Industrial Solutions for Citrus Debittering

Presentation to

International Citrus & Beverage Conference

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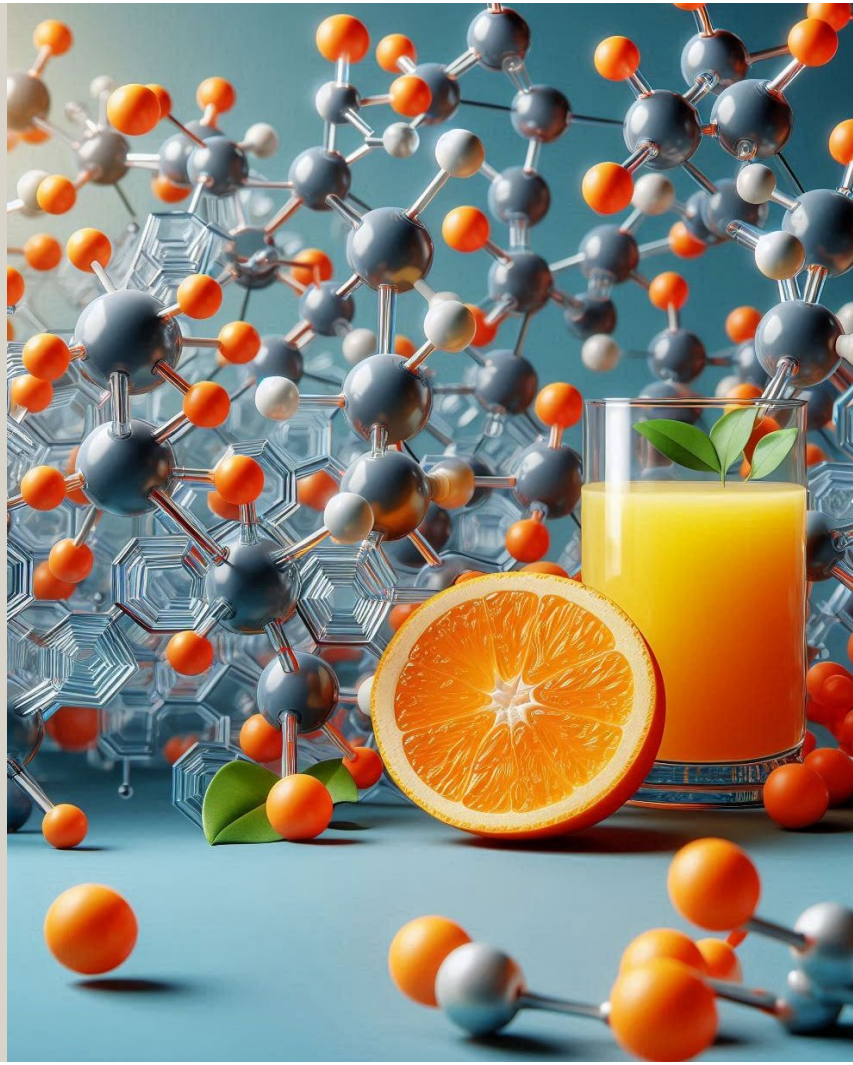
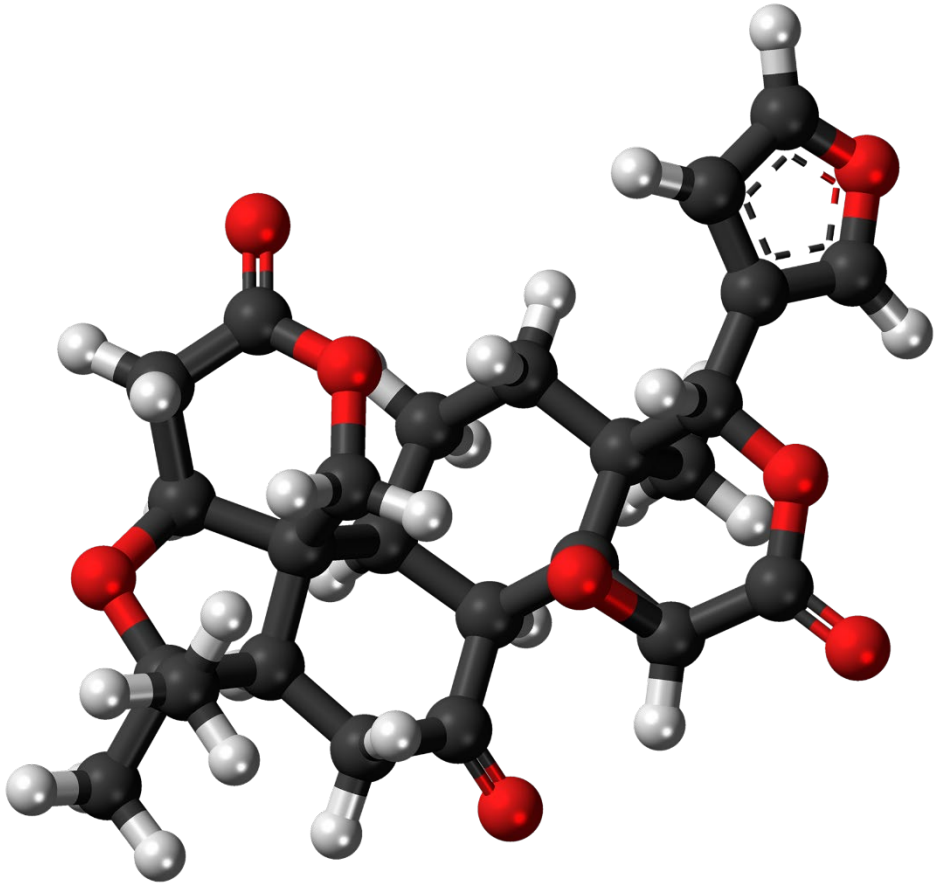


Topics

- About us
- What causes bitterness? –“limonin”
- Other challenges with citrus juices

  ... and solutions!
- How does it work?
- Benefits for juice businesses
- Advancements and development
- Contact and support



Bucher-Alimentech Ltd

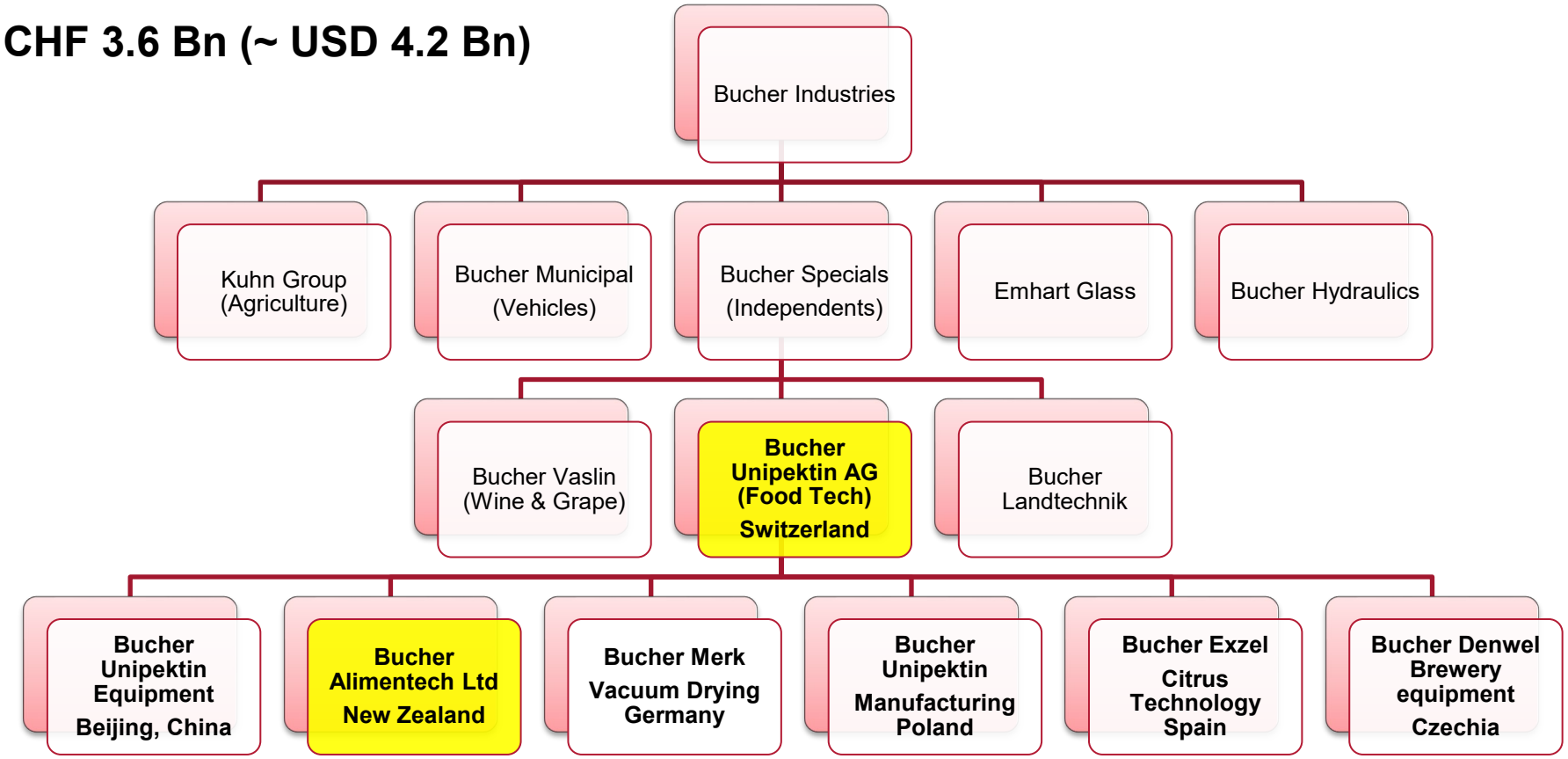
- Based in Auckland, New Zealand
- Started 1964 in specialized water-treatment
- Developed “Alimentech” fruit juice applications in 1980’s (“clear” apple then later “cloudy” citrus)
- Acquired by Bucher of Switzerland in 1996
- FDA approved our debittering 2006
- Ion-Exchange / Adsorption Expertise for fruit juice Asia-Pacific and Americas

