil, hydrogeological and geotechnical studies must be performed (30). It is important that the replenishment of basins is progressive, permitting the establishment of aerobiosis (thanks to precipitation and to wind), in order to limit bad odors (31). The evaporation reduces the volume of effluent by almost 97% (30), transforming it into dry sludges.

Natural evaporation has a fairly low exploitation cost and results in a total elimination of discharges but it is limited to climatic zones with good evaporation and sometimes generates bad odors. It is, moreover, necessary to supervise the watertightness of basins regularly, whose surface area is often large.

422. Forced evaporation

Evaporation can be optimized by a sequential spraying of the effluent on alveolar panels, of a honeycomb type, with a specific raised surface (31, 52, 83). The effluent streams along the honeycomb cells and forms a film on the mesh, which increases the air/water interface. A system of sequential cleaning by disinfectant detergent enables the clogging of the alveolar panels to be avoided. The capacity of evaporation per square meter can then be up to 100 times greater than with natural evaporation, which permits a significant decrease in the surface area needed to treat effluents and also reduces unpleasant smells. The capital investment for this system is reasonable and the running costs moderate. Several devices have been installed in the Mediterranean region, which is favorable for this type of treatment (significant natural air currents). For less favorable situations, fans are used to recreate conditions favorable to evaporation provided that the ambient air is not too humid.

5) BIOLOGICAL AEROBIC PROCEDURES

5.1. Principal

The purification of effluents by aerobic fermentation rests on the degradation, in an oxygenated medium, of the organic matter dissolved in the effluent by various microorganisms (bacteria, yeasts, protozoans...), leading to the formation of carbon dioxide, ammonia, water, and sludges. These sludges can then be separated from the treated effluent by simple decanting and then generally spread. Since microorganisms are present in the raw effluent, oxygenation is generally sufficient for the development of sludges. Numerous techniques of purification use this method of which the principle is the oxygenation of effluents.

The specific microorganisms used in purification are not very compatible with conditions of hygiene in wineries, which justifies taking all precautions to avoid risks of microbiological contamination.

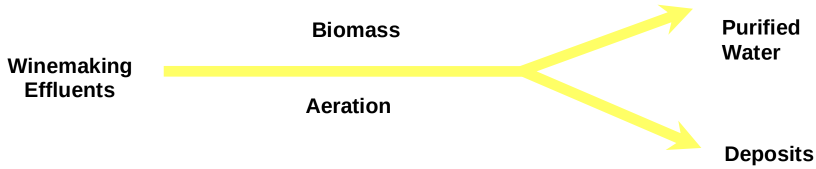

Figure 15. Principle of aerobic purification
Source ITV France

5.2. Microbiological aspects

Since Pasteur, enology has progressively integrated microbiological knowledge in order to understand the stages of vinification and to improve the elaboration of wines.

The utilization of selected yeast strains in the form of active dried yeasts and more recently the control of malolactic fermentation by inoculation, are some of the current practices of modern enology.

Beyond the elaboration of wines, environmental constraints justify the study of microbiological aspects in a new area for wineries: the treatment of winemaking effluents, a theme that is increasingly integrated in the syllabus for formal winemaking qualifications and in the practice of winemakers.

As with a vinification process, the purification of winery effluents involves a veritable biological factory in which microorganisms perform metabolic transformations that lead by anabolism and catabolism to the deterioration of complex organic compounds (60).

The natural deterioration of organic matter in watercourses has been known for a very long time. However, this progressive auto-purification wasn't sufficient when faced with the increase of wastes discharged at the time of the development of urban agglomerations and industrialization. So, the biological treatment of urban waste waters and then of industrial effluents developed progressively after the Second World War.

In the agro-food sector, after the sectors of activity reputed to be very pollutant (sugar refineries, distilleries), wineries have been increasingly concerned with the treatment of their effluents, under the influence notably of regulatory and financial pressures.

Leaving on one side the basic techniques of spreading or evaporation, the treatment of winemaking effluents is most often achieved by biological aerobic methods.

521. Organic matter conversion

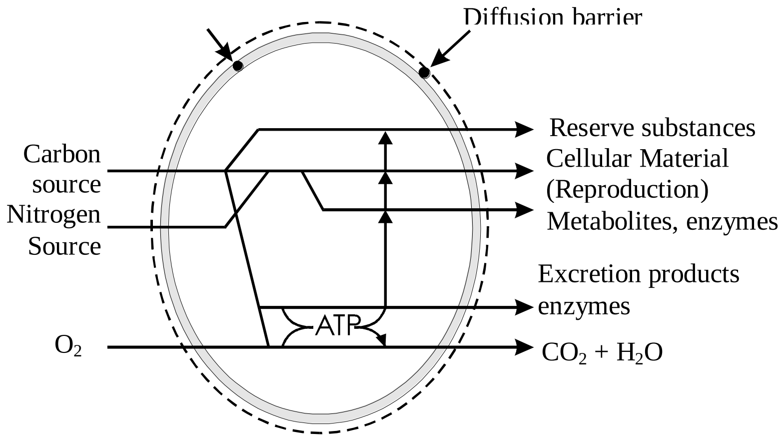

Figure 16. Representation of cellular metabolism (57) according to LEVEAU and BOUIX (1993)

The conversion of organic matter to biomass occurs according to the following process:

- the fine particles and the large molecules are fixed extracellularly on the biomass of the purification system. The compounds resulting from hydrolysis by extracellular enzymes, as well as compounds of low molecular weight, can then penetrate the cells of microorganisms;
- once in the cell, the organic compounds are transformed into intracellular reserves, into new cellular material, or are further oxidized, thus providing energy for the cell.

