Importance of Cleaning and Sanitation in the Winery*

By Murli Dharmadhikari

Cleaning and sanitation is crucial to producing quality wine. Over the past couple of years several new wineries have been started in the state. It is important that the wineries have a good understanding of cellar hygiene. Beginning in this publication we will be offering information on this subject in a series of articles. The first article deals with the significance of cleaning and sanitation.

Why Winery sanitation?

Legal
Wine is a beverage produced primarily from grapes and other fruits .Being a food product, the wine producer has a legal obligation to produce wine that is pure, wholesome and free from adulteration and contamination. Although wine is considered to be a most hygienic beverage, it can pose a serious health risk when contaminated. As a food/ beverage processing plant a winery has to comply with the regulations issued by several federal, state and local agencies in order to produce and market its product. Important federal agencies include Food and drug administration (FDA), Bureau of tax and trade (TTB) previously known as Bureau of Alcohol Tobacco and Fire arms and the Environmental protection agency (EPA).

Product quality
Protecting the integrity and the quality of the product is another reason why winery sanitation is important. Wine is a very flavorful beverage. It is like a symphony of aromas and flavors blended in harmony. Its delicate flavors can easily be lost resulting in poor quality, if sufficient attention is not paid to proper cleaning and sanitation during the course of its production. Maintaining good quality is paramount to earning and retaining consumer confidence. Simply put good cellar hygiene is a good business.

Wine tourism
More and more wineries are becoming tourist destinations. The wine consumers visit wineries in order to learn and experience the wine making process.
This seems to enhance their wine knowledge and thus wine appreciation and wine enjoyment. In Missouri and this is true of many neighboring states, the majority of wine is sold directly to consumers at the winery. This means a visitor's experience to winery is directly related to potential sales. Aseptically pleasing winery surroundings (inside and outside) contribute to a pleasant touring experience and possibly more wine sales.

Good business practice
Maintaining a clean and sanitary winery operation is a good business practice. A clean working environment is good for worker's morale; increases plant efficiency, protection and longevity of equipment, avoidance of off flavors, and consumer confidence. It portrays a good image of the entire business.

Regulatory agencies
Food safety is an important public health issue. Several government agencies are involved in ensuring the safety of production, processing, distribution and sale of food products.

Bureau of Alcohol, Tobacco Tax and Trade (TTB)
The bureau of tax and trade is the main federal agency that regulates wine industry. It regulates virtually all aspects of wine business such as production, labeling, sales, and distribution. From the point of sanitation and adulteration it's authorization of certain material in wine processing is important. Check the list of materials that are authorized for the treatment of wine. Some of the compounds allowed must be removed, or else it will constitute adulteration.

Federal Food and Drug Administration (FDA)
A winery is a food processing facility and therefore, can be subject to several FDA regulations; particularly those dealing with good manufacturing practices. These GMP regulations deal with sanitation issues in manufacturing, processing, packaging, and holding of food. Besides wine, some wineries produce grape related food products which may come under FDA's jurisdiction. Most recent FDA regulation requires all wineries to register with FDA. These regulations were issued in response to September 11th, terrorist incidence.

Environmental Protection Agency (EPA) Regulations
Many EPA regulations influence winery operation. Four major regulations include: federal water pollution control act, clean air act, federal insecticide, fungicide and rodenticide act and resource conservation and recovery act that deals with solid waste disposal issues.

Occupational Safety (OSHA)
OSHA deals mainly with the issue of worker's safety. In cleaning operation a worker can be exposed to hazardous situation. Workers have to use hazardous chemicals, be exposed to toxic gases such as sulfur dioxide, carbon dioxide (when high) and may be ozone, and may need to work in confined places such as a large tank. Because of the risk to worker's health OSHA regulation have a bearing on winery sanitation program.
In addition to federal agencies wineries are also subjected to various state and local regulation that deal with food plant sanitation. In order to comply with them a winery needs to be aware of them.

