WEA Conference – 8 September 2016

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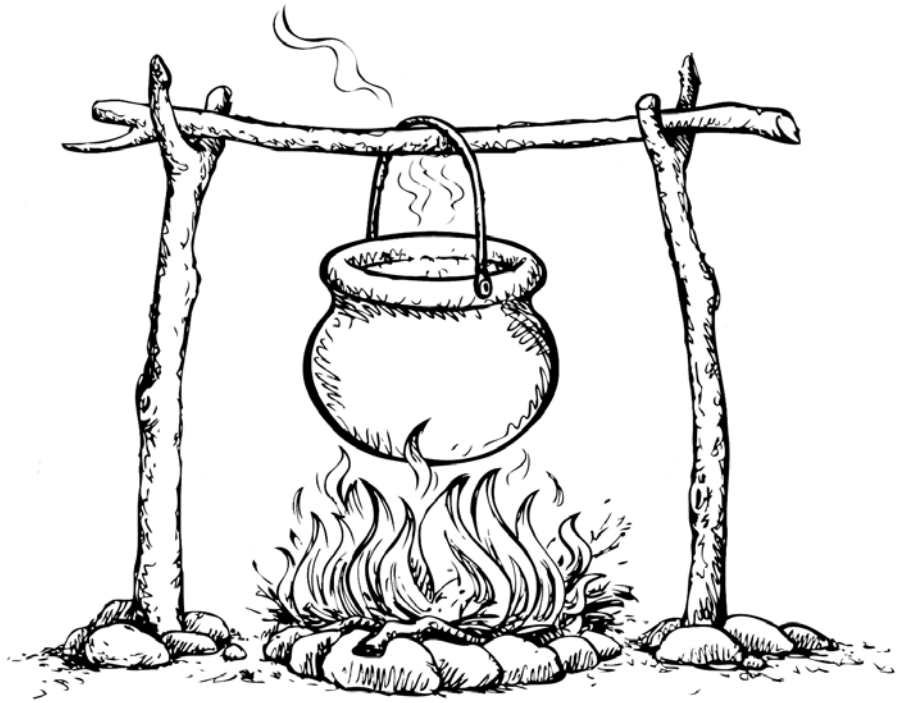

Rapid Extraction Techniques for Red Wine Production

Simon Nordestgaard
simon.nordestgaard@awri.com.au

Why rapid pre-fermentative heat extraction?

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- Classical red ferments in contact with skins
  - Need to facilitate colour extraction from skins
  - Need to facilitate skin removal from tank at the end

    ⟶ Requires relatively expensive tanks (e.g. SWAPs, Vinimatics, etc.) and/or labour to manage skins

- If could extract the colour before fermentation, could ferment red wines like white wines in cheap tanks without labour

  ⟶ May be of increasing interest as vintages get more compressed and need to buy more red fermenters (Note: 500 million L made with heat in France every year)

References: Moutounet (2008)

19th century France

Prunaire (1877):

- Proposed heat as one natural method of enhanced skin colour extraction to stop the adulteration of wines with fuchsine (a synthetic aniline dye)

References: Cooksey and Dronsfield (2009), Ferré (1928), Prunaire (1876)

Early 20th century – Heating skins with hot juice

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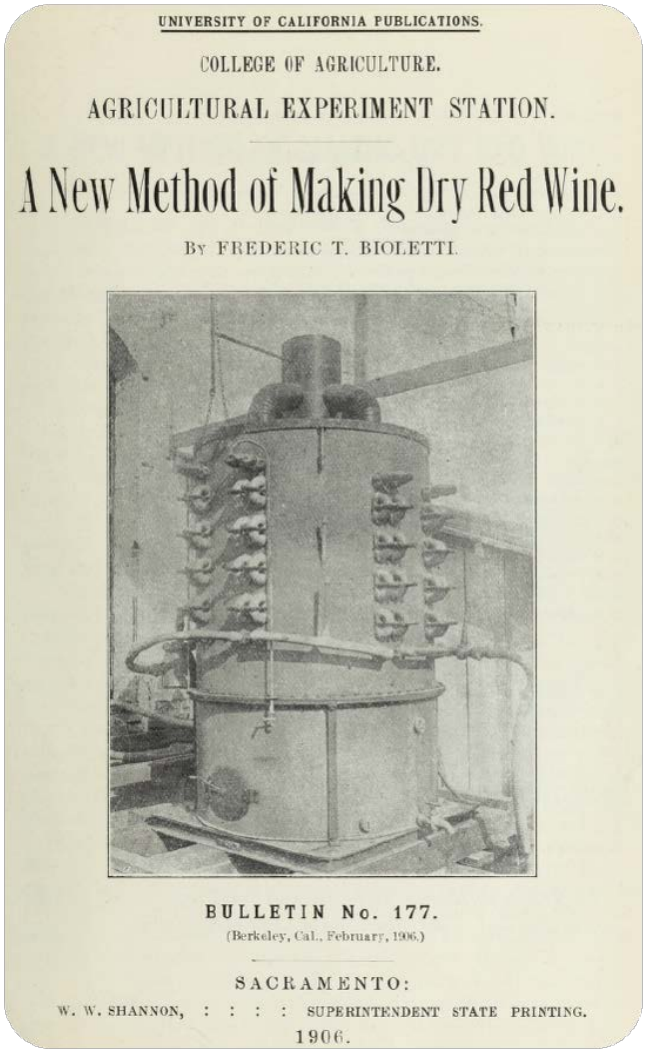

UNIVERSITY OF CALIFORNIA PUBLICATIONS.

COLLEGE OF AGRICULTURE.

AGRICULTURAL EXPERIMENT STATION.

A New Method of Making Dry Red Wine.

By FREDERIC T. BIOLETTI.

BULLETIN No. 177.

(Berkeley, Cal., February, 1906.)