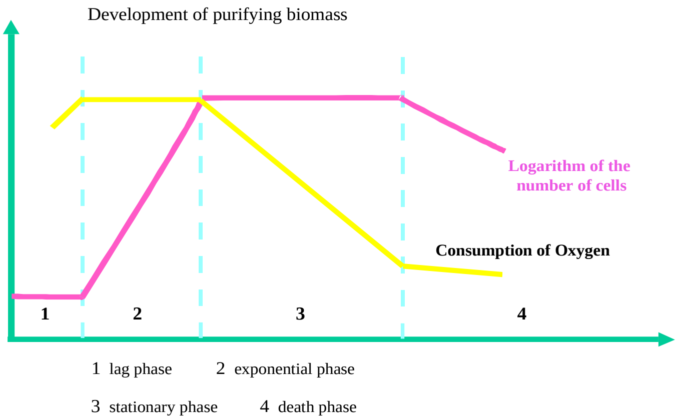

Figure 17. Development of purifying biomass according to SCHLEGEL (1976)

This process leads to the development of biomass and thereafter to the formation of sludges composed of biomass and of non-hydrolyzed organic matter.

According to the point reached in the process, a more or less significant part of the microorganisms autolyse, thus providing the medium with a new biodegradable substrate. The organic matter is thus recycled by successive death and regeneration, with a simultaneous elimination of CO_2 and H_2O.

This complex microbiological process that occurs especially during extensive treatments, enables at one and the same time a reduction in the quantity of deposits to be eliminated, an improvement in the facility of the decanting process, and a biological stabilization of the sludges, thus limiting olfactory nuisances. From a practical point of view, the net biomass produced is generally in the range of 0.3 to 0.45 kg of dry matter per kg of COD eliminated, which represents a volume of the order of 3 to 5% when the deposits are separated by decanting.

522. Characteristics of the biomass

This is most often composed of a complex population associating prokaryotes and eukaryotes for which bacteria constitute the purifying basis.

The nature of the organic compounds to be degraded and the conditions of the medium will encourage the development of a biomass specific to a given moment in the treatment. The characteristics of the biomass are conditional upon the evolution of the medium. A succession of species can be noted.

From studies performed on batch systems (aerated storage) on effluents from pressing, a purification cycle can be broken down schematically into four phases according to the evolution of the purifying biomass and the evolution of the physico-chemical characteristics of the effluent being treated.

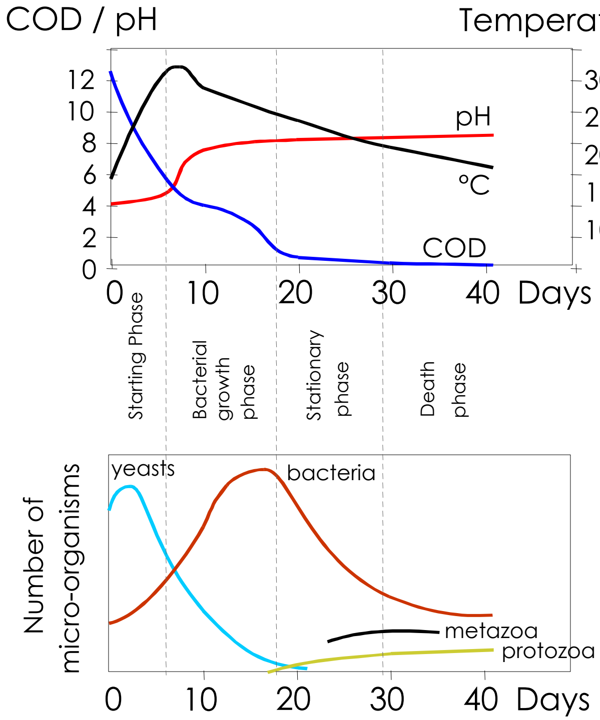

Figure 18. Schematic evolution of the characteristics of effluents treated by aerated storage and of the purifying biomass (60) according to J. ROCHARD, M.N. VIAUD, F. DESAUTELS, D. PLUCHART,

Starting Phase
This phase is characterized by a preponderance of yeasts partly because of the effect of inoculation of musts and favorable growth conditions (pH, sugars, nutritive factors).

