Cold stabilisation: past and present

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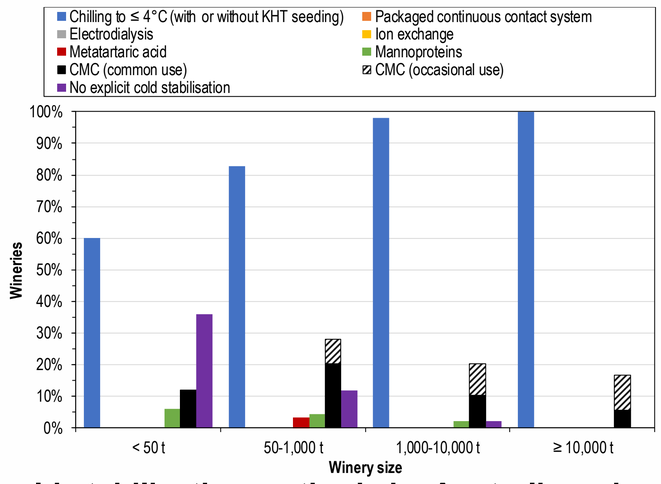
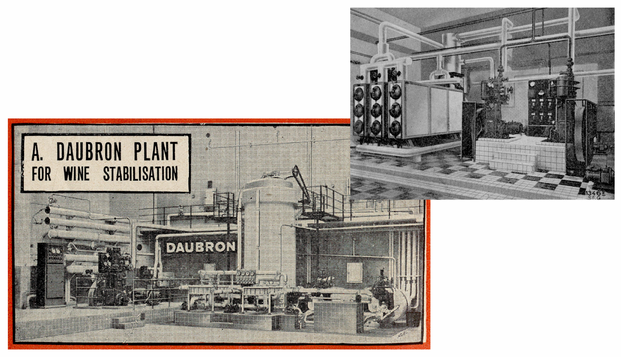
AWRI

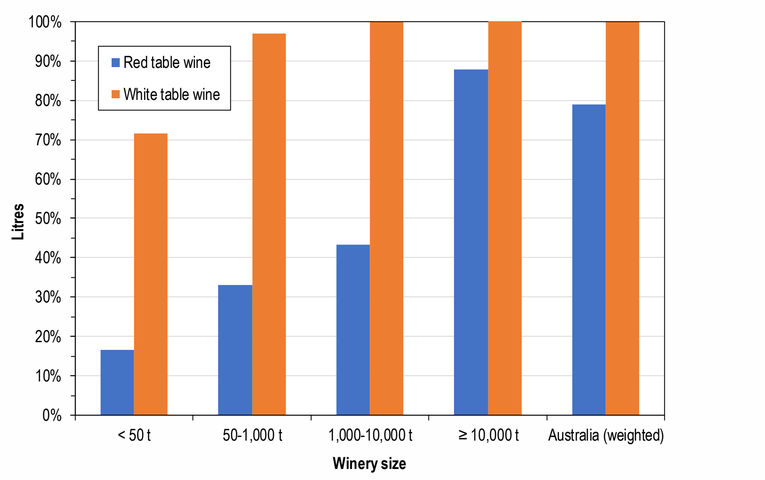


Use of cold stabilisation methods by Australian wineries in 2016 (www.awri.com.au/survey)



Cold stabilisation – an early use of refrigeration in wineries

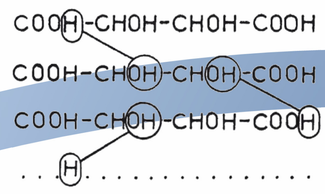
Cold water can be used for many cooling applications in wineries (e.g. fermentation and storage cooling) but the sub-zero temperatures required for cold stabilisation were only possible with refrigeration. Therefore many early refrigeration installations were specifically associated with cold stabilisation of wines.

