



THE NEW DIMPLE TUBE
A TECHNOLOGY TO IMPROVE VACUUM PAN PERFORMANCE
AND FACTORY EFFICIENCY

Introduction: The Challenge

Debottlenecking or expansion projects most often require vacuum pan capacity increases .

Energy efficiency projects demand more efficient factories and reduced steam consumption

- Improve existing vacuum pan performance
 - Mechanical circulation/stirrer
 - expensive and requires additional maintenance
 - Requires additional infrastructure
 - Movement steam or “jigger” steam
 - Additional steam usage
 - Increase heating surface area – welded calandria
 - Expensive and disruptive
 - Increases pan graining volume and hence cycle time



Introduction: The Challenge

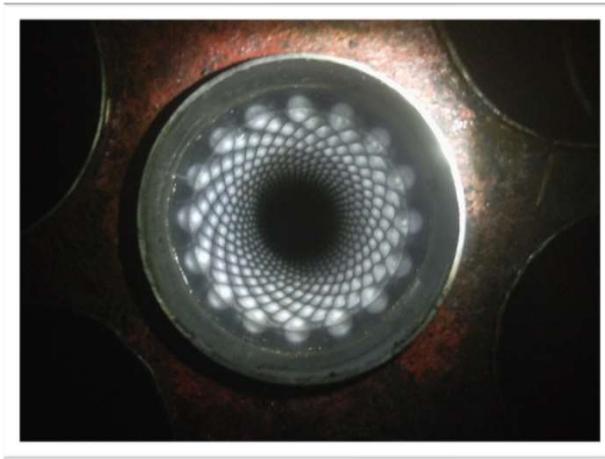
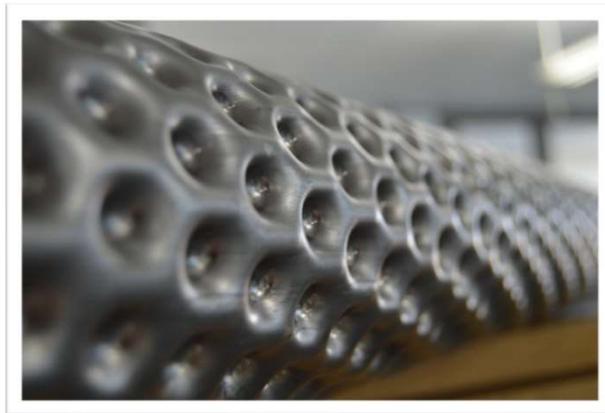
Debottlenecking or expansion projects most often require vacuum pan capacity increases

Energy efficiency projects demand more efficient factories and reduced steam consumption

- Improve existing vacuum pan performance – cont'd.
 - Increase heating surface area – alternative tubes
 - Expensive and disruptive
 - Further increases graining volume and hence cycle time
- Additional equipment and pan floor reconfiguration
 - Often the only option if others are exhausted
 - Requires auxiliary equipment and infrastructure
 - Large capital expenditure



Introduction: The Solution → Dimple Tubes



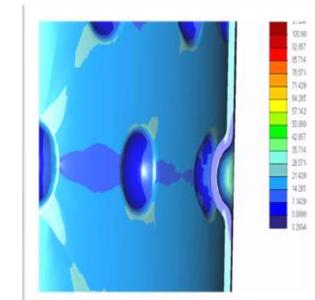
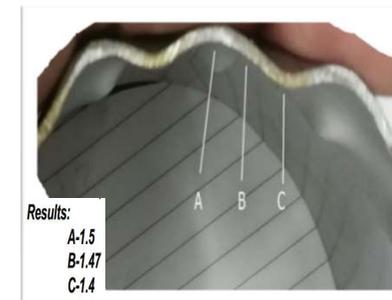
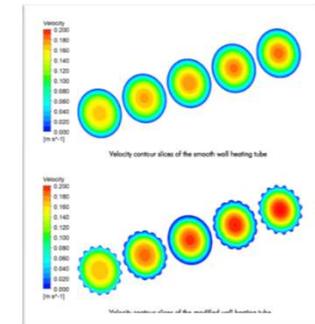
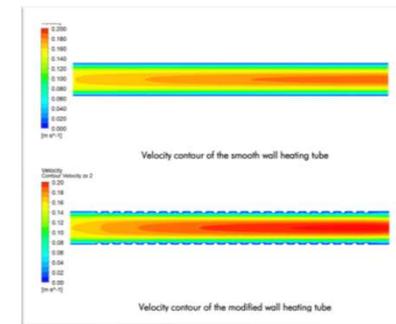
Introduction: The Solution → Dimple Tubes