Bucher Unipektin AG

Bucher – Established in Switzerland 1807

15,000 Employees

Turnover CHF 3.6 Bn (~ USD 4.2 Bn)



Question : What causes bitterness? Answer : Limonin

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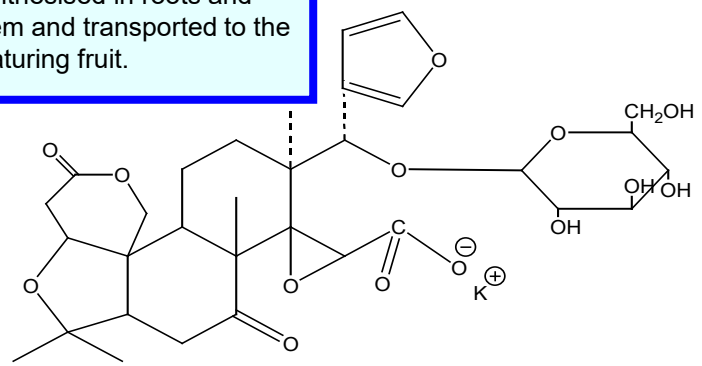
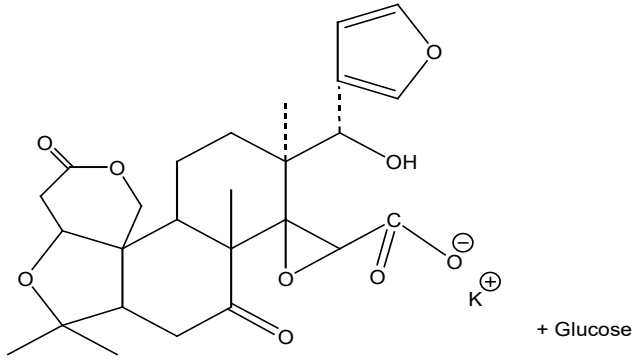
Limonin precursor synthesised in roots and stem and transported to the maturing fruit.



(1) Limonoate A-ring lactone-7-o-β-D-glucopyranoside (non bitter)

In the intact fruit (1) is converted to (2) in an Enzymatic controlled reaction. Enzyme confined to the neutral pH parts of the fruit flavedo, albedo, segment membranes, pith and seeds.

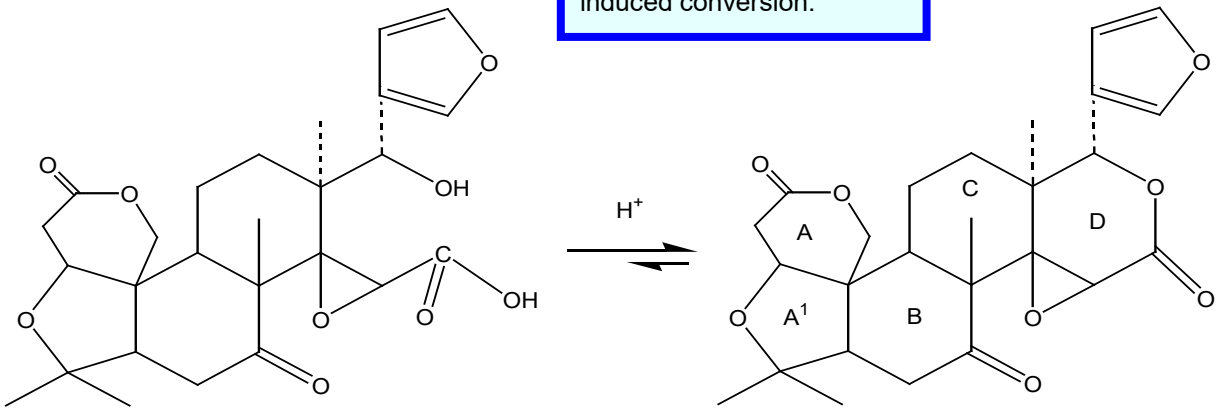


+ Glucose

(2) Limonoate A-ring Lactone (non bitter)

During the extraction, the Limonoate is dispersed into the acidic juice.

Enzymatic and acid induced conversion.



(3) Limonoic Acid A-ring Lactone (non bitter)

(4) Limonin (intensely bitter)

Key Points:

- The fruit is not bitter
- Juices from some orange varieties becomes bitter after expression, with time and heat

Problems we can solve

Full-cloud applications:

- **Prime endocarp citrus juice debittering (e.g. Early season fruit such as Navel)**
- **HLB greening affected fruit**
- **Acid reduction also possible**
- **By-product improvement (e.g. peel extract, core-wash)**
- **Orange varieties, grapefuit, tangerine, lime**

Also clear juice applications

- **e.g. Apple juice decolorizing and haze-stabilization**

How does it work?

