INTERNATIONAL MOLYBDENUM ASSOCIATION
THE VOICE OF THE MOLYBDENUM INDUSTRY

Wine improves with moly and time

Acid-resistant molybdenum-grade stainless steel vats and related equipment are essential in the production of many alcoholic beverages. They are used in alcoholic fermentation, vinification, aging, storage and transport. Hygienic and easy to clean, they help producers from high end to mass market, creating refined and well-crafted libations.

As the world's population has grown, global alcohol consumption has risen to its highest level ever. The annual per-capita consumption has remained relatively level in recent years at 4.3–4.7 liters of pure alcohol. Spirits account for approximately half the total, followed by beer (35%) and wine (8%). Although the beverages and their processes are very different from one another, they all require hygienic, specialized equipment for their production.

Stainless steel at the intersection of tradition and innovation

Alcoholic beverages have many sources. Wines are made from grapes, and sakes from rice, while gins are infused with juniper berries. Artisans who make the beverages strive for the highest quality while maintaining consistency from batch to batch and vintage to vintage. Each beverage's raw ingredients and processing steps dictate the optimal material for the process equipment. Stainless steels offer excellent hygienic properties, corrosion resistance, cleanability, durability and lightness of weight. Furthermore, they do not taint the product's taste or color. As a result, stainless steels dominate the alcoholic beverage equipment market.

A barrier to chemical attack

Alcoholic beverage production starts with musts, mashes or worts – mixtures resulting from pressing, boiling or malting of raw ingredients. Their chemical properties, in particular their acidity, dictate the optimal choice of the stainless steel grade, although alcohol itself is not corrosive. The starting musts and mashes are fermented to produce the alcohol, a process typically carried out in stainless steel vats. The vat material must resist chemical attack and satisfy the specific requirements of the alcohol produced. The same is true for the other stages of production before and after fermentation. These differ for each type of beverage, but wine requires the most complex and most delicate processes of all.

White wines: protecting the aging process

Wine is made by fermenting a "must" obtained from pressed grapes, and is often matured in vats or barrels. White wines are usually made from white grapes and red wines are made from red grapes, though the grape juice of both types of grapes is clear. For red wines grapes are macerated and fermented with their skins and seeds, giving them color and flavor.

White wines require more care at every stage of production than red wines, because they are more fragile and sensitive to oxidation. In fact, the best wineries even harvest white grapes at night to protect their subtle flavors. The pressing should be slow and gentle, typically in a pneumatic Type 316L ❯

Stainless steel tanks are hygienic, facilitating high-quality wine production. © Domaine Etienne Simonis / photo Benoît Facchi

Alcoholic fermentation – where it all plays out

In alcoholic fermentation, yeasts break down sugars contained in plants or obtained by conversion from starches. The yeasts transform sugars into ethanol (alcohol) and carbon dioxide (CO_2), raising the temperature in the vat. Temperature strongly affects the fermentation rate of yeasts. Below 10°C, the yeasts are unable to multiply; above 35°C, their activity decreases rapidly and fermentation may stop. Between those limits, the fermentation rate doubles for every 10°C increase in temperature. Depending on the end product, it may take several hours to several days to produce the initial alcoholic beverage.

stainless steel wine press. This way crushing of the skins and seeds, which could release bitter tannins, can be avoided. Only the juice of the grapes is fermented for most white wines. The 10 to 14 day fermentation at 18–20°C is cooler than for red wines in order to preserve the aromas of the fruit. Fermentation at 12–13°C for up to one month yields more delicate, well-balanced wines. Heat regulation systems, integrated into the vats, allow the winemaker to precisely control the fermentation temperature.

White wines' natural acidity is much higher than that of red wines. Furthermore, white wines are more sensitive to oxidation, which can occur when the must is exposed to air while it is pumped from one container to another. They therefore require the addition of sulfur dioxide (SO_2) to prevent oxidation. Besides being an important antioxidant, SO_2 is also a good antiseptic against certain micro-organisms and is therefore used throughout the winemaking process.

The combination of high acidity and SO_2 increases the corrosiveness of the must and wine. Therefore, Types 316 and 316L stainless steel, with 2% molybdenum for improved corrosion resistance, are preferred for making white wines, including champagnes and dessert wines, fortified wines and rosés. As red wines are less corrosive, Type 304 stainless steel is usually sufficient for the vats and is most widely used.