- Increased heating surface area → 16.5%
- Increased turbulence on massed and vapour sides of tube wall
- Increased Evaporation Rate → Reduced cycle time
- Higher heat transfer coefficients → lower required ΔT
- Reduced rate of tube fouling due to turbulence



Design, Testing and Verification

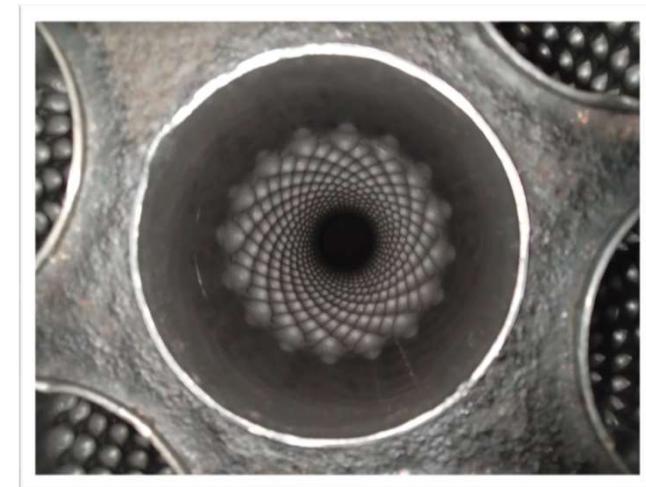
- Comprehensive CFD analyses predicted improved performance and optimised geometry
- Well within MAWP limits in terms of wall thickness. Direct stress and fatigue analyses confirmed theoretically infinite life in terms of fatigue.
- Pressure testing to 10 bar(g) confirmed no deformation or leaks