Yeast development leads to a rapid lowering of COD with a consequent high demand for oxygen and a significant temperature elevation.

At this stage, the separation of the biomass by decanting is difficult.

Bacterial Growth Phase
The activity of yeasts decreases progressively as that of bacteria increases. This appreciable evolution is linked to the increase of the pH on the one hand (organic acid oxidation) and to the elevation of temperature during the starting phase on the other hand.

At this stage of the purification, the biomass develops in a free form in the liquid and due to this fact decanting is very difficult.

Stationary Phase
This phase corresponds to a stabilization or even a reduction of the bacterial population and to the formation of the first flocs notably because of the exhaustion of easily biodegradable substrate in the medium and the decrease of temperature linked to the decrease in biological activity.

The appearance of protozoa generally capable of feeding on bacteria corresponds to the succession of species classically encountered in the purification of domestic sewage. However, there is a predominance of paramecium that is characteristic of media deficient in nitrogen, which is the case for winemaking effluents.

At this stage, the sedimentation of deposits becomes easier.
The COD level reached at the end of this phase generally makes discharge into the sewage network feasible, but the level of

purification is generally insufficient when the outlet is a natural habitat (ditch, river).

Death Phase

The bacterial population continues to decrease because of the low level of biodegradable carbon substrates and because of consumption by higher species. At this stage, bacteria are mainly in the form of easily separable flocs.

The evolution of higher species is characterized at the level of protozoa by a proliferation of paramecium and the more occasional appearance of vorticella, of amoebas,.... One then observes, in certain cases, the presence of metazoans: rotifers, nematodes.

This stage also corresponds to a progressive deterioration of the fraction classically named “hard COD”. Notwithstanding that little research has been conducted on this fraction of winery effluents, one can suppose that it corresponds to high molecular weight compounds for which complex hydrolysis phases are necessary before their microbial assimilation.

This phase finishes the treatment of effluents, which can then generally be discharged to the natural habitat after simple decanting.

It is also at the end of this phase that microphytes appear in open tanks. Their development and the contribution of pure oxygen that they produce often enable the point of saturation to be exceeded and probably accelerate the degradation process of the hard COD. On the other hand, they cause the inconvenience of an increase in the concentration of suspended material to discharge.

523. Influence of physico-chemical factors

The main findings of studies conducted in the context of micro-purification in 100 liter batches are summarized below:

- A supplementation of effluents in nitrogen and phosphorus has a significant effect;
- Neutralization gives a positive effect but to a lesser extent;

- The combination of neutralization and the addition of nitrogen and phosphorus doesn't achieve an additional improvement compared with supplementation in nitrogen and phosphorus alone;
- The heating of effluents to a temperature of 35°C accelerates process of purification significantly.

In the context of technological applications, the optimization of conditions in the medium is especially effective for intensive systems. This optimization focuses notably on the following aspects: regulation of the pH to 7, addition of nutritive factors on the basis of a BOD5/N/P ratio of 100/5/1 and possibly, partial control of temperature by insulation or underground installation of the reactor.

524. Inoculation with selected microorganisms

Beyond purifying performances, inoculation with microorganisms could be researched in order to obtain an active biomass from the beginning of the peak of pollution linked to vintages (biological starter effect). In most wineries, it is difficult to maintain a good viability of the biomass because of the lack of carbon substrate during the period that precedes vintages. In this context, some interesting results have been obtained with activated sludges from a purification station.

This study also incorporated tests on commercial strains. However, the results were not significantly different from the control.

An original principle based on the concept of a first stage of treatment where the inoculation is performed with yeasts (85) and a second stage with activated sludges functioning under prolonged aeration is currently developed industrially (40). The purifying performance of yeasts associated with a significant level of oxygenation, enables the achievement of an increased output of purification for a very short residence time (3 to 4 days). The effect of yeast-bacteria competition justifies the regulation of the pH to 4 in the first reactor.

This particularly compact process can integrate easily in urban site. This increase in intensification requires a very specialized monitoring technique. Furthermore, the separation of yeasts, which is difficult by decanting, justifies the use of a horizontal separating centrifuge. Moreover, in order to avoid the dissemination of yeasts in wineries, a system for sterilizing the air in contact with the effluent, as well as a treatment of the sludges with lime has been put in place.

525. Devices with immobilized microorganisms

Classically, the purifying biomass is established in free culture. This technique is limited by the acceptable concentration of microorganisms in the tanks, leading to large working volumes. In order to alleviate this inconvenience, immobilized culture processes have been developed. They are based on the propensity of bacteria to produce exopolymers (as in the winemaking fault, "graisse") permitting their fixation to a support in the form of a film.

Many supports differing in their surface-area-to-volume ratio (m^2/m^3), their shape and the type of material used, have either already been tested or are in the process of development.

