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WINE GRAPE TEAM

INDIANA HORT CONGRESS

Wine Cold Stability Assessments and Techniques

Christian Butzke
Enology Professor

www.indianaquality.org

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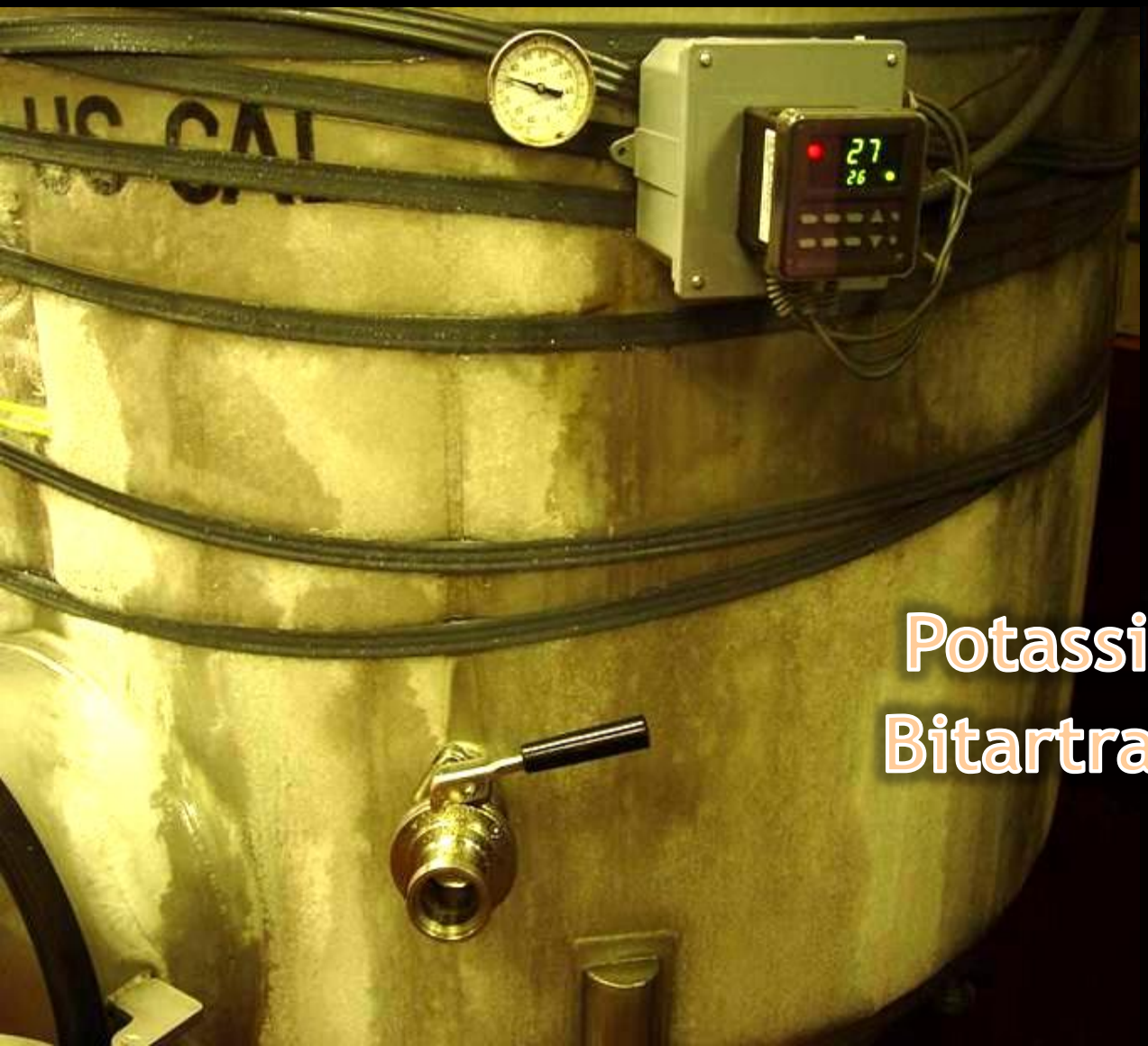
Cold Stabilization



Potassium Bitartrate !

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Wine Cold Stability Techniques

- Cooling/Freezing (w/seeding)
- Electrodialysis
- Metatartrate
- Mannoproteins
- Ion exchange
- Fluidized bed

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Cold Stabilization

Typically about 26°F for 3+ weeks

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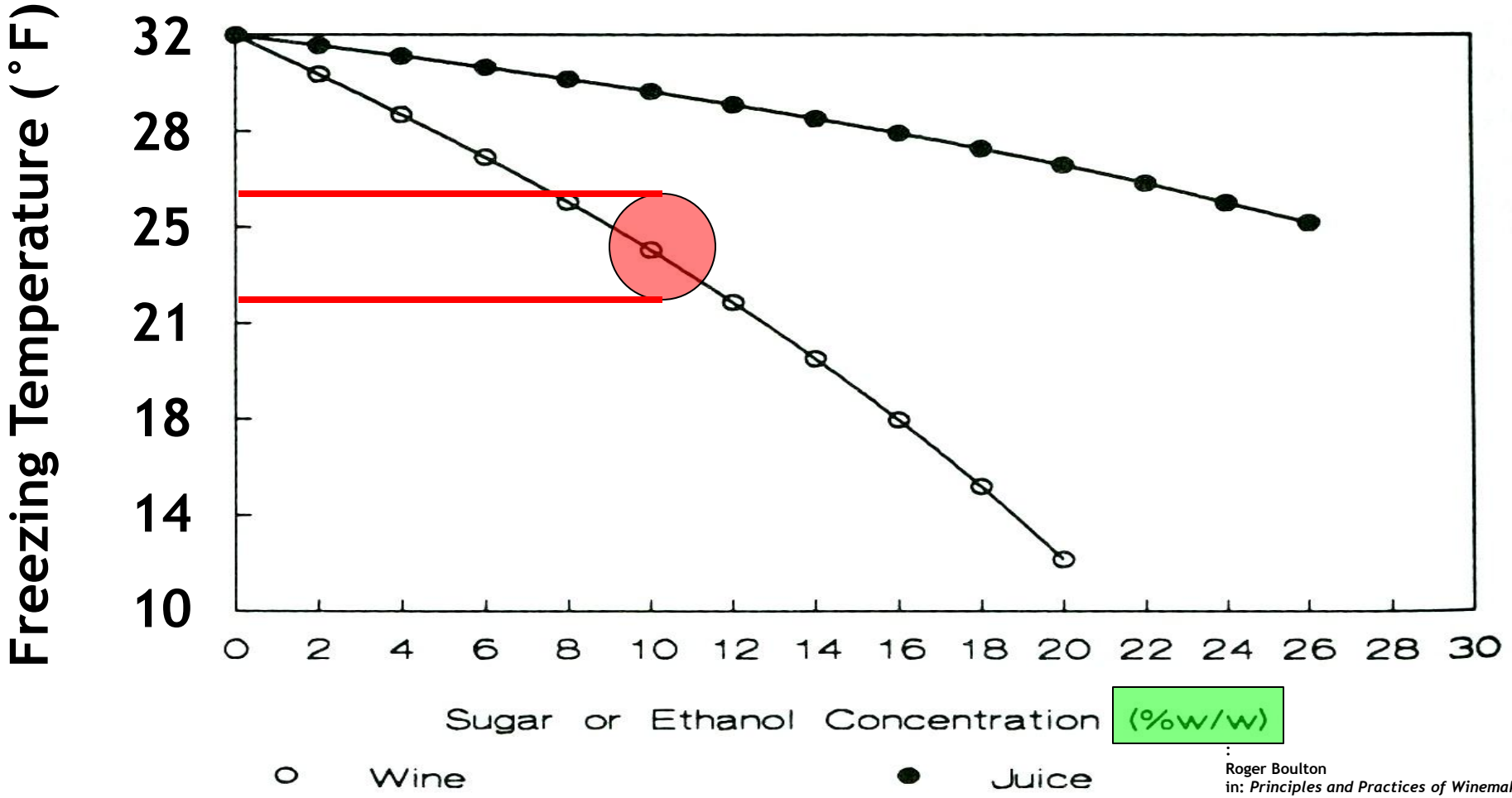
Cold Stabilization