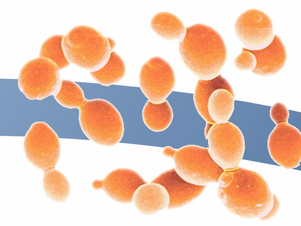


Fraction of wines explicitly cold stabilised in Australia in 2016 (www.awri.com.au/survey)

Crystallisation

Inhibitors



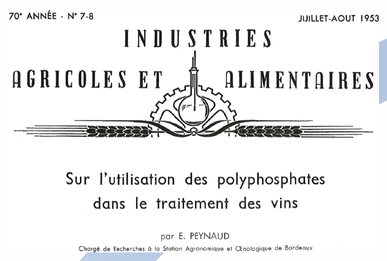


Metatartaric acid

Developed in the 1950s, this was the first successful specific crystallisation inhibiting additive. It is manufactured by heating tartaric acid to high temperatures to produce a polymeric form. Its disadvantage, known right from the beginning, was that it is slowly hydrolysed back to tartaric acid, losing its cold-protective effect. This hydrolysis happens much faster at warmer wine temperatures. Metatartaric acid is very cheap and its use is likely quite common in Europe.

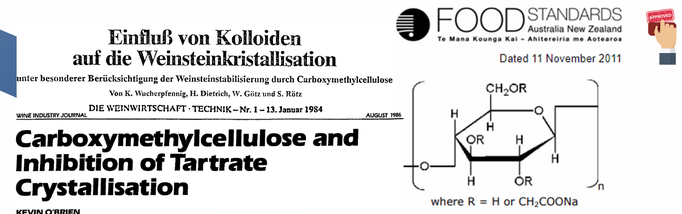
Yeast mannoproteins

Wine aged on yeast lees has long been known to be more resistant to tartrate instabilities. Part of this effect is due to the release of mannoproteins from yeast cell walls. Extending this knowledge, purified mannoproteins for cold stabilisation were released commercially in the 2000s. Anecdotally, these are quite expensive relative to other treatments and not always perfectly effective.



Hexametaphosphate

Hexametaphosphate had been used as a scale inhibitor for water treatment (i.e. to prevent formation of calcium carbonate crystals in pipes and boilers) and in the 1950s it was demonstrated experimentally to also inhibit tartrate precipitation in wine. The product was never used commercially – it increased ash and phosphates and could lead to a metal instability.



Carboxymethylcellulose (CMC)

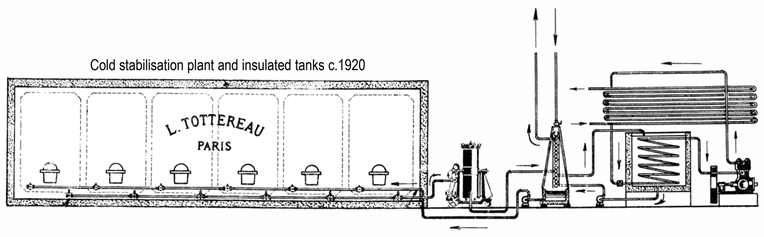
CMC has been investigated as a tartrate inhibitor since at least the 1980s, but was only approved by the OIV in 2008 and by FSANZ in 2011. Manufacturers recommend that it is not used with red wines, because of risks of dropping out colour.

Gum arabic

Gum arabic has long been used as a wine colloidal stabiliser. It is mentioned in early 19th century French textbooks as a wine additive. Interestingly, some mid-20th French wine textbooks have a large focus on colloidal stability, arguably more than many wine textbooks do today. This likely reflects the improved tools that most winemakers now have available to clarify and stabilise wines, such as membrane filtration, refrigeration, bentonite and stainless steel tanks (since they don't contribute metal ions to wine that can lead to hazes).

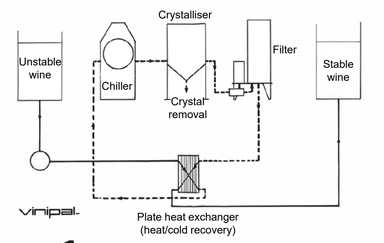
Crystallisation inhibitors vs. ion removal

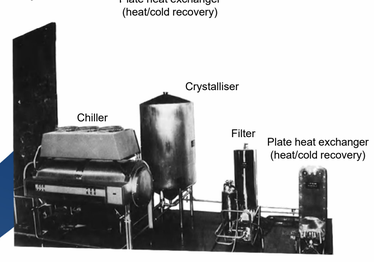
With the release of new crystallisation inhibitors to the market in recent years (e.g. CMC, potassium polyaspartate), there have been some philosophical/marketing discussions about additive versus subtractive approaches to wine production – some argue refrigeration is damaging because it is dropping wine compounds out, while others argue that additives are undesirable because they are not originally from the wine.