Management's Role and Responsibility
Management is legally responsible for operating a winery in a sanitary manner according to the provisions of FDA.TTB EPA and other state and local Agencies. Additionally implementing sound sanitation program can improve wine quality, wine sales, and can also be used as promotional tool. It is, therefore, important for the management to give its full support and commitment towards the institution and operation of a sound cellar sanitation program. The management needs to have a clear statement regarding winery sanitation policy. It should appoint a person in charge of winery sanitation who is well qualified, trained and can be held accountable for the winery's sanitation program. The sanitarian must be able to report to the top management. The management should require periodic (daily or weekly) sanitation report and give the sanitarian the proper authority, the needed tools and other support to implement an acceptable winery sanitation plan.
In a large winery the sanitarian would need a staff to carry out various duties. But in a smaller operation it may not be practical. In such a case this responsibility should be delegated to other key employee, in some cases it could be the owner.
During the grape harvest and processing, the work load significantly increases. It is the busiest time of the year. It is important that new and the existing workers be made aware of the sanitation protocol that must be followed during the critical time of crush.
Winery sanitation is some times viewed as a low skill mundane chore. The management may think of it as a cost to business and with little or no immediate benefits. This type of attitude undermines the importance of sanitation and is not good for the successful operation of a wine business.

Qualifications of Winery sanitation
Ideally the winery sanitarian should have the following qualification:

1. Should have a basic understanding of wine making process.
2. Should have some (formal) education and training in Food/Fruit processing plant sanitation. The knowledge could be acquired through an academic degree or various workshops and short courses.
3. Ability to detect existing and potential unsanitary conditions in the winery and have the necessary knowledge to correct the problem.
4. Ability to develop an applicable winery sanitation program. He/She should communicate with fellow employees about the significance of sanitation plan and encourage them to participate in the success of winery sanitation program.
5. A basic knowledge of federal, state and local laws and regulations relating to the winery operation should understand the inspection process and be knowledgeable about implementing the recommendations following inspection.
6. Should possess a good aesthetic sense of environmental sanitation values as related to winery operation.

Duties of winery sanitarian
The management should develop a job description and determine the duties of a winery sanitarian. The duties of a sanitarian may include the following:

1. Conduct thorough inspections of the winery premises on a daily/weekly basis, more often during the harvest and crush season, using a sanitation check list. Problem areas/
equipment/situation should be checked more frequently.
2. Submit the checklist to management with recommendations and follow up with the management to ensure that the problem issues have been addressed.
3. To confer with key winery personnel and solicit their suggestion on improving sanitation.

4. Give suggestions from sanitation viewpoint to the management when purchasing and installing equipment and building or remodeling the winery facilities.
5. In a lager winery the sanitarian would need to supervise the staff and conduct organized training for all winery personnel.

Tools for the sanitarian

The Winery sanitarian will need various tools depending on several factors such as winery size and location, kinds of equipment, types of products and the extent of automation. However, for most of the wineries following items are needed:

Ample supply of hot and cold water
Various detergents, sanitizers and other chemicals
Steam and /or high pressure washers fitted with proper nozzles.
Vacuum cleaners
Various kinds of nylon brushes, brooms, squeeze
Flash light
Black light equipment for detection of rodents and molds
Safety goggles, gas mask, rubber gloves etc.
CIP system for large tanks and equipment.

Worker's Training

It is the management's responsibility to make sure that winery workers are well trained in conducting winery operations under clean and most hygienic conditions. Winery employees, particularly those involved with the processing of grapes and handling of wines should be in good health and should have a greater sense of personal hygiene than the average population.

Workers in charge of cleaning and sanitation should be knowledgeable and trained in handling cleaning and sanitizing compounds, should be proficient in using various cleaning equipments, have a good understanding of sources of contamination, and have expertise in cleaning various types of surfaces such as concrete, metal, plastic, stainless steel and wood. They should be aware of the sanitation plans dealing with pest control and liquid and solid waste disposal.

In winery many temporary workers are hired during crush. It is necessary to train these new workers in clean and sanitary ways of handling grapes and wine. It is a good business practice for a winery to have a formal training program for its workers in winery cleaning and sanitation.

This would lead to a superior product and an efficient operation.

Some Basic Definitions

Soil: Soil is matter out of place.

Cleaning: Removal of soil from the surface.

Sanitizing: Treatment of a cleaned surface to reduce the population of spoilage causing organisms to a safe level. This means reducing the number of vegetative cells to an acceptable level.

Disinfecting: Destruction of all the cells in the vegetative state.

Sterilization: Complete destruction of all the cells, including all vegetative cells as well as all the spores.

How do Cleaners Work?

1. In the first step the detergent establishes a close contact with the soil. For this action it is necessary for the cleaner to contain a wetting agent.

2. The next step is the displacement of the soil from the surface. This can be achieved by actions such as dissolving sugars, saponification or emulsification of fats, peptizing protenaceous soil and solubilizing minerals.

3. The third step involves holding displaced soil in solution or suspension. This means that the detergent should have good deflocculating property.