SACRAMENTO:

W. W. SHANNON, : : : : SUPERINTENDENT STATE PRINTING.

1906.

Bioletti (1906) in California:

- Grapes crushed, destemmed and drained
- Juice heated to 60-66 °C
  - Steam used to heat juice running in copper tubes
- Hot juice added back into tank with skins
- After desired contact time, juice is drained, cooled and liquid ferment performed
- Author notes that method was also used successfully in France by one winery for their whole vintage of 280,000 L

Reference: Bioletti (1906)

1920s - Whole grape immersion heating

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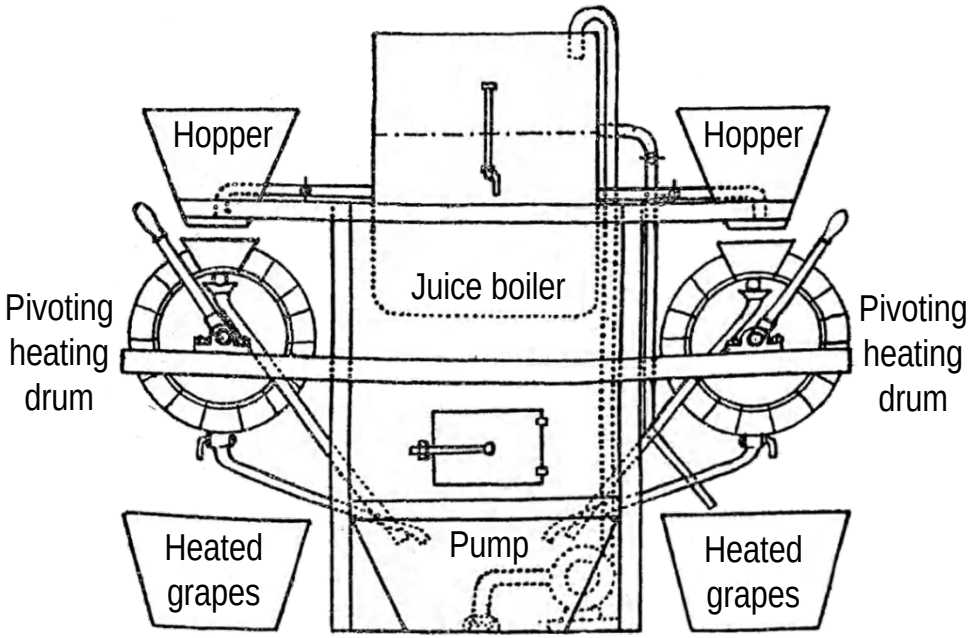


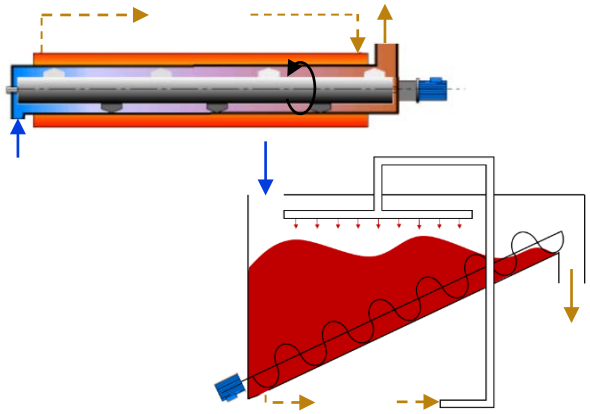
"Thermograppe" designed by Roy
(a winery collaborator of Louis Ferré - Director of the Burgundy Oenological Station)

Ferré (1928):

- One drum filled with grapes
- A quantity of juice is boiled and added to the grapes
- After 4-5 minutes juice is drained and pumped to boiler for reheating
- Grapes tipped from drum and left in tubs for 12-24 hour
  - Colour from skins diffuses inwards
- Crushing, destemming, pressing and liquid ferment follow

References: Ferré (1926, 1928, 1958)

1960s & 1970s – High throughput equipment



- Some disastrous vintages in France in the 1960s, created interest in better ways of managing rot/laccase
- High throughput continuous equipment was developed that allowed large tonnages to be rapidly heated and processed
  - Managed laccase
  - Reduced tank/labour requirements

"Thermovinification": <1 hour hot maceration time (often less) and a liquid ferment

References: Blouin and Peynaud (2012), Peynaud (1981), Rankine (1973)

1970s – Widespread interest

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Heat Extraction of Color From Red Grapes Of Increasing Importance

DR. B. C. RANKINE

HEAT extraction of color from red grapes prior to fermentation is one of the most important recent developments in Australian winemaking. The process is now used commercially and many winemakers are very interested in its possible adoption in their own wineries.

Wines and Vines 1973

SECOND WINE INDUSTRY TECHNICAL CONFERENCE

Location: Tanunda, South Australia
Time: 7-9th August, 1973 inclusive

HEAT EXTRACTION OF COLOUR FROM RED GRAPES

Mr. G. Prass.
G. Gramp & Sons Pty. Ltd. Rowland Flat,S.A.