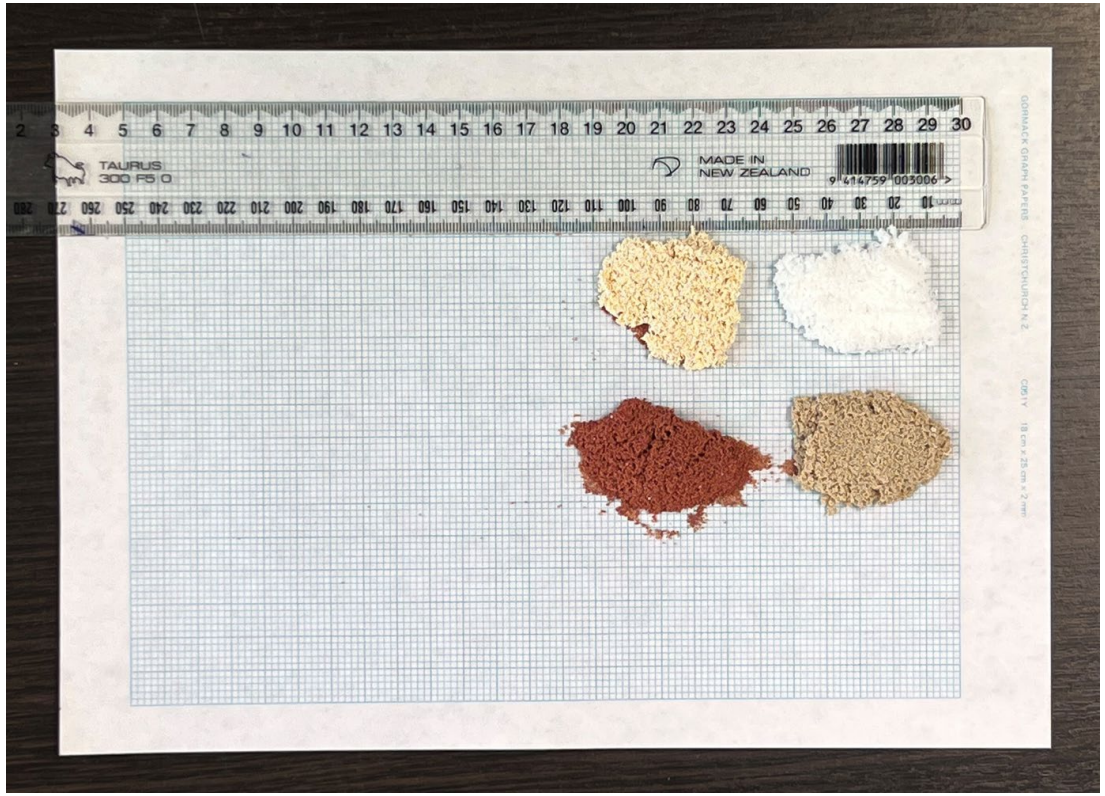
- Juice flows through a machine with multiple pressure-vessels
- Pressure-vessels contain specific or different types of porous resin beads
- Undesirable compounds are removed by the resins
- Resins are regenerated for re-use for many years

Types of Resin : porous beads ~0.8 mm (~1/32”)

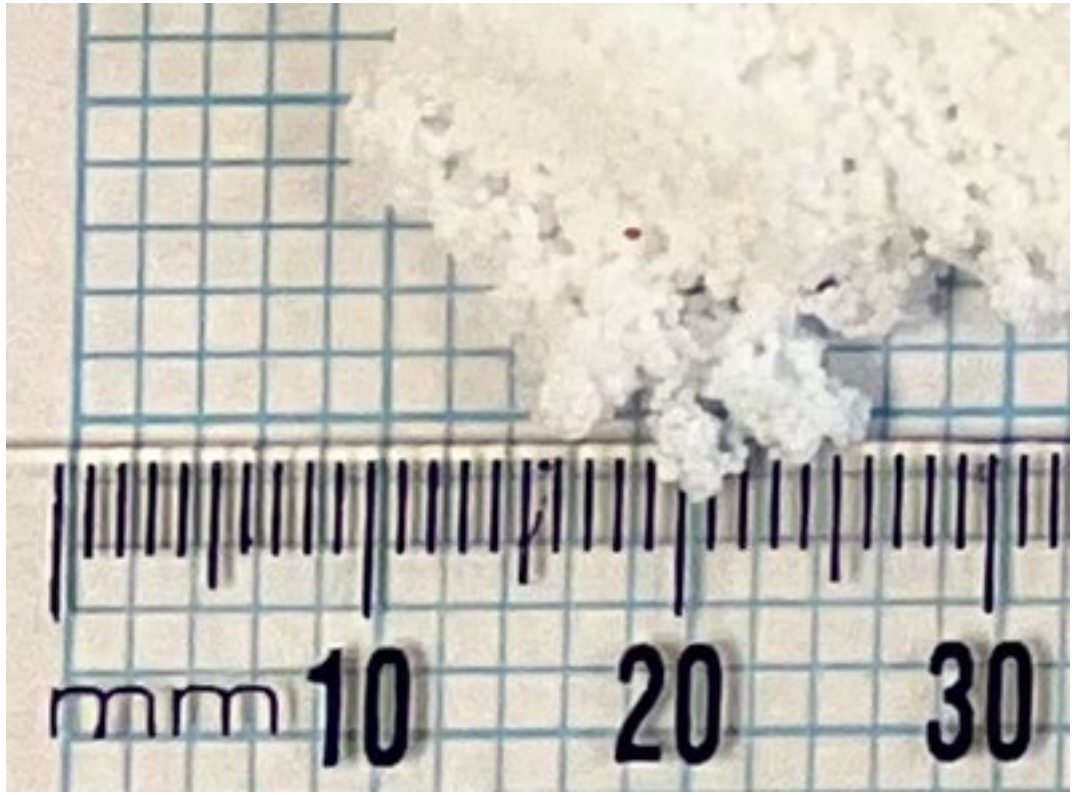
Machinery

Different Resins

Naked Eye on A4 Sheet



~ 10x Zoom



Spherical Beads ~ 100x Magnification

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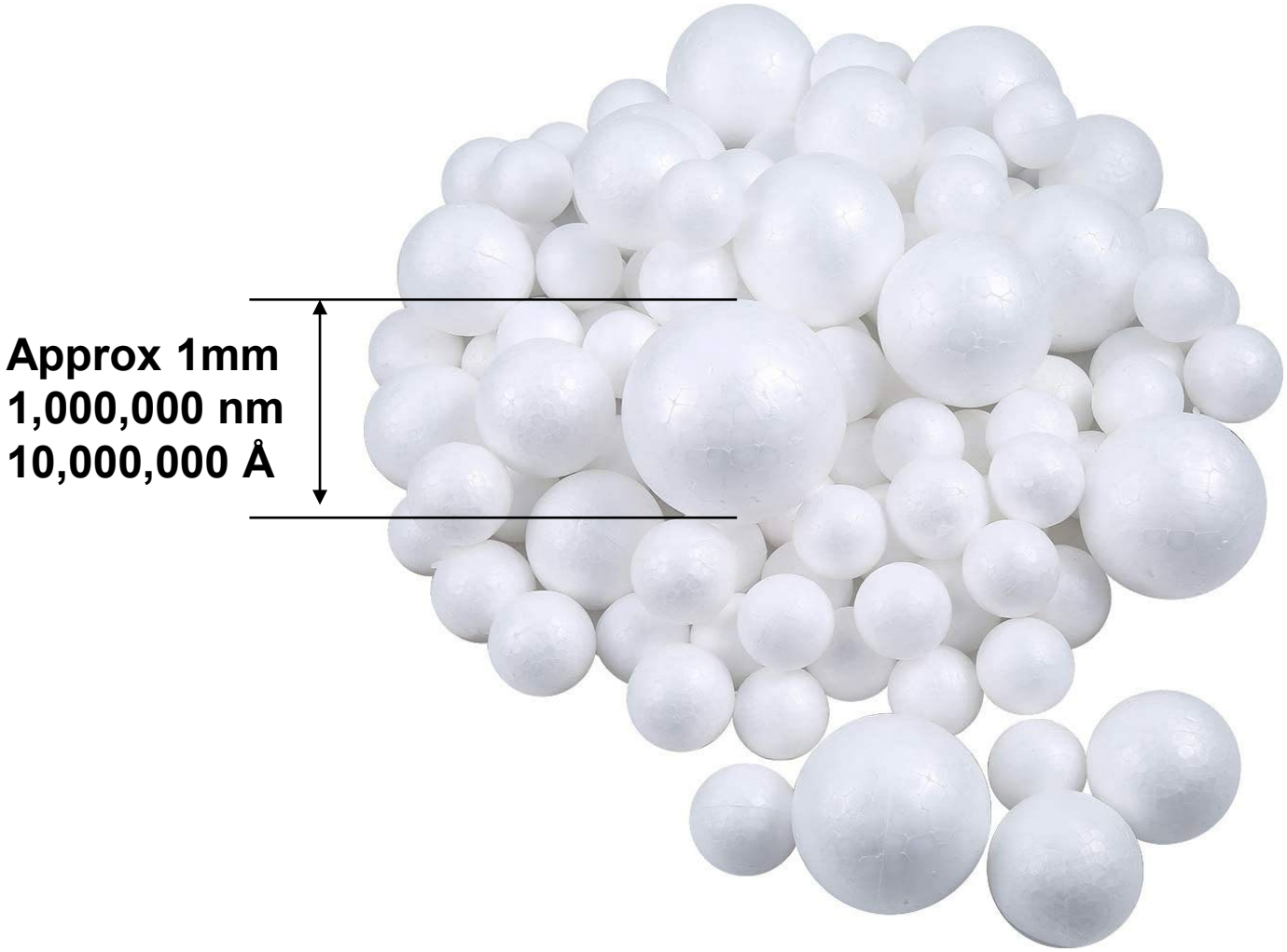
Typical diameter = 0.3 – 1.0mm