4. Final step is rinsing. The soil as well as the detergent residue, all should be easily and completely removed with the application of potable water.

Thorough cleaning must precede sanitization. A soil deposit can serve as source of nutrient to the unwanted microbes and also shield them from the action of sanitizing agents. Therefore effective cleaning is the first step in cleaning and sanitization.
Cleaning compounds used in the food industry are complex formulations. Generally, detergents are blends of several chemicals. Chemicals in the blend possess certain specific properties and they are added to detergent formulation to perform a particular function. No one detergent is suited for all kinds of cleaning applications. Therefore, it is important to select the appropriate cleaner based on the type of soil to be removed, the surface to be cleaned and the method of application.
A good understanding of the chemicals in detergent mixtures and their properties is essential to choosing the right cleaner.

There are several terms used to describe the properties (and the mode of action) of a detergent. A sanitarian should be familiar with these terms. A brief description of the commonly used terms follows.

Properties of Detergent

1. Water conditioning-
This is also called water softening. Hard water contains calcium and magnesium which with heat or under alkaline condition precipitate and leads to scale formation. Water softening agents inactivate or remove the minerals. Orthophosphates such as tri-sodium phosphate soften water by precipitating hardness. The polyphosphates soften water by
sequestering the minerals. Chelating agents soften by forming soluble compounds. It is important to note that both the chelating and sequestering agents soften water without the precipitation of salts.

2. Wetting- Wetting agents establishes a close contact between the detergent and the soil. They lower the surface tension of water and thus permit the cleaner to penetrate the soil, and make it easier to remove.

3. Dissolving-
This is the ability of a detergent solution to solubilize or dissolve the soil. Some soils such as sugars are water soluble. Proteins are soluble in alkaline or slightly acidic solution. They are not water soluble. Fats are insoluble in water and soluble in alkali. Minerals require acidic solution to dissolve. The dissolving property enables the detergent to remove soils effectively.

4. Emulsification-
Is the action of breaking down fats and oils into small particles and dispersing them in solution. Notice the action is not dissolving; the soil (lipids) particles are still there but they do not settle, they are held in suspension.

5. Peptizing-
Refers to breaking down large protein molecules into small particles yielding partially soluble colloidal solution.

6. Deflocculating-
This involves breaking down the soil aggregates into smaller particles and keeping them from settling. The suspended soils are easily removed by flushing the surface.

7. Rinsing property-
This is the ability to easily carry away or completely remove the soil in solution or suspension from the surface. A good rinsing property is essential otherwise one would merely exchange detergent residue for the soil.

8. Saponification-
This is a chemical reaction between fats and the alkali resulting in the formation of soap. The process renders fats soluble and thus easy to remove.

9. Surfactant-
These compounds have the ability to allow closer contact between soil and detergent solution. This action is similar to the action of wetting agents.

10. Germicidal property-
This refers to antimicrobial action, where spoilage organisms are destroyed. Some detergents are toxic to germs; however, they are not a substitute for sanitizing.

In addition to the properties discussed above the detergents should be economical, nontoxic to humans, not corrosive, and noncaking, dusting, and easy to measure.
Stable during storage and easy to dissolve and handle.

Selecting the Proper Detergent

Selecting an appropriate cleaning compound depends on several factors. The main factors include type of soil, the surface to be cleaned and the method of cleaning.

Type of Soil

Soil was defined as unwanted matter or material in the wrong place. Thus a soil includes a wide range of materials. Generally, soils can be classified as inorganic and organic.
Inorganic soils include hard water scales such as Ca and Mg carbonates, metallic deposits (rust), alkaline deposits such as films left behind due to improper rinsing of alkaline cleaner.
Inorganic soils are soluble in acidic solution and, therefore, acidic cleaners are effective in removing them.

Organic soils: these include organic substances such as sugars (carbohydrates) fats, oils, and proteins. As mentioned earlier fats and oils are alkali soluble and proteins are alkali soluble and also soluble in slightly acidic solution. Organic soils can be removed by using alkaline cleaners.
In addition to soils left from processing food/grapes, many compounds can contaminate the food product/wine. These include fungicides, insecticides, foliar fertilizers and other foreign matter that can come in the winery with grapes.
Many substances are authorized for treatment of wine (such as fining agents) during production, which are later removed. These compounds become part of the soil that needs to be removed. In a winery the main soil consists of grape fragments, sugars, acids, salts (bitartrates), pigments, tannins, proteins, yeast, bacteria and fining agents. It is important to know their chemical characteristics in order to effectively remove them.

