In-tank fermentation monitoring: past and present

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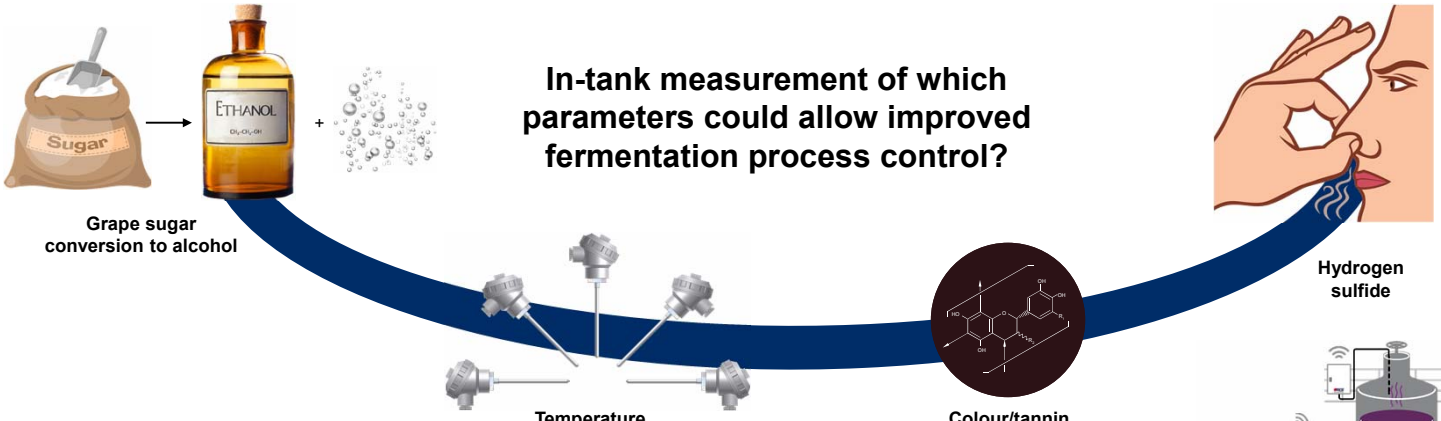
In-tank measurement of which parameters could allow improved fermentation process control?

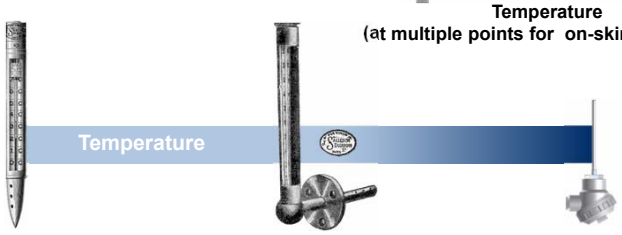


Grape sugar conversion to alcohol

Hydrogen sulfide

Temperature (at multiple points for on-skins ferments)

Colour/tannin extraction



Robust thermometer

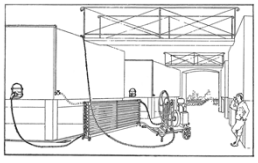
This dipping thermometer could be attached to the end of a stick and poked through the cap. It would retain a record of the highest temperature via a system using a magnet.

Tank thermometers

These provided a dedicated permanent measure of temperature in a tank.

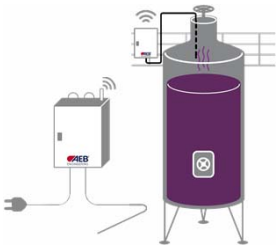
Modern temperature probes

These have facilitated automated temperature control, with measurements being used to actuate brine solenoid valves.



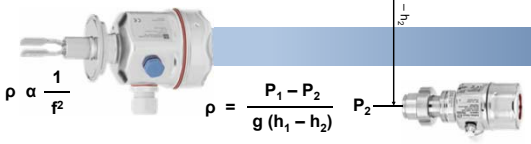
Temperature measurement and control

The adoption of temperature measurement and control had massive implications for wine production. High temperatures sometimes led to yeast being killed. Cooling systems allowed larger volumes to be fermented without the temperature getting too high.