Freezing point of wine



Roger Boulton
in: *Principles and Practices of Winemaking*

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Cold Stabilization
Energy

- 25% of winery energy use
- Uninsulated tanks: 1,200 Wh/gal
- Insulated tanks: 22 Wh/gal
- Electrodialysis: 8 Wh/gal
- Ion exchange: ? Wh/gal
- Fluidized bed: ? Wh/gal

http://www.practicalwinery.com/sepoct08/page1.htm

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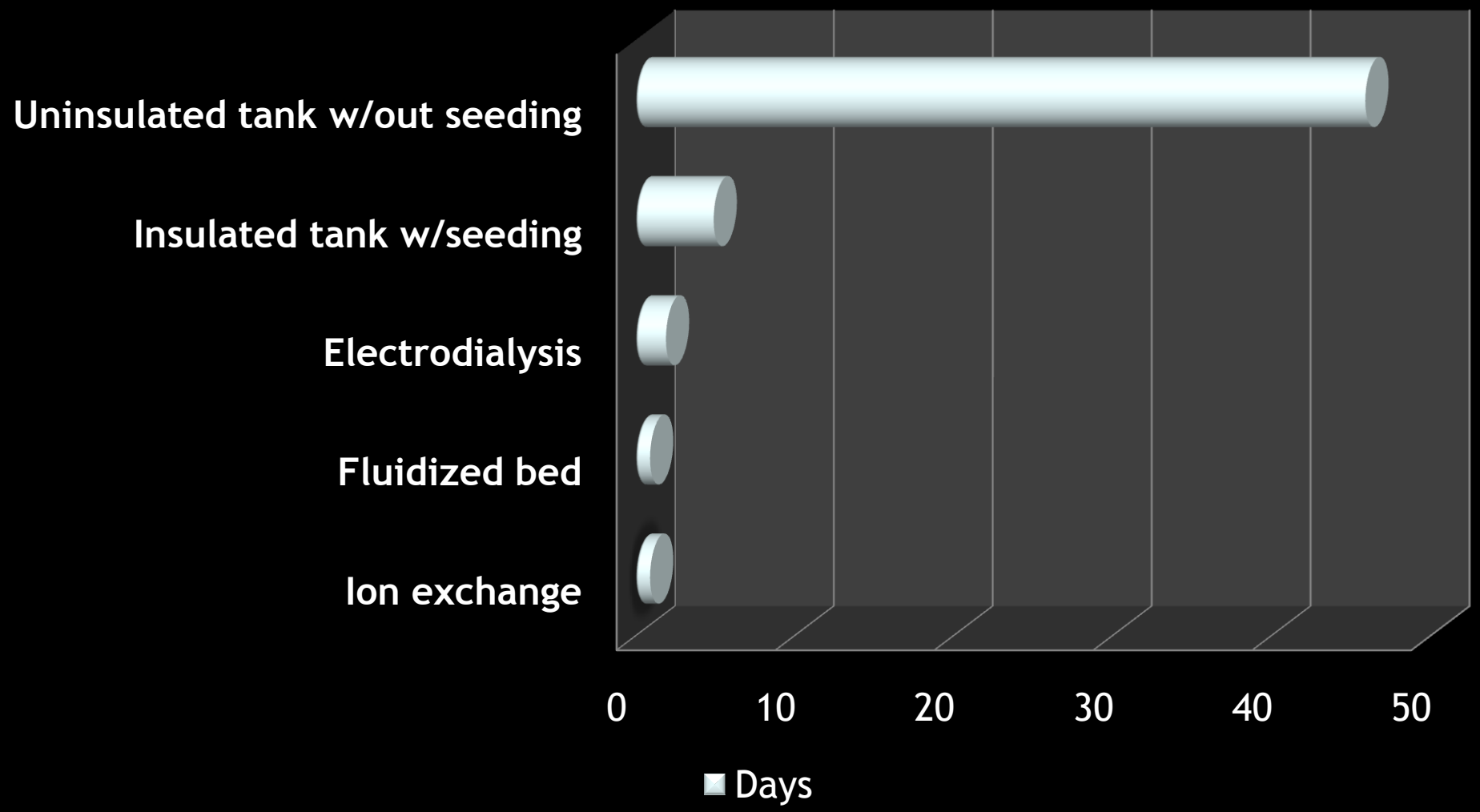
Cold Stabilization

Time



http://www.practicalwinery.com/sepoct08/page1.htm

⇨ Cooling w/seeding

ISSUES:

Crystallization rate proportional to:

- Agitation rate
- Smaller seed particle (nuclei) size
- Seed concentration
- Lower temperature

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⇨ Cooling/Freezing

Standard jacketed tank
=> no/little agitation

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⇨ Cooling/Freezing

Standard *cream of tartar*
= large crystal size

Powdered KBT => source?