PARTIAL HEAT-TREATMENT OF RED MUST

G. Kolarovich,
Barossa Co-op Winery Ltd. Nuriootpa S.A.

References: Kolarovich (1973), Prass (1973), Rankine (1973)

1970s – Thermovinification equipment

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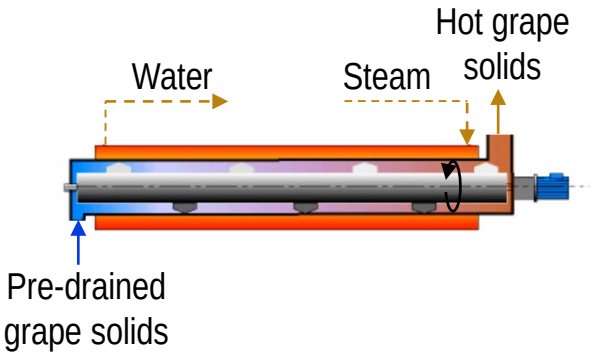
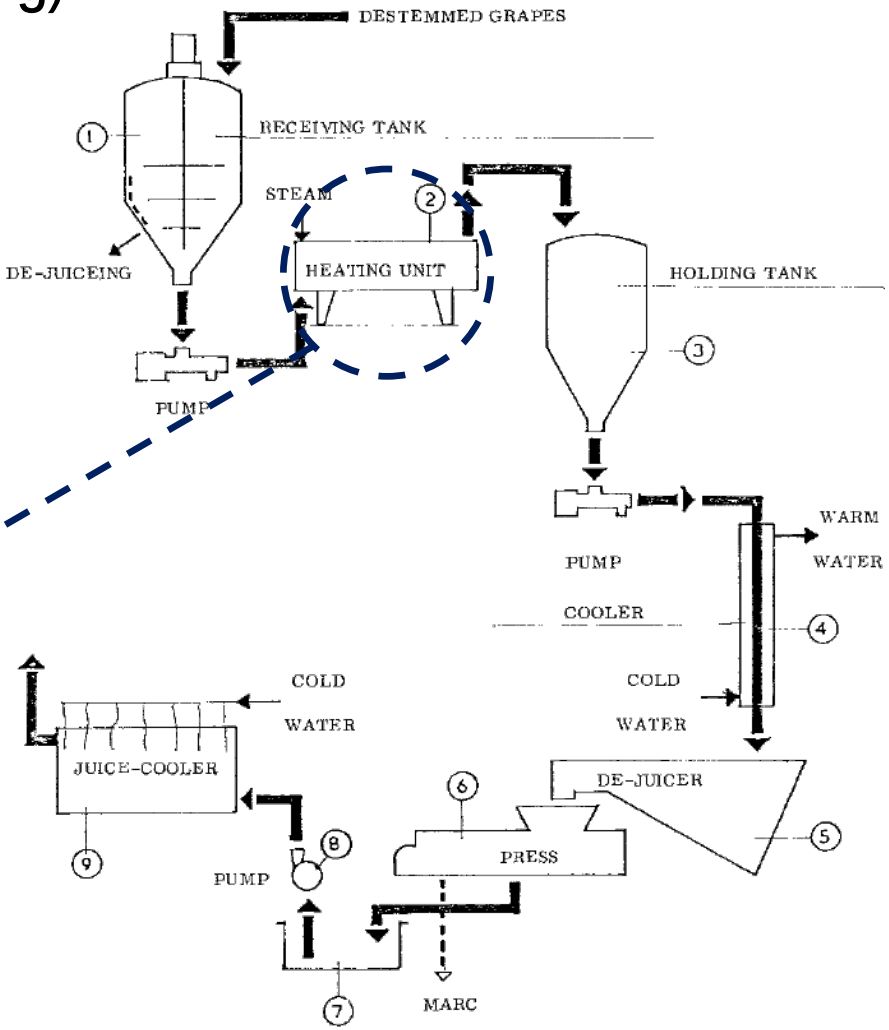
A. Gasquet (scraped-surface heating)





Reference: Blouin and Peynaud (2012), Wagener (1981)

1970s – Thermovinification equipment

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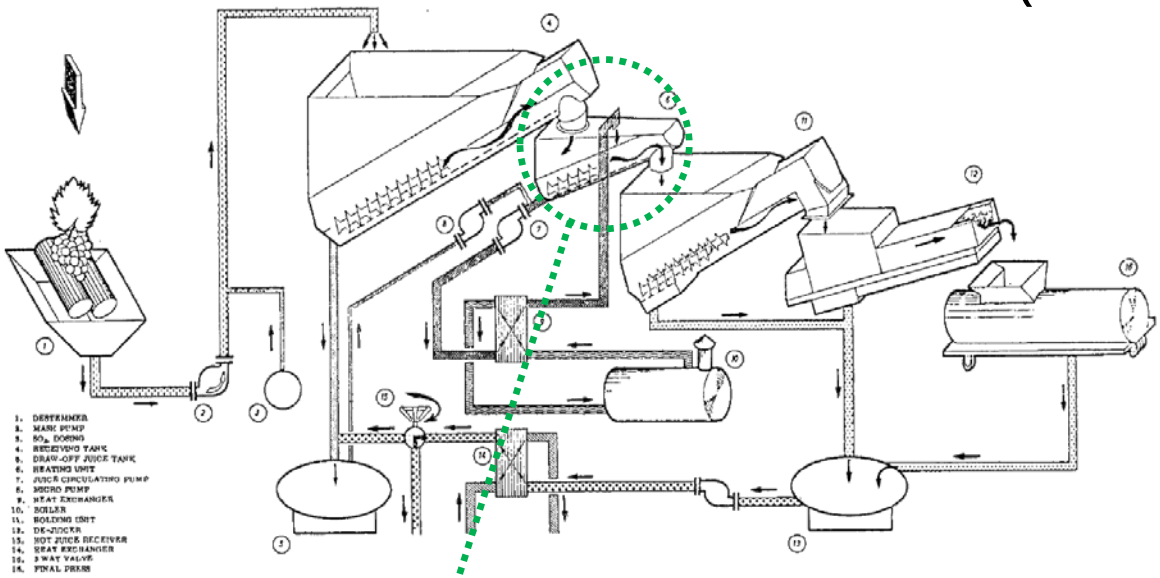
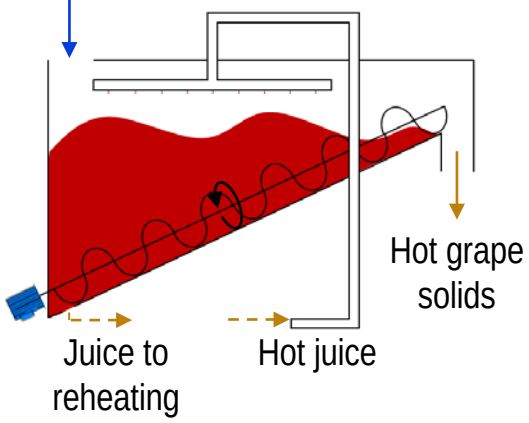
B. IMECA (immersion heating)