Type of Surface

Next to soil the knowledge of the surface being cleaned is vary important. The kind of surface affects the mode of soil attachment. The interaction between the soil and the surface determines how (tightly) the soil is held by the surface. Various physical (particle size, density) and chemical (surface tension, wetting power), characteristics determine the bonding of soil to the surfaces. The cleaner must overcome these bonding forces (adhesion, adsorption) to dislodge the soil from the surface. It should be obvious that a strongly attached soil would take special effort to remove it. The removal of soil involves three main steps.

1. Separation of soil-
First step is the separation of soil from the surface. A cleaner weakens the bond between the soil and the surface and thus causes the separation. It is essential that both the soil and the surface be thoroughly wet in order to facilitate the process of separation. Other
factors such as heat or mechanical action (scrubbing) can also assist in detaching the soil from the surface.

2. Holding the Soil-
The soil removed from the surface must be held by the cleaning solution to be carried away. Soluble soils can be held in solution to the point of saturation. The insoluble
soils needs to be held in suspension. That means without permitting them to settle. To
facilitate suspension the soil particles must be broken down into very small fragments so they remain dispersed. Mechanical action such as shaking, agitation and high
pressure can help in breaking the soil into fine particles.

3. Preventing re-deposition-
The cleaning solution containing the (removed) soil should not permit redeposition of the soil back on the surface. This is achieved by flushing and rinsing the cleaning solution which will carry away the soils. To prevent soil from re-depositing, prior to flushing, some agitation may be necessary. It is also important to use

soft water for cleaning. This way
the minerals will stay dissolved and their deposition on surface would be minimized.

The kind of surface being cleaned also affects the choice of cleaning compound. Some surfaces are easily damaged by certain types of cleaners. It is important that a sanitarian be familiar with the various kinds of surfaces such as concrete, wood, plastic, glass and metal and how they are affected by different cleaning compounds. Surfaces that are uneven, containing cracks, crevices and hard to reach are difficult to clean. On the other hand smooth, hard and impervious surfaces are relatively easy to clean.
Wood is porous and soaks up moisture. It is difficult to clean and especially to sanitize. Strong alkaline detergents can cause damage to the surface. In a winery that uses wine barrels for storage, cleaning and sanitation can be a challenging task.
Stainless steel offers a hard and smooth surface. It is generally resistant to corrosion but prolonged exposure to strong chlorine and iodine based cleaners/ sanitizers can cause surface corrosion. However it is nonmagnetic and easier to clean and sanitize. In modern wineries most of the storage tanks and processing equipment is made of stainless steel. Concrete surface is etched by acidic compounds. Wine is acidic and can cause etching. For this reason concrete surfaces in a winery should be coated with acid resistant material. In a winery, floors and many other parts of the premises are made of concrete; therefore, a sanitarian must be knowledgeable about cleaning concrete surfaces.
Many items such as containers, buckets, paddles and equipment parts made of plastic are used in the winery. Only food grade plastic material should be used. Various plastic materials react differently with chemical cleaners. Follow manufacturer's direction when using chemicals for cleaning items made of plastic.
Glass is smooth and impervious. It is easy to clean. Items made of glass (containers, bottles, lab equipment) are frequently used in the winery. Strong alkaline detergents can cause etching of glass surface.
In Winery cleaning many kinds of surfaces are encountered. Winery premises are generally made of concrete floors, containers are made of wood (barrels) stainless steel, plastic and glass. Equipment can be made of stainless steel and other metals and some times wood (basket
press). They can also contain many plastic and rubber parts. Because of the diversity of surfaces to be cleaned a sanitarian needs to have a good knowledge of various cleaning and sanitizing compounds.

Water Composition

Water composition will also influence the choice of cleaner. Hard water will need a
detergent containing a water softening agent for effective cleaning. In addition to water composition, water temperature also needs to be considered in selecting a cleaner.
Generally, most cleaners work well in 100-140°F hot water.

Detergent Complexity

Some detergents are complex and contain variety of chemicals. They are promoted as all purpose cleaners. One should be concerned about choosing such cleaners because they may contain unnecessary chemicals. It is better to use a chemical that is specific for removing certain soil.

Method of Application

Cleaners can be applied manually or automatically using cleaning in place (CIP) systems. In manual cleaning safety is an important issue. The cleaner must be safe to handle. Thus the choice is restricted due to safety. In CIP systems strong concentrations can be used to enhance the efficiency of cleaning because the worker is not directly handling the chemical.