5.3. Reed beds

Tests conducted in Germany, the United States and France examined the utilization of a lagoon in which reeds are planted. The principle of this process rests on the symbiosis between reeds and microorganisms. Effluents pass through a basin containing aquatic plants, whose rhizomes are populated with microorganisms that degrade the organic matter in effluents. It seems that the treatment should be compatible with loads of 1600 kg of COD/ha/day and with no olfactory nuisance problems (53, 70). These results, obtained with limited volumes, must be validated on site, however.

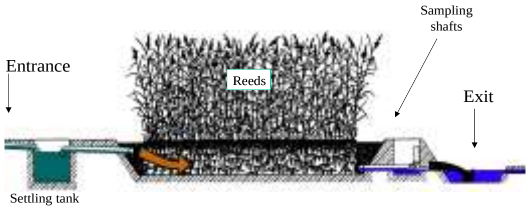

Figure 19. Diagram of a reed bed
Source - *D.H. MÜLLER*

5.4. Lagoon treatment

541. Natural lagoons

Natural aeration is the simplest method of purification both in its principle and in its practice. It merely involves storing effluent, after sieving, in a waterproof basin, aeration being assured only by natural transfer of oxygen. In these conditions, the aeration is often insufficient: the time for organic matter degradation is fairly long and unpleasant odors develop due to the reducing medium that exists. In addition, the surface area needed is considerable. Nevertheless, by reason of its simplicity of operation, this technique will continue to be used in zones distant from dwellings and with no supply of electricity.

542. Aerated Lagoons

In order to overcome the problems of odors and to accelerate the process of purification, one or more surface aerators (34) may be added to the aeration basin where effluent has been stored. The time for purification is then of the order of forty to one hundred days, followed by decanting into a second basin. The exploitation of this installation type requires little manual labor but needs regular inspection of the aerators and regular cleaning of the aeration basin as well as elimination of sludge from the decanting basin. The investment is relatively small but the running costs are higher.

In California, results from this technique are improved by the use of several aeration basins as well as a basin for storage of purified effluent, whose water is then used to irrigate the neighboring plants under cultivation (6).

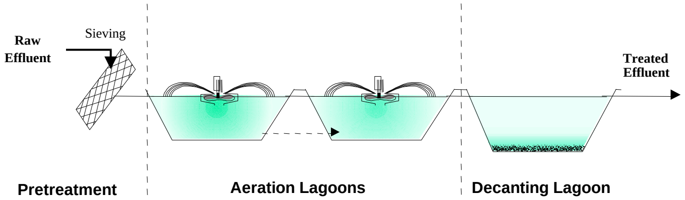

Figure 20. Diagram of the principle of aerated lagoon treatment
Source - ITV France

5.5 Aerated storage

This is a batch technique of extensive aerobic purification. The following operations are performed in a single container:

- storage, after sieving, of the whole of the effluents from the harvest,
- sequential aeration and mixing
- decanting of sludge formed

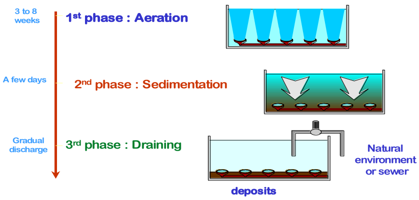

Figure 21. Diagram of the principle of aerated storage
Source ITV France – CIVC

The time necessary for treatment varies according to objectives fixed for discharges (72), depending on whether the discharge is to a purification system (about 15 days) or to the environment (30 to 40 days), on the type of installation (one or several storage vats) and on the activity of the winery (winemaking effluents). This procedure is well adapted to the seasonal variations of wineries.

Several types of vat are currently in service. Most often it comprises a buried concrete tank, which negates the risk of frost and also accelerates the treatment by allowing a fairly high temperature to be reached. Since winery effluents are acidic, the concrete must undergo a specific treatment in order to avoid deterioration. In the same way, metallic vats must be coated with an appropriate material. The ventilation and the mixing are often assured by one or several immersed pumps fitted with a Venturi effect water outlet. In the case of open basins, surface aerators or external Venturi devices are generally used (86). This configuration limits the cost of storage but may pose problems of aesthetic integration and of noise and olfactory nuisances. The procedure is well adapted to the seasonal variations in wineries.

Monitoring is limited to periodic measurement of the COD and pH, enabling the kinetics of the purification process to be established. A more complete analysis must generally be performed before the draining phase.

A system used in the context of a European project included a second treatment stage on a bed of sand, which enabled efficiency greater than 98% to be obtained (76).

5.6. S.B.R. (Sequenced Batch Reactor)

The S.B.R process is based on the cyclical operation of an aerobic reactor, that is to say in a discontinuous, sequential fashion. Effluents are stored, after sieving, in one or several vats equipped with a pump permitting transfer to the reactor. Every day, a quantity of effluent generally varying from 10 to 30% of the volume of the tank is aerated until the pollution is reduced to the desired level. The aeration is then stopped in order to allow the sludge formed in the reactor to settle. A part of the supernatant (purified and decanted effluent) is then removed, replaced by raw effluent and a new cycle begins. When the proportion of deposits becomes too great, some of them are removed.

