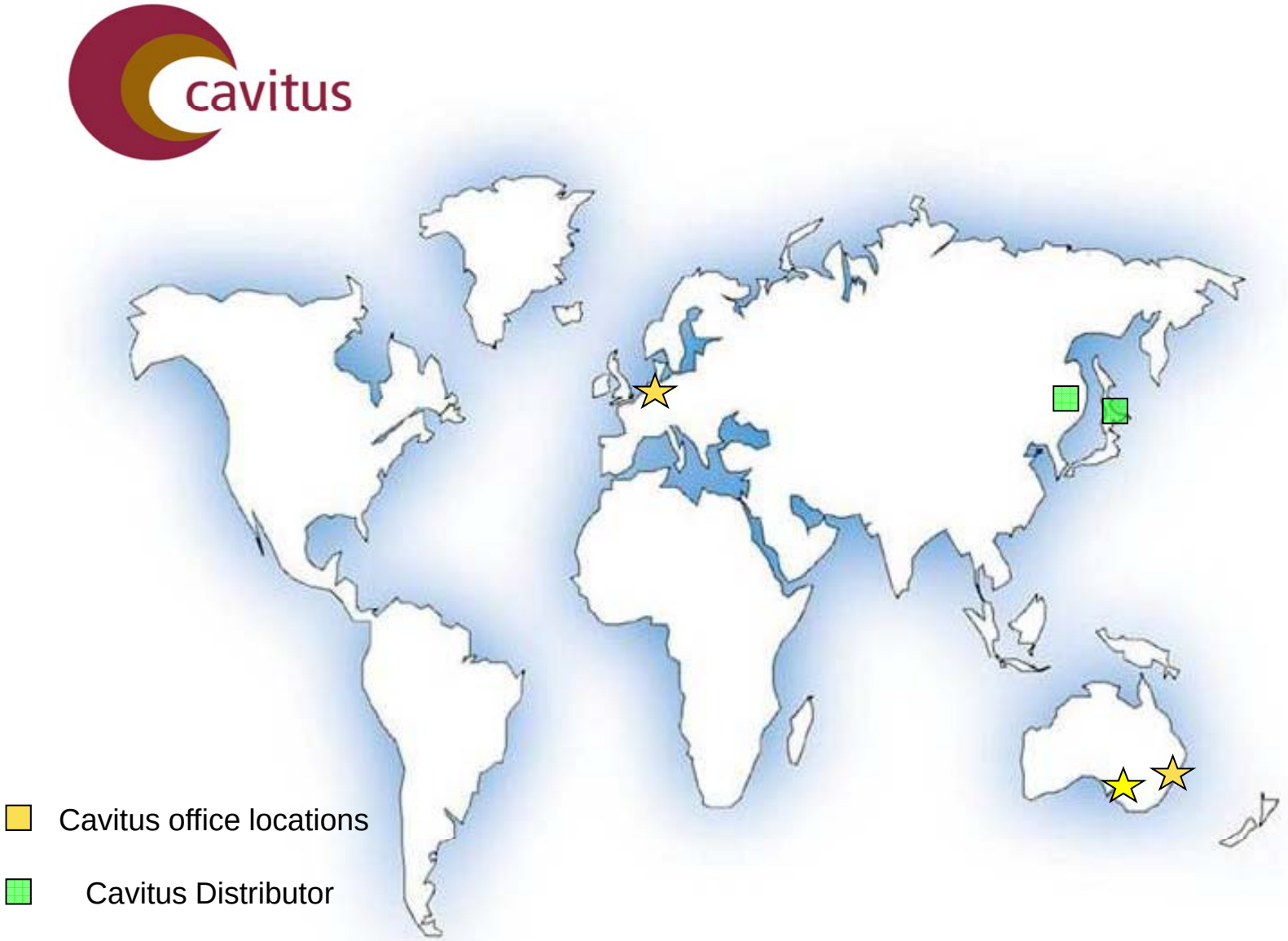
Taste the edge of sound

Cavitus Pty. Ltd.
ACN 112 372 488

Cavitus Presentation

Darren Bates
(Cavitus)


Cavitus office locations
Cavitus Distributor

Cavitus

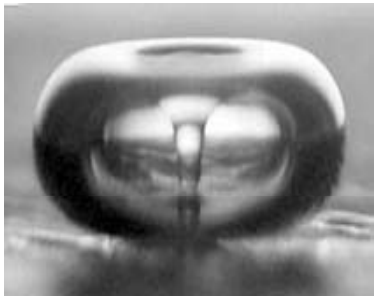
- **Technical Advisory Committee**
  - ✓ Dr. Terry Lee – wine industry (ex- CTO for Gallo)
  - ✓ Dr. Jenny Robertson – National Foods/Kirin and dairy industry
  - ✓ Paul Byers – CEO Sara Lee and coffee industry
  - ✓ Tony Sauzo – R&D Director Mars, Cadburys
- **Investors**
  - ✓ David Hayman – SVP Operations (Diageo and ex-Constellation)
  - ✓ Dr. Joel Muse –F&B ingredients and industrial chemistry (ex-Goodyear)
  - ✓ Peter Roorda – F&B operations and marketing (ex-Sara Lee, Campina)
  - ✓ Peter Barnes – F&B operations and FMCG marketing and industrial chemistry (ex-Philip Morris, Yalumba, Ansell)
  - ✓ Bill Webb – F&B (ex-Altria, Kraft and Philip Morris)
- **Others**
  - ✓ Chuck Tronolone – wine industry engineering and operations (ex-Gallo)
  - ✓ Olle Bergman – F&B industry sales and marketing (Tetra Pak)

Why Have Major F&B Companies Invested In Cavitus HPU Technology

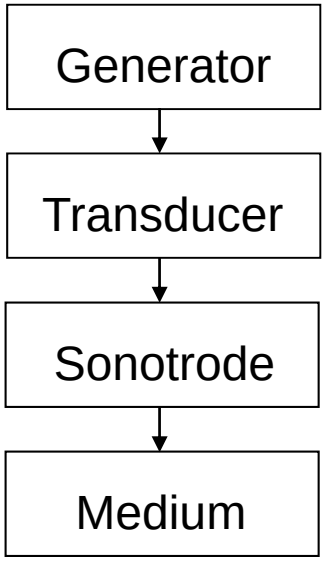
- None thermal technology (no heat)
- “Cleantech” technology
- No negative changes in taste, texture, quality
- HPU In most cases – “improved taste, quality, texture”
- HPU reduces chemical additives – “cleaner label”
- HPU – reduces thermal energy requirement
- HPU designed for large commercial scale 50lit/min to 5000lit/min
- HPU has low operational and maintenance costs
- OH & S – HPU is a safe technology

Principles of HPU

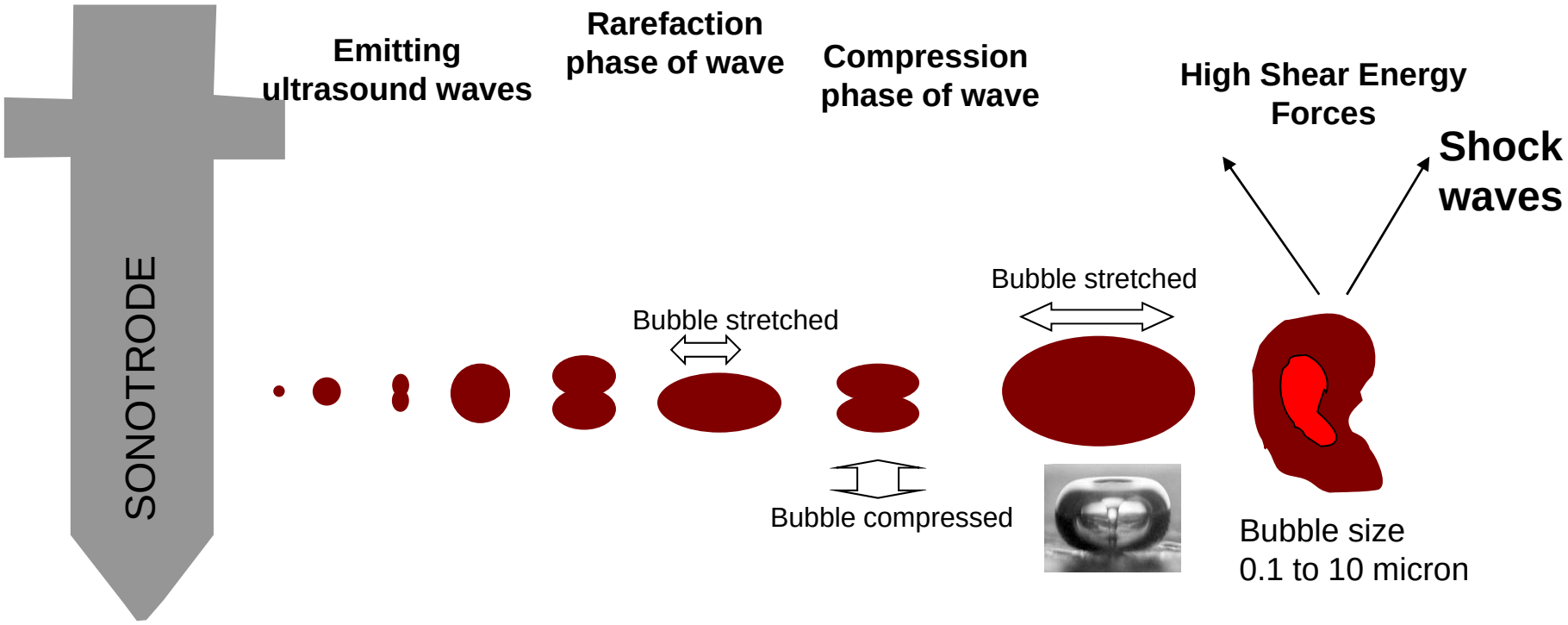
- Mechanical energy in the form of vibrations
- Ultrasonic waves cause microscopic cavitation bubbles
- Very high temperatures and pressures upon implosion (5000 K, 2000 bar)
- Very limited bulk heating



Cavitation bubble (µm size range)



Bubble Formation and Cavitation



Why is it attractive to the food industry?