Reference: Blouin and Peynaud (2012), Wagener (1981)

Thermovinification equipment

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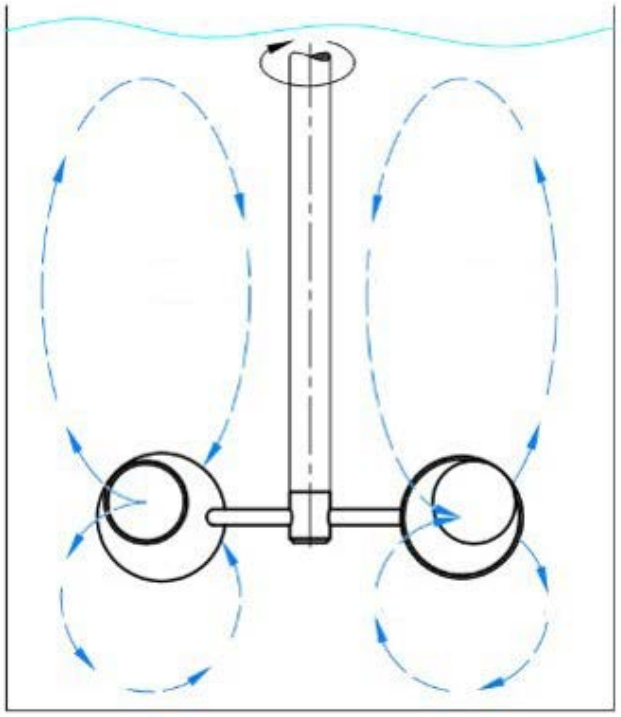
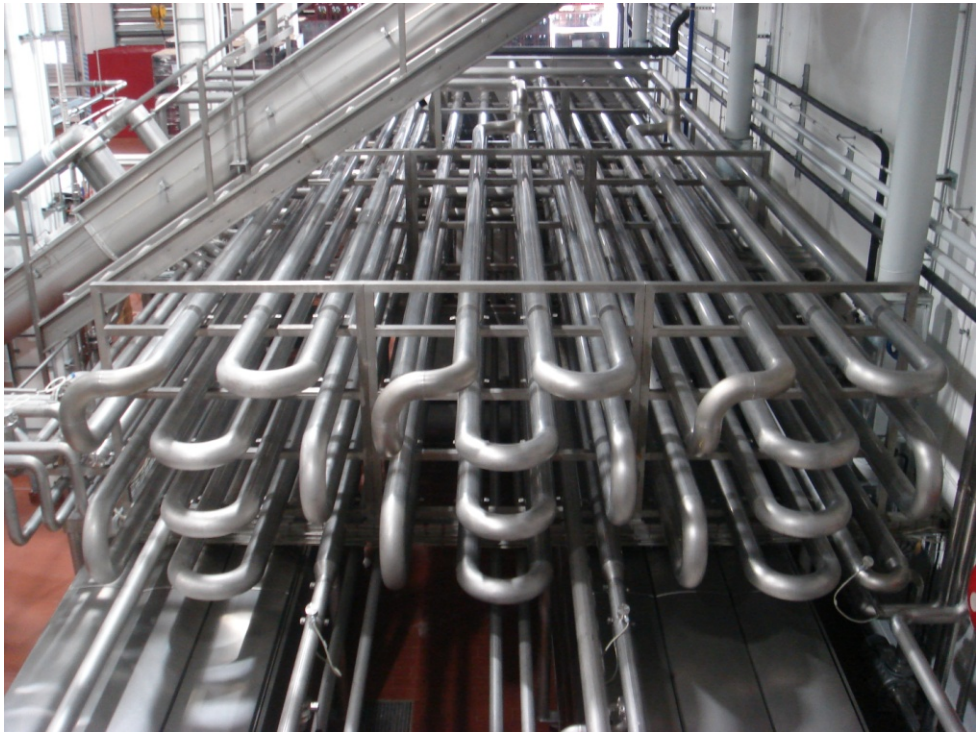
C. Gentle must homogenisation and long tube-in-tube heat exchanger (2-stage heating: 1. Pre-heating using hot product, 2. Steam)





Reference: Fischer (2016)

