AIR LIQUIDE™

Pre Fermentative Cryomaceration

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The Background Research

“Cold maceration in Tuscany”, 27th May 2003

University of Florence

Department of Agrarian Biotechnology

Director of Research; Prof. Mario Bertuccioli

“Multiple factors may influence the quality of wine, and they include:

- Maturation of the grapes,
- The use of oxygen,
- Temperature,
- Maceration techniques,
- Refining methods.

By varying these factors it is possible to modify the quality profile of the wine to better achieve objectives including conformity, characteristics & style”

C.P.M. Defined

- Cold pre fermentative maceration (CPM) is a treatment which consists of deliberately blocking the commencement of fermentation by contact of the juice with the skin in conditions of low temperature. The target temperature is <15°C, and possibly <10°C for periods of up to 72 hours.

- CPM is considered to:
  - Increase fruit flavour & aroma
  - Increase aromatic intensity & complexity
  - Increase mouthfeel & palate fullness (linked to phenols & polysacharrides)
  - Increase colour intensity &/or hue
  - Generally produce wines with softer astringency.

- CPM can be achieved in three ways:
  - Accidentally, due to cold temperature
  - With the use of mechanical refrigeration
  - With the use of cryogens (pre fermentative cryomaceration).

Pre Fermentative Cryomaceration

- Pre fermentative cryomaceration (PFC) is another winemaking technique that is having immense success on a world-wide scale.
- The University of Florence research commenced in vintage 2001 & summarised:

  Two cryogens were used (solid state carbon dioxide & liquid nitrogen).

  Temperature ranges -5°C to +5°C.

  Wines obtained were characterised by chemical analysis & sensory evaluation.

  - "higher quality resulted as seen from the analytical & sensory characteristics with a higher extraction of polyphenolic compounds at lower cold maceration temperature"
  - "proportional increase of wine quality with lower cold maceration temperature was observed for solid carbon dioxide"

  Solid state carbon dioxide in particular protected from oxidation & bacteriological proliferations.

  - Very high chilling effect (150kcal/kg)
  - Fast temperature drop.
  - Anti oxidant, antiseptic action, reduction in SO2 use.

Pre Fermentative Cryomaceration

- The University of Florence concluded that PFC “increased the primary aroma content” when compared to mechanical refrigeration.
- The work was carried out in association with the Italian wine industry & Air Liquide Italy.
- The solid state carbon dioxide injection was carried out in an equipment & technique development called “BOREAL”
- BOREAL uses liquid carbon dioxide, but could equally use liquid nitrogen.