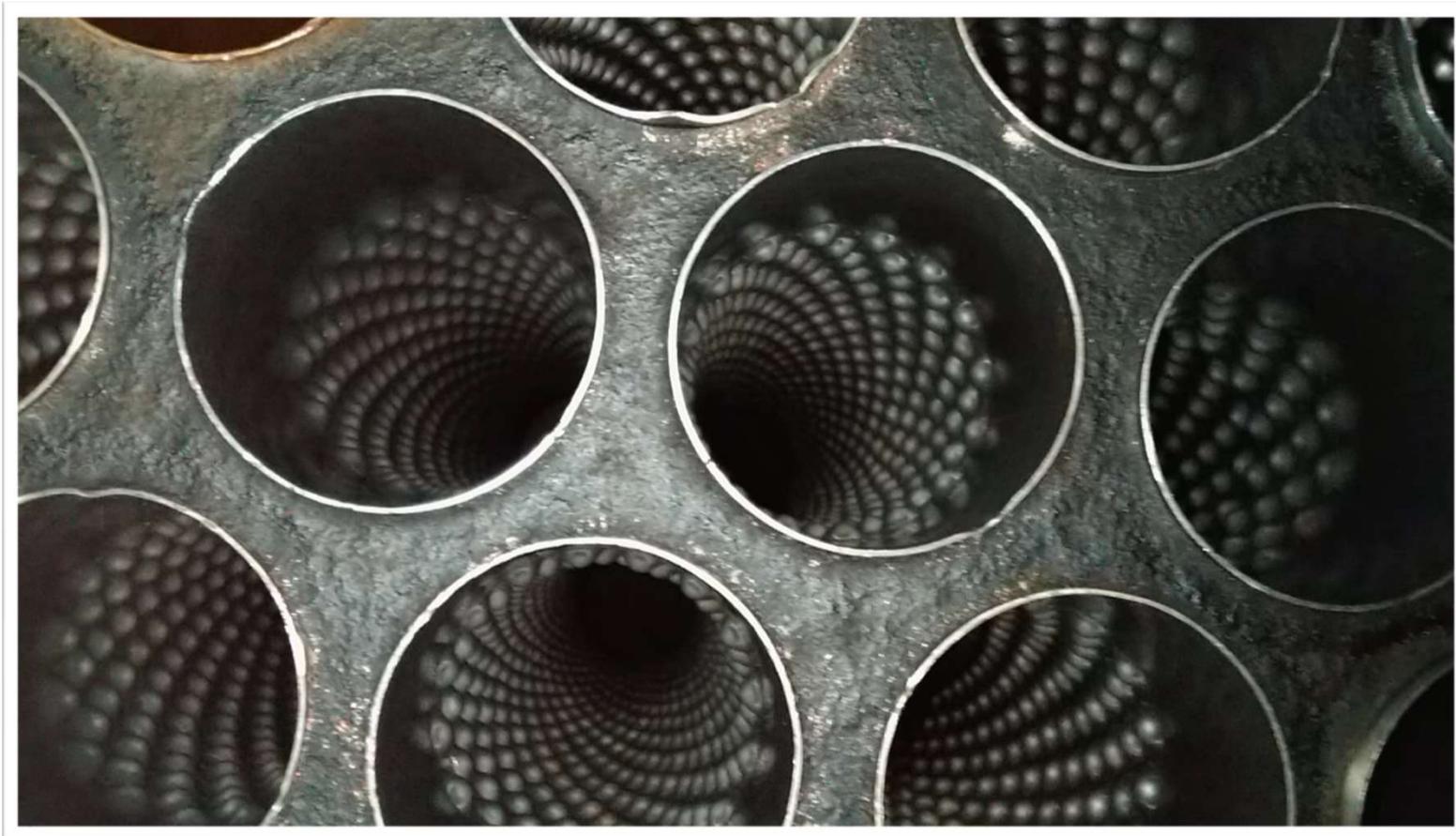
Pressure	Time	Remarks
6 Bar	20 min	No deformation or leaks
7 Bar	20 min	No deformation or leaks
8 Bar	20 min	No deformation or leaks
9 Bar	20 min	No deformation or leaks
10Bar	20 min	No deformation or leaks