Operational

- Non-thermal process
- Food grade
- Easily installed
- Modular/Bolt on solution
- Low maintenance
- ROI < 2 years
- Low energy costs

(< 0.01kWh/L)

Process

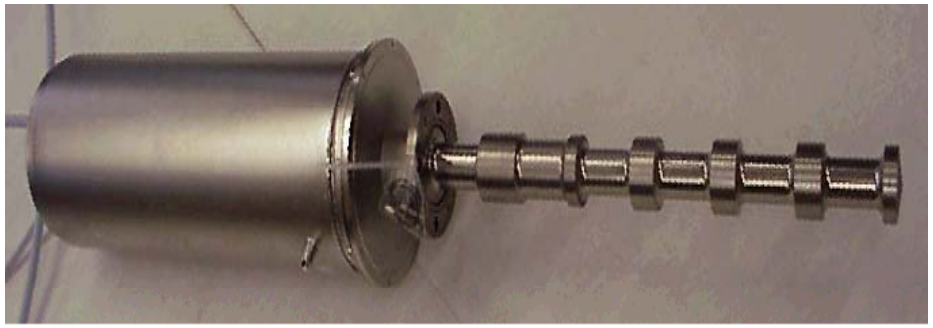
- Reduced thermal input
- Enhanced heat transfer kinetics
- Enhanced cleaning and sanitation
- Reduced fouling
- Potential for improved food safety
- Production efficiency gains
- Extraction yield improvements
- Potential for enhanced health, wellness and nutrition

Product

- Modification - Viscosity alteration
- Stabilisation & Consistency
- Reduced additives – “Greener Label”

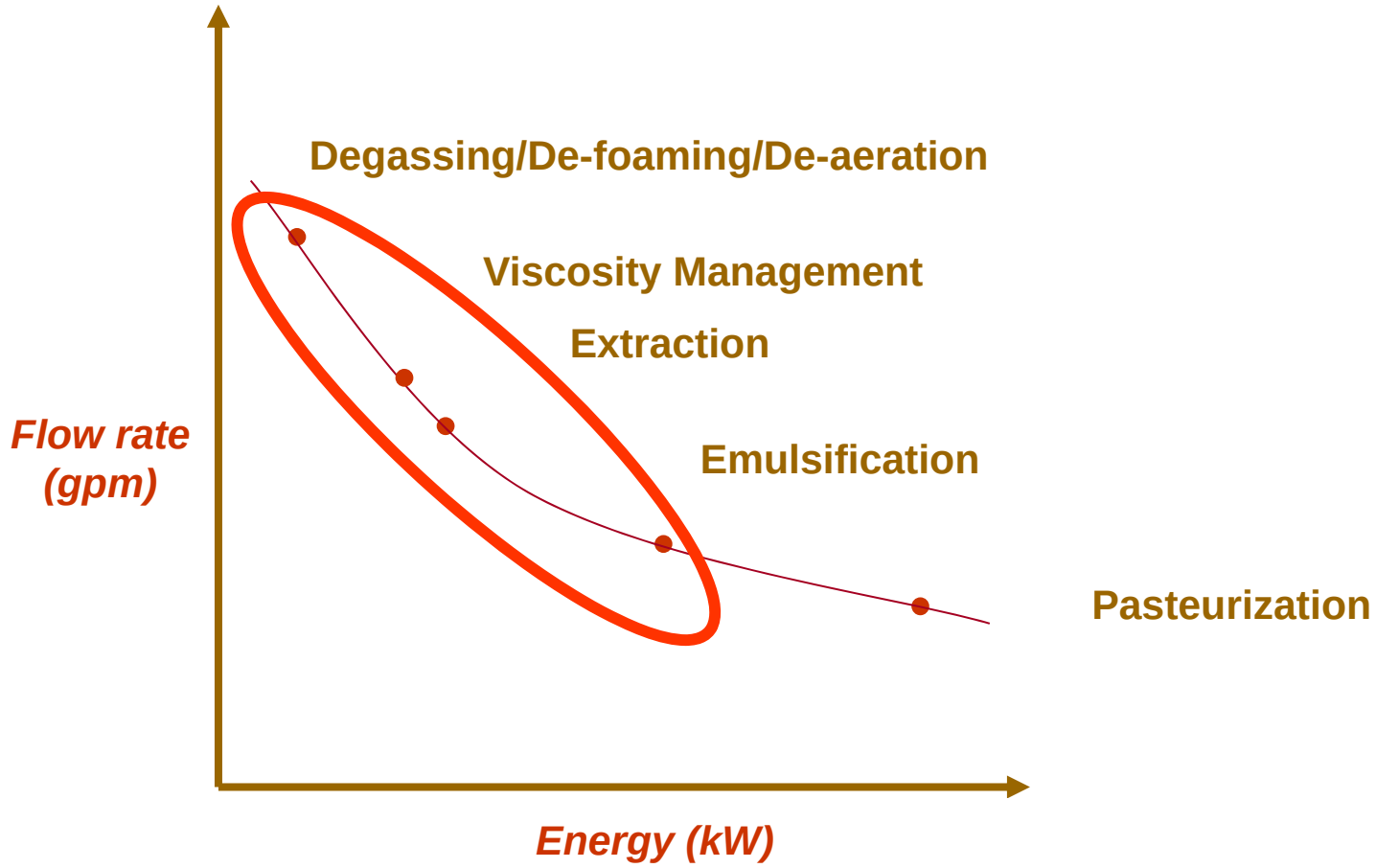
HPU Today

- Innovation in sonotrode design
- 85-90% energy efficiency output
- Automatic resonance frequency scanning
- Amplitude regulation
- Robust/durable
  - ✓ 24 x 7 operation



HPU is a complementary technology to existing unit processes used to improve their performance

Varying the Energy Input To Optimally Impact the Chemistry of Different Unit Processes



In spite of the energy intensity delivered, HPU is a non-thermal process technology, i.e., there are no bulk temperature changes during treatment

Key to Successful Commercialization of Innovative Technologies:

Form A 'Sound' Partnership

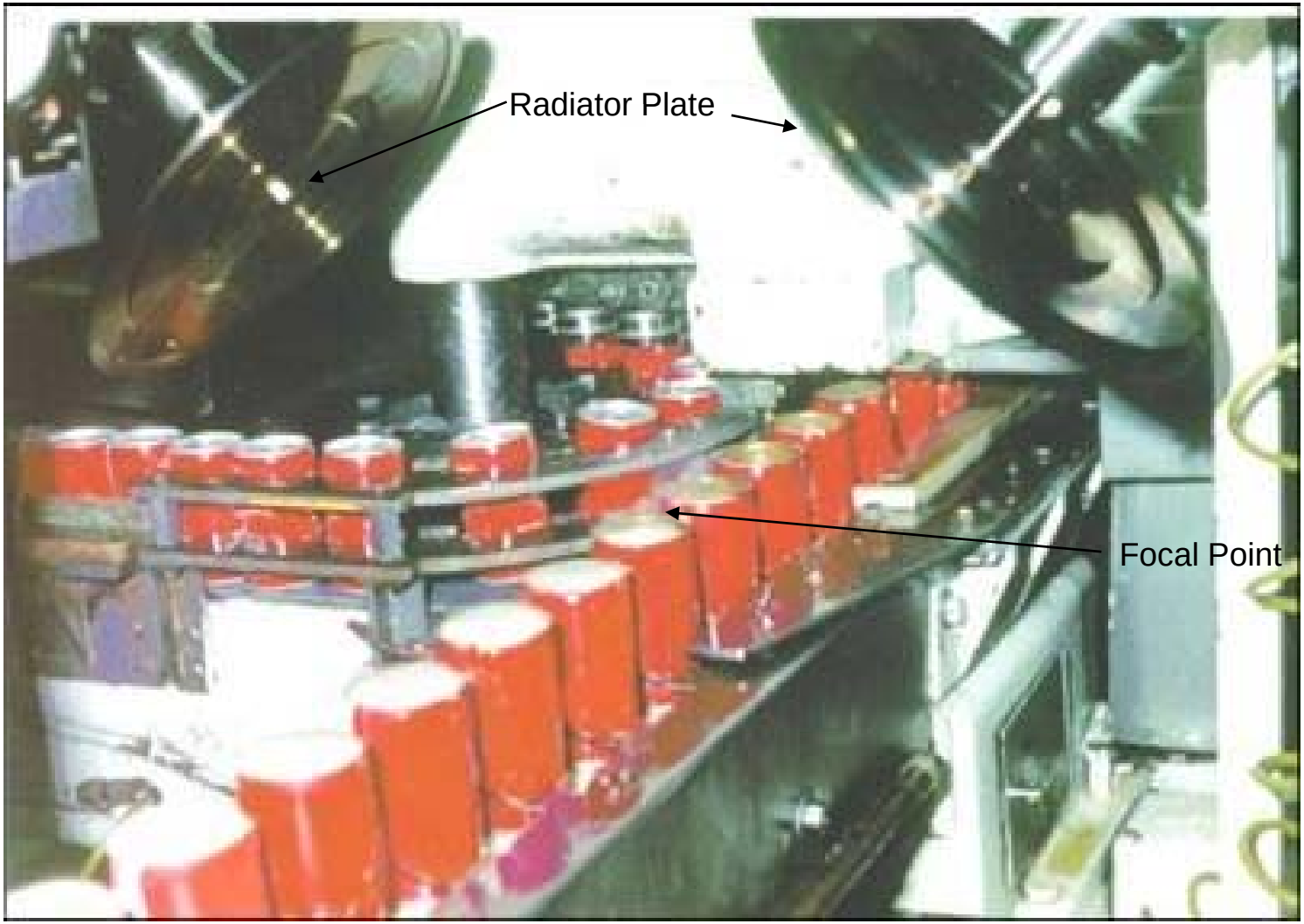
Cavitus Patents

- Extraction
- Cleaning/Disinfection
- Viscosity Reduction
- Mass transfer/Hydration
- Anti-fouling
- Thermal Heat transfer
- De-aeration
- De-foaming (Exclusive IP License)

Controlling Foam

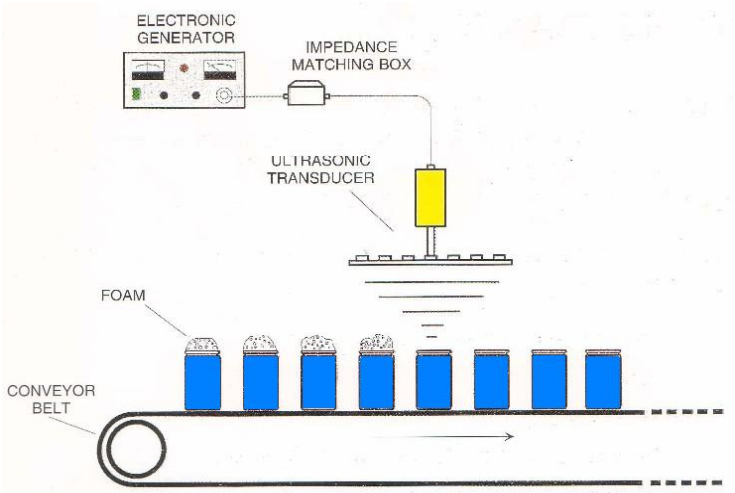
- **Ultrasonic De-foaming**
  - ✓ **High Power ultrasonics destroys foam by a combination of:**
    - **Fluctuating high pressures**
    - **Resonance of bubbles**
    - **Cavitation**
    - **Pressure waves**
  - ✓ **Applications**
    - **Fermentation vessels, canning lines**
    - **Pharmaceutical, brewing, beverages**