Development in Vineyard Solutions

Harvest

Cooling & Protection
by Alvin vineyard

Press + fermentation off skin

Receipt in winery

Protection by
Alrid

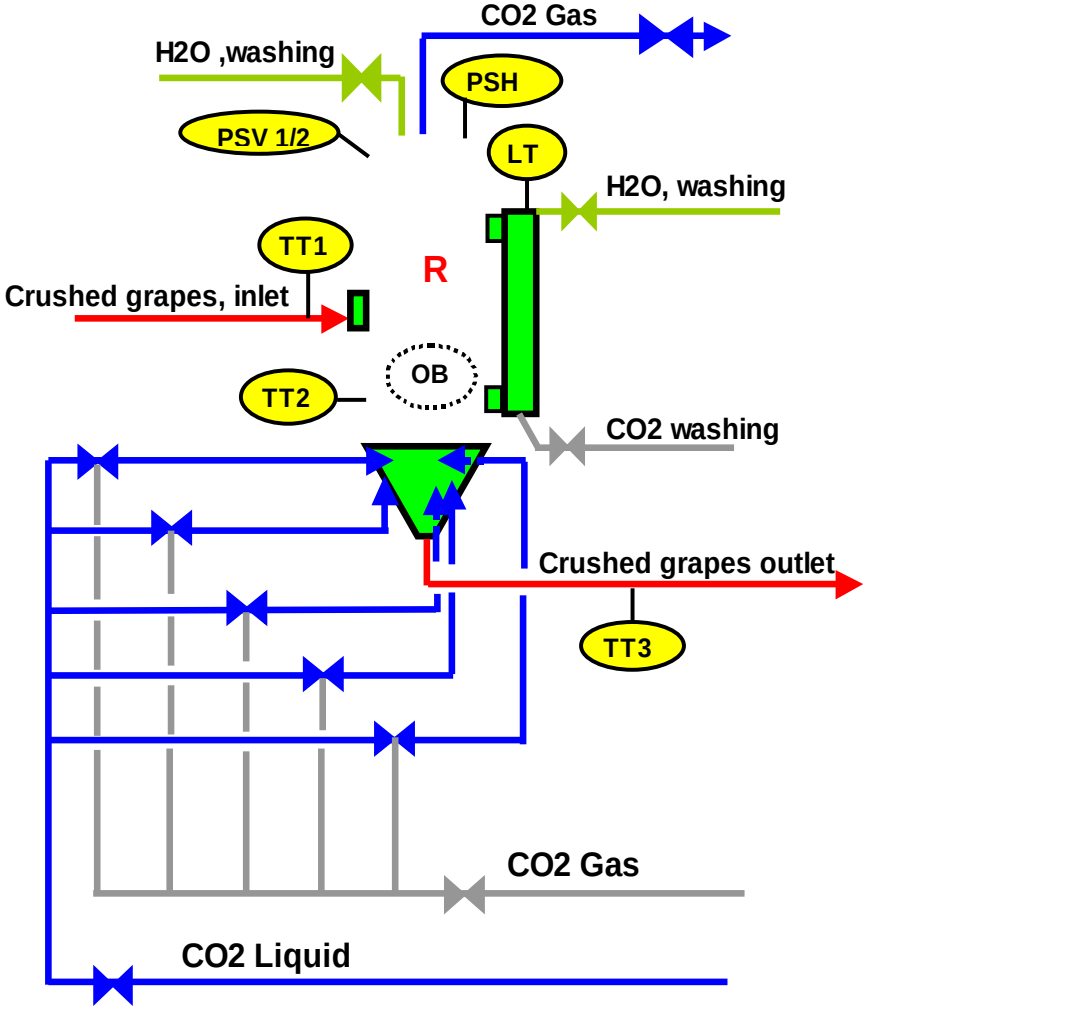
Crushing

Cooling & Protection
by
BOREAL & ALvin winery

Cooling in tank

Fermentation on skin

BOREAL FLOW SHEET



BOREAL in Detail

Click on BOREAL

Crushed grapes and liquid CO2 have a thermal exchange by direct contact, and this means:

- *high thermal exchange*
- *Small size cooler*

Thermal exchange and CO2 separation takes place in the same vessel. This permits the discharge of crushed grapes without CO2 gas, consequently the relative speed in the pipeline outside the vessel is lower: this means that the crushed grapes will have less mechanical stress.

Pressure in the cooler is variable, its value can be that necessary for the pressure drop in the pipeline from cooler to next process stage and this means:

- *maybe no need to install a pump*
- *no mechanical stress in the crushed grapes*

BOREAL TECHNICAL CHARACTERISTICS

AIR LIQUIDE

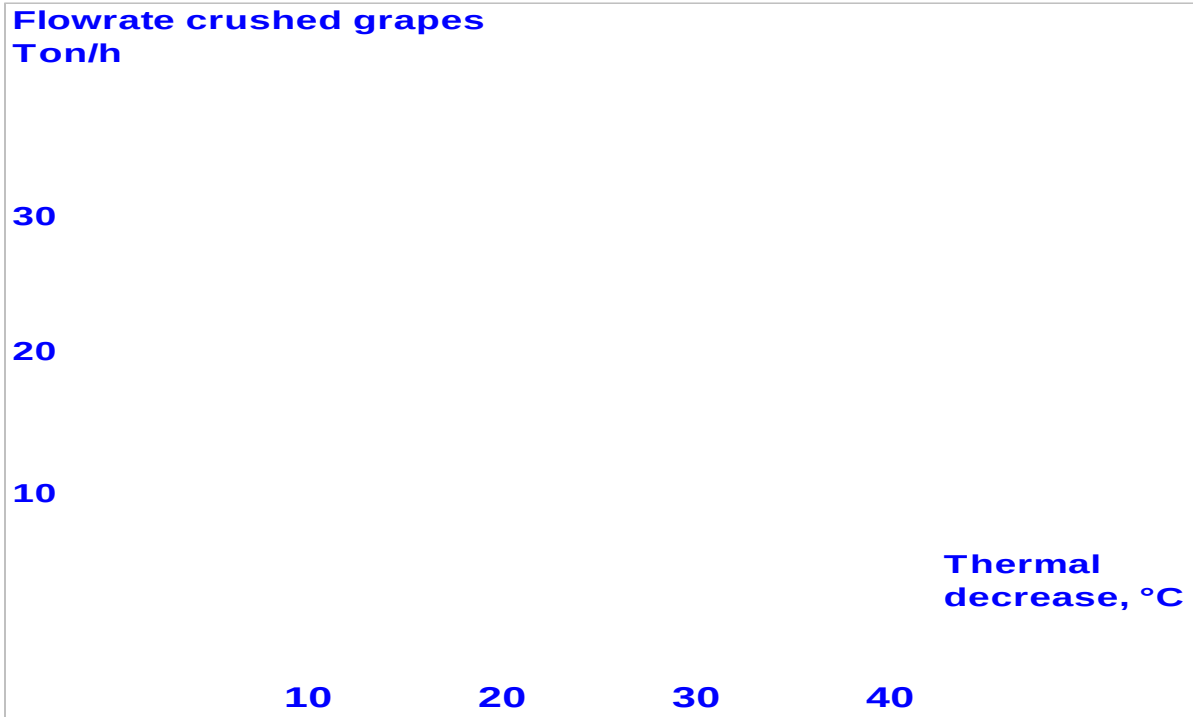
- **Maximum working pressure: 4 bar**
- **Overall dimension: 1800 x 1800 x 4000 mm**
- **Internal capacity: 1350 litres**
- **Weight: 600 kg**