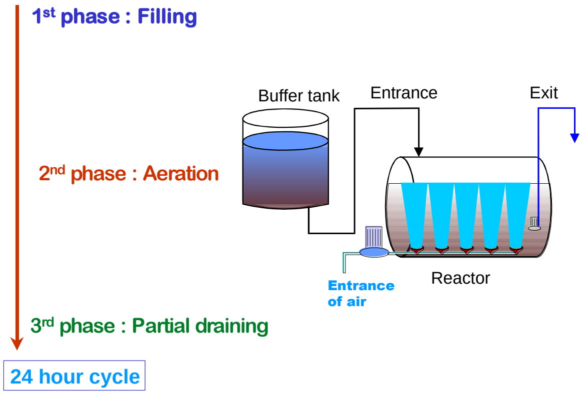

Figure 22. Diagram of the principle of SBR
source ITV France

This method of operation enables a large and active biomass to be maintained thus ensuring good purification efficiencies. The difficulty is linked to the management of the purification cycles (food, residence time, settling) especially when the effluents show great variability in their composition (35) which justifies the use of a storage buffer at the beginning so as to minimize the fluctuations.

5.7. Activated sludge

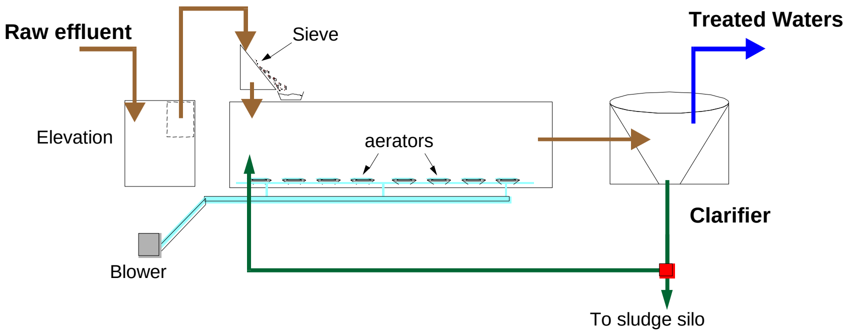

Figure 23. Principle of treatment with activated sludges
source ITV France

This process, much used for urban purification, involves a continuous treatment with separation of the phases of aeration and of decanting. After sieving, effluents are treated with a controlled bacterial culture, in a fermentation vessel, with controlled oxygen concentration; then, in a clarifier, the purified effluents are separated from the sludge, part of which is recirculated to the aerated tank. Excess sludge is extracted and treated with a view to spreading. Often, purification occurs in only one vessel (low pollutant load), possibly preceded by another vessel (heavy pollutant load) for the peak period (75). The utilization of the heavy load process with low load effluent entails a significant oversizing of the installation but can be put into operation when one or several existing vats in the winery can be used as aeration and decanting vessels. In the case of the heavy load process, the supplementary aeration basin is only used during the peak period and enables the load of the effluent to be lowered considerably before it is sent to the low-load vessel (38). It is also possible to use a bacterial bed system as a preliminary heavy-load treatment prior to the low load vessel (39). Another variant consists in splitting the aeration phase up into several tanks with resulting concentration gradients of COD associated with a specialized biomass in each of the reactors (73).

A very intensive, continuous system has been developed industrially. It comprises a first stage using yeast and a second bacterial stage with activated sludges functioning under prolonged aeration (55). The purifying performance of yeasts, associated with a significant level of oxygenation, enables the achievement of an increased output of purification for a very short residence time (3 to 4 days). The effect of yeast-bacteria competition justifies the regulation of the pH to 4 in the first reactor.

This technique requires qualified labor to ensure the regulation of the biological processes. This simple technique is frequently used, generally in wineries of large capacity.

5.8. Bacterial bed

The principle consists in running the effluent over a material of large surface area (provided by plastic granules serving as a support to microorganisms that form a film). This surface has many pores, which permit natural oxygenation. Effluents first undergo a fine sieving so as not to clog the spray system and then they are neutralized with lime, and nitrogen and phosphorus are added in a buffer vessel. They are then applied to the surface of the bacterial bed using a rotary spraying system. The excess biomass detaches itself from the support and passes into a clarifier, entrained by effluents. A specific residual sludge treatment must be provided for.

The advantage of this process is the destruction of a significant fraction of the organic load with a low energy expense. It constitutes an interesting pretreatment system for wineries that are able to discharge their wastewaters in an urban network. However, this technique requires a fairly long start-up period (15 to 30 days), which is not well adapted to the seasonal variations that characterize winery effluents. In addition, the installation requires good technical knowledge on the part of the user (regulation of the pH, nutrient addition, start-up)(7).