Foam Destruction



De-foaming on Bottling/Canning Lines

- Benefits
- Increased production speed (10-20%)
- Reduced labour cost
- Reduced waste (foam over flow)
- Reduced cap/seal contamination
- Enhanced fill level control
- Reduced additives/anti-foam chemicals
- Green/Cleaner label
- CIP Cleanable
- Carbonated/none carbonated beverages
- Aseptic filling lines
- ROI < 2years
- Single plate unit – up to 1000bpm
- Cost – 70k euro
- Double plate unit – 1000 – 2000 bpm
- Cost – 130k euro

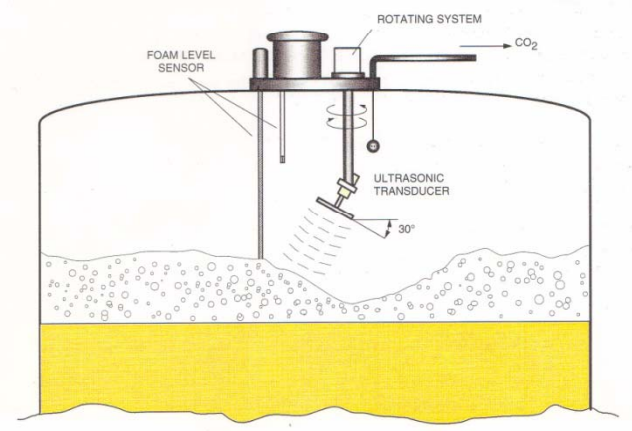


Ultrasonic Foam Control in Tanks

- **Fermentation vessels**
  - ✓ **Reduction in anti-foam chemicals**
  - ✓ **Increased vessel capacity/production**

- **Demonstration Business Case**
  - ✓ **Canola oil seed plant (Europe)**
  - ✓ **Increased throughput (11%)**
  - ✓ **Power - 1 x 300 W ultrasonic unit**
  - ✓ **Value > 2 million euro**
  - ✓ **Payback < 1 year**

- **Equipment Costs**
  - ✓ **Single plate – up to 6m diameter tank**
  - ✓ **Cost – 70k euro + tank installation mounting**
  - ✓ **Double plate – 6m to 10m diameter tank**
  - ✓ **Cost – 130k euro + tank installation mounting**



Filling Line Example

- **Major international soft drink company, Australian line**
- **1500 cans per minute nameplate capacity**
- **Variable cost savings**
  - ✓ 0.2% spillage reduction = AUD 0.72 per 1000 cans
  - ✓ 5^{o}C fill temp increase = AUD 0.15 per 1000 cans
- **Semi-fixed costs**
  - ✓ 10% reduction in line labour (speed increase) = AUD 0.34 per 1000 cans
- **Total potential saving AUD 1.21 per 1000 cans**
- **Payback periods**
  - ✓ Spillage only = 20 months
  - ✓ Spillage + labour = 14 months
  - ✓ Spillage + temp + labour = 1 year
- **If more sales are possible, payback << 1yr**

De-foaming of Caseinate Production Plant

Two 7000 L tanks, one plate in each tank
Caseinate solution is 25% solids, prior to spray-drying
UDS successfully collapsed foam during all stages of production

Target is to recover product just prior to CIP
CIP is conducted daily
Between 64 and 300 kg of product (dry basis) goes to waste each CIP
Product currently not recovered as it is in foam form and cannot be pumped to dryer
Foaming during production requires frequent hosing

Product	**Mass Dry Caseinate Remaining at Shutdown Tank 1 (kg)**	**Mass Dry Caseinate Remaining at Shutdown Tank 2 (kg)**	**Mass Dry Caseinate Remaining at Shutdown Tank 3 (kg)**	**Daily Amount Recovered by UDS (kg)**	**Daily Gross Profit Increase (AUD)**	**Annual Gross Profit Increase (AUD)**
Calcium caseinate	300	300	700	1,040	$ 6,150	$ 387,420
Sodium caseinate	64	64	150	223	$ 1,318	$ 332,074
					Total	**$ 719,494**
Operating & maintenance costs						**$ 35,975**
					Justified Spend	$1,367,038
					RRP	$1,367,038

Ultrasonic Extraction

- **Mechanisms:**
  - ✓ Enhance mass transport of solvent
  - ✓ Cavitational dislodgement of extractant
  - ✓ Particle size reduction
  - ✓ Micro-streaming effect

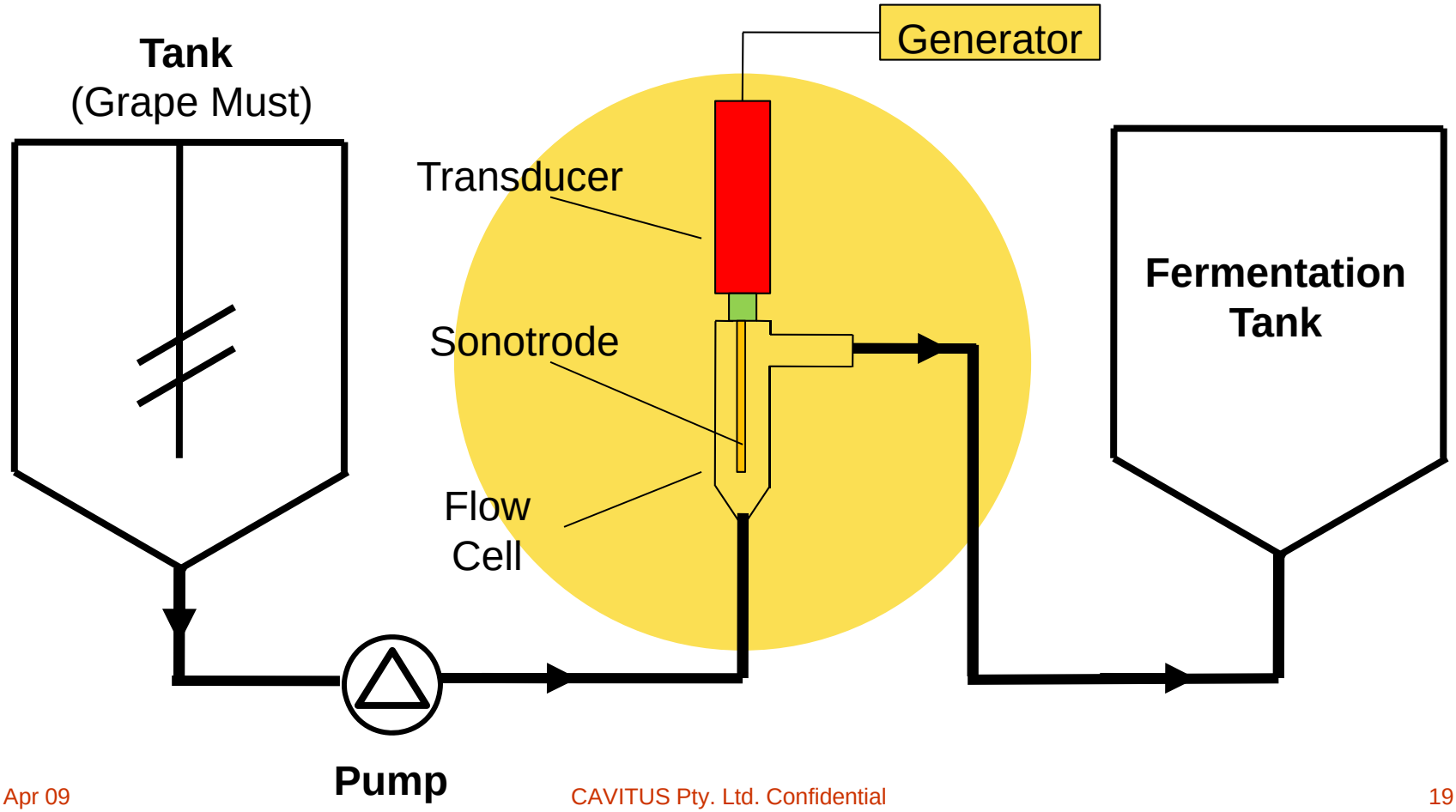
- **Extraction of antioxidants, oils, colour compounds, flavour compounds, poly phenols.**

- **Citrus Peel oil**
- **Palm Oil**
- **Coffee and Tea**
- **Grape Must (Wine)**
- **Starch from Fibre**
- **Lycopene (Tomato)**
- **Carotenoids (Carrot Juice)**