BOREAL PERFORMANCE

AIR LIQUIDE

- **Cooling capacity : up to 400,000 kcal/h**
- **Crushed grapes flow: up to 45 m^3/h**
- **Minimum temp. outlet crushed grapes: 5 °C**
- **CO2 specific consumption: 11-12 kg/Tonne/°C**

RELATIONSHIP FLOWRATE / TEMPERATURE



dT = 400/Q

Based on 900mm diameter unit, 1,100mm unit also available.

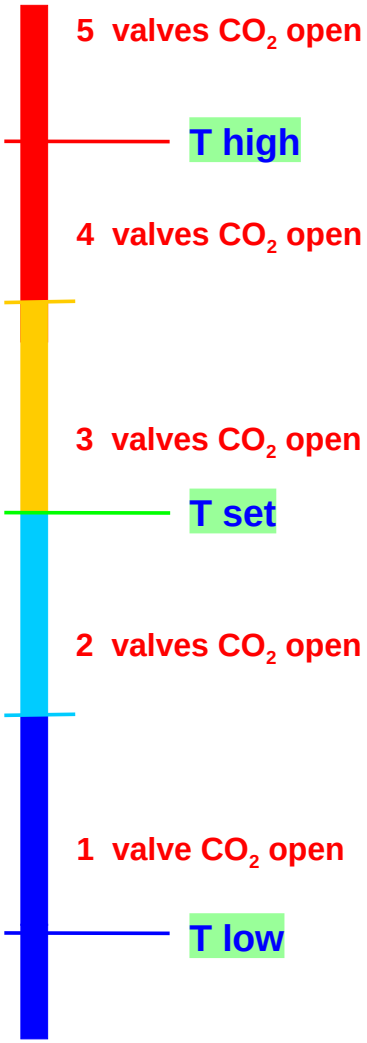
CONTROL LOOPS / 1

TEMPERATURE:

There are 5 points to introduce liquid CO_2 each of them are linked to the PLC that takes the temperature of cool crushed grapes in the outlet line.

Highly accurate, temperature always in range (<=0.5^{0}C)