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⇨ Cooling/Freezing

Polish stainless steel tank
= few nucleation sites/volume

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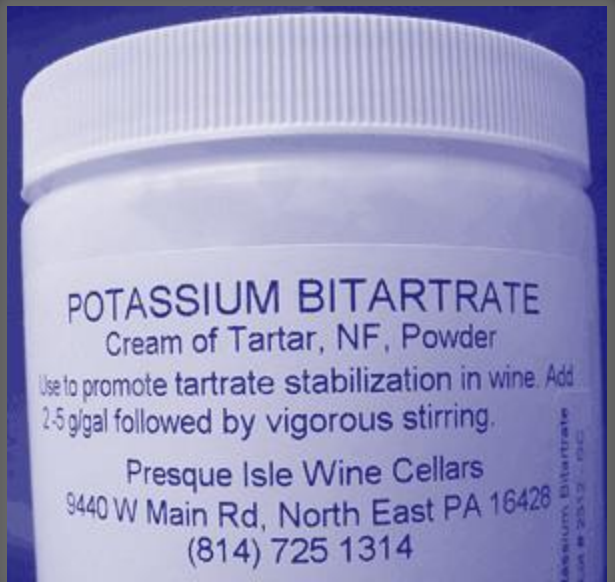
⇨ Cooling w/seeding

Cream of tartar pricey/imported

=> too few seed crystals used

4-15 g/L = 33-125 lb per 1,000 gal

= $112-418 = 2-8c per bottle



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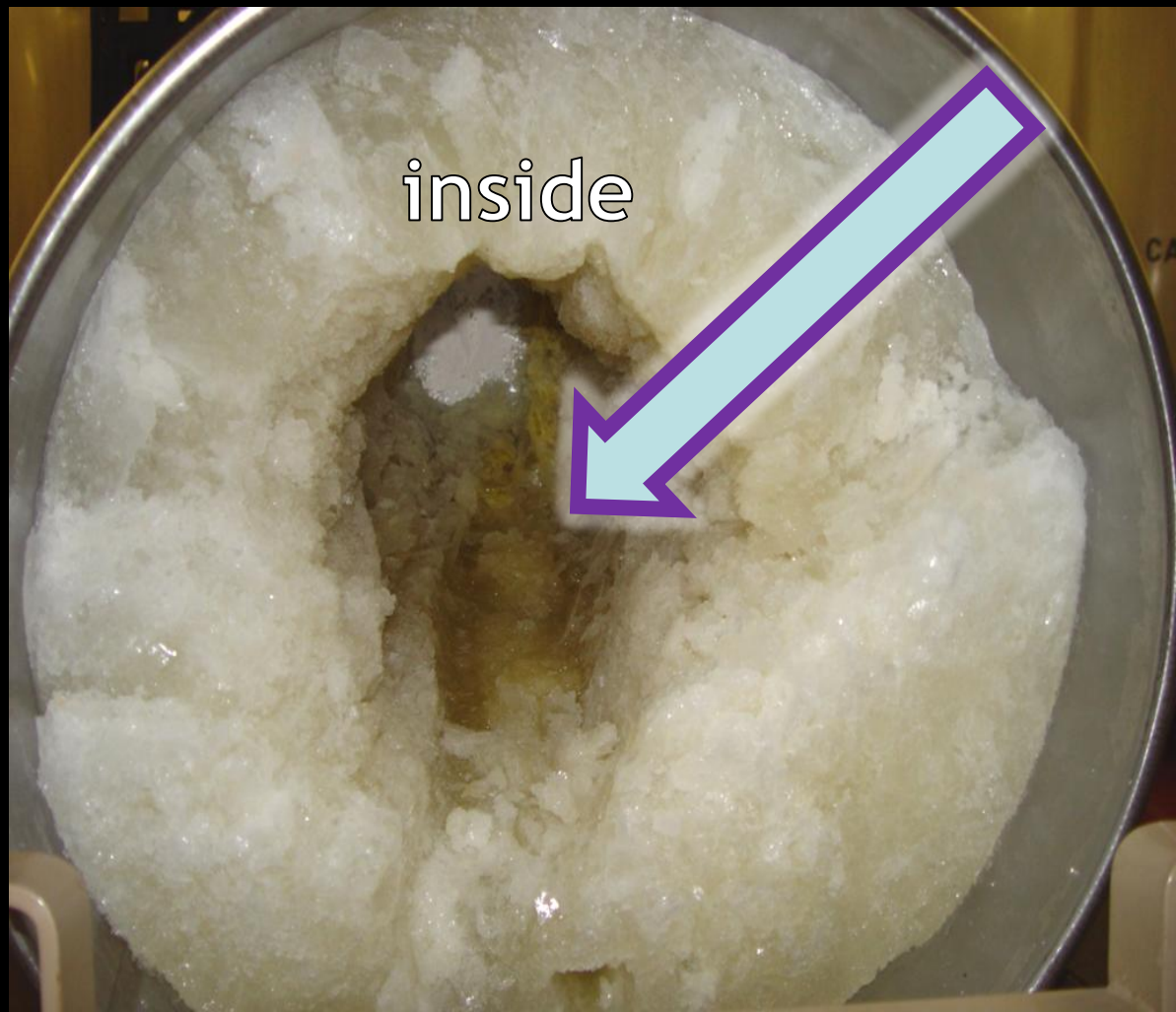
⇨ Cooling/Freezing

Poor heat transfer
= waste of energy



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⇨ Electrodialysis

PRACTICAL WINERY & VINEYARD

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September/October 2008

PG&E studies electrodialysis for cold stability

BY Steve Fok, PE
Pacific Gas & Electric Co.

California's 1,100 wineries produce 500 million gallons of some of the world's finest wines. In the process, they consume around 400 gigawatt-hours (GWh) of electricity every year — the equivalent of powering almost 60,000 homes. More than 25% of this electricity is spent on clarification-stabilization, the final step in which tartaric acid is reduced through energy-intensive refrigeration.

As an alternative to refrigeration, some winemakers are using electrodialysis, a technology developed in Europe in the early 1990s. The titratable acidity (tartaric, citric, malic and ascorbic acid concentrations) is unchanged. Potassium bitartrate and calcium tartrate salts are removed from solution.