H_2S sensors

AEB has released a system using relatively cheap H_2S sensors from industrial safety monitoring equipment, to assist with timing of nutrient additions.

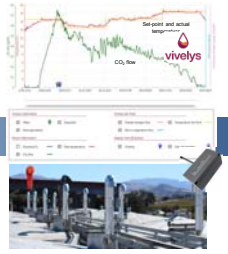


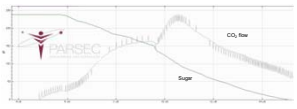
Tuning fork

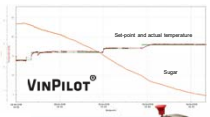
Determines the resonant frequency of each liquid, which is related to density (similar principles are used to determine density in Coriolis mass flow meters).

Pressure transducers

Liquid density influences the pressure that a column of liquid exerts, and therefore density can be calculated based on pressure measurements. Trials of this technique for brewery fermentations were first performed in the 1970s.







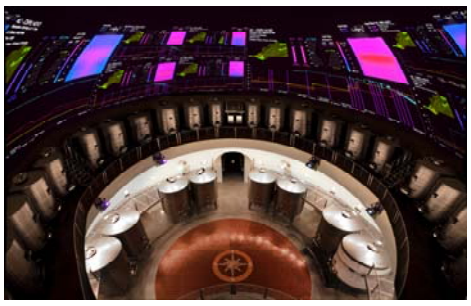
Sugar conversion

CO_2 flow

Measurement of the CO_2 flow (either by constant flow or pressure build-up and release) allows back-calculation of the sugar content, provided the initial sugar content is known. Sometimes this technology is used more for timing the introduction of aerations to prevent sluggish ferments rather than for monitoring Baume reductions. Significant research was performed on this topic in France in the late 1980s, with the maximum rate of CO_2 release that occurs early in the ferment being a key parameter related to fermentability.

Refractive index

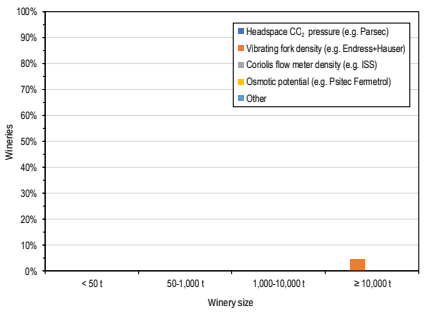
Refractive index is widely used for measuring juice sugar content, but is complicated during fermentation by the presence of alcohol also contributing to refractive index. This can, however, be approximately corrected for based on the refractive index before fermentation (when there was no alcohol). Systems are now being released using cheaper refractometers costing ~$1,400 instead of ~$8,000.



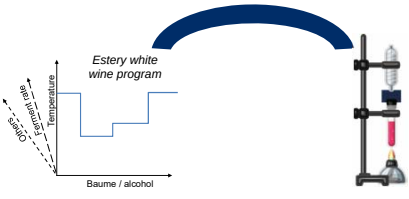
This US winery has both tuning fork density sensors and a system that measures temperature at multiple locations within each tank. The data is projected on the walls for winemakers to read.

Red ferments are most challenging

- Red ferments have skins and seeds, which can foul sensors (fouling can be a problem with whites as well).
- Pressures build up and are released as the cap forms and is broken.
- Starting liquid volume is not known.



Use of ferment progress sensors by Australian wineries in 2016 (www.awri.com.au/survey)



Structured fermentation programs

Fermentation programs could have all parameters/interactions pre-set for the fermentation (e.g. fermentation rate, temperatures, pump-over consistency, air injections, time) instead of just changing temperatures manually during fermentation as is now most commonly the case. An automated program approach would facilitate continual improvement and lead to better quality in the long term. (After each vintage, winemakers should be able to readily summarise every fermentation and plan enhancements to the programs for the next year.)

More than just substituting a lab measurement?

Online measurement has the potential to not just substitute the cost of a vintage casual collecting and analysing samples – it offers an opportunity to understand processes better and help craft desired wine styles.

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.