TEMPERATURE CONTROL



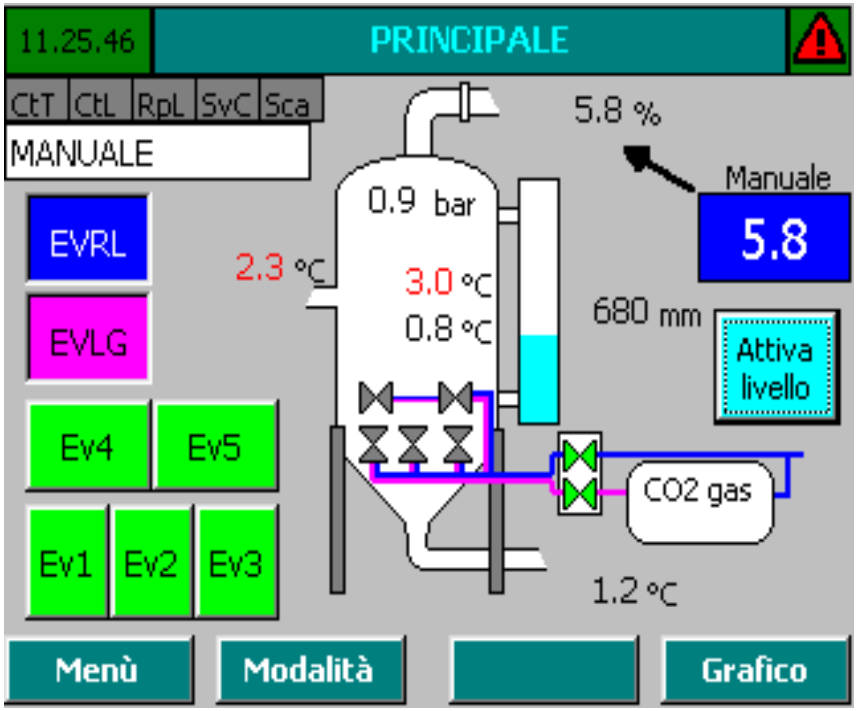
CONTROL LOOPS / 2

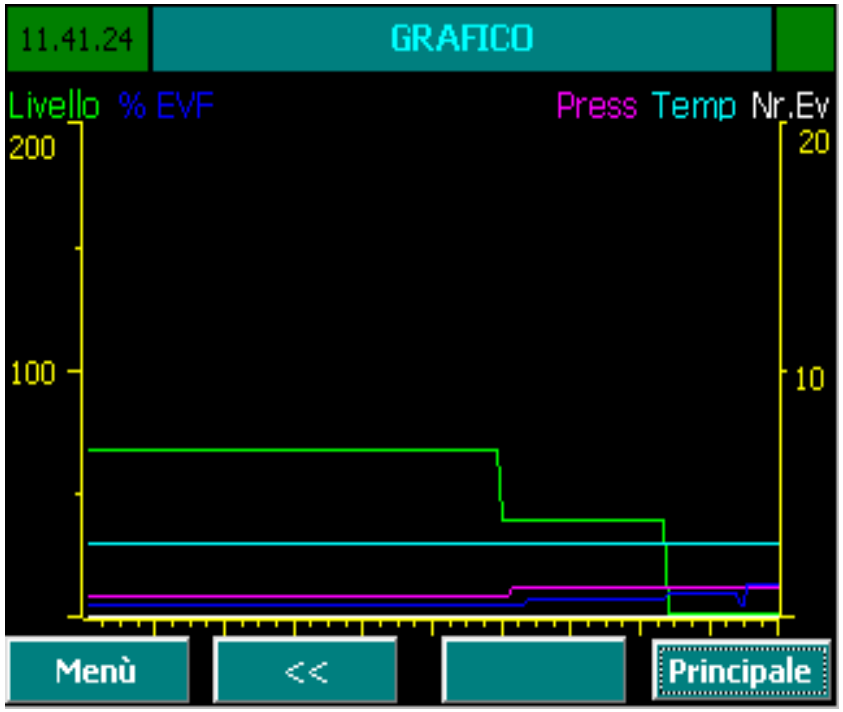
LEVEL:

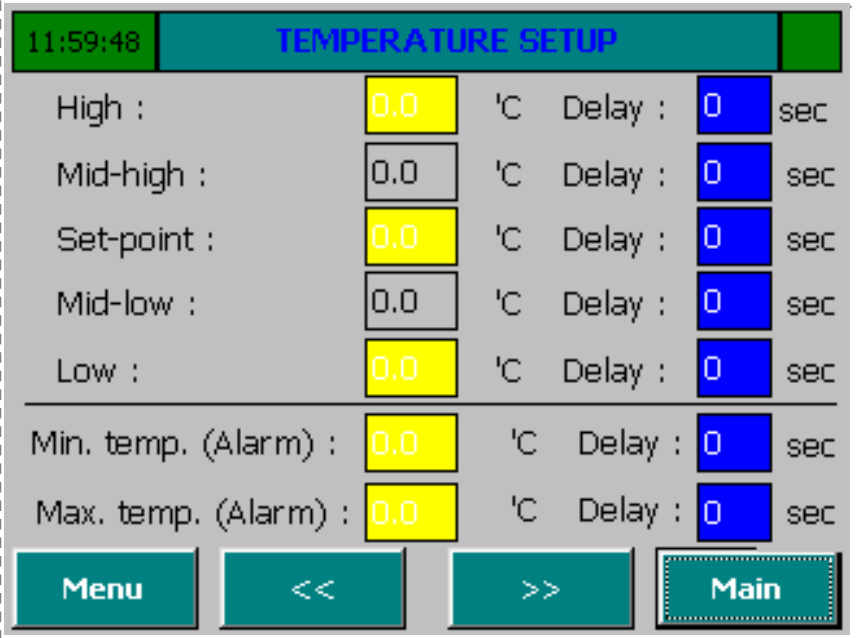
The level control enables the same flow of crushed grapes in the outlet as in inlet, this means that in the cooling vessel there is a fluid-dynamic equilibrium.

The level is regulated by the internal pressure and the internal pressure is regulated by the butterfly valve linked to the PLC & installed in the CO_2 gas discharge.