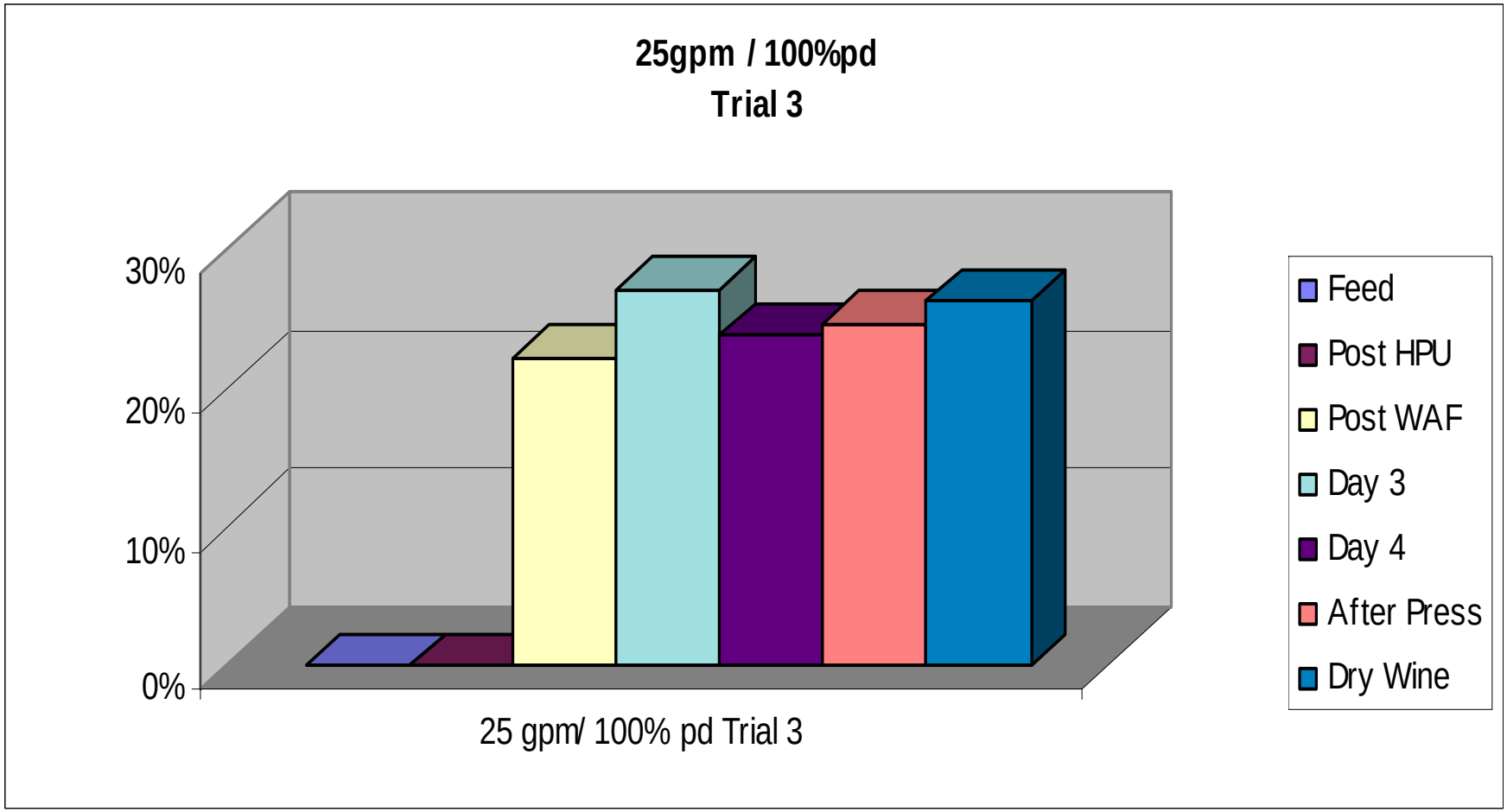
- **Equipment Estimates**
- **10m3/hr – 10kw (90-120k euro)**
- **30m3/hr – 25kw (280-350k euro)**

Extraction

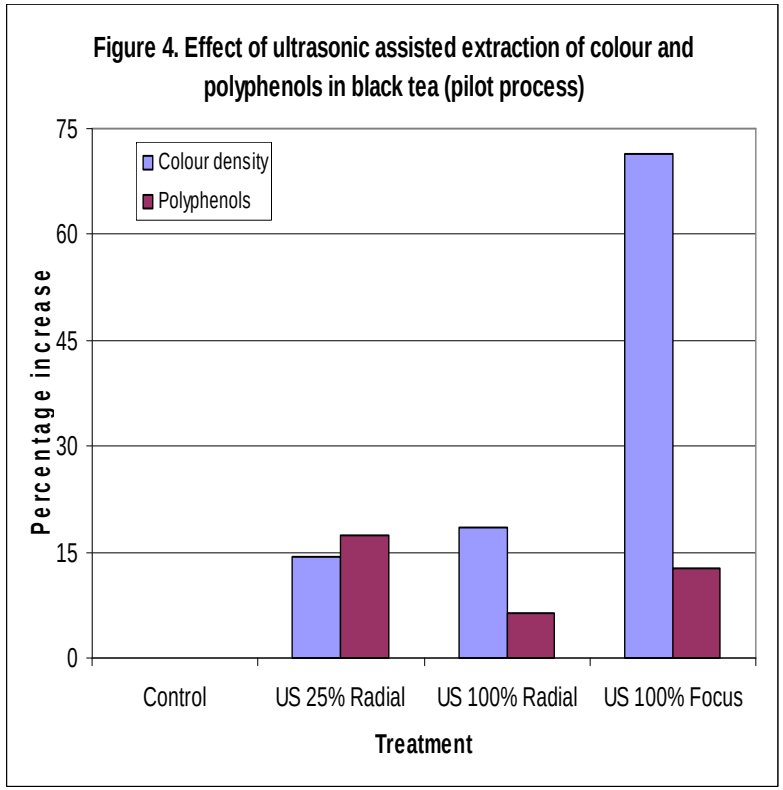
Block Diagram of Equipment for an Exemplary Application

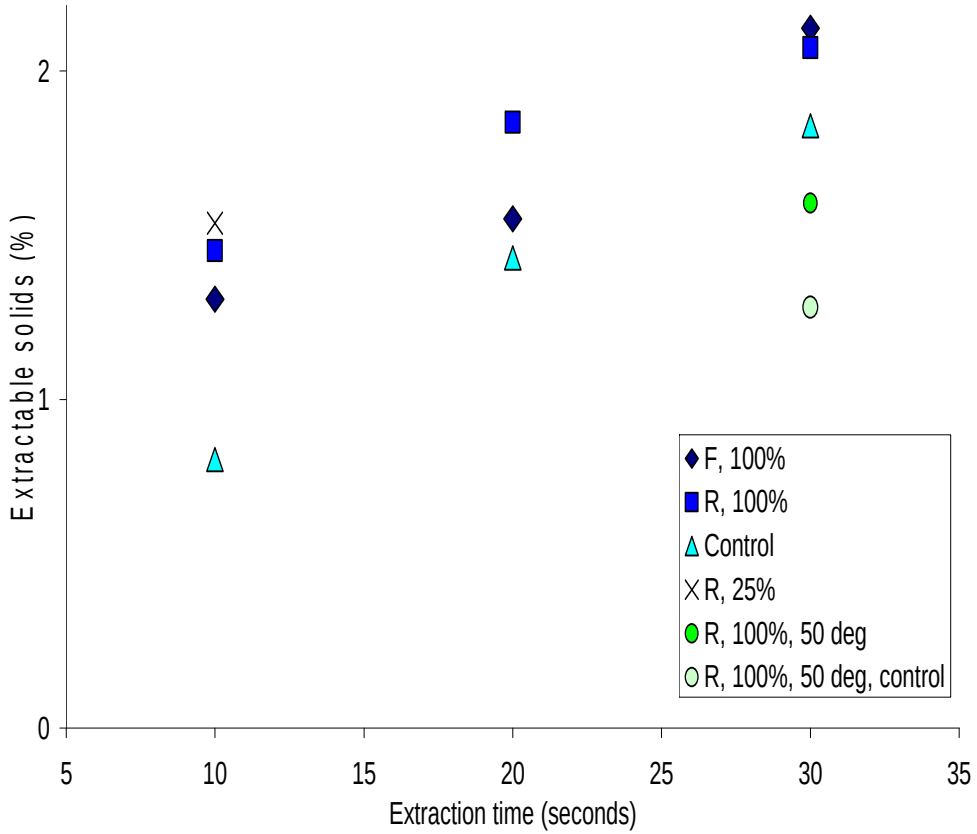


Grape colour extraction – gain in anthocyanin concentration (pilot trial – 6 tons Merlot ferments)



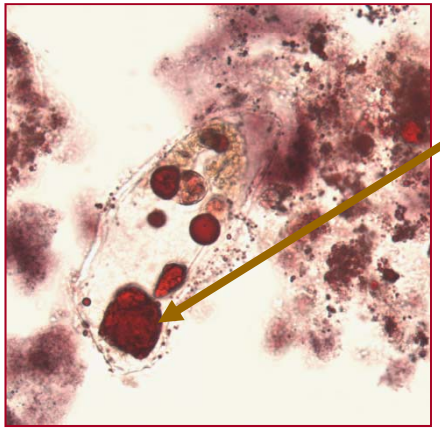
Ultrasonic Tea and Coffee Extraction





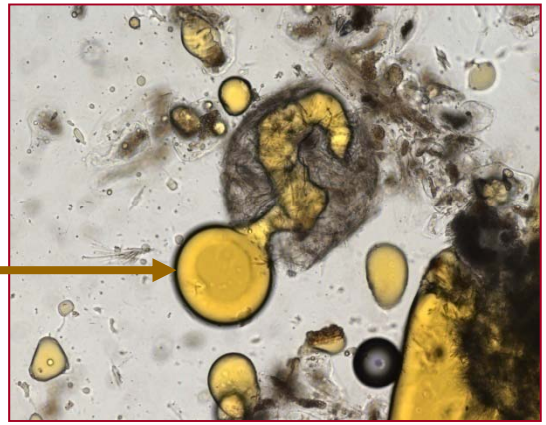
Improvements Observed from HPU Extraction

Medium	Solvent	Extractable	% yield increase over conventional process	% kinetics increase over conventional process
Grape Skin	Water	Anthocyanin, Colour	+ 30%	NA
Corn Germ	Hexane	Corn Oil	NA	+ 75%
Citrus Peel	Water	Citrus oil	+ 30%	NA
Palm Fruit	None	Palm oil	+ 10%	NA

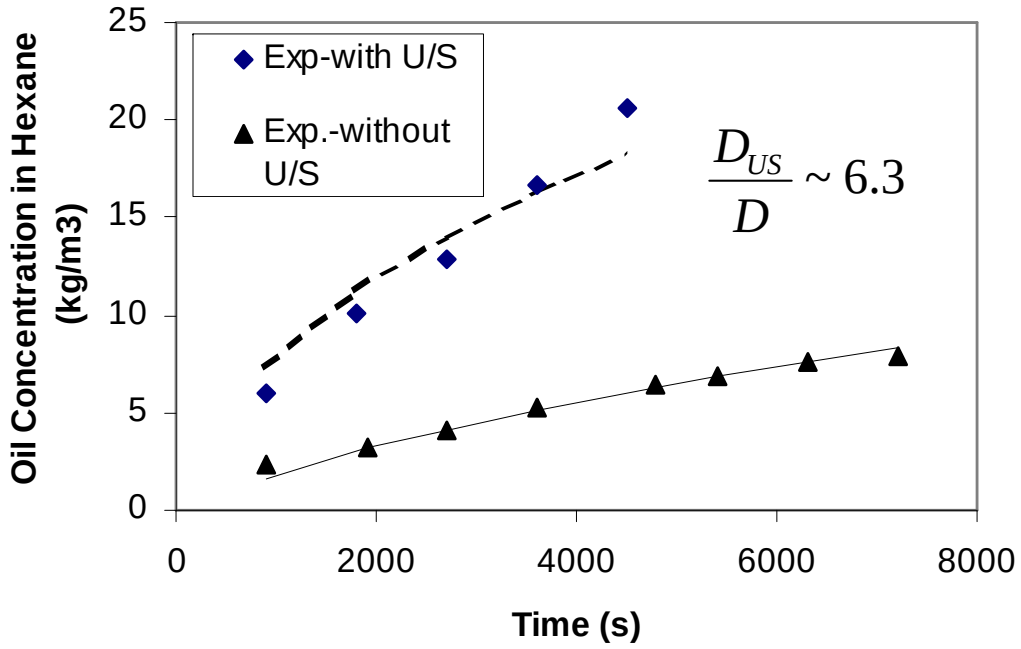


Cell-bound oil before sonication

Free oil after sonication



Effect of Ultrasound on Solvent Extraction of Oilseeds



D_s= 1.2x10^{-8} cm^2/s

(without Ultrasound)