Pacific Gas & Electric Company (PG&E) commissioned two studies at California wineries, with the goal of determining the most energy-efficient methods to stabilize wines. The first study, which took place at Fetzer Vineyards (Hopland, CA), compared the energy consumption of electrodialysis to that of cold stabilization. The second study compared the energy efficiency of cold stabilization at Fetzer Vineyards to that at another site, where cold stabilization was enhanced by seeding, using insulated tanks, and other factors.

Despite using more water, the electrodialysis process was found to be up to 99%more energy efficient than cold stabilization, using eight watt-hours (Wh) per gallon to stabilize the wine versus 22 to 1,200Wh per gallon for the cold stabilization process (whether tanks are insulated or not). For uninsulated tanks, it is 95%of 1,200Wh per gallon; for insulated tanks, it is 95%of 22Wh/gal.

Cold-stabilizing wine in uninsulated tanks is the least efficient method available, resulting in greater energy demand.

Energy efficiency of the cold stabilization process varied greatly depending on a number of factors, including tank insulation, wine type, seeding, and duration of stabilization. Electrodialysis was shown to maintain wine quality, reduce wine loss, and reduce processing time from weeks to days.

Electrodialysis stabilized wine in just a little over one day, while the cold stabilization system that included seeding and tank insulation required five days. The unenhanced cold stabilization system took a full 46 days.

PG&E and Fetzer Vineyards: energy efficiency partners

These studies are part of PG&E's Emerging Technologies (ET) program, which identifies, assesses, and brings to market the next generation of energy-efficiency solutions for Californians at home, at work, and in industry. ET works with a wide range of customers who have opened their homes or businesses to host these studies.

Working with PG&E, Fetzer Vineyards tested electrodialysis as part of the winery's goal of adopting innovative and sustainable viticulture and winemaking methods. The mobile trailer-mounted "STARS" ED unit was provided by Winesecrets (Napa, CA).

"We have been very pleased to participate with PG&E in this electrodialysis study," says Ann Thrupp, Fetzer sustainability manager. "As innovators in sustainable winegrowing practices, we hope this kind of information can be useful to others who are interested in saving energy and gaining efficiency benefits from new technologies."

Science behind tartrate stabilization

As the final step before bottling, stabilization reduces the concentration of potassium bitartrate (cream of tartar) in wine. For customers, this means no "wine diamonds" will be visible at the bottom of a chilled bottle of wine. Traditionally, this is accomplished by chilling the wine to around 27°F for a period of 1½ to 3 weeks, depending on how quickly the potassium bitartrate is crystallized.

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http://www.practicalwinery.com/sepoct08/page1.htm

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⇨ Electrodialysis

Tartaric acid is removed as the wine passes through an electric field and separates ions on anionic and cationic membranes.

The cationic membrane allows positively-charged potassium (K^+) and calcium (Ca^{2+}) to pass through, while the anionic membrane allows negatively-charged tartrate to be removed.

Chamber #1 holds the wine.
Chamber #2 contains a solution of potassium and calcium ions that have been extracted. Water flows through the second chamber, creating a brine solution made up of the potassium and calcium ions.

http://www.practicalwinery.com/sepoct08/page1.htm

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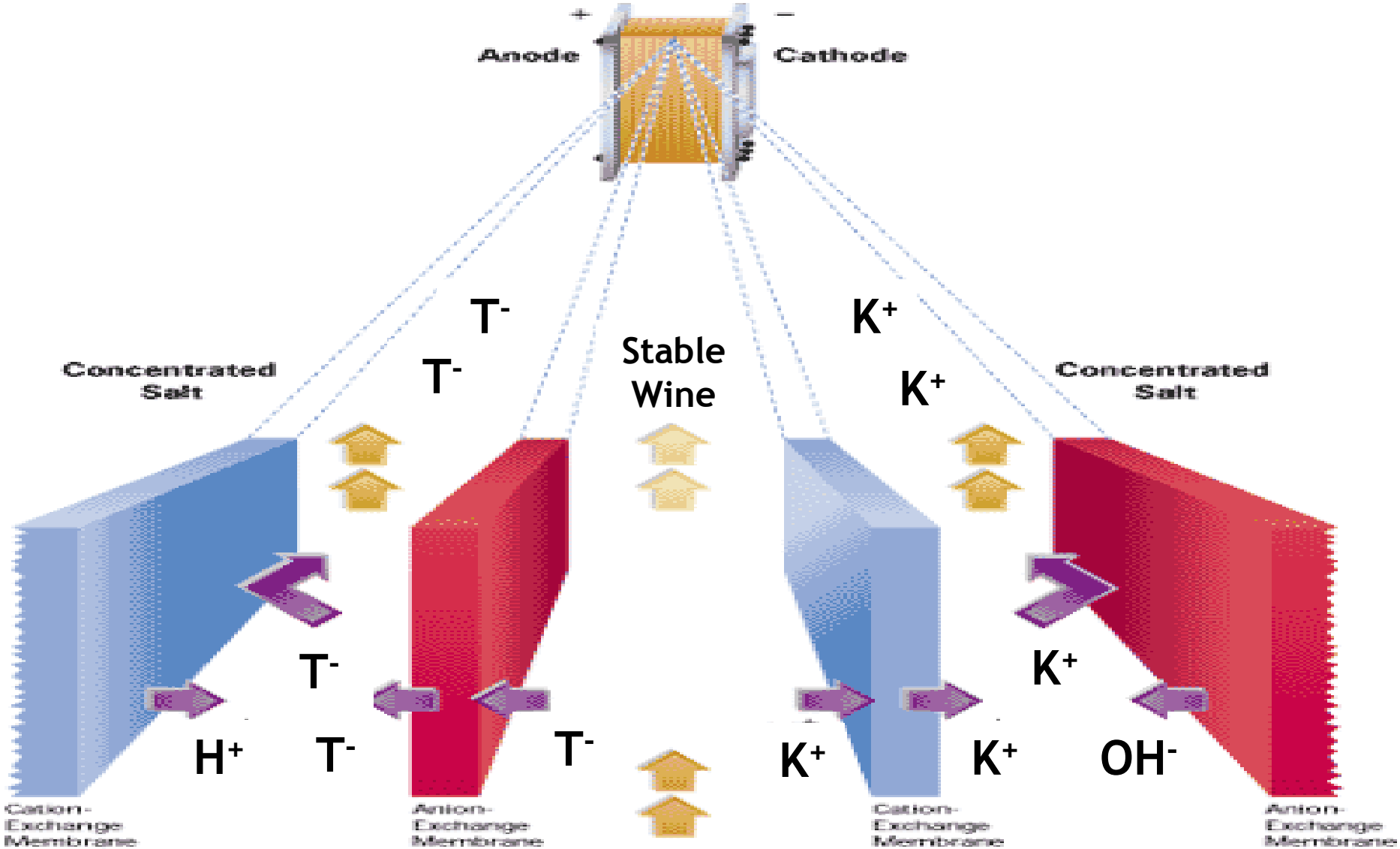
⇨ Electrodialysis