1991 - Evolution of immersion heating

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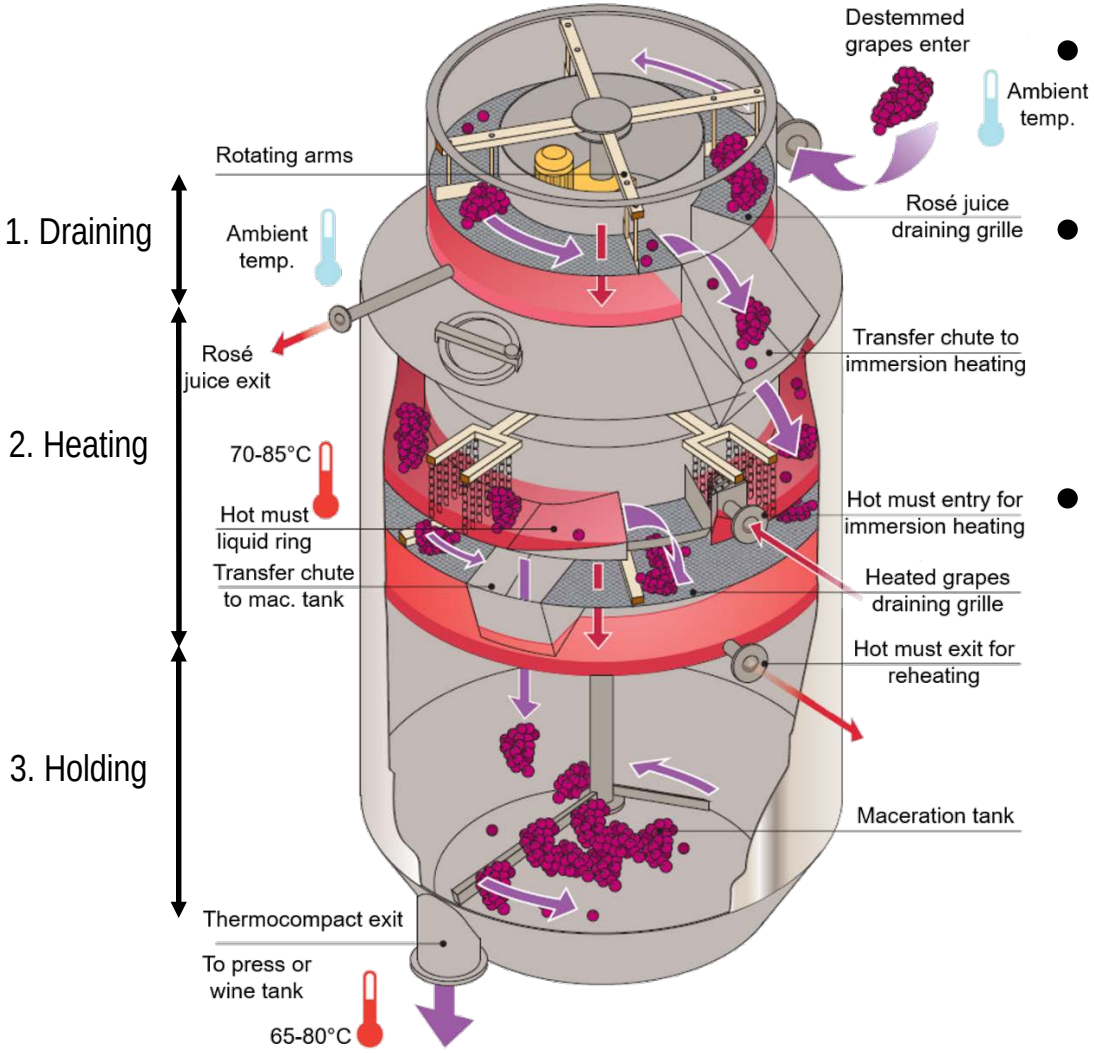

- IMECA Thermocompact
- Combines 3 units from the earlier system in 1 device
- Immersion heating techniques allow considerable pre-draining from crushed grapes if desired (Rosé), minimising the material to be heated

2000s – Modern immersion heating

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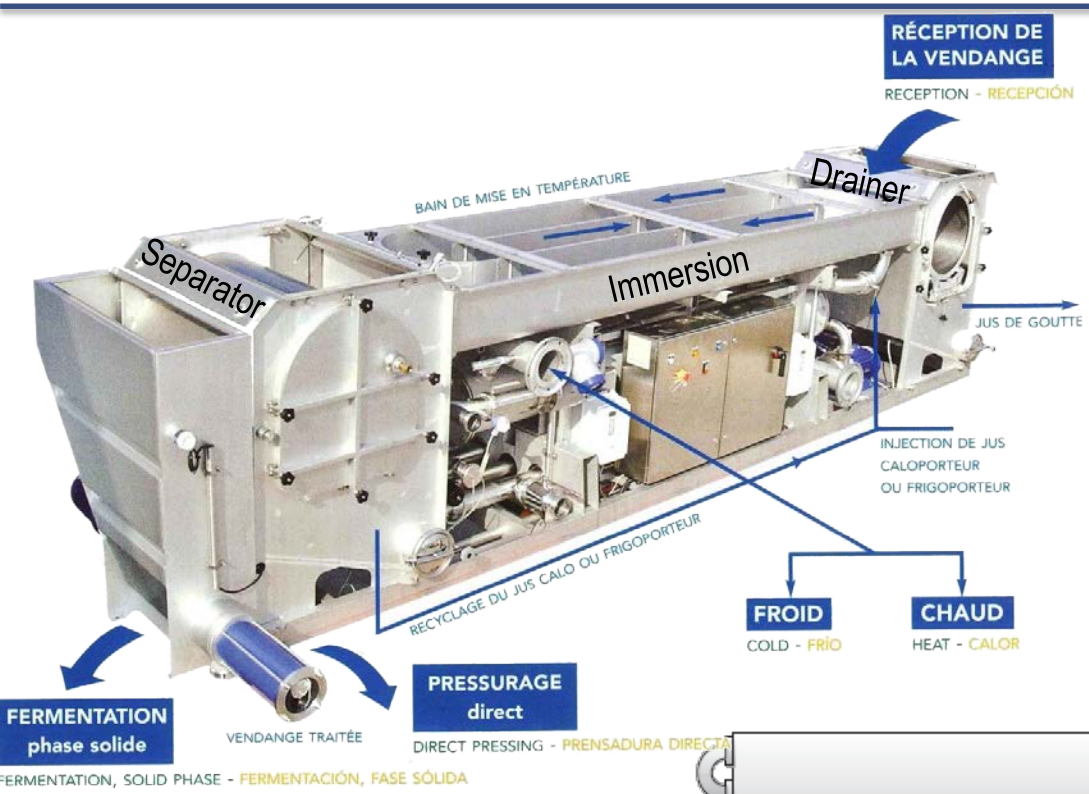
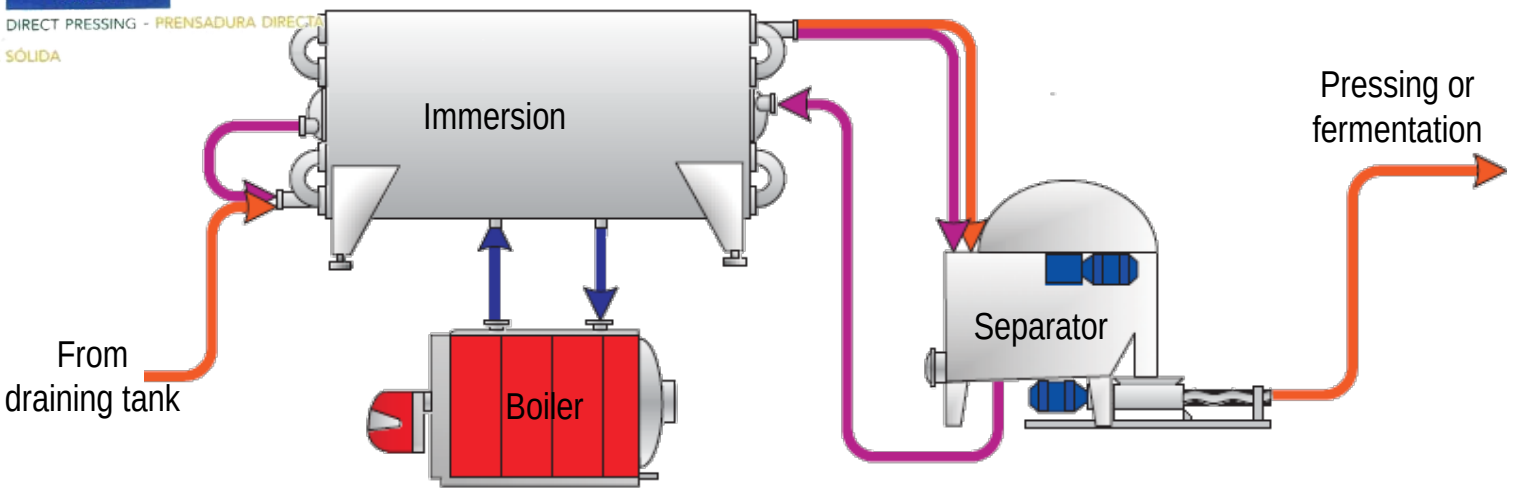