D_s= 7.6x10^{-8} cm^2/s

(with Ultrasound)

Viscosity Management

- **Temporary viscosity reduction**

- **Reduced viscosity potentially improve other down stream processes (e.g. retorting, spray drying, homogenizers pasteurization, evaporators, heat exchangers, membrane filtration, packaging/bottling operations)**

- **Reduced fouling, contamination build up,**
- **Improved heat transfer**
- **Potential for improved food safety**

- **Ultrasonic viscosity reduction**
  - ✓ Juice (concentrates/single strength)
  - ✓ Dairy
  - ✓ Confectionary
  - ✓ Products containing hydrocolloid materials/oils
  - ✓ None Carbonated Beverages
  - ✓ Concentrates used for carbonated beverages

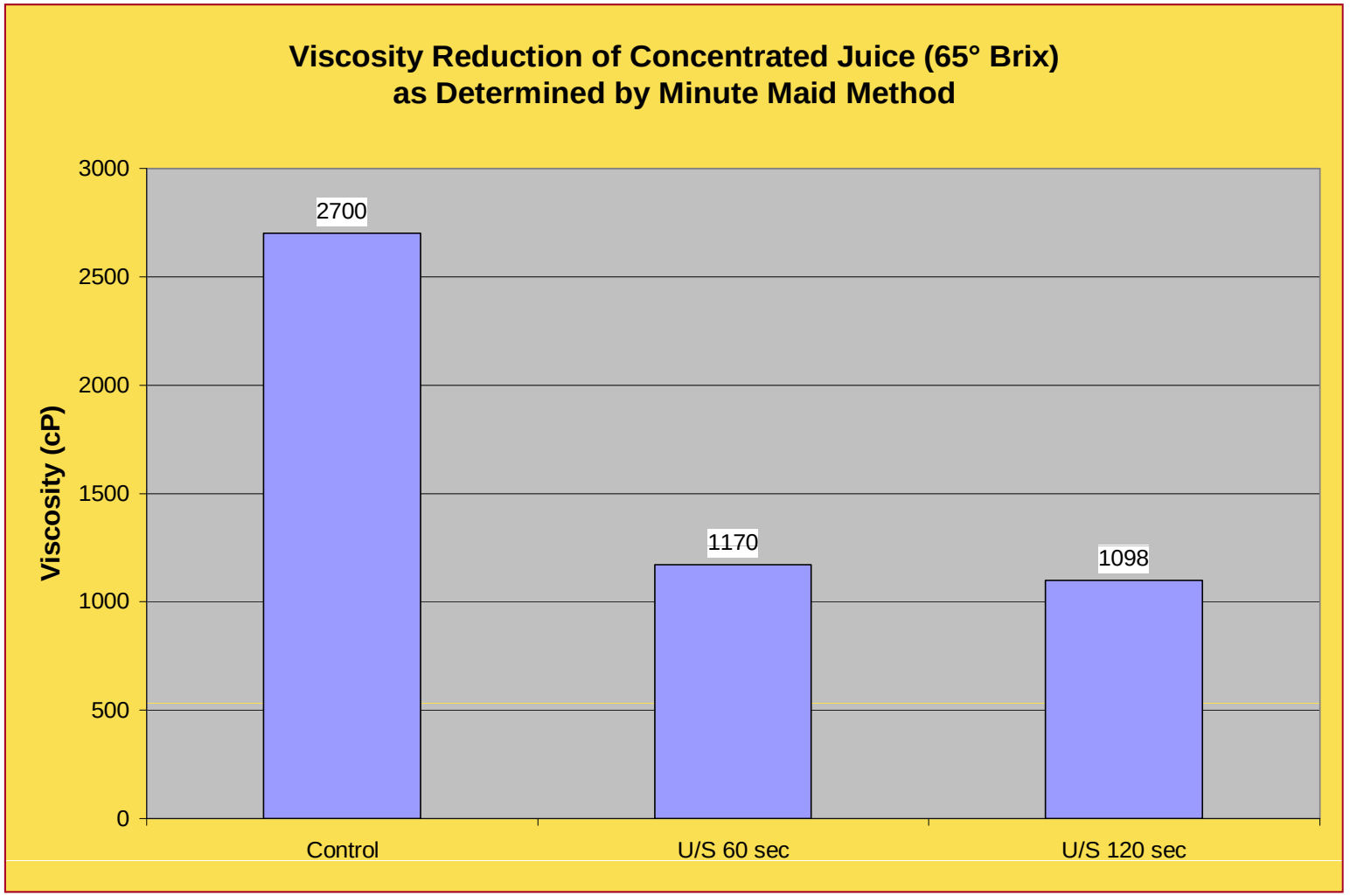
- **Equipment Estimates**
- **8m3/hr – 10kw (120k – 150k euro)**
- **30m3/hr – 25kw (280-350k euro)**

Application: Viscosity Management and Reduction

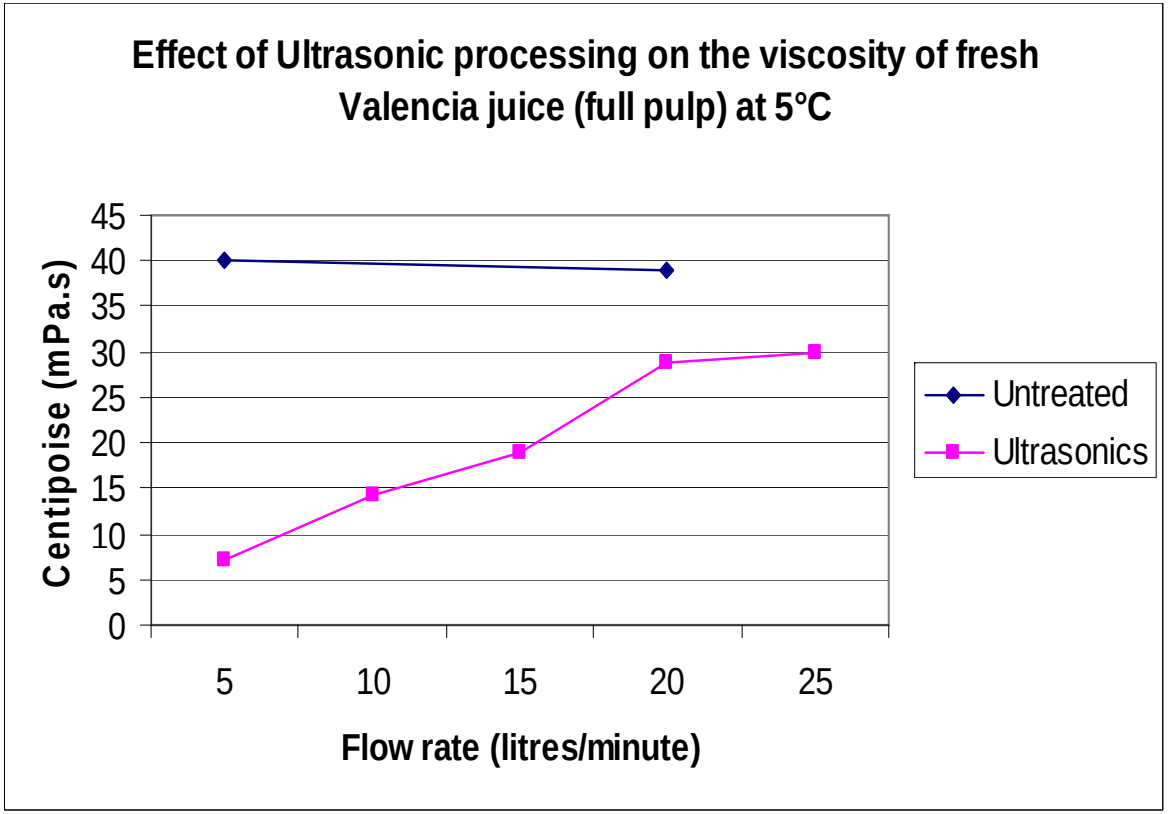
- **Benefits**
  - ✓ **Temporary viscosity reduction ('TVR') –products return to original state after few minutes/hours**
  - ✓ **Improves down-stream processes**
  - ✓ **Potential for improved food safety**
- **Case Study**
  - ✓ **U.S. protein manufacturer increased dry solids concentration by 15% prior to spray-drying**
  - ✓ **Savings in operating/ maintenance costs, CAPEX (from throughput increase)**
  - ✓ **Improved product quality**

Product/Medium	% Reduction in Viscosity
Skim Milk	30-40
Low-fat Milk	30-40
Infant (Milk) Formula	30-75
Whey-protein/ Casseinate	40
Dairy & Juice-based Beverage	70
Single-strength Citrus Juice	60