BOREAL CONTROL PARAMETERS DETAILS






11:59:48
TEMPERATURE SETUP
High : 0.0 'C Delay : 0 sec
Mid-high : 0.0 'C Delay : 0 sec
Set-point : 0.0 'C Delay : 0 sec
Mid-low : 0.0 'C Delay : 0 sec
Low : 0.0 'C Delay : 0 sec
Min. temp. (Alarm) : 0.0 'C Delay : 0 sec
Max. temp. (Alarm) : 0.0 'C Delay : 0 sec
Menu
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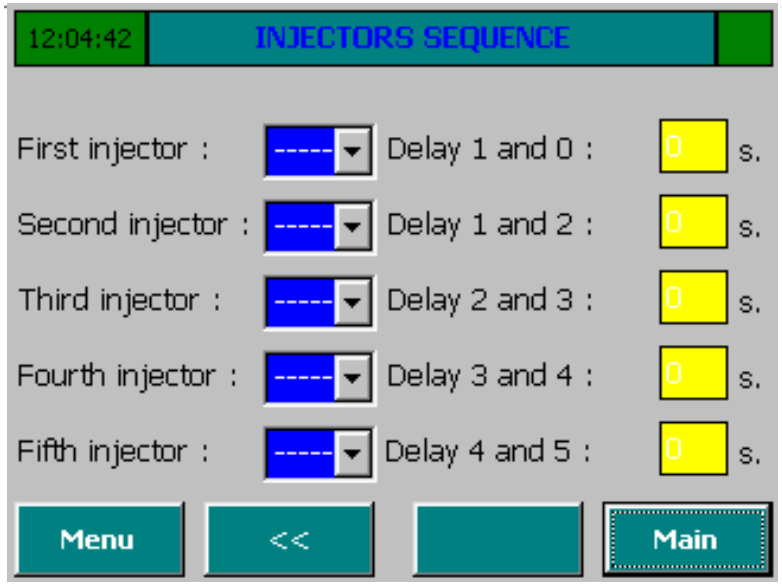
Main


12:04:42
INJECTORS SEQUENCE
First injector : ----- Delay 1 and 0 : 0 s.
Second injector : ----- Delay 1 and 2 : 0 s.
Third injector : ----- Delay 2 and 3 : 0 s.
Fourth injector : ----- Delay 3 and 4 : 0 s.
Fifth injector : ----- Delay 4 and 5 : 0 s.
Menu
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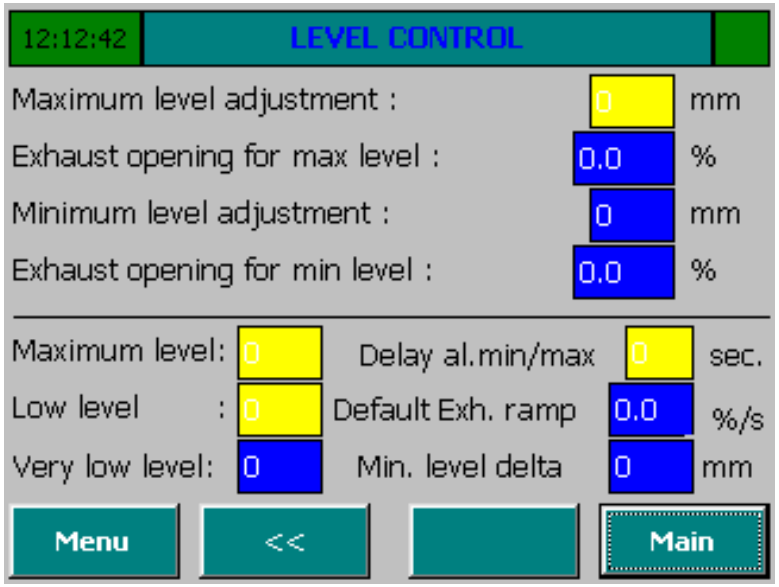
Main