Pera-Pellenc Gulfstream

Della Toffola Biothermo



Issues with thermovinification

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- Colour instability
  - Major colour losses during fermentation and storage
    - Lots of anthocyanins but not enough tannin to stabilise them
    - Lots of small particles that can fine out anthocyanins
- Lack of structure
  - Anthocyanins are extracted more than tannins

References: Moutounet (2008), Peynaud (1981), Yerle (2008)

Colour stability & clarification – RDVs, c. 1980

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- Heat extracted musts are very difficult to clarify (natural grape enzymes have been destroyed by heat)

- Rotary drum vacuum (RDV) filtration prior to fermentation allowed a thorough clarification (< 50 NTU)
  - Removed particles that could fine out anthocyanins
  - Colour was a bit more stable

- Low solids content during fermentation:
  - ⟶ Fruity and estery wines (described by some as "banana yoghurt")

References: Gros and Yerle (2014), Moutounet (2008), Yerle (2008)

Improving structure & further stabilising colour

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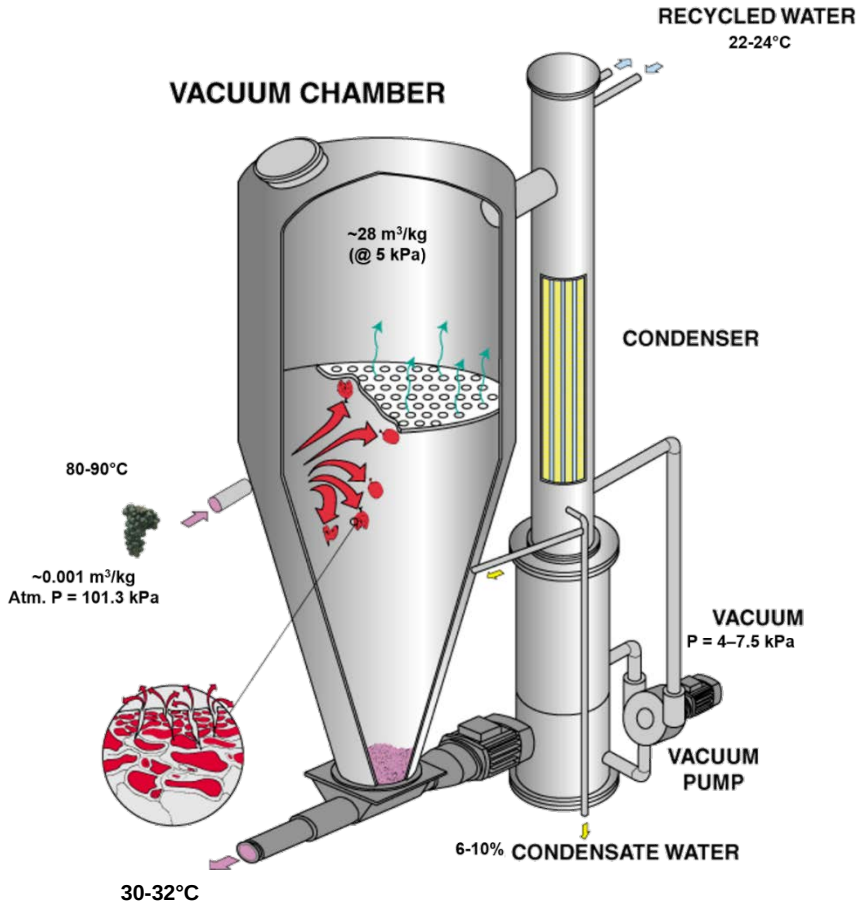
- "Pre-fermentation hot maceration" (MPC – French acronym):
    - Up to 12 hours (instead of < 1 hour for "Thermovinification")
    - Coupled with either a liquid ferment or a period of fermentation on skins
- Post-heating techniques to further permeabilise skin cell walls and enhance extraction:
    - Flash détente
    - Thermo détente
    - Coupled with either a liquid ferment or a period on skins