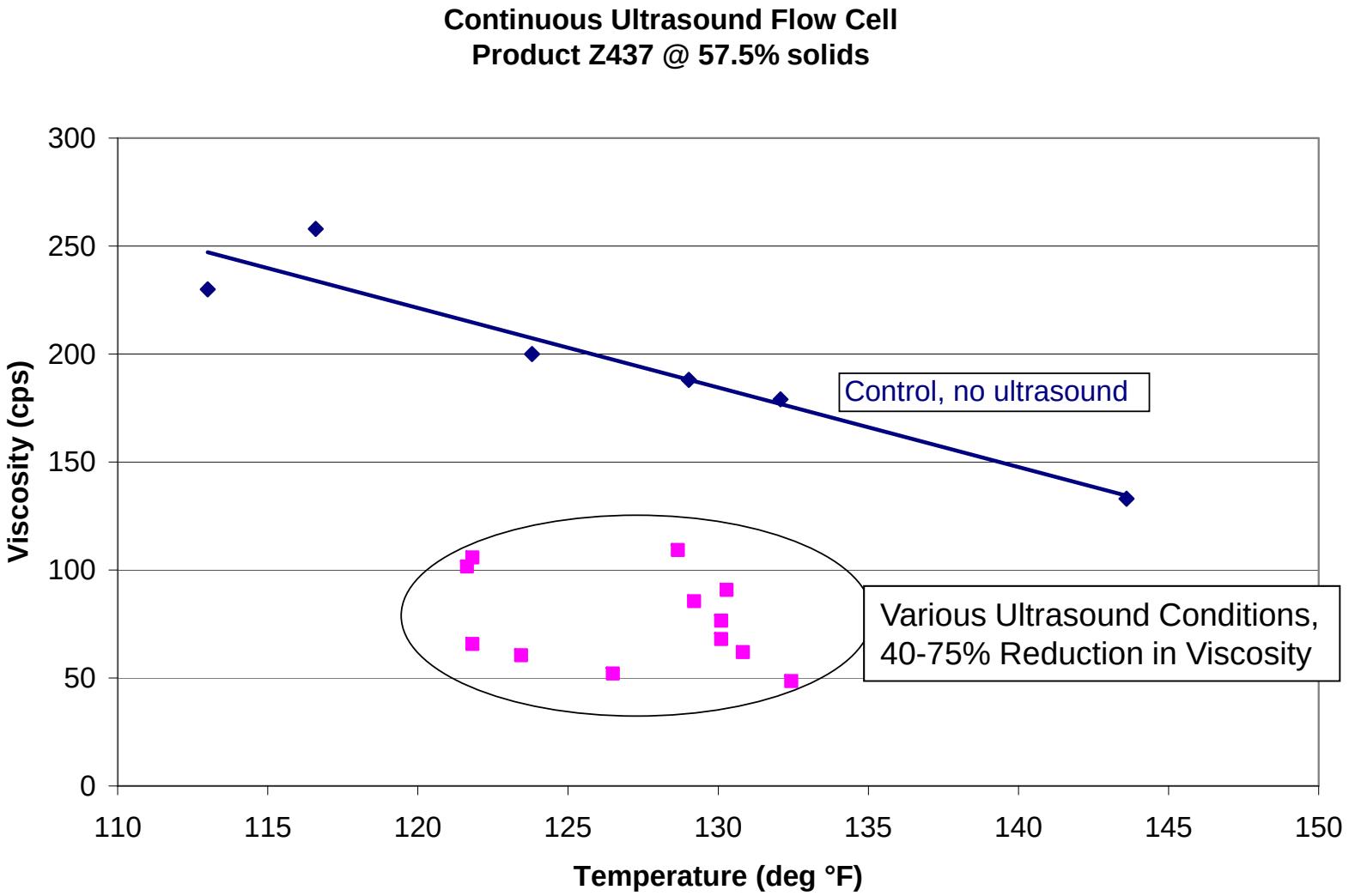
Illustration -- Viscosity Reduction in Orange Juice Concentrate



TVR of Juice

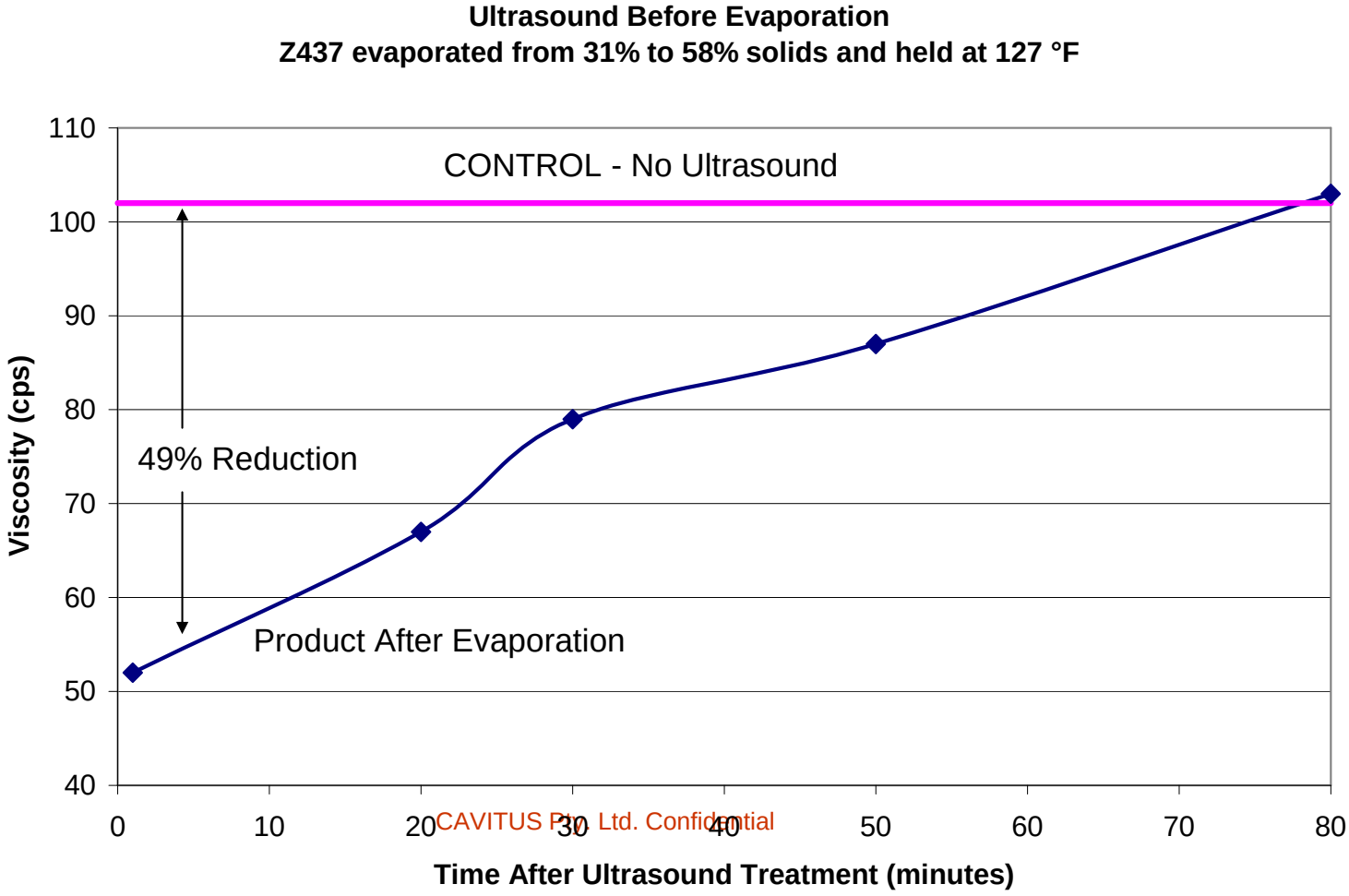

Effect of Ultrasonic processing on the viscosity of fresh Valencia juice (full pulp) at 5°C
Centipoise (mPa.s)
45
40
35
30
25
20
15
10
5
0
5
10
15
20
25
Flow rate (litres/minute)
Untreated
Ultrasonics

A reduction in viscosity of 40 to 75% is achievable using ultrasonic energy in a continuous flow cell



When ultrasound is applied before evaporation, the viscosity reduction lasts for about 1 hour.

- Product was treated with ultrasound prior to evaporation at 31% solids and then evaporated to 58% solids.
- A sample with a 49% reduction in viscosity was held in an agitated tank at 127 °F.
- Over 80 minutes, the viscosity increased and returned to the same viscosity as the product that was not treated with ultrasound.

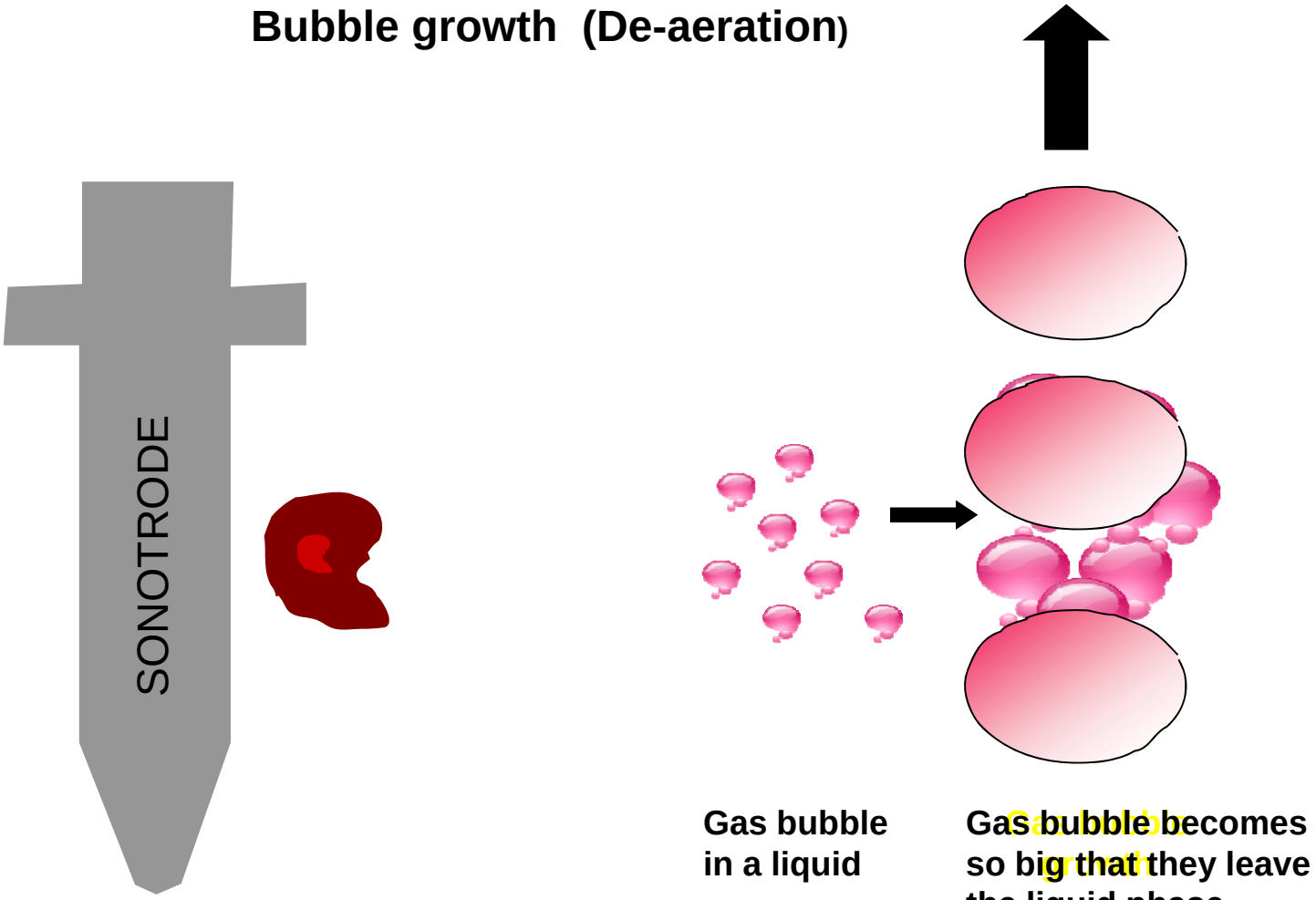


Case Study – Soy Protein Spray Drying

- **Spray dryer constrained by atomisation capacity**
  - ✓ Maximum number of sprays installed
  - ✓ Pump pressure close to maximum
- **Maximum solids concentration < 13%**
  - ✓ Higher concentrations caused atomisation problems
- **Cavitus' TVR reduced viscosity by 70%**
  - ✓ Solids concentration increased from 13% to 15%
  - ✓ Maintained atomisation quality
- **Business case showed better than 2yr payback**
  - ✓ 18% drying energy saving
  - ✓ 16% labour saving or 15% production increase, market dependant