Dedicated cold stabilisation plant vs. shared brine loop

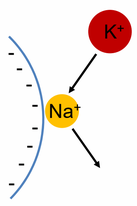
Initially, winery refrigeration plants were often dedicated to cold stabilisation and therefore they tended to be used with a common set of insulated tanks and a wine to be stabilised was almost always pre-chilled with a wine that had already been stabilised (the initial pull-down is the biggest use of energy). Modern use of refrigeration in wineries with systems shared between many operations and many jacketed tanks has led to a decrease in practice of energy recovery since it is easier to just chill in a tank by changing the tank set-point temperature than to pump the wine out of the tank and schedule it for pre-chilling against another wine exiting cold stabilisation. The benefits of the 2 approaches are debatable (one saves energy, the other saves labour). One problem with using a shared brine loop is that the required brine temperature is dictated by the coldest temperature on the loop, meaning that if a single tank is being cold stabilised the whole loop must be run with a very cold temperature, and refrigeration plant efficiency is much lower at colder temperatures. The use of dedicated cooling systems for cold stabilisation appears more commonplace in Europe – partly because many of the wineries are older.





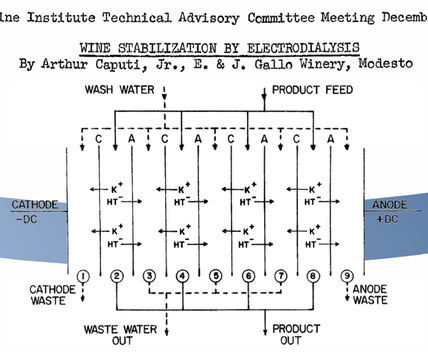
Potassium polyaspartate

Potassium polyaspartate is the latest crystallisation inhibitor to be released to the wine market. Initial reports suggests that it addresses some of the technical shortcomings of previous crystallisation inhibitors (e.g. longevity and colour precipitation). This compound (in sodium form) appears to have among other things been used as a scale inhibitor in water circuits, and as an ingredient in detergents. Its application in wine was approved by the OIV in 2017 and by FSANZ in 2019. Its use for wine tartrate stabilisation has been patented by ESSECO (Enartis, Martin Vialatte, et al.). The commercial offerings from Enartis are a potassium polyaspartate solution for white wines and a combined potassium polyaspartate and gum arabic solution for red wines that also assists with colour stabilisation.



Ion exchange

Stabilisation is achieved by exchanging potassium ions with sodium or hydrogen ions on a packed bed of cation exchange resin. Only a fraction of the wine is treated (typically 10%), just enough such that when it is recombined the overall potassium levels have been sufficiently reduced. This technique was pioneered by the Australian wine industry in the 1950s, but largely replaced by cooling for cold stabilisation following the widespread installation of refrigeration plants for fermentation temperature control. Resins were typically charged in the sodium form, making sodium pick-up an issue, and there were negative sensory impacts on some wines.



Electrodialysis

Electrodialysis uses an electric field and ion-selective membranes to remove ions responsible for tartrate instability from wine. It has been trialled in this application since the 1960s, but was only launched and adopted commercially by wineries in the 1990s. In Caputi's 1967 report on the technique he notes the high ongoing expense of replacing fouled membranes. This cost is a still a major consideration in the economics of the process today. An advantage that electrodialysis has over refrigeration is that it can also help with calcium tartrate stability.

Ion removal

Continuous contact stabilisation

Continuous contact systems work by building up a large amount of potassium bitartrate crystals onto which further potassium bitartrate in the wine will quickly crystallise, allowing the process to be performed continuously. Another key feature is that the exiting wine is used to pre-chill the same incoming wine, avoiding the scheduling problem that occurs when pre-chilling is attempted to be performed with different wines stabilised in a batch manner. The original system appears to be the Vinipal system developed in Portugal in 1969. Since then many other suppliers have built systems based on the same general principles (sometimes also in semi-continuous arrangements), but modified and updated and incorporating their company's equipment strengths – centrifuges, filters, etc. and with increasing levels of automation. Batch size is a consideration in these systems as initial development of the crystal mass can take some time and the system hold-up volume can also be significant.

Acknowledgements: Winery staff and suppliers that provided information and the AWRI library.

Article: This poster is a summary only - a more detailed article may be written in the future.