Average 0.8 mm (~1/32 inch)



Scanning Electron Microscope - ~ 80,000x Magnification

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Average pore:

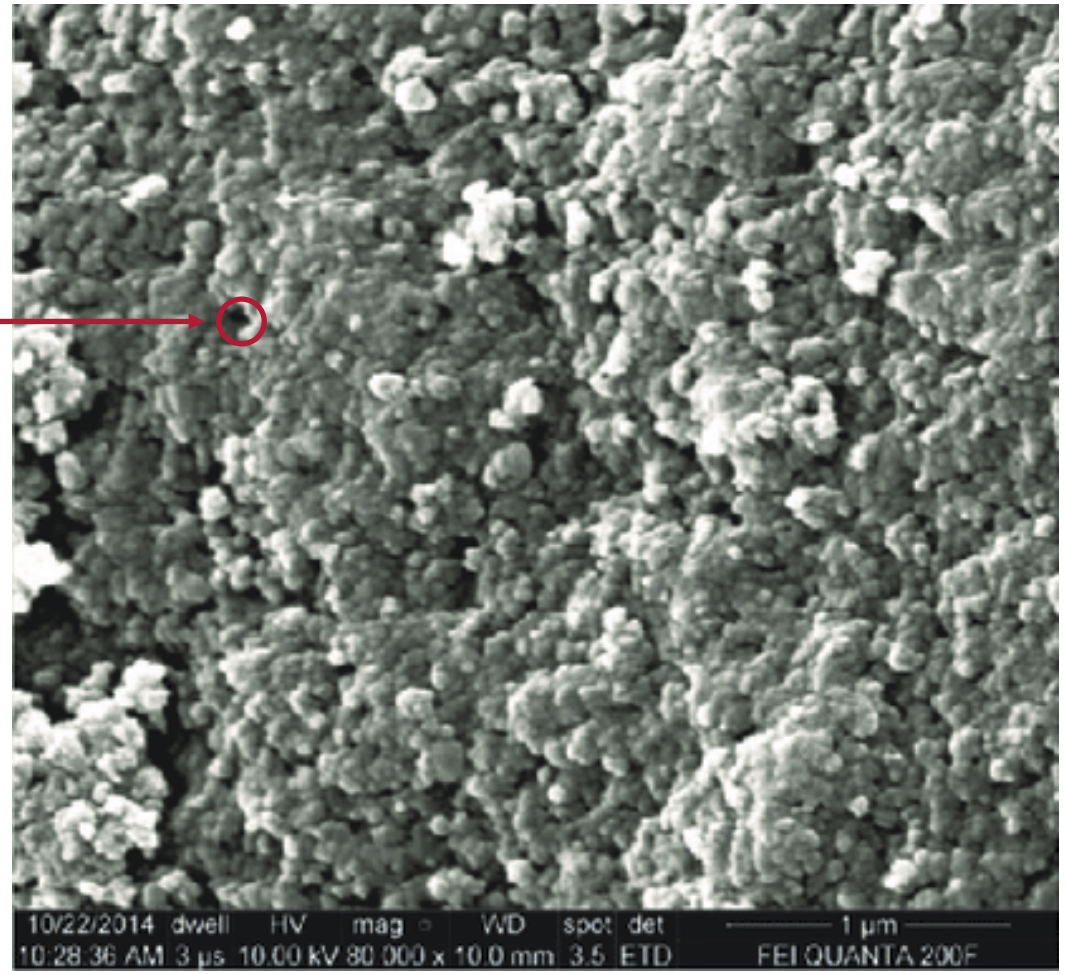
Approx 0.00024 mm

= 0.24 µm

= 240 nm

= 2,400 Å

= 0.00001”



Source : Tiwari, Shelja & Sharma, Niharika & Saxena, Reena. (2015)

Resin matrix at molecular level
~ 50,000,000 x Magnification

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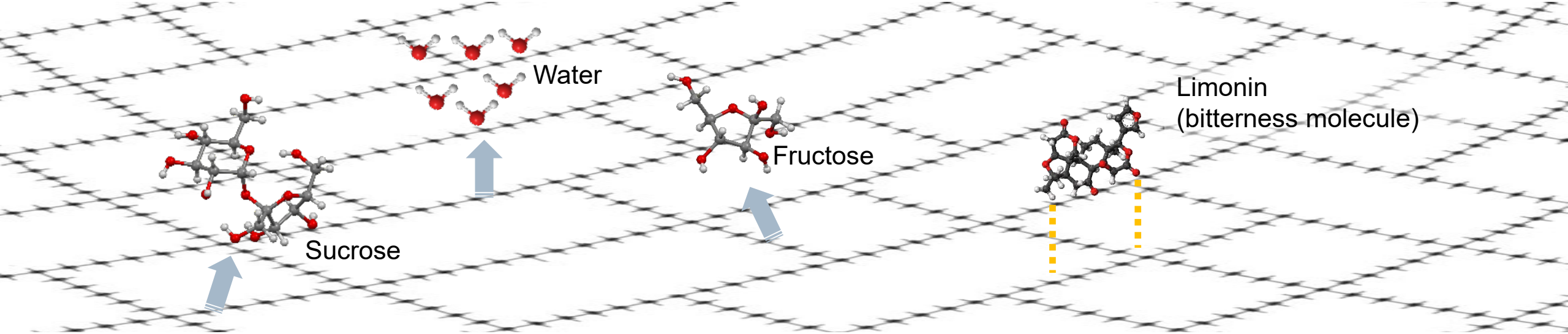
Resin polymer matrix on pore surface with typical molecules in juice, at same scale



Some molecules pass through

Some are attracted to the resin surface

10 Å

10Å (Angstrom) = 1 nm = 0.000001mm = 0.000000001m
10e-6 mm 10e-9 m

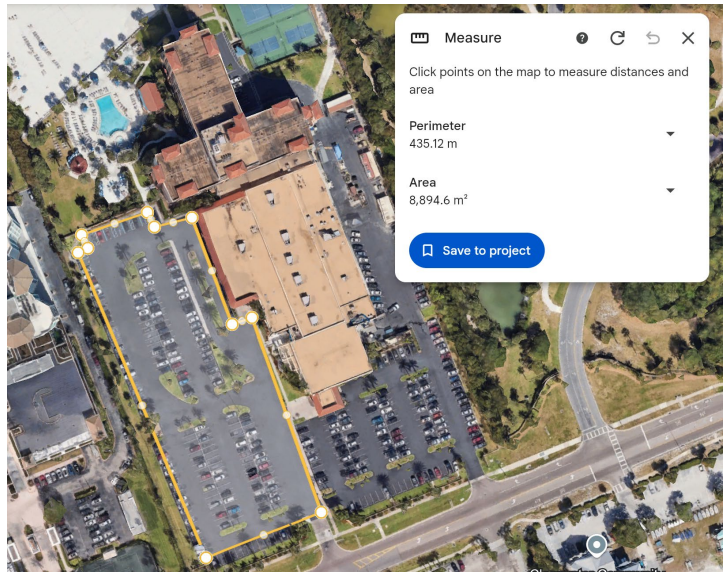
Important - the "magic" happens on the surface!

Adsorbent resins:

High internal surface area:

- **Surface Area to Volume ratio : Typically 400 - 800 m^2 / g**
- **One tablespoon of resin: = ~15ml (~0.5 fl.oz)**
- **9,000 m^2 = 2.2 Acres, or…**

  …. Main carpark at Sheraton Sands!