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Wine Cold Stability Techniques

- Cooling/Freezing (w/seeding)
- Electrodialysis
- Metatartrate
- Mannoproteins
- Ion exchange
- Fluidized bed

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⇨ *Meta* Tartraric Acid

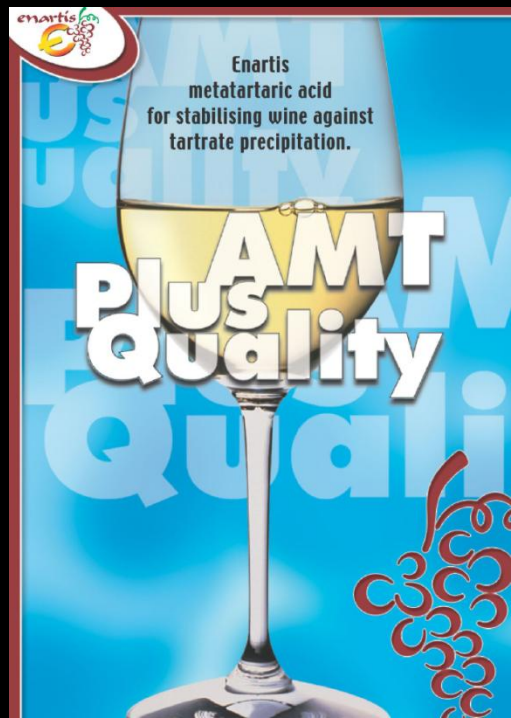
Mixture of mono- and di-esters

ISSUES:

- Only temporary stability

  Fine if wine is sold and consumed within 6 months

- Use not permitted in the US!
- 100 mg/L in Europe



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⇨ Mannoproteins

ISSUES:

- **Protein Additions**

  150-300 mg/L

Timing

"It is essential to avoid any subsequent operations which affect the colloidal structure of the wine (blending, fining, pre-filtration, etc.)."

- **Aroma Scavenging?**
- **Magic?**

YEAST BIOPRODUCTS

Back to previous page

MANNOSTAB®

TARTARIC STABILISATION THAT ENHANCES THE QUALITY AND REPUTATION OF YOUR BEST BLENDS.

MANNOSTAB® is a targeted œnological treatment, based on the inhibition of potassium bitartrate crystallization. It provides a natural, simple solution to the stability requirements of filtered or non-filtered wines.

- A natural constituent already present in wines, MANNOSTAB® perfectly conserves the quality ofthe wine.
- Involving no waste materials, no energy or water consumption, MANNOSTAB® is an ecological treatment which complies with new environmental constraints.

> Product data sheet (pdf)
> Technical data sheet (pdf)
> MSDS (pdf)
> Direction for use (pdf)

		Storage	25 °F
Wine types	Untrea-ted	MANNOSTAB®	Cold
late harvest, AOC, Jurançon	5 days	> 95 months	> 95 months
dry white wine, AOC, Bordeaux	3 days	> 91 months	> 91 months
Red wine, AOC, Irouléguy	5 days	> 89 months	> 89 months
Rosé	4 days	> 89 months	> 89 months

"The microscopic observation of the potassium bitartrate crystal development in the presence or absence of Mannostab® shows that it prevents the preferential growth of certain crystal faces, flattening the shape of the crystals. The crystal only grows in a certain orientation, thus preventing it from precipitating."

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Wine Cold Stability Techniques

- Cooling/Freezing (w/seeding)
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⇨ Ion Exchange

ISSUES:

- Nutrient stripping

  Amino acids and vitamins

- Rise in T.A. (perceived tartness)

  If cation exchange only

- Regeneration waste stream

  Salinity

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Wine Cold Stability Techniques

- Cooling/Freezing (w/seeding)
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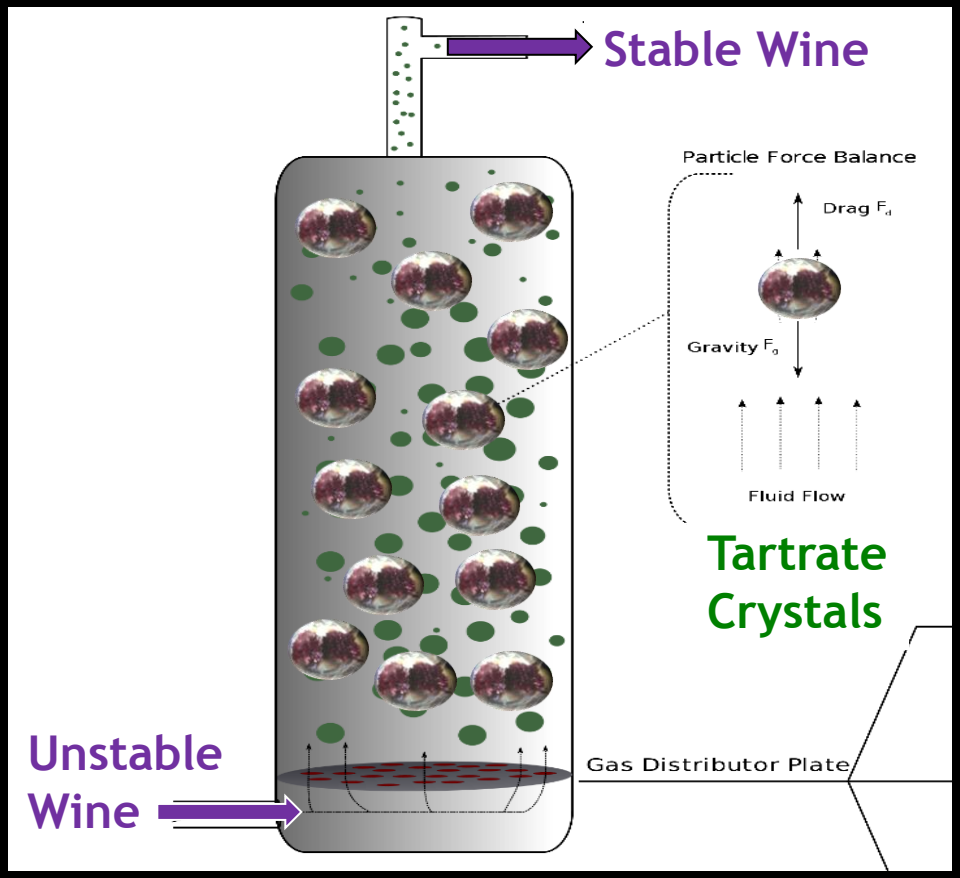
⇨ Fluidized Bed