In-factory Testing

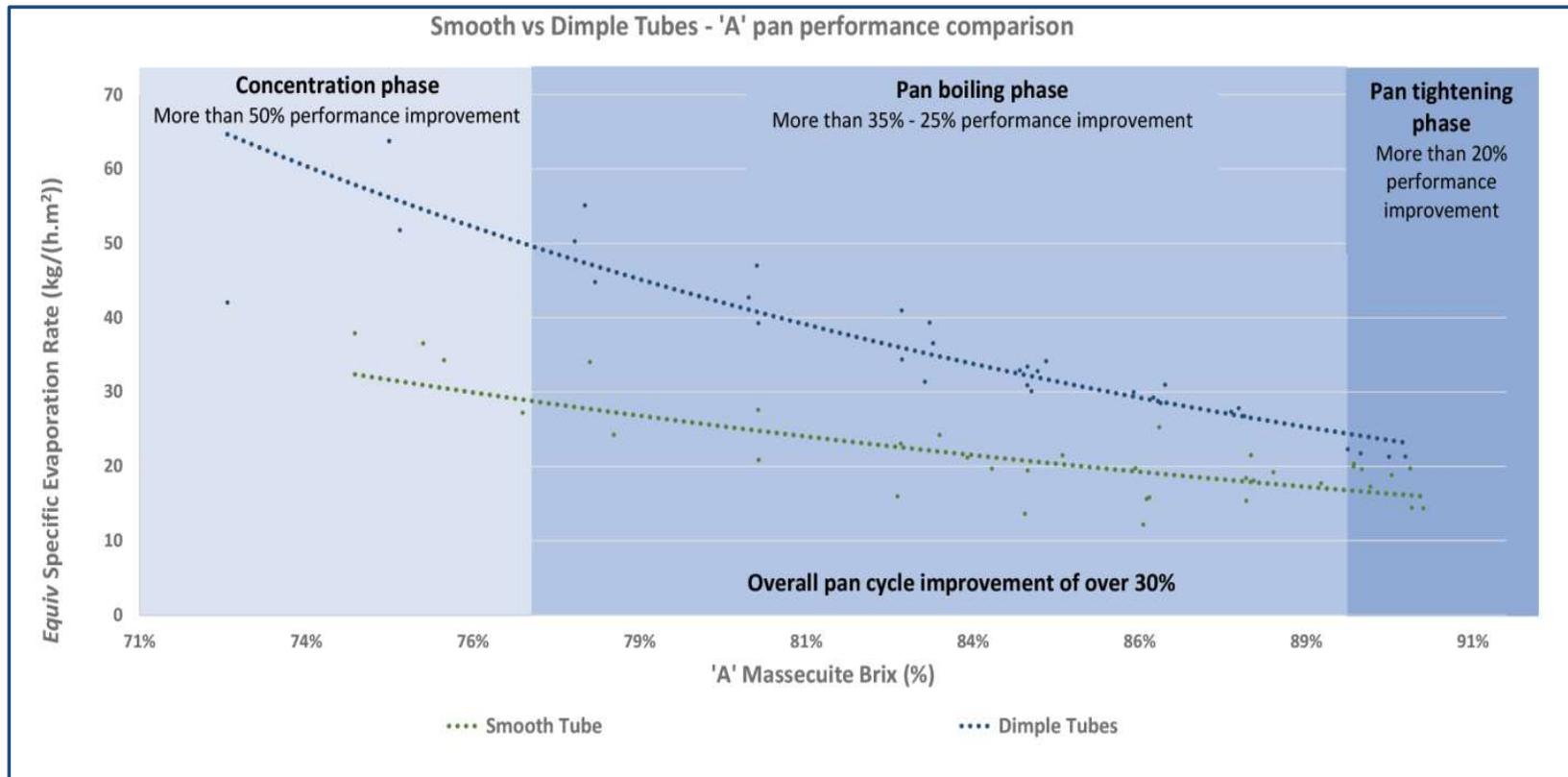
- Bosch Projects installed 10 Dimple Tubes in an existing batch vacuum pan in 2019, these have been operational for 4 full seasons
- Tubes were inspected at various intervals, no effect on encrustation, build up or cleaning/steaming out
- Some tubes were removed, inspected and destructively tested, there were no signs of wear or damage



In-factory Testing

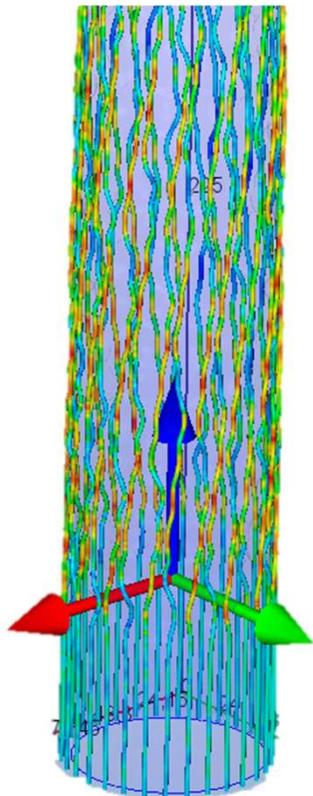


Testing and Performance – Trial Results

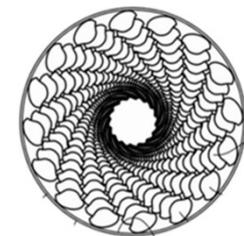
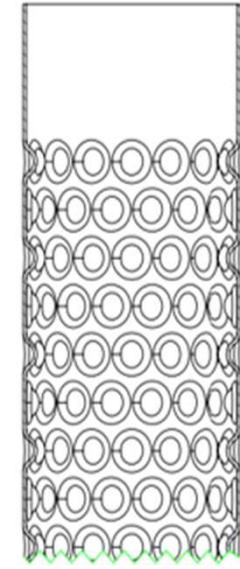
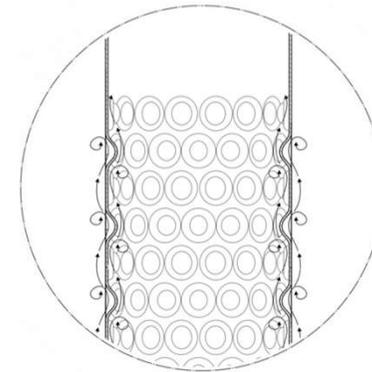