Different resins for different applications

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Key differences:

- **1) Co-polymer materials**
- **2) Resin porosity**
- **3) Functionality : Cationic, Anionic, non-functionalized**

Also:

- **Particle size distribution**
- **Other manufacturing subtleties**

These factors make a lot of difference in application, operation, and regeneration

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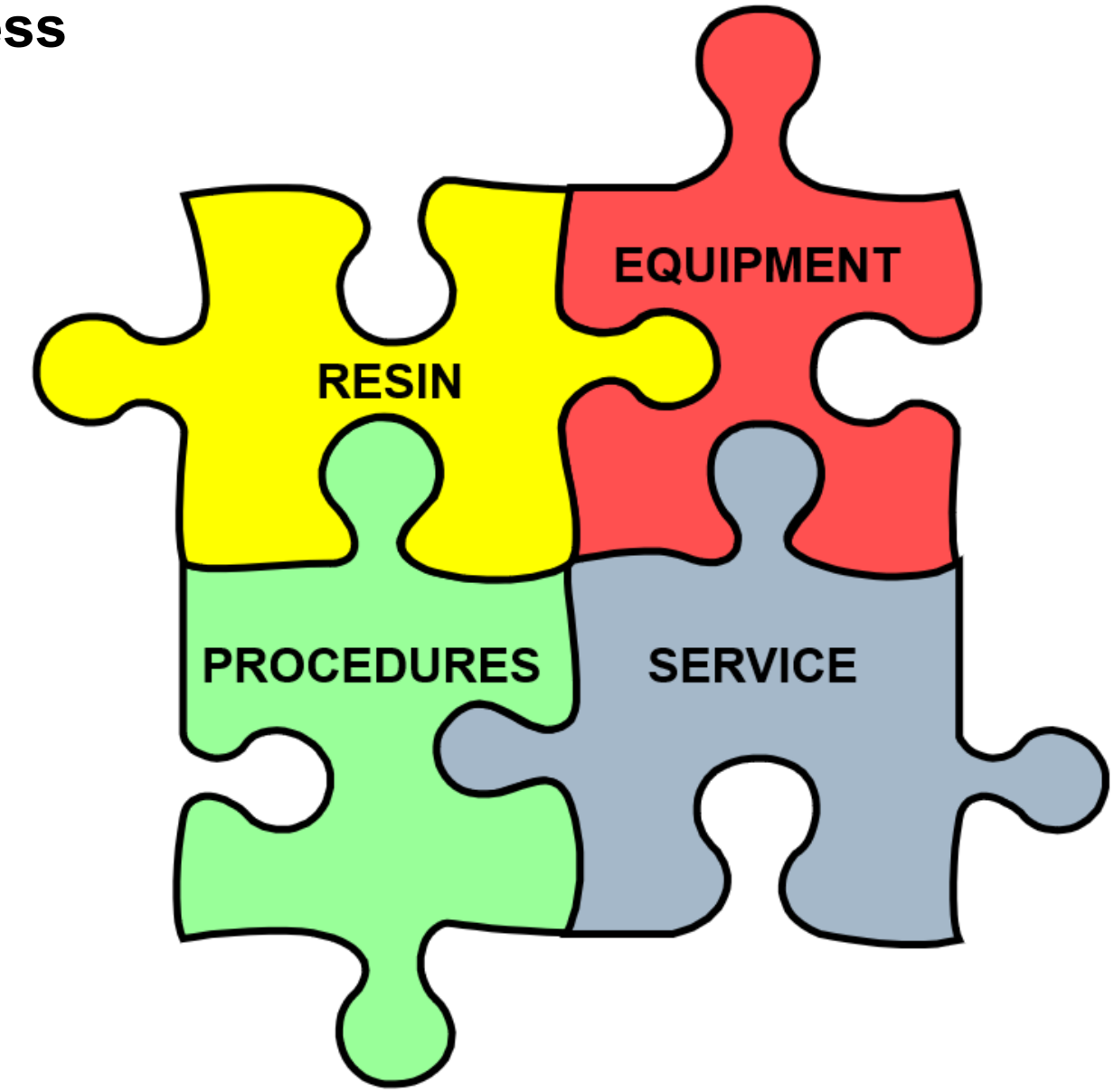
Recipe for success



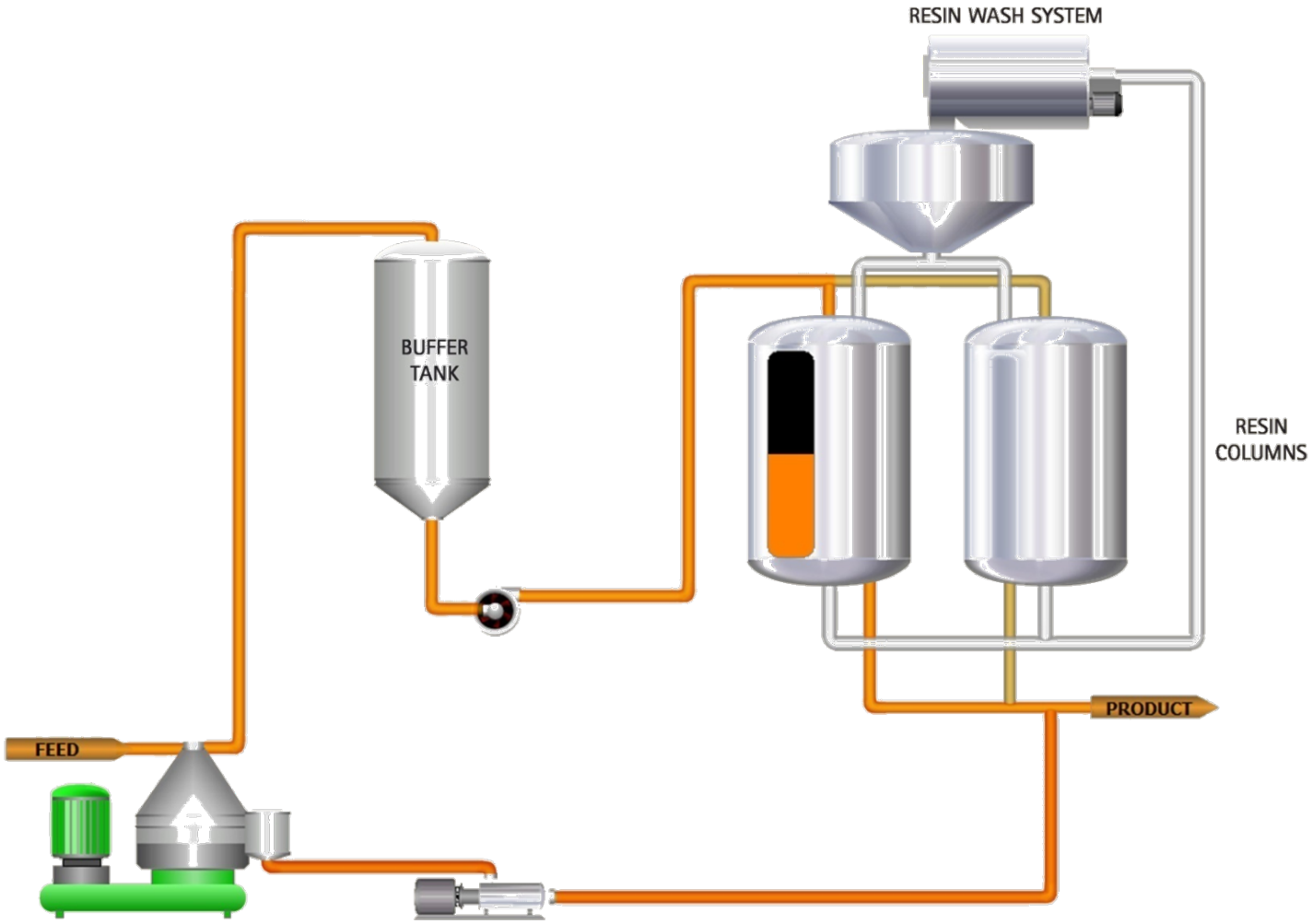
Typical Processing Equipment
Citrus Debittering