12:12:42
LEVEL CONTROL
Maximum level adjustment : 0 mm
Exhaust opening for max level : 0.0 %
Minimum level adjustment : 0 mm
Exhaust opening for min level : 0.0 %
Maximum level: 0 Delay al.min/max 0 sec.
Low level : 0 Default Exh. ramp 0.0 %/s
Very low level: 0 Min. level delta 0 mm
Menu
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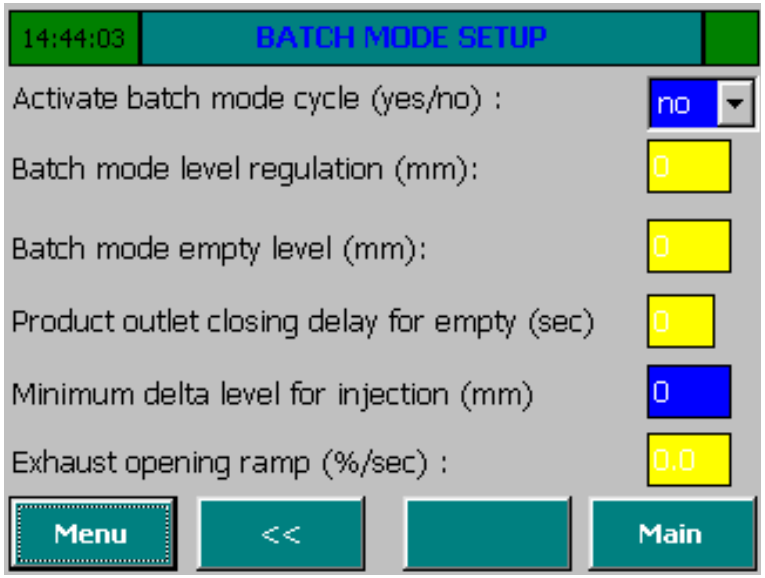
Main


14:44:03
BATCH MODE SETUP
Activate batch mode cycle (yes/no) : no
Batch mode level regulation (mm): 0
Batch mode empty level (mm): 0
Product outlet closing delay for empty (sec) 0
Minimum delta level for injection (mm) 0
Exhaust opening ramp (%/sec) : 0.0
Menu
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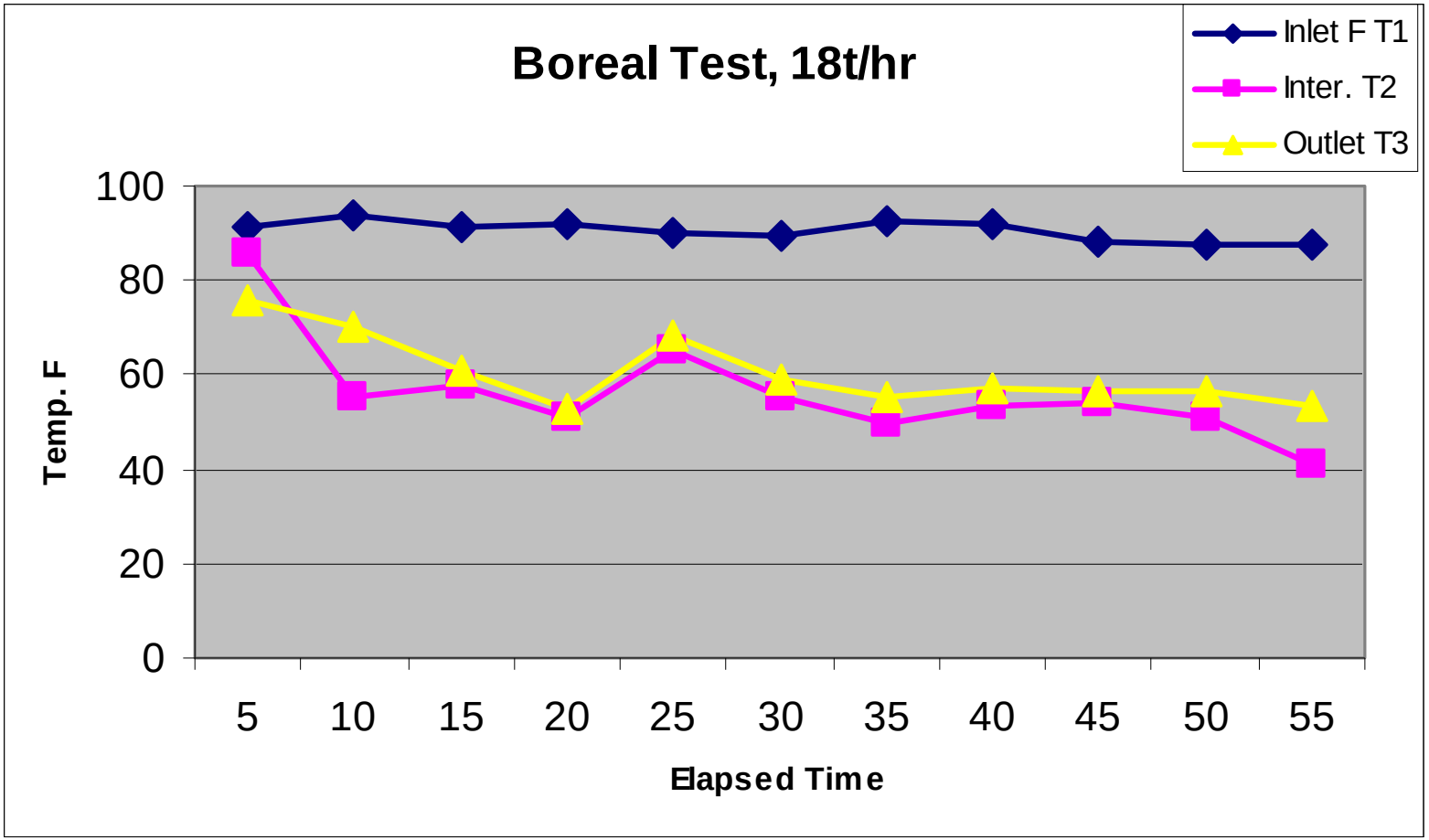
Main