De-aeration

Bubble growth (De-aeration)

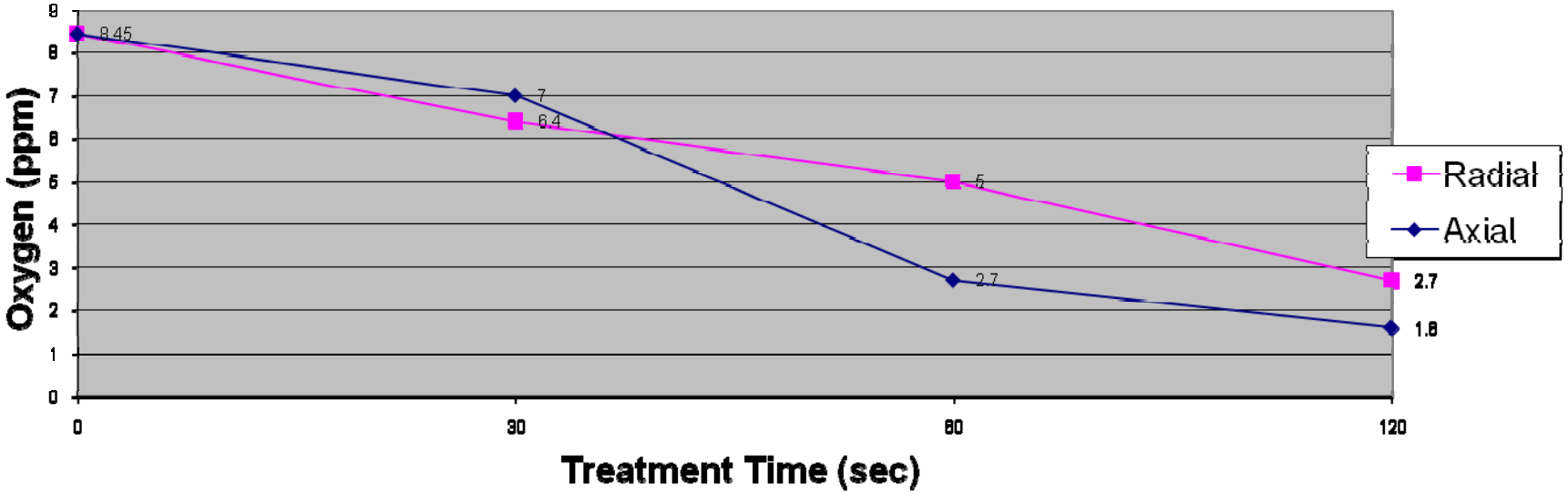


Gas bubble in a liquid

Gas bubble becomes so big that they leave the liquid phase

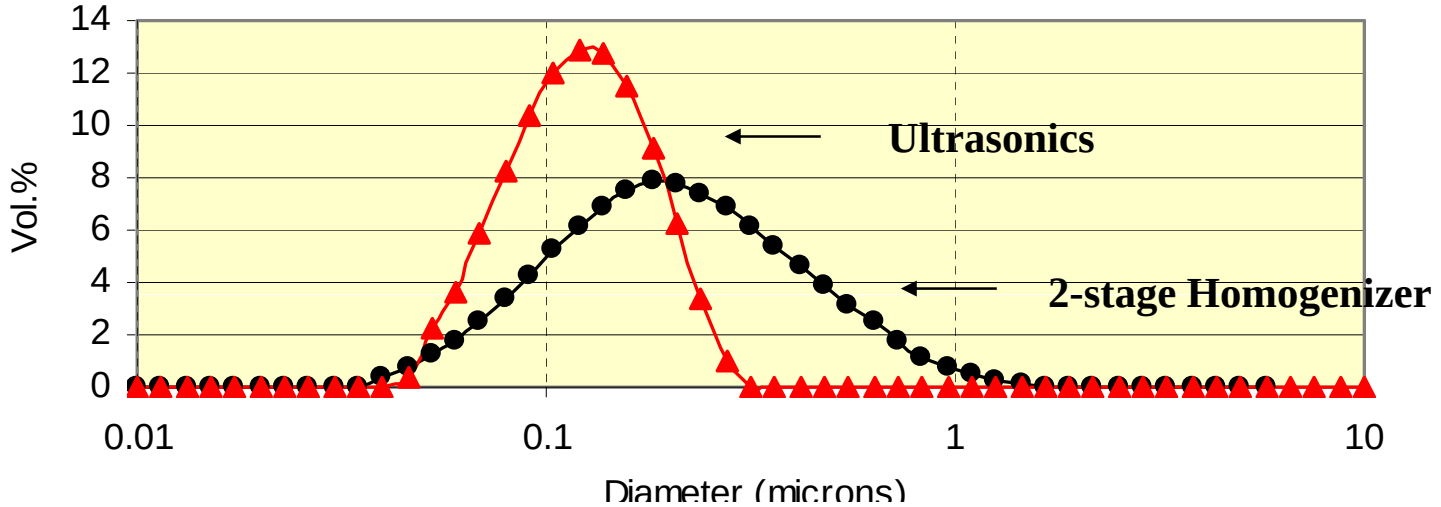
Ultrasonic De-gassing of Orange Juice

Potential for improved shelf-life
Improved efficiency at packaging or bottling lines
Improved fill levels and control
Equipment Estimates
10m3/hr – 4kw (40-60k euro)
30m3/hr – 10kw (90-120k euro)

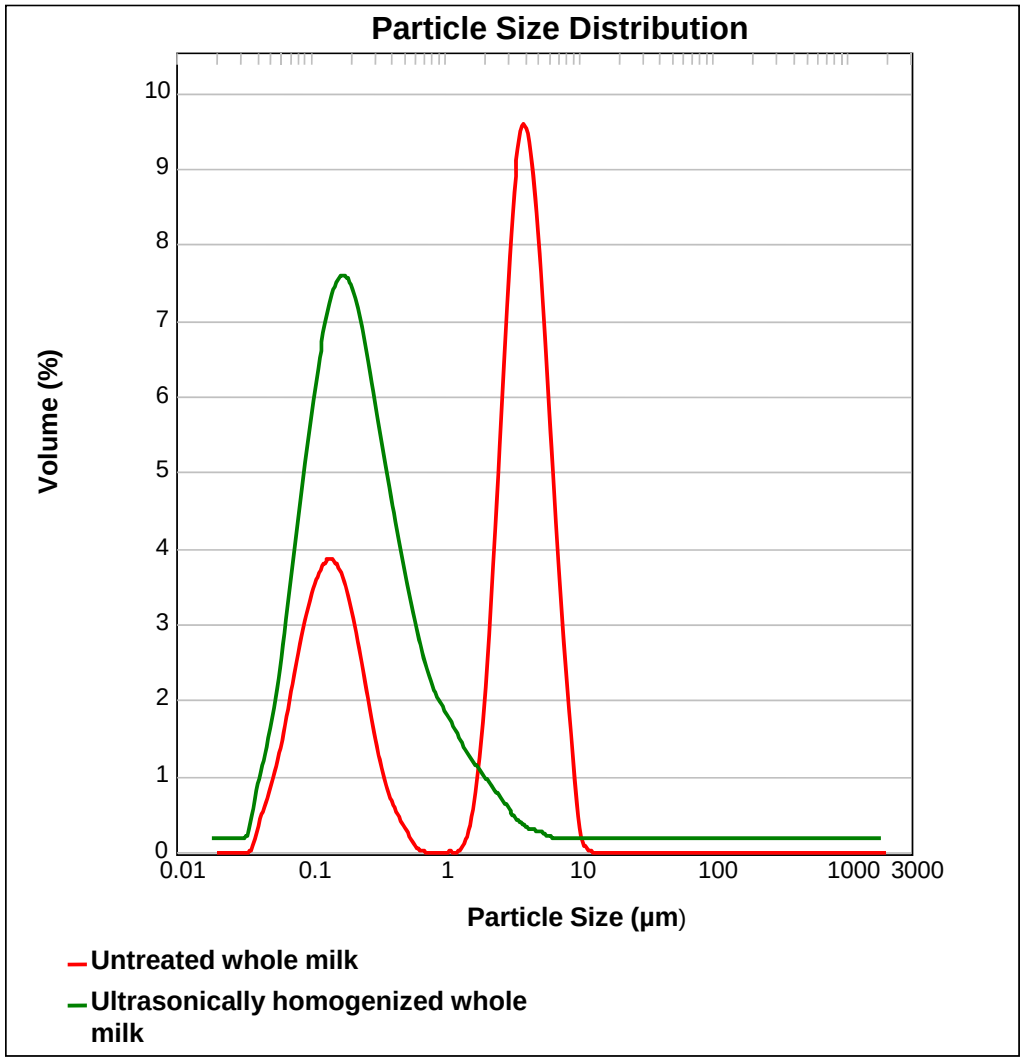


Emulsification of a “Healthy Beverage”

- **Advantages**
  - ✓ Smaller particles, narrower distribution ➔ longer shelf-life
  - ✓ Reduced level of emulsifiers (‘clean label’)
- **Demonstration Business Case**
  - ✓ Reduced emulsifier/additive, energy, maintenance costs
  - ✓ Annual Savings > $US 500,000
  - ✓ Payback < 2 years