Bucher-Alimentech
Model DB2-1750

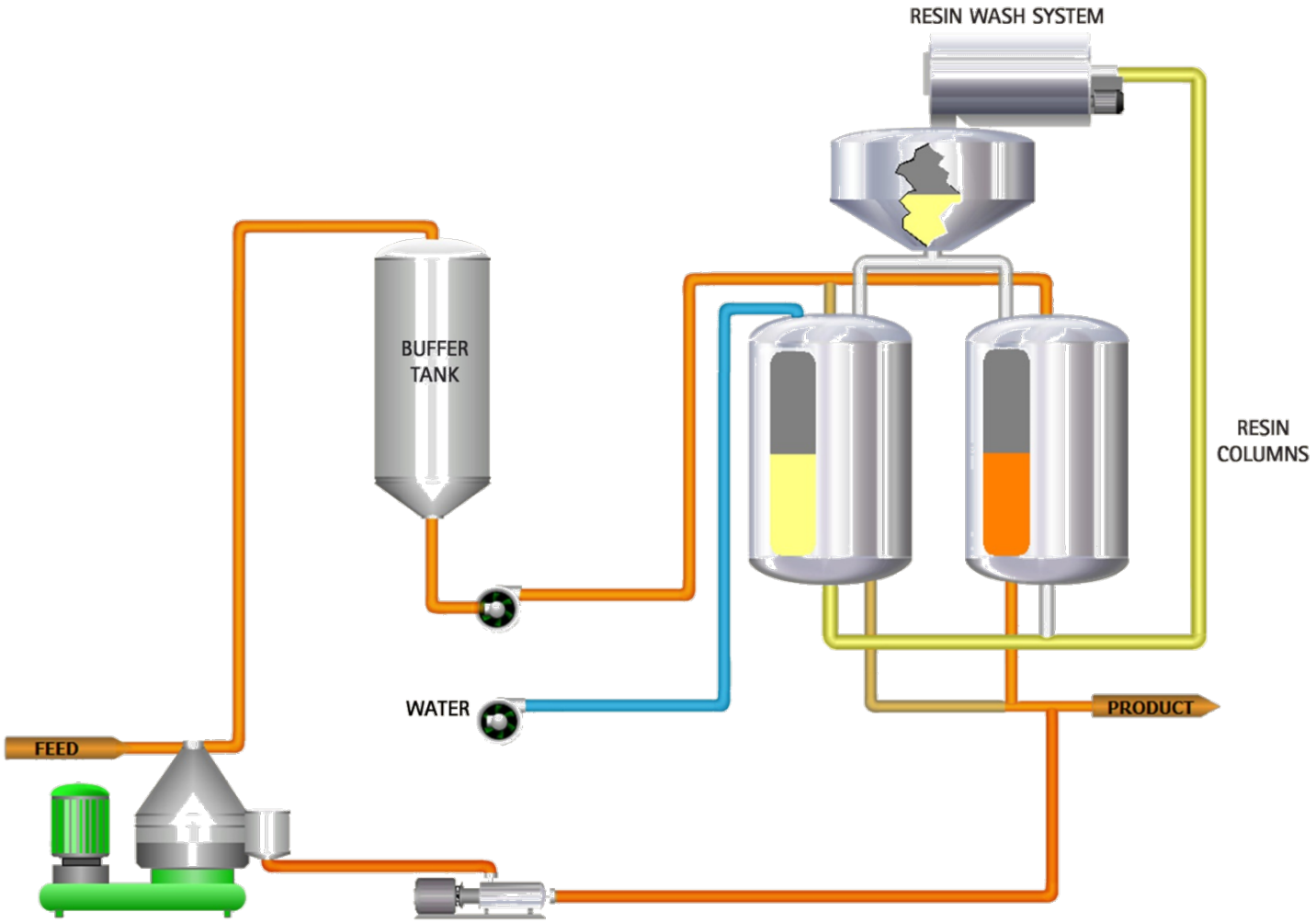
Continuous debittering
plant for cloudy juice
15,000 litres per hour
(65 ~ 70gpm)

6.0m L x 2.3m W x 5.5m H
(19’6” X 7’6” X 18’. approx)