5.9. Biological disks

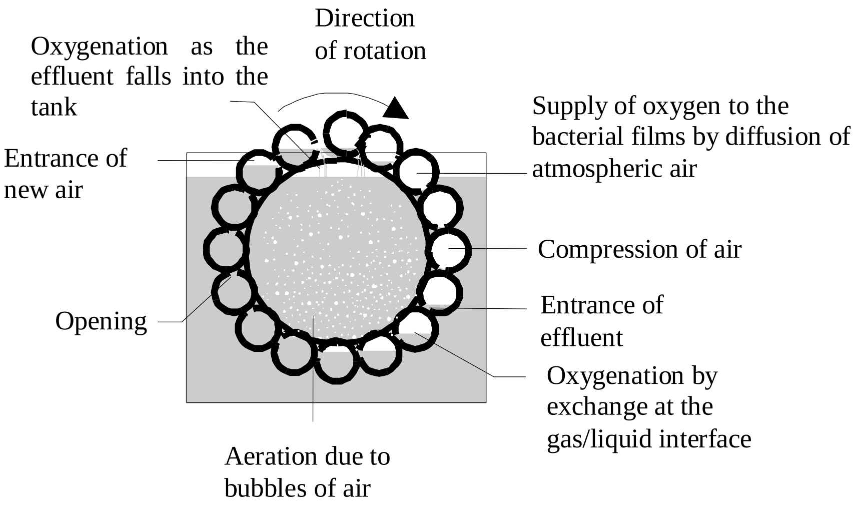

Figure 24. Diagram of the principle of biological disks
Source D.H. MÜLLER

The principle consists in the axial rotation of a cylinder furnished with hollow tubes whose partitions serve to support purifying microorganisms that form a film. The cylinder is immersed to about ¾ of its diameter in a reactor containing the effluent as well as activated sludge. This technique combines the processes of activated sludge and bacterial bed in a single reactor. The oxygenation of the medium is assured by the rotation of the cylinder. After passage through the reactor, effluents are separated from the sludge in a clarifier. A part of this sludge recirculates to the reactor; the remainder must be made the object of a specific treatment. The efficiency of this system is of the order of 80 to 95%, based on reduction of COD (41, 43).

5.10. Treatment associated with urban effluents

This consists in connecting winemaking operations with the urban purification system, whose purification station must be reasonably oversized with regard to the normal urban population. In the harvest period, the effluents are stored in watertight basins of large capacity, upstream of the station, in order to not to overload the aeration vessel, the tolerance of the bacterial flora being relatively limited with respect to a peak period. At the same time, pumps are put into service and nourish the aeration vessel to its maximal capacity of treatment, the daily output being determined by measures of COD and BOD5. Once harvest is finished, the stored effluents are pumped progressively to the station, during a period of 6 to 10 months. Outside periods of winemaking activity, the domestic effluents are sent directly toward the station (39, 71).

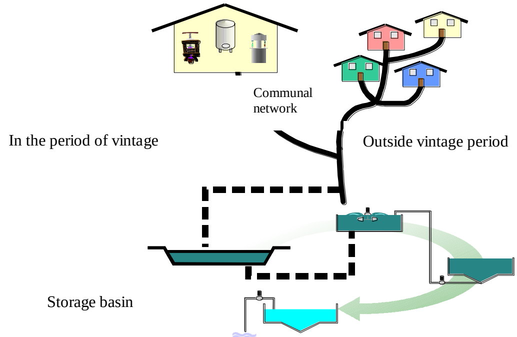

Figure 25. Aerobic treatment procedures : mixed collective treatment
Source - Leovin, European Leonardo da vinci Program

This type of treatment requires an important investment on behalf of the collective. At the administrative level, it is necessary to prepare an agreement between the collective and the winemaking centers, that fixes modes of connecting to the purification system and of participation in the expenses of capital investment and running costs. The interesting aspect of this technique is to control problems of purification of all centers of pressing and vinification a village at a time, while guaranteeing the quality of the purification.

In parallel with the effluents, it is possible to use the solid matter coming from the clarification of musts to eliminate the nitrogen in urban effluent (86).

6) OTHER TECHNIQUES

6.1. Biological Anaerobiosis

611. Principle

This anaerobic, biological treatment of effluents, also called anaerobic fermentation or methanization, is based on the transformation of organic matter to methane and carbon dioxide by microorganisms functioning in the absence of oxygen.

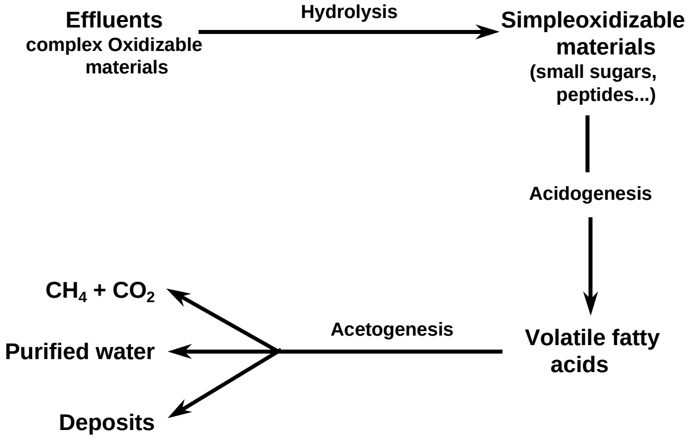

Figure 26 Principle of degradation by anaerobic digestion
Source ITV France

612. Methanization vessel

This is the simplest system and consists of a deep vessel of large volume, covered by a floating cover. The biomass is located mainly at the bottom of the vessel, so the residence time is fairly long and the COD reductions rather low (44%). It is feasible to increase the output by adding a sequential agitator to the reactor, or by inserting a non-clog coating in order to serve as a support for microorganisms. This type of treatment doesn't allow discharge to the environment but its simplicity of implementation and the low volume of sludge produced make it a process well adapted to wineries of more than 10 000 hl (44).