Ultrasonic homogenization of milk



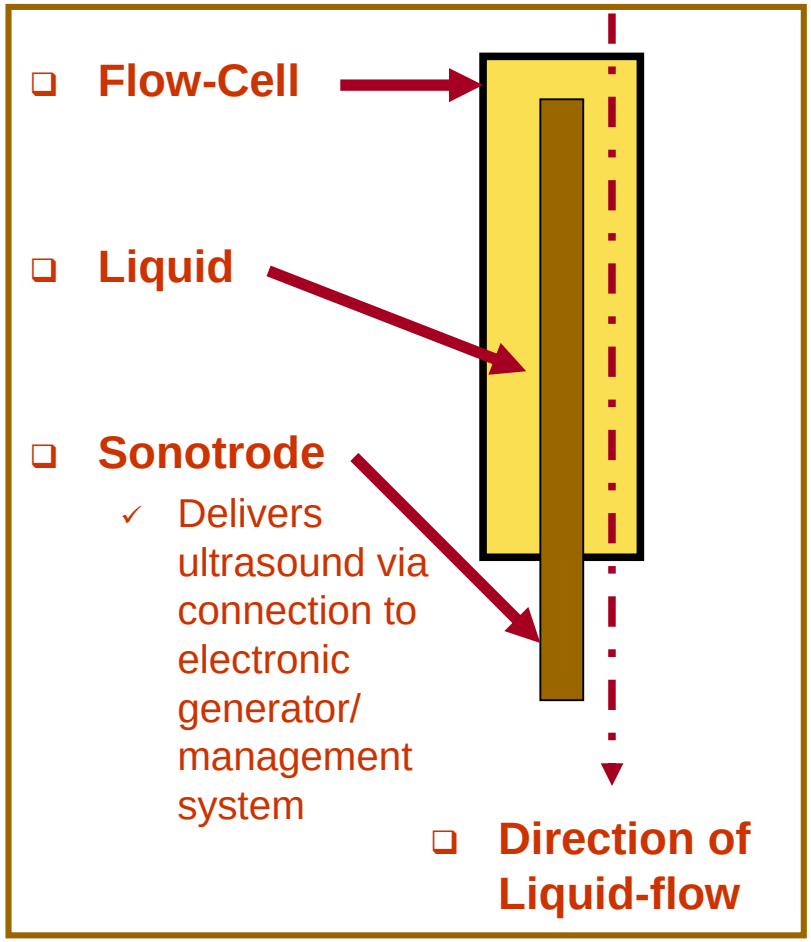
Milk Sample	Fat globule size micron d (0.9)
Untreated	6.06
Mechanically homogenised	1.59
UHT	0.86
U/sound amplitude 1	1.44
U/sound amplitude 2	0.84
U/sound amplitude 3	0.72
U/sound amplitude 4	0.59
Micro fluidizer	0.99

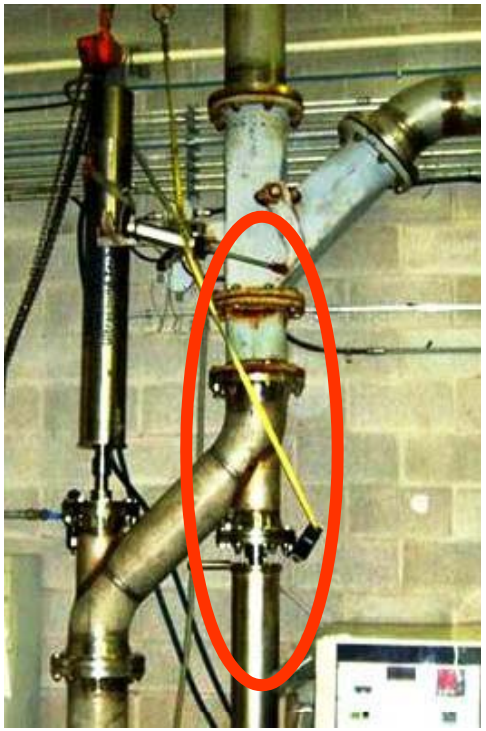
Enhanced Mass Transfer/Hydration of Liquids

- **Applications:**
  - Soya proteins
  - Grains (oats, barley, corn, rice)
  - Starch
  - Hydrocolloids
  - Dairy proteins
- **Mechanism:**
  - ✓ Enhanced mass transport of liquid
- **Demonstration Case**
  - ✓ 50% reduction in process time
  - ✓ Flow rate 120 mt/hr
  - ✓ Payback – 2 years

Malt Hydration

- Standard installation of flow-cell into process piping
- 50% reduction in malting time/water use
- Cleaner barley





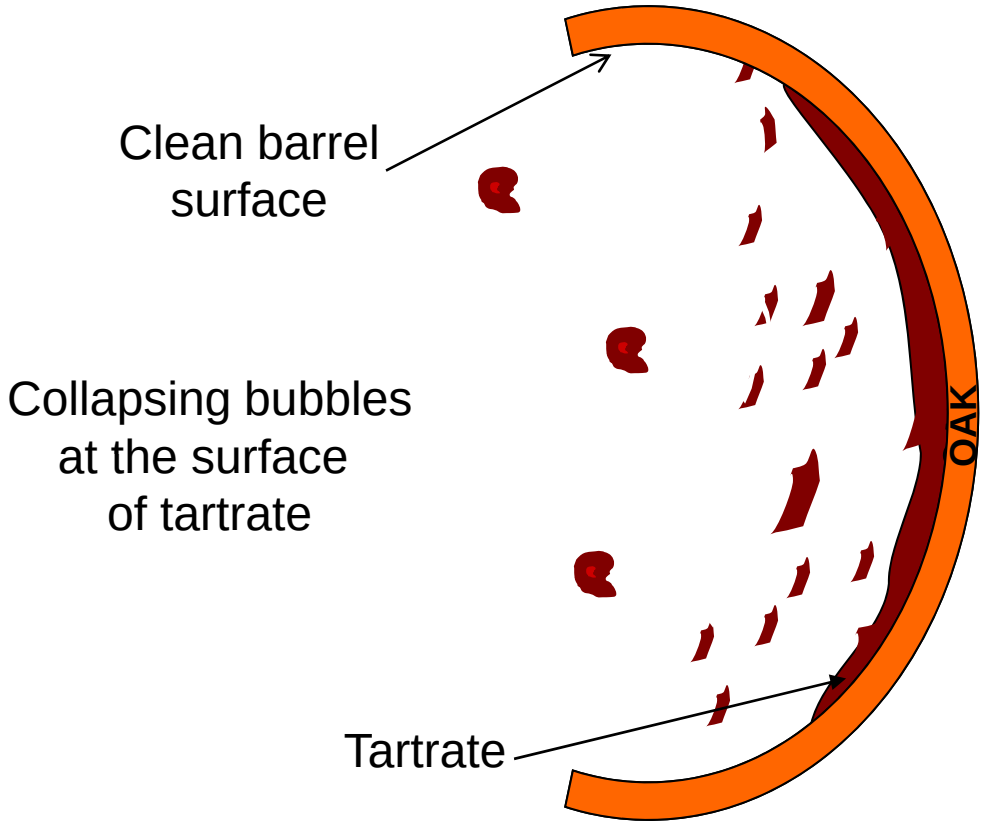
In-line flow-cell for grain hydration – malting

Ultrasonic Enhanced Thermal Heat Transfer

- Increase the rate of heat from liquid to solids
- Enhanced convective heat transfer through packaging materials – liquid filled retorts
- Canned potato cubes/pineapple chunks +50%
- Canned seafood (abalone) +40%
- Reduced processing time – improved product quality
- Potential for improved food safety
- Reduce the thermal resistance of yeasts, moulds and bacteria
- Enhanced thermal heat transfer during frying of snack foods, french fries, potato products, bakery products
- Result – reduced cook time (15 - 30%)

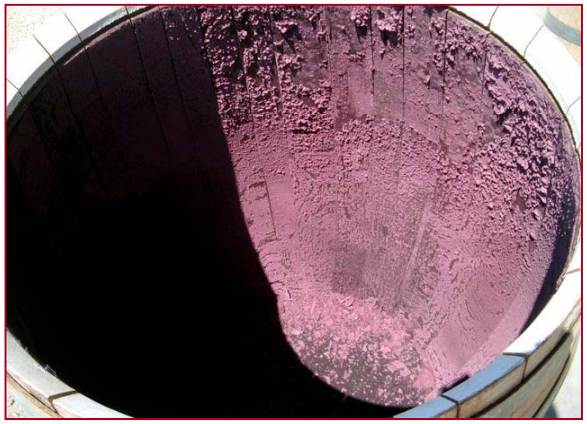
Cleaning and Sanitation

(in wine barrels)



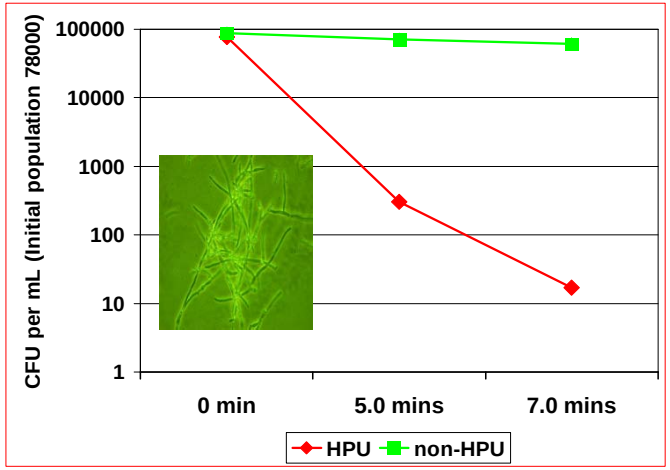
Tartrate is eroded away by the high shear force

Example: Wine Barrel Cleaning and Disinfection with HPU

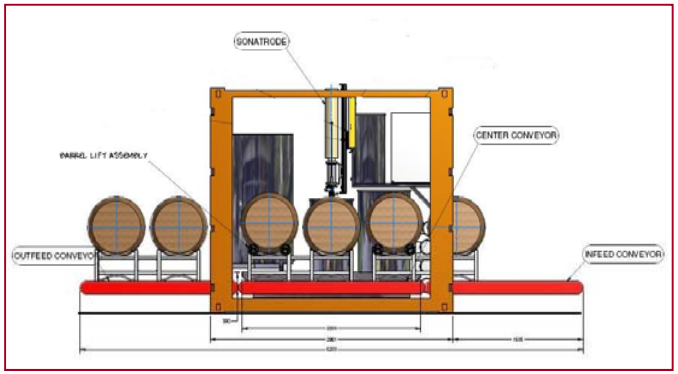


Before Sonication

After Sonication



HPU vs. HPHW in Oak Barrels



Cavitus BWDD system

Beta Barrel cleaning and disinfection Machine

Summary

- Innovative and new technology
- None thermal process
- “Green technology”
- Significant advancement in the last 15 years
- Commercially viable
- Continuous flow
- Easily integrated
- Low operational costs
- Pay back on capital investment < 2 years