Installation, Spain

Installation, Spain

Winery Run, USA 2004



Winemakers Comments

- Spain (23,000t winery):

  “We needed something to cool crushed white grapes as a previous step to maceration & pressing, something versatile, effective & economical”.

  “The results exceeded the prospects we anticipated. The equipment is well proven, user-friendly and does not require additional manpower or specialised labour. The investment is 30-40% compared to other alternatives, which is very interesting taking into account that it is equipment that will be used about one month per year. The operating costs are lower compared to alternative cooling techniques, and offers some added values such as inert atmosphere. It opens possibilities with white, red and rosé wines. Quality improved noticeably.”

- Italy:

  “Slightly more expensive than mechanical refrigeration, but as it frees up capacity during vintage it is more than justified. Pre fermentation benefits, added aroma, better cell maceration, lower oxidation, and better temperature control. Definable palate & profile differences. Does need to form part of a quality improvement program”

Winemakers Comments

- France:
  - Chilling & inerting;
    - *Whites sensational, juice clear green, non oxidised, average 10^{0}C. Rosés average 10^{0}C, "in every case the best tanks were those treated with Boreal. Reds average 15^{0}C, qualitative benefits already evident."*
  - Settling;
    - *"Slower settling due to the impact of the chilling, cold settling better. Temperature reduction much faster, must deposits much firmer."*
  - Colour;
    - *"Much more honest, no orangey rosés, no oxidation. No accidental starts to fermentation.*
    - *Stress observed to be consistently lower with Boreal.*
  - Comparing mechanical;
    - *Mechanical now only used to maintain the initial temperature. No more problems of insufficient tanks to cool the crush.*
    - *No extra capital outlay for mechanical refrigeration."*

Overseas Installations 2006

4 References in Spain (+3 in late 2006):

* El Coto (D.O. Rioja)
* Protos (D.O. Ribera de Duero)
* Barbadillo (D.O. Jerez)
* Costers de Sió (D.O. Costers del Segre)

38 References in Italy (mid 2006):

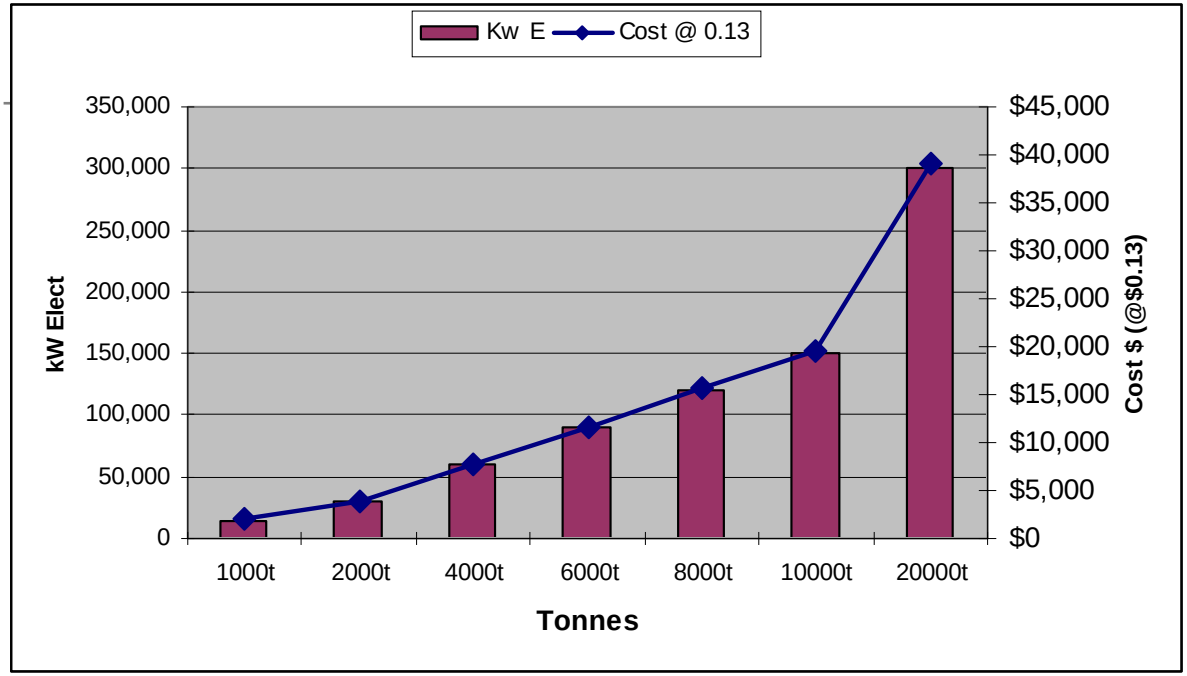
* Antinori (2 BOREAL)
* Banfi
* Fattoria dei Barbi
* Fattoria del Cerro
* Cantine Avignonesi
* Agricoltori Chianti Geografico
* Cantine Cecchi (2 BOREAL)