613. UASB process

The UASB process (Upflow Anaerobic Sludge Blanket, ascending flow on a bed of sludge) is described very little in the literature. It comprises an anaerobic reactor containing granular sludge. The COD reduction obtained is around 75 to 95%, and the activity of the sludge is little dependent on the load in the reactor. It seems it can even tolerate a total stop without significant loss of activity or structure, the recovery of activity also being rapid. This system presents several advantages: speed of treatment, low energy consumption, possible value recovery from the methane, low production of sludge, low impact on the soil, but the operation requires qualified manual labor (45).

614. Immobilized biomass filter

The aptitude of microorganisms to adhere to supports (organic, plastic or mineral) enables a significant improvement in the kinetics of degradation, and thus a reduction of the volume of fermenters. With supports in plastic (PVC) or lignocellulose (wood chips, stems), purification efficiencies are around 80 to 98% based on COD. This type of reactor gives the same advantages as the UASB process, and its operation also requires qualified manual labor.

6.2. Physico-chemical treatment techniques

These processes, for which the principle is similar to that of fining in wines, use flocculating products and coagulants to improve the elimination of suspended material in the form of flocs. The separation phase can be performed by centrifugation, filtration or flotation. The visual effect is often spectacular but efficiency based on COD is often fairly low (less than 30%). These techniques are also used as a complement to a biologic aerobic process in order to facilitate the separation of deposits.

6.3. Physical Procedures

631. Membrane techniques

The purification properties of membranes are linked to their selectivity. Tangential microfiltration, in which the pore size is generally between 0.1 and 0.2µm, assures the elimination of microorganisms and some of the macromolecules (82). But purification efficiencies expressed as COD are fairly low (10 to 30%). This technique is also being tested for separation of deposits after a biological aerobic treatment (biomembrane). The industrial applications seem to be in the agro-food sector; in contrast few large scale experiments have been conducted in the winemaking sector so far. It is the same for the membrane techniques of nanofiltration and reverse osmosis.

632. Evapo-concentration to fractional condensation (ECCF)

The process rests on the fact that more than 90% of the COD of winemaking effluents is due to the ethanol and the sugars present in these wastewaters. This process uses a fractional distillation (separation of the ethanol and the secondary products) and a concentration by evaporation (69).

After sieving, winemaking effluents are stored in tanks where alcoholic fermentation of the sugars present in the vintage period wash waters occurs. The alcoholized effluents are rectified on a column in order to separate and to concentrate the ethanol, that will undergo value recovery in a distillery. Dealcoholized effluent, collected as it leaves the column, is concentrated by evaporation.

This operation leads to the production of purified water (distillate) which can be recycled or discharged into the natural habitat and to a concentrate, rich in regenerable tartaric acid. The interest of this technique resides in the value recovery from the products contained in the effluents.

If the system appears attractive in principle, its applicability for wineries won't be able to be established until after industrial validation associated with an economic appraisal linked to the investment and the running costs.

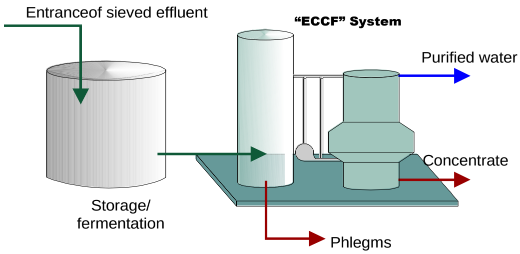

Figure 27. Device for evaporation and fractionated condensation

Source: INRA, Pech Rouge

7) DISTILLERY EFFLUENTS

7.1. Introduction

The production of alcohol entails the generation of significant quantities of organic matter-laden wastes.

Distilleries have often been integrated into the environmental legislation of the different wine producing countries ahead of wineries.

The spreading of still slops is often practiced on grapevines (3,46). This technique, which demands rigorous management, has the advantage of reconciling the obligations of purification with the agronomic respects of the vineyard.

Other techniques of purification (30,37) can be established:
Biological treatment:

- by aerated storage;
- by treatment in aerated lagoons;
- by bacterial bed;
- in batch processes with sequential aeration;
- by activated sludges;
- by methanization.

In certain cases, the purification of slops is conducted in collective centers, by methanization.