© Roger Boulton, UC Davis

- Robert Bolan, M.S. 1996
  Development of a Fluidized-Bed Crystallizer for Wine Treatment

- David Hirzel, M.S. 2008
  Development of a Fluidized Bed for Crystallizing K Bitartrate from Wine

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MARCH 2012

South America for Wine Professionals

The International Wine Industries of Chile and Argentina

Join Purdue's leading experts on Grape and Wine Production for an Extension adventure to Chile and Argentina, and an opportunity to explore and experience global viticulture and enology!

Schedule

Our group will travel to Santiago de Chile on March 9 and return on March 18. We will travel to several of the key wine production regions of Chile, including the Maipo, Casabanca, and Aconcagua Valleys. Stops will include visits to several of Chile's top wineries and vineyards (Viña Veramonte, Viñedos Orgánicos Emiliana, Viña Errázuriz). We will visit conventional, organic, and biodynamic farming operations.

The group will have the opportunity to explore the magnificent scenery of Chile, from its Pacific Coast beaches to the Andes Mountains.

A day trip across the 22,841 ft high Andes will take us to Mendoza, Argentina, to explore in the other center of the South American wine industry with visits to premier wine producers (Finca Decero, Catena Zapata, and Familia Zuccardi). We will stay in the old city of Mendoza, with its beautiful plazas and tree-lined streets, and plenty of opportunity to experience the vibrant culture of Argentina.

Program Information

The program is open to professionals in the Midwestern wine industry.
The enrollment is limited to 20 participants. Deadline for enrollment is November 30, 2011.
Cost for the Purdue Extension class *South America for Wine Professionals* is approximately $4,000 per person.

INTERESTED?
CONTACT CHRISTIAN OR BRUCE!

Faculty:

Dr. Christian Butzke — *Enology Professor* — *butzke@purdue.edu*
Dr. Bruce Bordelon — *Viticulture Professor* — *bordelon@purdue.edu*

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Wine Cold Stability Assessments

- Cooling
- Freezing
- Conductivity

ISSUE:
Testing stability @ 32°F for 5 days to assess stability for shelf-life of wine?

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Wine Cold Stability Assessments

- Cooling
- Freezing
- Conductivity

ISSUE:
Testing stability of slushie at 0°F to assess wine stability at 32°F?

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Wine Cold Stability Assessments

- Cooling
- Freezing
- Conductivity

ISSUE:
Testing stability at same temperature as stability is desired at (e.g. 32°F)

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Wine Cold Stability Assessments

⇨ Davis Conductivity Test

- Strirred, KBT-seeded sample of wine
- Temperature-controlled => *choose T*
- Conductivity probe:
  - Conductivity down => unstable
  - Conductivity stable => stable at T
  - Conductivity up => stable at and below T
- Results are *wine-specific*!

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Wine Cold Stability Assessments

⇨ Davis Conductivity Test

- Conductivity probe:
  - Ranges: 100 µS to 1.0 mS and 1.0 to 10 mS
  - Accuracy: 0.5% or better
- Seed crystals: 1.5 g *powdered* KBT per 100 mL
- T-controlled, *refrigerated* water-bath
- Magnetic stir bar => read again after 20 min

Source:
Roger Boulton, Sinclair S. Scott Chair in Enology and Chemical Engineering
in: *Principles and Practices of Winemaking*

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Wine Cold Stability Assessments

⇨ Davis Conductivity Test

- Final conductivity of sample
  = target for whole tank
- No magic number to shoot for = *wine-specific*
- Look for changes of less than 3 to 5%
- Keep conductivity records of older vintages

Source:
Roger Boulton, Sinclair S. Scott Chair in Enology and Chemical Engineering
in: *Principles and Practices of Winemaking*

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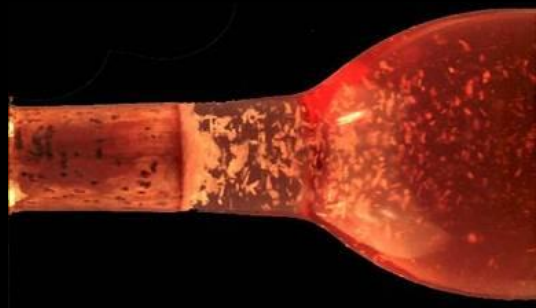
Potassium Salt Additions

mg/L aka "ppm" aka "parts"

	Salt		K^+
Bitartrate	+200	39/188 =	+ 41
Bicarbonate	+660	39/100 =	+257
Sorbate	+268	39/150 =	+ 70
Metabisulfite	+ 50	78/222 =	+ 30

=> Cold stability compromised !



=> For bottled-fermented *sparkling wine dosage* use SO_2 *gas* dissolved in water, not potassium metabisulfite.