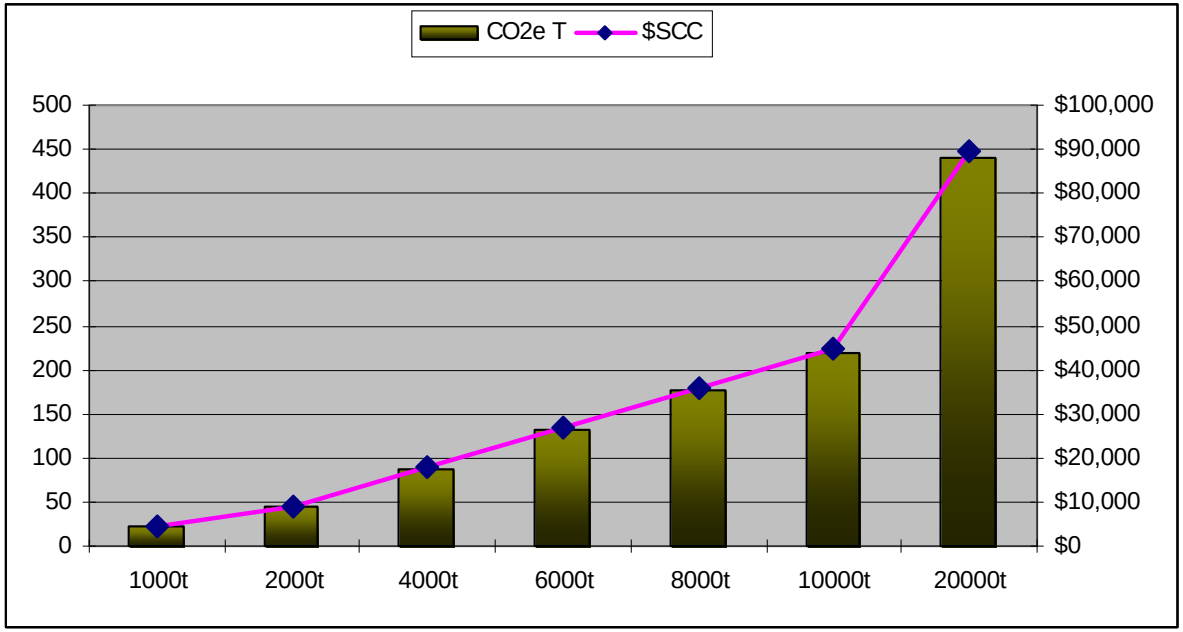
Others: France, Greece, interest in NZ.

BOREAL in Australia

- One system manufactured & imported for use mid 2006.
  - Designed to satisfy all Australian certification for pressure vessels, plus electrical standards. Compliant with PED & CE.
  - Full risk analysis & Hazop completed.
- Relocated to NSW & run in batch mode May 2007.
  - Temperature range, inlet 28^0C outlet 8^0C.
  - Production run, 15 tonnes/hour.
- Scheduled for run in the Hunter Valley August 2007.
- Supply source, bulk CO2, either temporary or permanent installation.
- Can be linked with telemetry.
- BOREAL unit available as an outright purchase, lease to own, or on a fully maintained monthly facility fee.

Future?



- Refrigeration = 60-70% of a winery's energy use
- Each 100,000kW = 146.7t CO2e.
- Using the UK SCC @ $204/t gives indicative carbon cost.
- 720 trees = 146.7 t CO2e

- BOREAL can save a % of this energy cost.
- Better utilisation of existing mechanical refrigeration & tanks.
- Better quality & product differentiation.