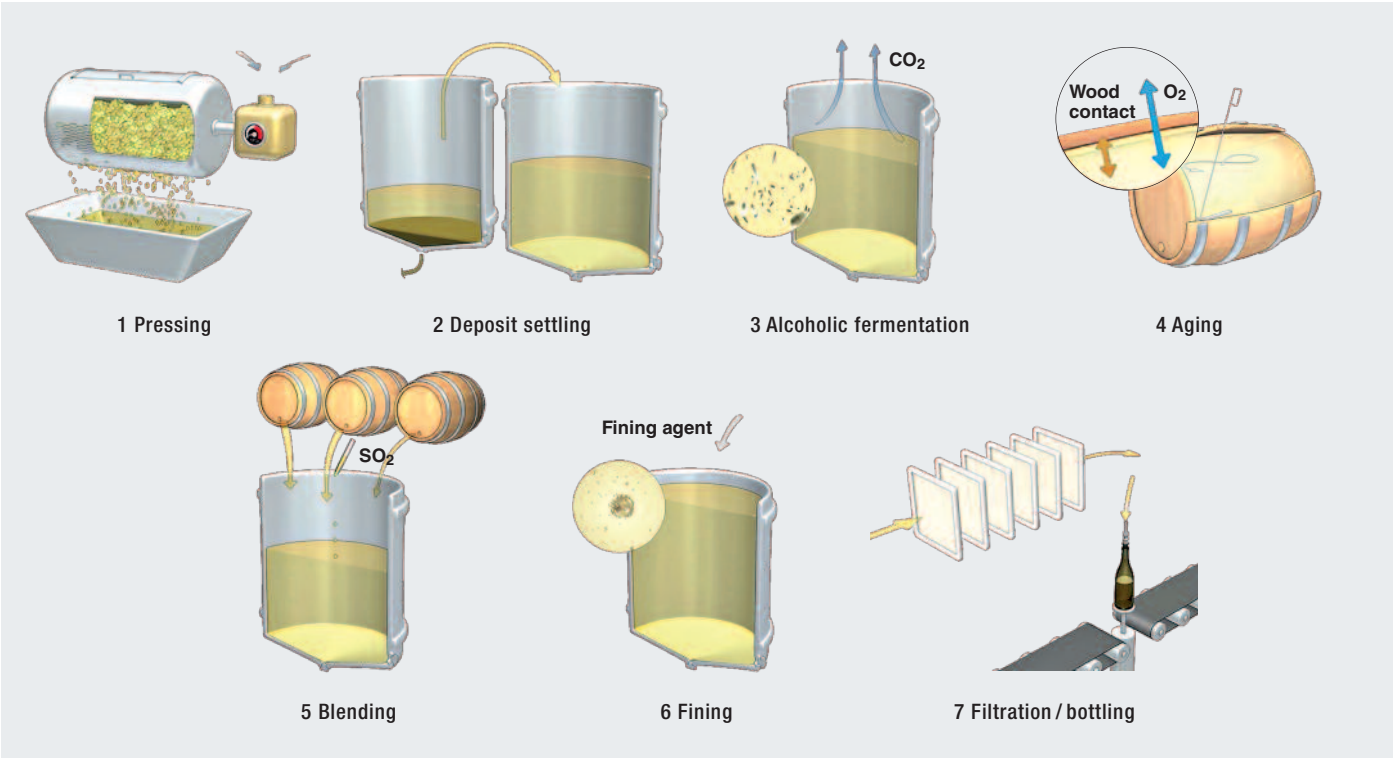
Champagne wineries use 316L vats for storage before bottling, and for the delicate gasification process that follows. © Champagne Laurent Perrier, photo Didier Boy de la Tour

Typical stainless steels used for different alcoholic products

Product	Process step	Material
Spirits	Fermentation/aging/storage	304L, 316L
Beers, ales	Fermentation/storage/water tanks	304L (316L, 2205 in special cases)
White, rosé and fortified wines	Pressing/maceration/fermentation/ blending/aging/filtering/storage	316L
Red wines	Fermentation	304L (316L, 2205 for vat covers)

However, Type 316L is utilized for fermentation vat lids where the CO_2 gases from the process concentrate.

Even long-term exposure to acids and SO_2 during storage and aging has no effect on the stainless-steel vats. This means nothing can leach from the tanks into the wine, allowing the wines to improve on their own. And because the tanks can be hermetically sealed, they also prevent unwanted oxidization of the wine during aging. ›



Main steps in the production of white wines. Wood barrels are typically used for aging of Burgundian-style wines. Most other white wines use stainless steel equipment throughout. © Courtesy of Comité Interprofessionnel des Vins de Bourgogne / www.bourgogne-wines.com

The easily-cleaned and sterilized stainless steel vats improve food safety and prevent defects in the wine more effectively than competing materials such as wood, concrete or resin, and at a lower cost. Before bottling the wine even passes through 316L stainless steel mesh filters or beads that retain residual impurities without altering the wine's taste.