7.2. Distillery Wastes

721. Continuous distillery

The production of alcohol of viticultural origin can take place in continuous systems; slops leave at the feet of the columns and contain all the compounds present in wine except the ethyl alcohol and aromas. Generally the water flows and the organic loads are high and the exit temperature of the column is of the order of 100 to 105 °C.

Distillation of wine lees is an even more significant process from the point of view of the environmental protection. Here, it is necessary to take account of the dissolved pollution and also of the pollution contained in suspended solids.

722. “Charentais” Distilleries

At the time of the charentais process of double distillation, different types of slops are produced from each of the distillations:

- The wine slops are the residue of the first distillation in the charentais still. They represent 2/3 of the volume of the wine used and on average their pollutant load is 30 g/l of COD.
- Slops from the second heating stage (French: “vinasseses de bonne chauffe”) represent 2/3 of the volume of distillate used from the first stage. Their pollutant load is exclusively soluble and is in the range of 2 to 4 g/l of COD.

7.3. Techniques for treatment of distillery effluents

Distillery wastes contain high loads of pollutants

<table>
<tr><th colspan="2"></th><th>COD</th><th>BOD5</th><th>SM</th></tr>
<tr><td colspan="2">“Charentais” slops</td><td>30 g/l</td><td>20 g/l</td><td>1 to 3</td></tr>
<tr><td rowspan="2">“Column” Slops</td><td>Lees</td><td>50 to 60 g/l</td><td>30 to 40 g/l</td><td>20 to 50 g/l</td></tr>
<tr><td>Wine</td><td>20 g/1</td><td>15 g/l</td><td>1 to 2 g/ls</td></tr>
</table>

There is a very large selection of techniques for effluent purification:

- spreading on agricultural lands;
- anaerobic treatment (methanization);
- aerobic treatment (treatment in a lagoon and aerated storage);
- concentration coupled with aerobic treatment of condensate;
- membrane techniques;
- aero-flotation.

The last two techniques are less frequently used.

731. Spreading on agricultural lands

This technique is much used by home distillers. Some professional distillers as well as state alcohol distilleries also use it to treat their effluents.

732. Anaerobic treatment (Methanization)

This process enables an energy-producing value recovery from wastes, thanks to the association of two groups of bacteria (acid-producing and methane-producing), that transforms the organic matter into biogas (methane and carbon dioxide).

Two types of methanization can be used for the treatment of more or less concentrated slops:

- very concentrated lees slops can be made the object of an “infinitely mixed” methanization characterized by an applied load of the order of 3 to 4 kg of COD/m^3/day and a production of biogas of about 1 to 2 m^3/m^3 reactor/day;

- less concentrated slops of marcs and wines can be treated by a new generation of fermenters (called “fluidised bed” or “fixed bed”) with a much higher applied load than in the previous case; of the order of 10 to 15 kg of COD/m^3/day, for a production of biogas of 6 m^3/m^3 reactor/day.

When these systems are working well, the efficiency of this process can reach 90% based on the raw COD to be treated.

The production of deposits from this type of process (less than 0.5 kg of SM per kg of COD eliminated) is lower than in the case of an aerobic procedure.

Downstream of these two successive stages, the sewage must undergo a complementary treatment before discharge to the natural habitat (aerated lagoon, biological treatment).

Efficiencies can reach very high levels in these conditions (99.5 for DOB5 and 99% for COD).

Deposits recovered after decanting can have value recovered through agricultural use. The cost of treatment by a purification center is around 3 Fr. (0.46 euro) per hectoliter of slops, or 25 to 30 Fr (3.81 to 4.57 euro) per hectoliter of pure alcohol.

733. Aerobic Treatment

This type of procedure has not been developed in the Adour-Garonne basin.

Aerated lagoon treatment: This technique consists in biological treatment of slightly concentrated effluent with a small artificial supply of oxygen in basins of simplified civil engineering (of the order of 10 to 15 watts/m^3). It is differentiated from activated sludges by the absence of sludge recirculation, a concentration of these sludges in non-controlled basins and a relatively long residence time (of the order of 2 months).

Precautions need to be taken in choosing the site of the basin, its capacity and watertightness.

Aerated storage: This functions by alternation of 2 phases:

- an aeration phase that corresponds to the treatment of the effluent (3 to 6 weeks);
- a decanting phase of some hours to some days at the end of cycle.

It requires a storage capacity equal to the totality of effluents produced during the production season.

734. Concentration with aerobic treatment

This technique is often established in large distillation units.
Its principle rests on the use of a falling film evaporator that enables

- recycling of the steam on the distillation columns;
- recycling of the preconcentrated slops on marc diffusion equipment.

The condensates produced must undergo a complementary aerobic treatment before their discharge to the natural habitat.

The preconcentration enables a reduction by 40% of the pollution created by distillation activities.

The running costs of this type of installation rises on average to 20 Fr. (3.05 euro) per hl of alcohol produced.

ANNEX 1

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ANNEX 2

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