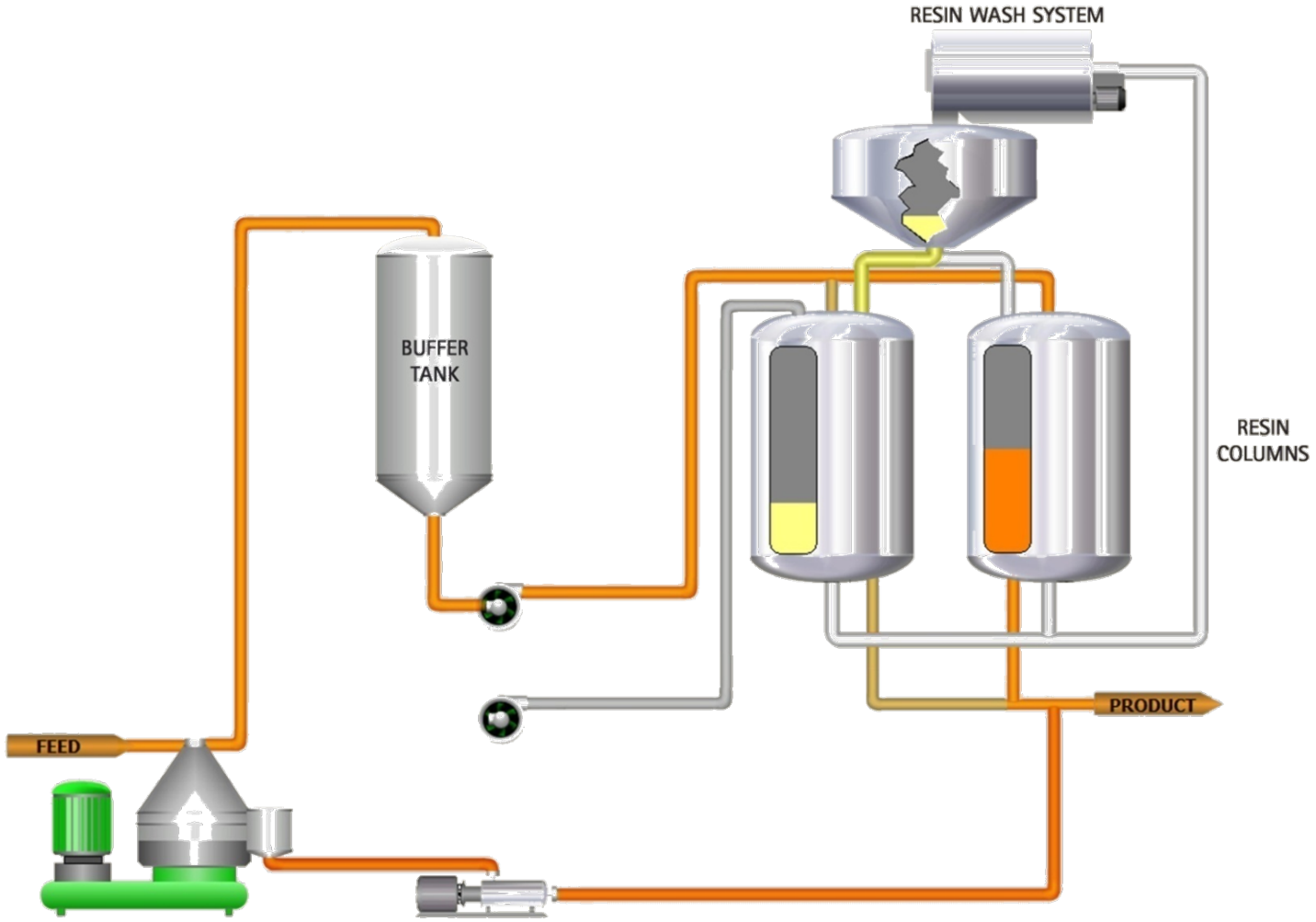
Juice Process



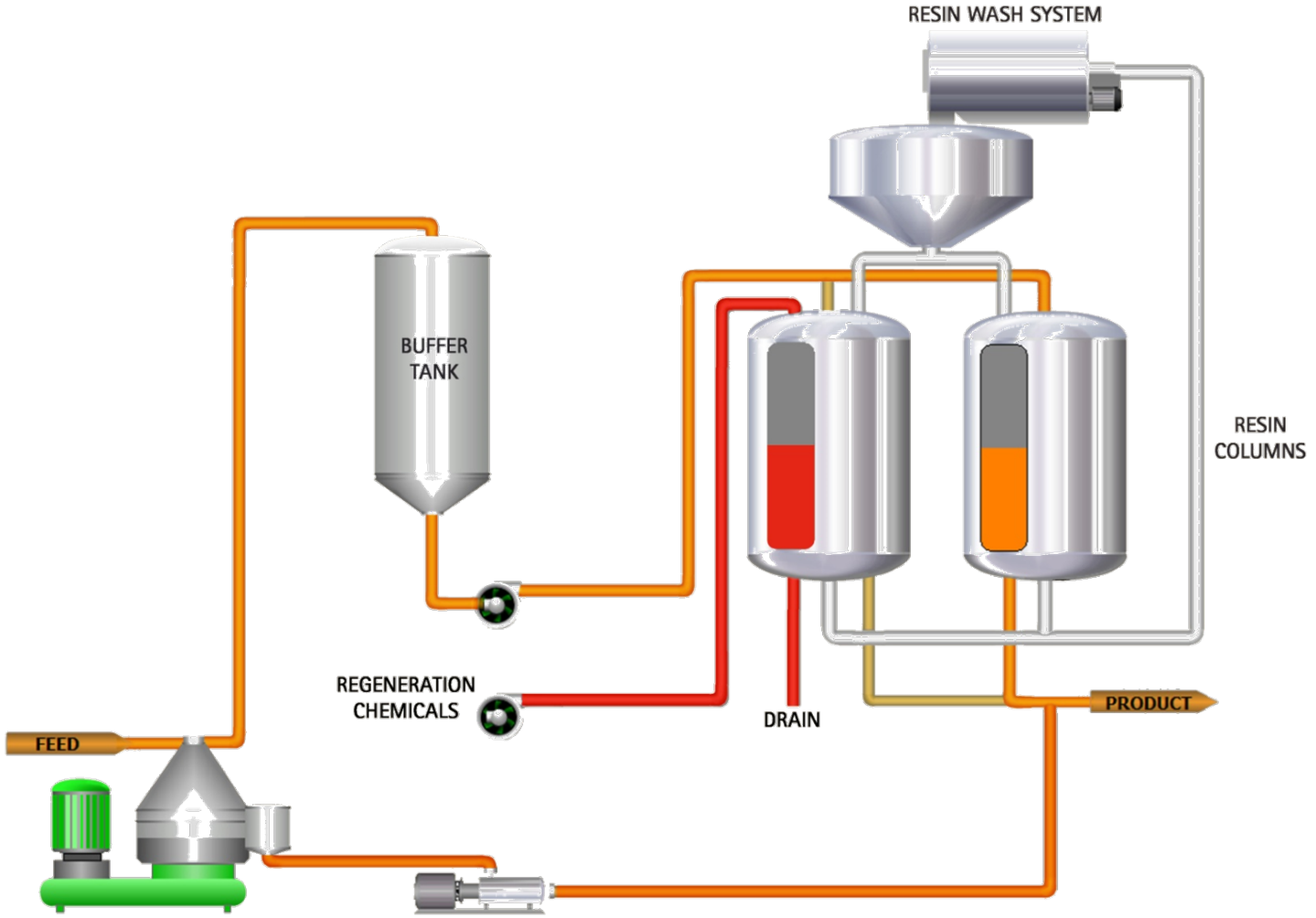
Resin Transfer and Wash



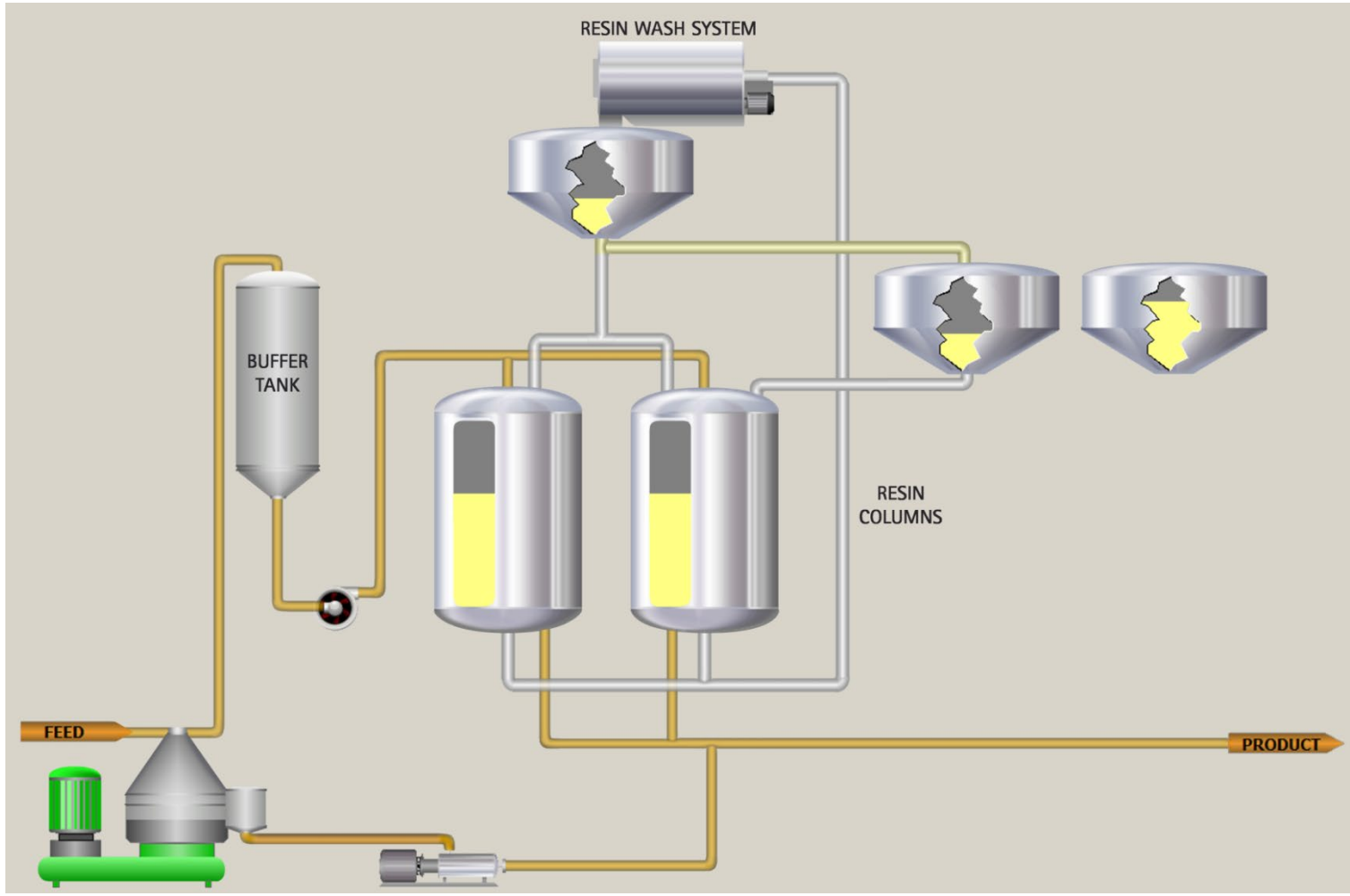
Resin Return



Regenerate Resin

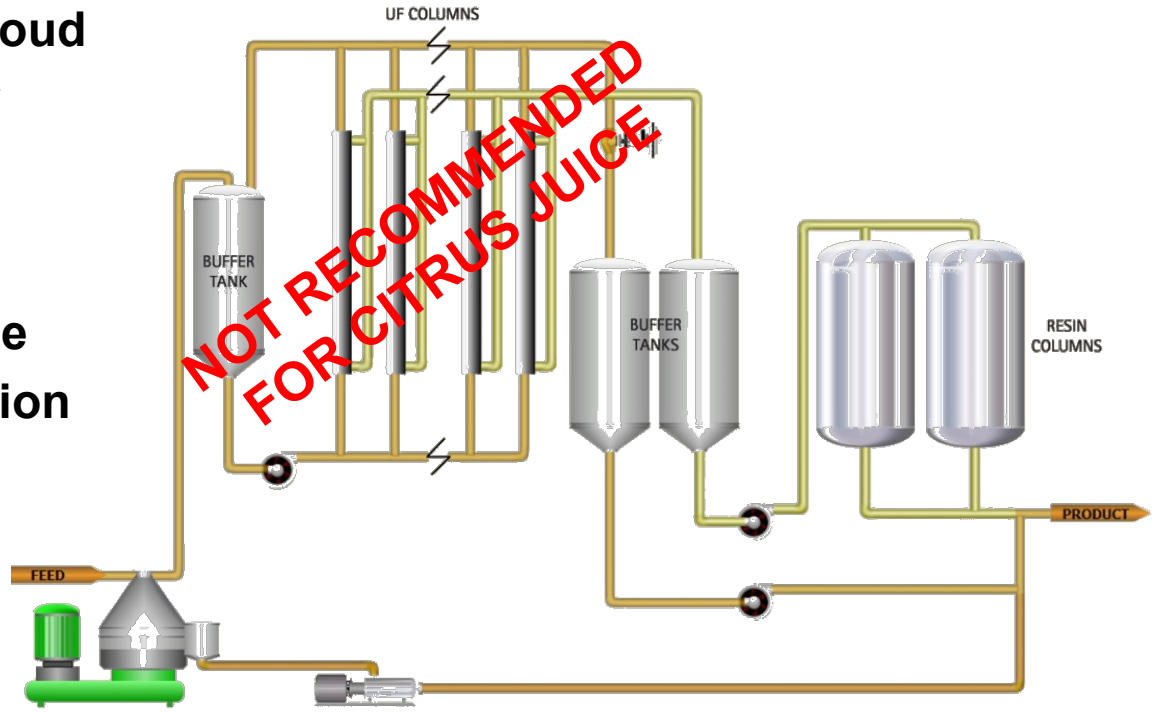


Optional Resin changeover – Debittering OR Deacidifying



Comparison to the other technology :
UF Membrane + Debittering Columns “Combined System”

- OK for clear juices but not good for prime orange juices
- 100% cloud and pulp in one stream and 0% cloud and pulp in the other – recombination stability problems
- Oil level must be below 0.01% (100 mg/l)
- When there is membrane failure, pulp clogs the resin bed, very difficult to clean – lost production
- COST of Membrane replacement
- COST of Energy

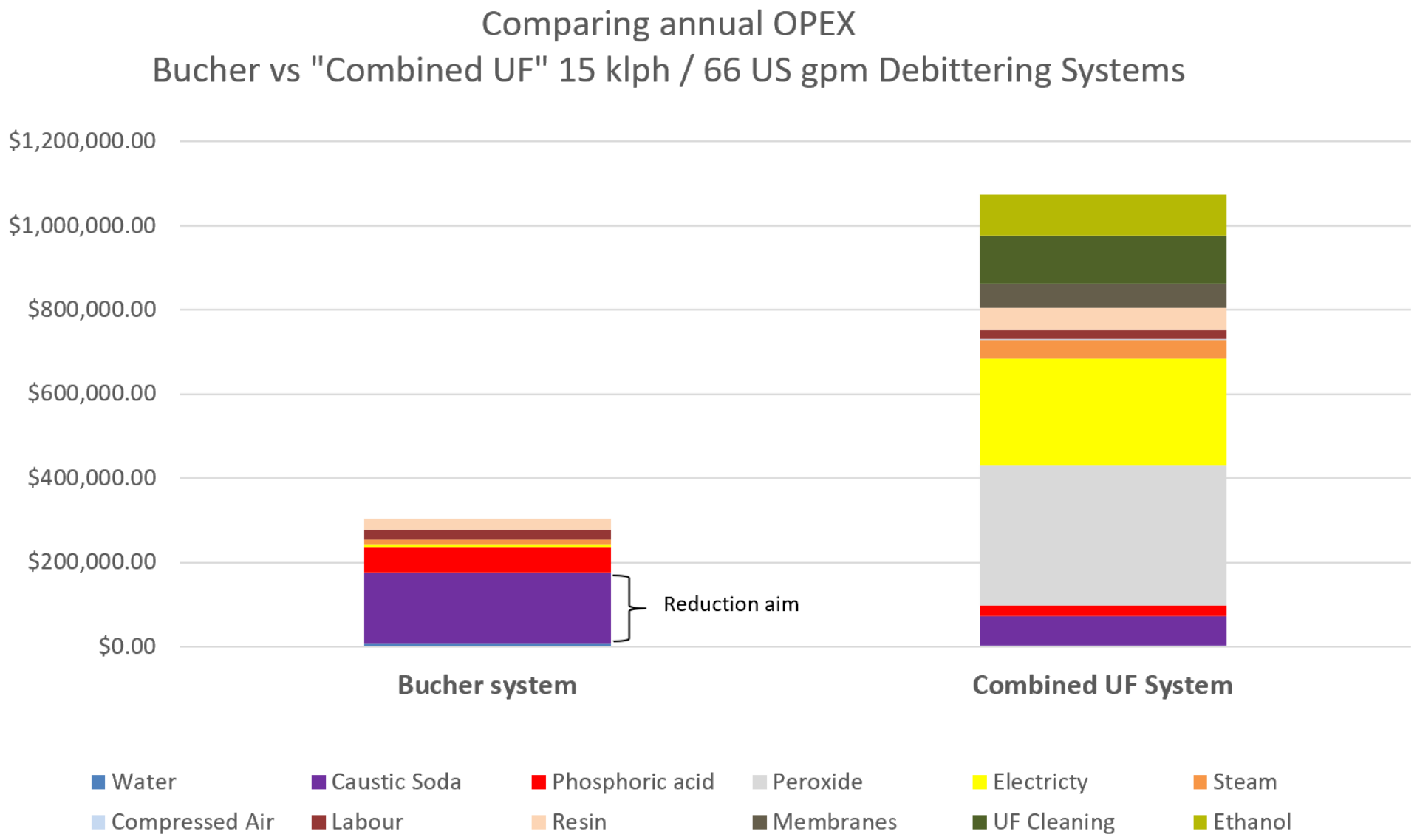


Advantages of Bucher “Cloudy System“

- Processes cloud and pulp up to 1% - good recombination
- No enzymes required
- Resin is completely cleaned and regenerated every 3.5 to 5 hours.
  No bacteriological contamination
- Oil tolerance – can process up to 0.1% (1,000 ppm)
- If pulp gets into bed, immediately regenerate and continue
- Longer resin life
- NO membrane costs
- Energy costs significantly lower
- <u>TOTAL OPERATING COST MUCH LOWER</u>

Bucher-Alimentech
Model DB2-1750
Citrus Debittering Plant

Advancements – reduce resource use and operating costs



Benefits for juice businesses

- Reduction in purchasing costs for fruit (for example, use more Navel)
- Add value to prime juice – achieve better prices