1993 - Flash détente



- Patented by INRA in 1993
- Grapes heated to near boiling and when exposed to a vacuum, a portion boils immediately (flashes)
  - Flash cools the grapes
  - Enhances extractability of tannins and polysaccharides
  - Allows removal of pyrazines in condensate water (or can be recombined with or without activated carbon treatment)
- Brands: Pera-Pellenc Flash détente, Della Toffola Thermocooler, TMCI Padovan Red Hunter

References: Ageron et al. (1995), Escudier et al. (1993) – WO 95/13360

2011 – Modulated flash détente

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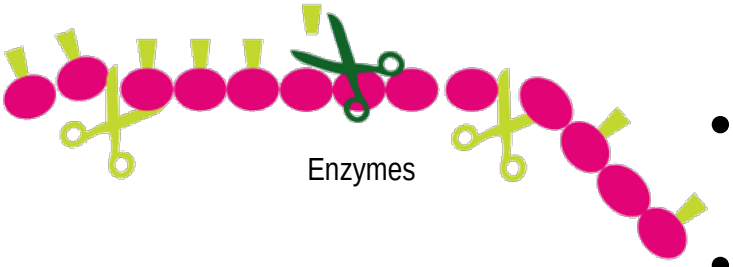

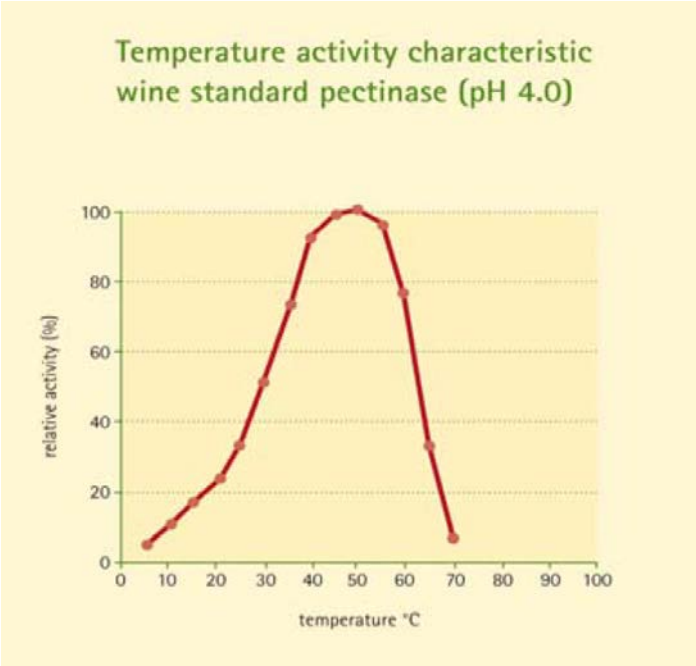

- Patented by INRA together with Pera-Pellenc
- Use a slightly weaker vacuum so that the harvest is only cooled to 55°C instead of 30°C
- Enzymes added to assist extraction
  - At 55°C they are near their optimum activity
- Don't have to worry about laccase because this was denatured by heating before flash détente
- Don't have to worry about fermentation, because yeast won't grow much at 55°C
- Can perform the maceration while filling a large membrane press

References: Erblsöh, Escudier and Favarel et al. (2011) – US2015/0140166, Gros and Yerle (2014), Laffort

2000s – Thermo détente (Bucher-Vaslin Extractys)

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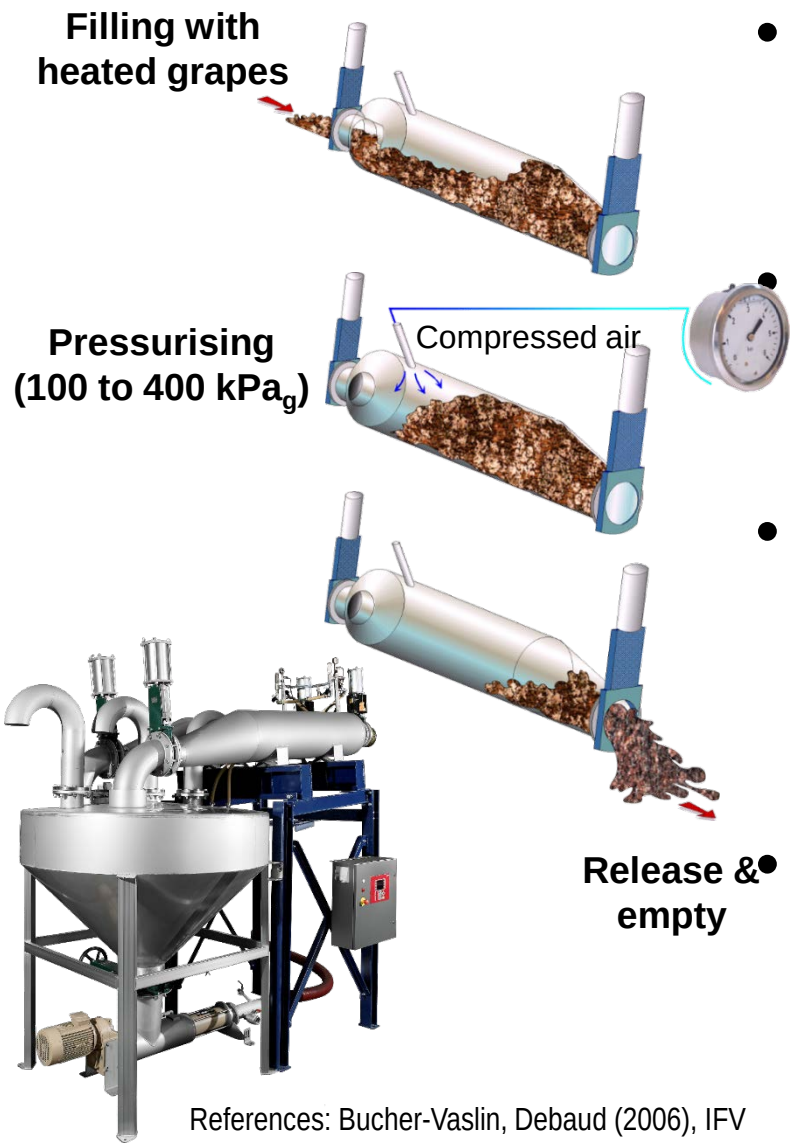