Disposal of Rinse Water (waste water disposal issues.)

Disposal of waste water is a matter of concern to all, due to the problem of water pollution. In selecting a chemical cleaner the issue of waste water disposal must be kept in mind. This means use of certain chemicals may be restricted or prohibited. From the ongoing discussion it should be clear that many factors affect the choice of cleaning compounds and a sanitarian must be thoroughly familiar with a wide array of compounds in order to make a proper selection.

Wine Spoilage Organisms
Microorganisms are associated with the production of many fermented food products including wine. In the process of wine production many microorganisms such as molds, yeast and bacteria are involved. In fact their participation is
By definition spoilage causing microbes are those found in a wrong place at a wrong time. This would

obviously include organisms capable of producing off taste and foul odors but also include the desirable ones when they are found in an unwanted place and time. For example a good strain of yeast used in primary alcoholic fermentation would be considered a spoilage microbe when it found in a bottled wine with residual sugar. The challenge for the winemaker is to use only the desired microorganism when and where they are needed and control or eliminate all others (good and bad) during the rest of the wine making process.

To control the spoilage causing organism the winemaker needs to institute and a rigorous cleaning and sanitation program. A deeper understanding of the various spoilage causing organisms is essential to implementing a successful sanitation plan. The main spoilage microorganisms include yeasts, bacteria and mold. The process of winemaking can be viewed in three stages at which the microorganisms can enter the process and negatively impact the wine quality.
The first stage is the raw material, mainly the grapes at harvest and their delivery to winery. How clean is the fruit? Is it healthy or diseased or damaged? Hand picked or machine harvested? The shipping distance, temperature of the fruit in transit and use of sulfur dioxide are all the factors that will influence the kinds of microbes, extent of their proliferation and the spoilage they would cause.

The next step is the processing of fruit and the fermentation. General sanitary status of equipment such as crusher, press, pumps, and hoses; the winery premises and the processing steps such as must settling and cold soak (red wine) will influence the entry of wine spoilage microorganisms. Generally, the fermentation is conducted by the wine yeast Saccharomyces cerevisiae. However, microbes originating from grapes and the winery environment also participate in primary alcoholic fermentation. Growth of undesirable microorganisms at this stage can cause spoilage of the product.
In the post fermentation period a wine is clarified, fined, stabilized, matured, and bottled. At this stage wine is susceptible to spoilage by various kinds of microorganisms. Control of these spoilage organisms is absolutely essential for producing high quality wines.

Spoilage by yeast

Yeast is widely distributed in nature and many strains are found on grapes and the winery environment (floors, walls, equipment, containers etc). At this point it is important to define the terms wine yeast and the wild yeast. The term wine yeast refers to the strains of Saccharomyces which consistently complete fermentation without producing off flavors. These yeasts are relatively more alcohol, sugar and S02 tolerant than the wild yeasts. The term wild yeast refers to those non Saccharomyces strains which can partially ferment the must and produce various kinds of off flavors.

Can wine yeast be a spoilage causing yeast? The answer is yes. Recognizing its valued contribution to alcoholic fermentation, it also needs to be noted that its presence where it is not wanted constitutes spoilage. An example would be the wine yeast causes re-fermentation of bottled wine usually containing some residual sugar.

At harvest, a significant number of non saccharomyces strains are present on the surface of grapes. Commonly found strains include Kloeckera, Hansenula, and Henseniaspora and less commonly present include specie of Metschnikowia, Candida and Pichia. It is important to note that the presence of yeast Saccharomyces is extremely rare on grapes. Whether non saccharomyces strains are considered spoilage yeast is debatable. In un¬inoculated fermentations these yeast certainly make significant contribution to the fermentation. Some winemakers like the complexity of flavors generated by these yeasts. However these yeasts are also capable of producing high levels of acetic acid and ester ethyl acetate which gives wine vinegar like aroma and is considered spoilage. These non saccharomyces strains are sensitive to ethanol and are dominated by the saccharomyces even in un-inoculated fermentations. They are also sensitive to sulfur dioxide and can be easily controlled by an appropriate dose of S02 to the must prior to fermentation.

When a wine is exposed to air during storage a layer of film can develop. This is caused by strains of yeasts such as Candida and Pichia. These organisms utilize ethanol and produce higher concentrations of acetaldehyde, acetic acid and ethyl acetate. Proper sanitation and wine storage in absence of air is important in avoiding the spoilage caused by the film forming yeasts.