- Adding value to by-products (e.g. core-wash, peel extract)
- Monetizing waste-streams
- Greater process and blending flexibility, and inventory management
- Low OPEX
- Economic returns may vary (selling prices, input costs, operating hours)

Benefits for juice businesses
Business case example

Location:	**State of São Paulo, Brazil, 2024**
Challenge:	**Achieve premium of USD 700 / Metric Ton (concentrate)**
	(Compare average price USD 5,270 / Metric Ton)
Solution:	**Debittering and acid-reduction**
Payback:	**30,000 lph juice = 720,000 l/day of juice (190,000 Gal / day)**
	~130 Tonnes per day of concentrate = USD ~90,000 per day

Commercial issues
General regulatory comment - Not legal advice

Application	Jurisdiction	Comments
OJ Debittering	USA	Specifically approved
	EU	Permitted
OJ Deacidification	USA	Permitted
	EU	Not permitted
Deionisation	Generally	Care when labelling

Key points:

- **Generally accepted techniques in the fruit juice industry globally**
- **Requirements vary between jurisdictions**
- **Some smaller jurisdictions have co-opted US FDA regulation**
- **Seek independent advice**

Process development

Test centres in Switzerland and New Zealand

Available for testing and global pilot trials

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- Process proving on site
- Multipurpose 100 litre (26 U.S. gal) column (resin volume)
- Up to 1,000 lph (4 U.S. gpm)
- Variety of resins = various processes
- Designed for airfreight

Looking forward to talking further

Thank you!

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