- Hot grapes pressurised to 100-400 kPa$_g$ (1-4 bar$_g$) then released
- Goal is again to try and enhance skin extractability
- Different to Flash détente because there is no evaporative flash expansion of intracellular fluid
- No cooling effect, but can perform further pre-fermentative hot maceration after treatment

References: Bucher-Vaslin, Debaud (2006), IFV

More tannins – Can then modulate level of clarification

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- With more tannin, the anthocyanins are somewhat more stable and thorough clarification using RDV is not such a necessity
  - Can increase solids levels during fermentation to try and shift profile away from fruity fermentation esters if desired

Flotation: 150-600 NTU

Centrifugation: 600-1200 NTU (small particles)

References: IFV, Yerle (2008)

IFV – Practical grape heating summary

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Treatment		Aroma	Palate	Comments
Thermovinifcation (<1 hr hot maceration)		• Fresh fruit • Estery	• Little body • Not very stable colour (tannin addition helps)	• Weak concentration • Used in blending to add fruitiness • Suitable for grapes with green or neutral aromas
Pre-fermentation hot maceration (MPC)	Liquid ferment	• Riper fruit • Less green	• Balance approaching a classic red	• Used pure or in blends with thermovinified or classically made wines • Useful for under-ripe grapes
	Ferment on skins	• Very ripe fruit (jammy) • Less green aromas but some still present	• Wealth of tannin, sweetness • Hard tannins, rarely dry	• Needs aging (micro-oxygenation or wood) • Used in blends with MPC or thermovinified wines
Flash détente	Liquid ferment	• Fruity to estery • Reductive and green if must poorly clarified	• Balanced wine • Green tannins if insufficient phenolic maturity	• Used pure • Not very suitable for under-ripe grapes
	Ferment on skins	• No estery notes • Ripe fruit characters if good grape maturity • Green characters if average or insufficient grape maturity	• Richness and sweetness of ripe grapes • Aggressive tannins with under-ripe grapes	• Used for blending • Not very suitable for under-ripe grapes (aggressive tannins)

Translated and adapted from www.vignevin-sudouest.com/publications/fiches-pratiques/aspects-pratiques-thermovinification.php

IFV – Practical grape heating - Parameters

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Parameter	Influence
Maceration time	• Determines extraction of tannin • 30 min to 12 hrs, 3-6 hrs is typical • Tannin/anthocyanin ratio of 2-3 optimal for stable colour without tannic aggressiveness
Maceration temperature	• Has a greater influence on anthocyanins, but also some influence on tannin extraction • 65-85 °C is typical
Clarification level for liquid ferments	• Influences weight and fruitiness • >400 NTU favours weight, <100 NTU favours estery wines
Fermentation temperature for liquid ferments	• Can modulate wine aromas • 18°C gives esters, 23°C gives ripe fruit

Translated and adapted from www.vignevin-sudouest.com/publications/fiches-pratiques/aspects-pratiques-thermovinification.php

Energy costs– estimate

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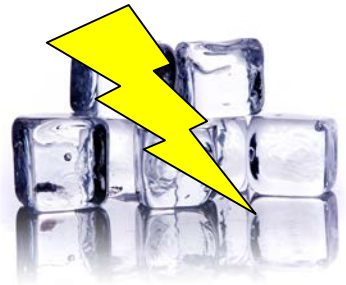
Basis: 750mL bottle of wine

Heating = 0.67kg x 4.18kJ/kg/°C x (70-20°C) / 0.7
= 200kJ = 0.2MJ
~ $0.006 / bottle

Cooling = 0.67kg x 4.18kJ/kg /°C x (65-20°C) / 2
= 63kJ = 0.018kWh
~ $0.004 / bottle



Total ~ $0.01 / bottle (utility costs only)

(Assumptions: 1 kg grapes needed for 1 bottle, 1/3 juice pre-draining, 20°C initial temp, 70°C at start of maceration, 65°C after pressing, 20°C after cooling, heating efficiency: 0.7, Cooling COP: 2, natural gas cost: $0.03/MJ, electricity cost: $0.20/kWh)

Conclusions

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- Heating grapes for extraction is not new, but understanding and techniques have evolved through research and experience
- A variety of outcomes can be achieved depending on process conditions
- Heat could be a useful tool for some Australian producers to help them manage compressed vintages, keep production costs low, and in tailoring some wine styles for consumers

Acknowledgements and further resources

- Equipment suppliers who have provided information on their equipment
- The French National Agricultural Research Agency (INRA) and The French Institute of Vine and Wine (IFV)
  - They have performed large amounts of work on this topic over the years and have a great deal of useful information on the internet that I have drawn on for this presentation:

www.vignevin-sudouest.com/publications/fiches-pratiques/aspects-pratiques-thermovinification.php

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