Type 316 stainless steel barrels help preserve the freshness and fruitiness of wine while aging. © Maison S.Delafont

Spirits: corrosion-resistant vats for unadulterated products

Virtually any plant can be fermented and distilled to produce alcohol. Grains, vegetables, fruit, sugar cane and agave are all well-known starting materials. The basic steps in the production of spirits are fermentation of the raw plant material, usually through the addition of yeast, followed by distillation of the fermented mash to obtain ethanol. Type 316L stainless steel vats are used in spirit production for high acidity mashes. They enable rigorous control of the fermentation process and provide ease of handling and cleaning.

Fermentation vats used for whiskey can have capacities varying from 1,000 to over 50,000 liters. Vats were traditionally made from woods, but stainless steel vats are more cost-effective, and easier ❯

to empty, maintain and clean. They also protect against the “bad yeasts,” bacteria, and molds that can plague wooden vessels, because the mirror-polished interior of stainless steel vats can be meticulously cleaned and hermetically sealed.

Fruit and aromatic plant brandies and gin also sometimes use Type 316L vats for maceration, a process that infuses flavors to the product, and for storage. For example, brandy produced in Alsace, France, after six to eight weeks of maceration, is aged outdoors in Type 316L stainless steel vats for at least six years to allow the brandy to mellow. There the brandy is subject to variations in the Alsatian microclimate, increasing its complexity. Some Japanese sakes are aged similarly for up to ten years.

Beer: barring air and contaminants

Beer is the most widely consumed alcoholic beverage in the world. It is produced from wort (a mixture of water and germinated barley called malt, boiled together with hops). The wort is sown with yeast and fermented in stirred vats in an oxygen-free environment within strict temperature ranges, according to the type of beer being produced. After fermentation and until consumption, the beer has no contact with air, so the equipment has to be hermetically sealed. In some cases, it is aged after fermentation for three to six weeks at 0°C, allowing it to mature and produce carbon dioxide. The standard grade used in breweries is Type 304 stainless steel. However, Type 316 stainless steel and even 2205 duplex stainless steel are sometimes used for applications requiring higher corrosion resistance.

Alcoholic beverages have been produced for thousands of years. The results in terms of taste have often been unpredictable. Only very few producers had the wealth and knowledge to make high quality beverages in materials that were prone to bacteria growth and other contamination. However, with the broad introduction of stainless steel processing equipment, many of the potential problems have been eliminated. Today well-made, high-quality alcoholic beverages are available at almost any price point, thanks in part to molybdenum-containing stainless steels. (Thierry Pierard)

Wood, concrete or stainless steel vats – which material is best?

- Wooden vats have been used to produce alcoholic beverages for centuries. Wood can enhance color and subtle flavors in both wines and spirits. It remains necessary when aging in casks is essential, but this is one of the few uses left for wood today. Wood is sensitive to contamination by micro-organisms, is not completely leak-tight, and incurs high-maintenance costs.
- The 20th century brought concrete vats to the production of spirits and wines. Concrete is thermally stable, inexpensive, and easily shaped into nearly any form. However, concrete vats are difficult to maintain; they often require an inert epoxy resin coating or even stainless steel cladding to resist chemical reactions. Once installed and sealed, a concrete vat is almost impossible to move, a significant disadvantage.
- In recent years stainless steel alloys have replaced nearly all competitors in alcoholic-beverage production because they offer great advantages in installation, operation, and maintenance. The manufacturing flexibility of stainless steel allows for a variety of customized vat shapes (e.g. cylindrical, curved, squared, tapered or even subdivided). Stainless steel vats may be installed on legs, on a slab, or suspended from the ceiling. They are light and easily moved to optimize the layout of a production area. Integrated external coils or jackets allow precise temperature control during the critical fermentation stage. They can be hermetically sealed to avoid oxidation of the product. They are neutral and hygienic in contact with food, easy to sanitize and offer numerous options for modular stainless steel add-ons such as pumps, thermostats, tubing, and valves. Finally, stainless steel allows designers to create spectacular production sites that attract visitors from near and far.

Beer production also benefits from the hygienic properties of stainless steel. © shutterstock.com/ Viacheslav Nikolaenko