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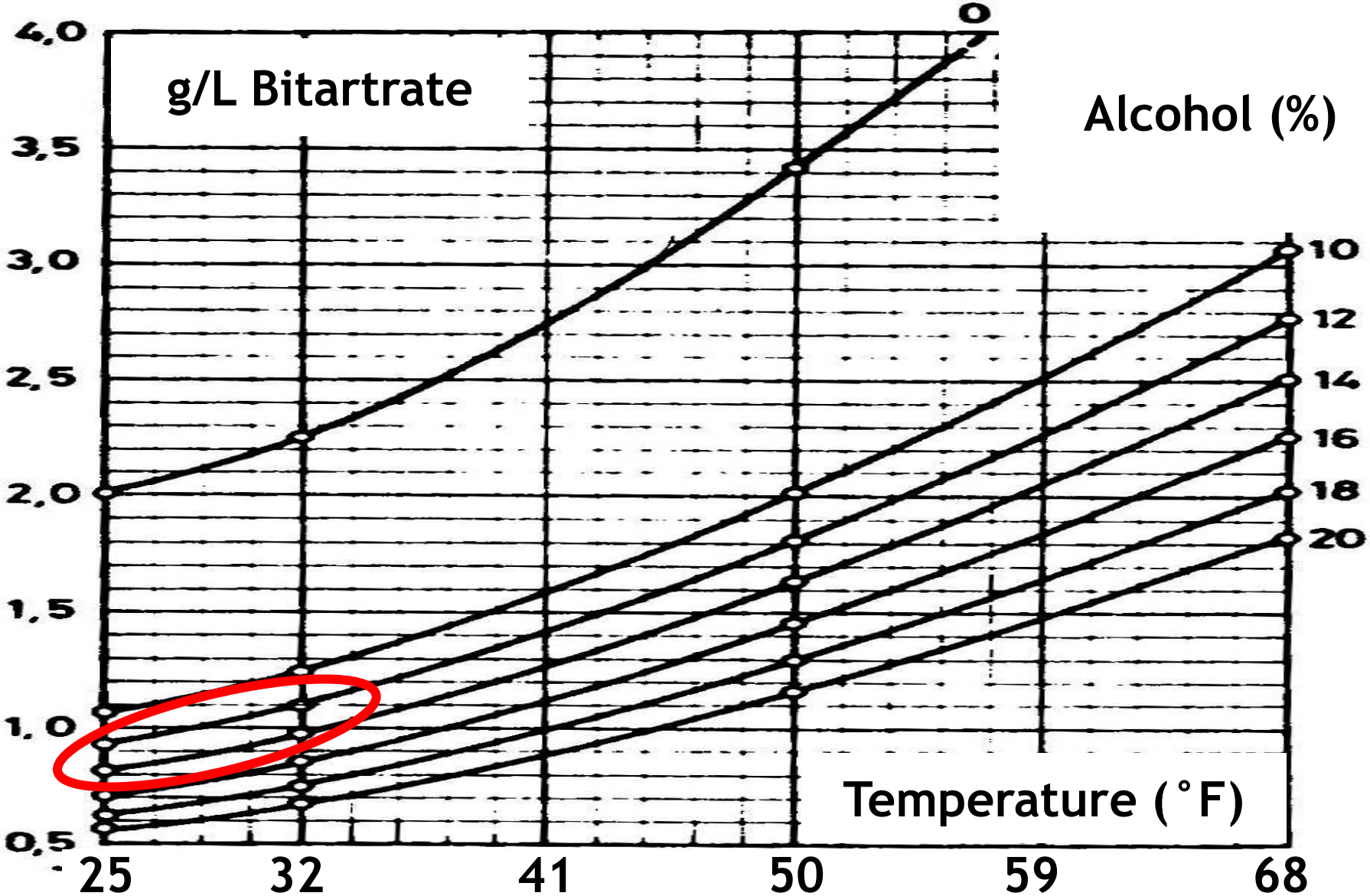
Potassium Bitartrate Stability



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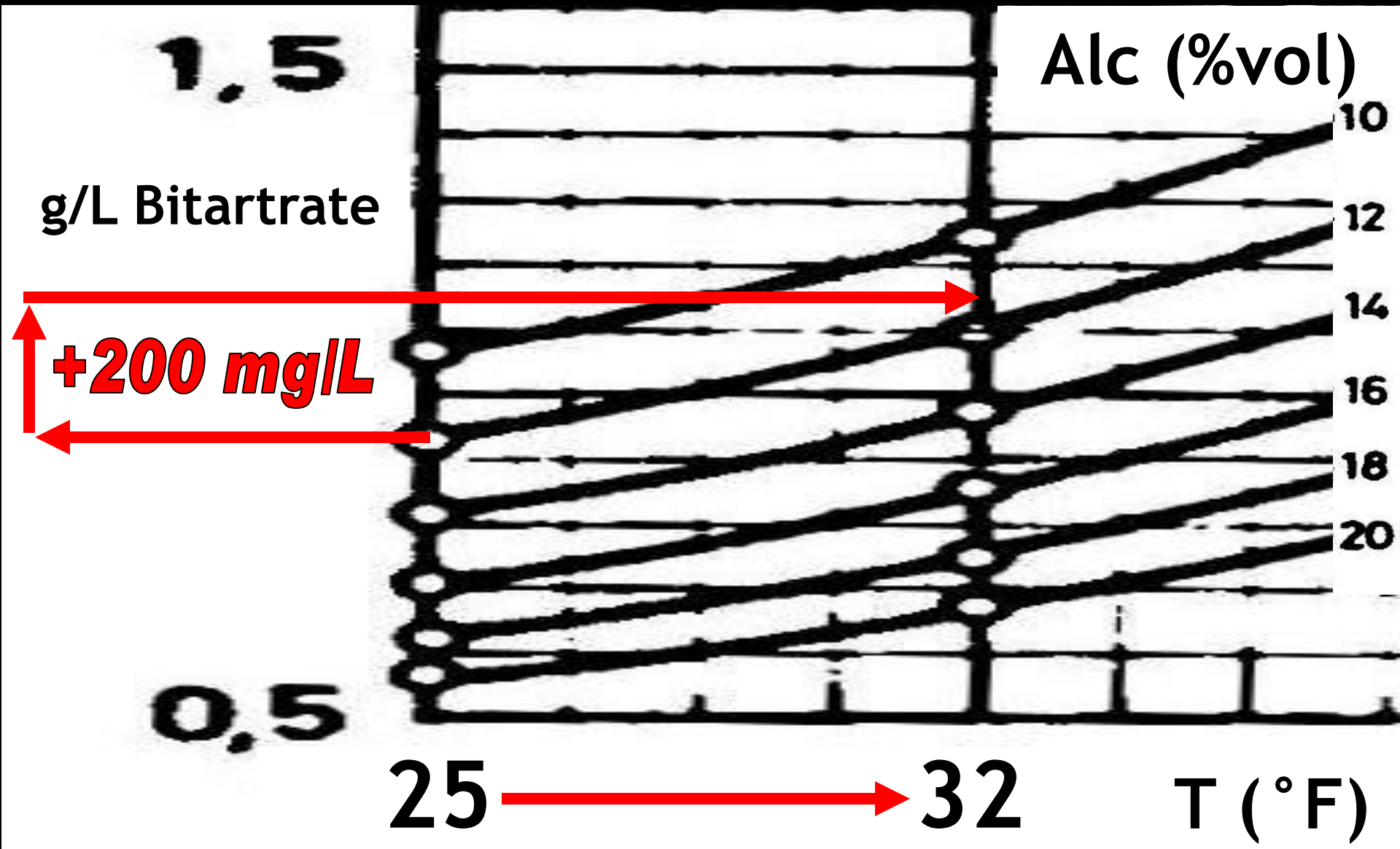
Potassium Bitartrate Stability