Some non Saccharomyces yeast can complete fermentation but also cause spoilage. Species of the genera Brettanomyces, Zygosaccharomyces and Schizosaccharomyces belong to this group. Brettanomyces produces volatile phenols which gives wine medicinal, mousy and barnyard off¬flavors. Zygosaccharomyces causes re¬fermentation, turbidity, and high levels of acetic acid and esters. Schizosaccharomyces is rarely found in wine but can cause deacidification and lead to high pH. In order to control the spoilage yeasts

proper sanitation is crucial.

Kinds of spoilage by yeast

Various spoilage causing yeasts have been briefly described above. Their activity can produce various kinds of wine faults. It is vital to understand them in order to realize the significance of cellar sanitation.

Re-fermentation
Many species of the yeast Zygosaccharomyces can cause re-fermentation of bottled wine containing sugar. The main spoilage causing species Z.bailii has many unusual properties. It can tolerate high concentrations of ethanol (.15%), and sugar (.70%) and shows resistance to high concentration of preservatives such as sorbic acid, benzoic acid and sulfur dioxide. The yeast is a main contaminant of grape juice concentrate, especially when stored at room temperature over extended period. Spoilage occurs when contaminated concentrate is used for sweetening the wine. A wine spoiled by Z.species can show turbidity, sediment increased level of succinic, and acetic acid and reduction in malic acid. To avoid the risk of spoilage by this organism winemaker should not use contaminated juice concentrate, and follow sterile filtration and sterile bottling.

Ester formation
Ester taint is associated with high levels of ethyl acetate and in some cases may also be due to methyl butyl acetate. In a wine containing >200mg/l ethyl acetate and 0.6g/l acetic acid the off odor is perceived as spoilage. High concentration of ethyl acetate was shown to be related the activity of the wild yeast such as Hanseniaspora uvarum in the early stages of fermentation. The potential for the taint to develop is significant when the must contains a high population (106cells/ml) of H.uvarum in relation to Saccharomyces, in initial stages of fermentation.

To minimize the taint problem a winemaker should not use damaged and diseased fruit, settle and clarify the must, and inoculate with a high population of Saccharomyces cerevisiae and maintain sufficient level of free S02.

Film forming yeast
During storage in a partially filled container, species of Candia and Pichia can develop a layer of film on wine surface. The cells appear as clumps which will develop into a film. As the cells grow the film layer becomes thick and sinks to the bottom. The yeast requires oxygen for their growth. They metabolize ethanol and produce acetaldehyde, acetic acid and ethyl acetate. The wine acquires oxidized aroma and may also have pronounced vinegar like odor. To prevent this type of spoilage a winemaker needs to store wine in completely filled containers, (no air in headspace) use inert gas during wine transfer, keep a blanket of inert gas in head space during short term storage maintain high S02. Some strains have been found to be resistant to high S02 and in this case S02 may not be effective. If containers become infected, they must be cleaned and sanitized with steam. Sanitation is the key to avoid spoilage problems.

Undesirable flavor formation
Many types of off odors are attributed to the activity of spoilage yeast. Wine contamination by Brettanomyces yeast can cause variety of off odors .These odors are often described as barnyard like, medicinal, band-aid like, wet dog, tar, tobacco, creosote, leathery, mousy, phenolic, spicy(4-ethyal phenol), and acetic. At high levels these odors are obviously objectionable. In smaller concentrations these odors are perceived as complex and not a fault by some winemakers.
The yeast is a slow fermenter but can complete fermentation. In sparkling wine production it can cause problems with riddling and can also cause gushing due to C02 generation.

The key to control this organism is to pay scrupulous attention to cleanliness and sanitation particularly at harvest. During processing the equipment should be periodically cleaned to prevent the build up of a large population. One should also avoid infected barrels for wine storage. The yeast is fortunately sensitive to S02 and therefore, can be controlled by maintaining appropriate levels of free S02 in wine during storage.

Another group of objectionable odors originate from the presence of sulfur compounds. Hydrogen sulfide is produced by yeast during fermentation. This compound has a rotten egg odor which is not pleasant. The formation of H2S is dependent on yeast strain and many environmental factors. It is important to use a low H2S producing strain of Saccharomyces cerevisiae to minimize this fault from developing in wine.

High levels of acetic acid also contribute to acetic spoilage aroma. Many microorganisms including wild yeast acetic and lactic acid bacteria are involved in acetic acid formation. Acetic acid is a major volatile acid

in wine and its amount in wine is restricted by federal regulations.

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