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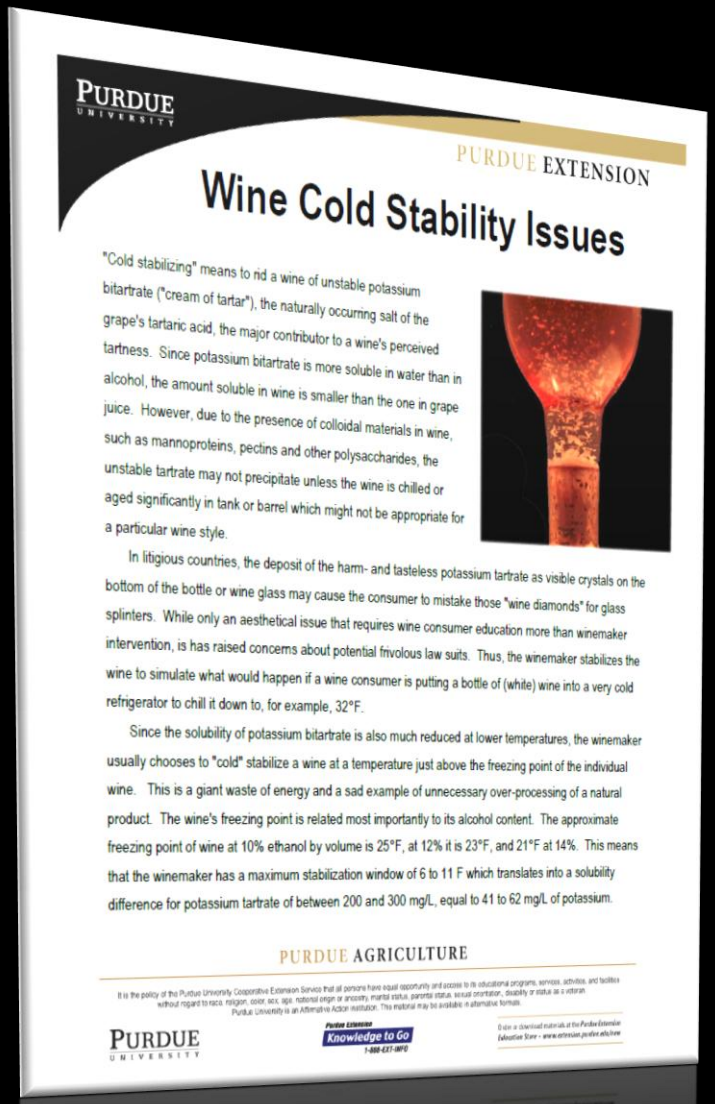
Cold Stability Issues



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Wine Cold Stability Issues

"Cold stabilizing" means to rid a wine of unstable potassium bitartrate ("cream of tartar"), the naturally occurring salt of the grape's tartaric acid, the major contributor to a wine's perceived tartness. Since potassium bitartrate is more soluble in water than in alcohol, the amount soluble in wine is smaller than the one in grape juice. However, due to the presence of colloidal materials in wine, such as mannoproteins, pectins and other polysaccharides, the unstable tartrate may not precipitate unless the wine is chilled or aged significantly in tank or barrel which might not be appropriate for a particular wine style.

In litigious countries, the deposit of the harm- and tasteless potassium tartrate as visible crystals on the bottom of the bottle or wine glass may cause the consumer to mistake those "wine diamonds" for glass splinters. While only an aesthetical issue that requires wine consumer education more than winemaker intervention, is has raised concerns about potential frivolous law suits. Thus, the winemaker stabilizes the wine to simulate what would happen if a wine consumer is putting a bottle of (white) wine into a very cold refrigerator to chill it down to, for example, 32°F.

Since the solubility of potassium bitartrate is also much reduced at lower temperatures, the winemaker usually chooses to "cold" stabilize a wine at a temperature just above the freezing point of the individual wine. This is a giant waste of energy and a sad example of unnecessary over-processing of a natural product. The wine's freezing point is related most importantly to its alcohol content. The approximate freezing point of wine at 10% ethanol by volume is 25°F, at 12% it is 23°F, and 21°F at 14%. This means that the winemaker has a maximum stabilization window of 6 to 11 F which translates into a solubility difference for potassium tartrate of between 200 and 300 mg/L, equal to 41 to 62 mg/L of potassium.

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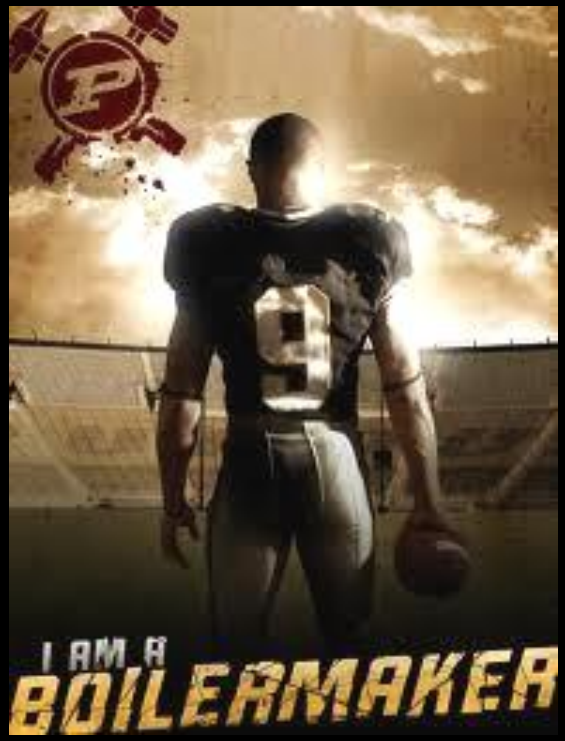

Bob Kreisher, Ph.D.
President

mna
mavrik north america

Bob was born and raised in Indianapolis. He graduated from Purdue University the year it started its Enology and Viticulture program, completely unaware of this development. After many years in university administration, teaching, and consulting, Bob moved to California to help with the organizational design of an emerging winery. Meanwhile, Bob developed a keen interest in developing technologies of winemaking that are gentle and cost-effective to allow cutting edge cellar techniques that enhance the expression of terroir and winemaking, rather than reducing wines to similarity. After intensive research into available and emerging technologies, Bob formed MNA with Mariana Brown.
In his spare time, he enjoys cooking, film, hiking, gardening, travel, and spending time with his family and friends.