→ Over 30% decrease in batch pan cycle times

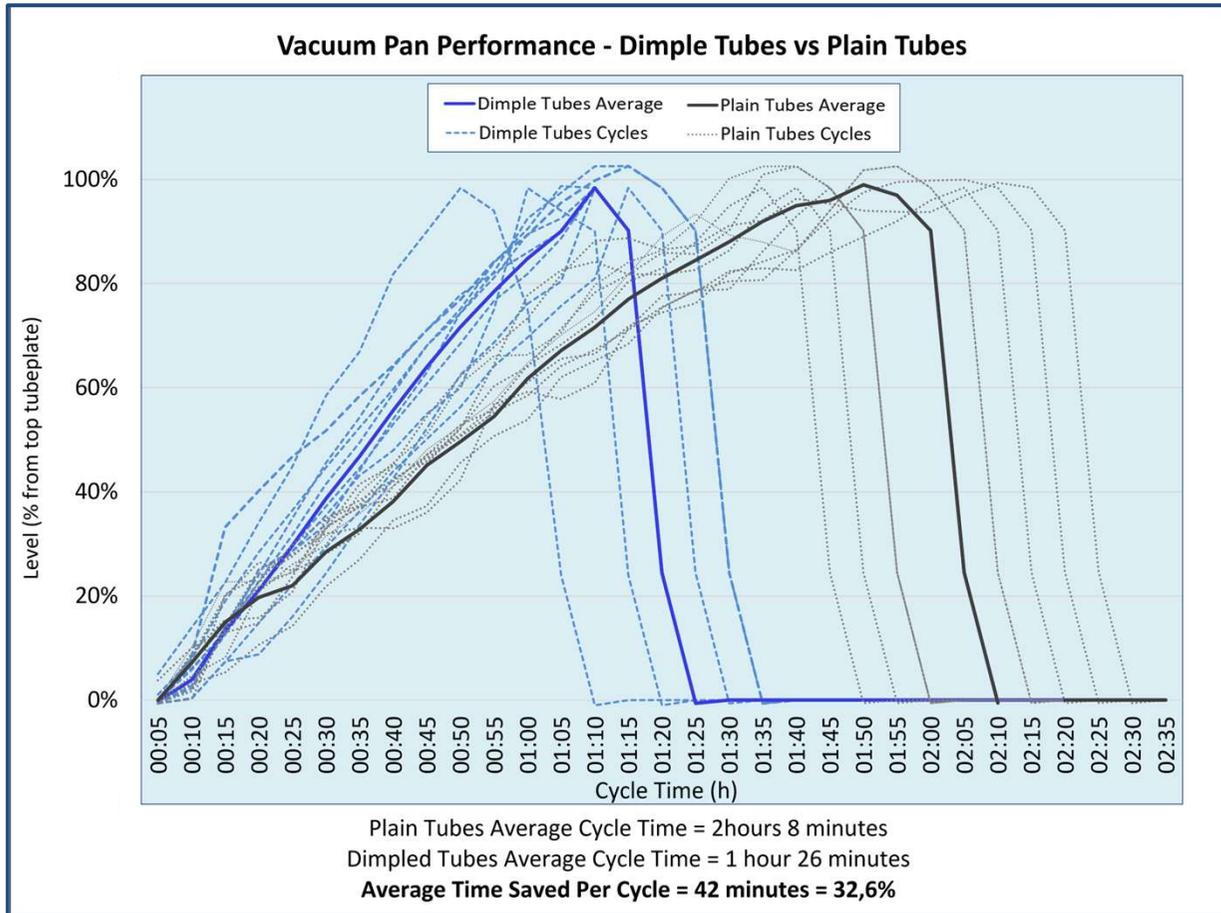
Improved Heat Transfer - Performance



- Additional heat transfer area
- Masseurite side turbulence
- Vapor side turbulence
- “Rifled” pattern limits “dry-phase” during multiphase heat transfer usually experienced in the vacuum pan tubes

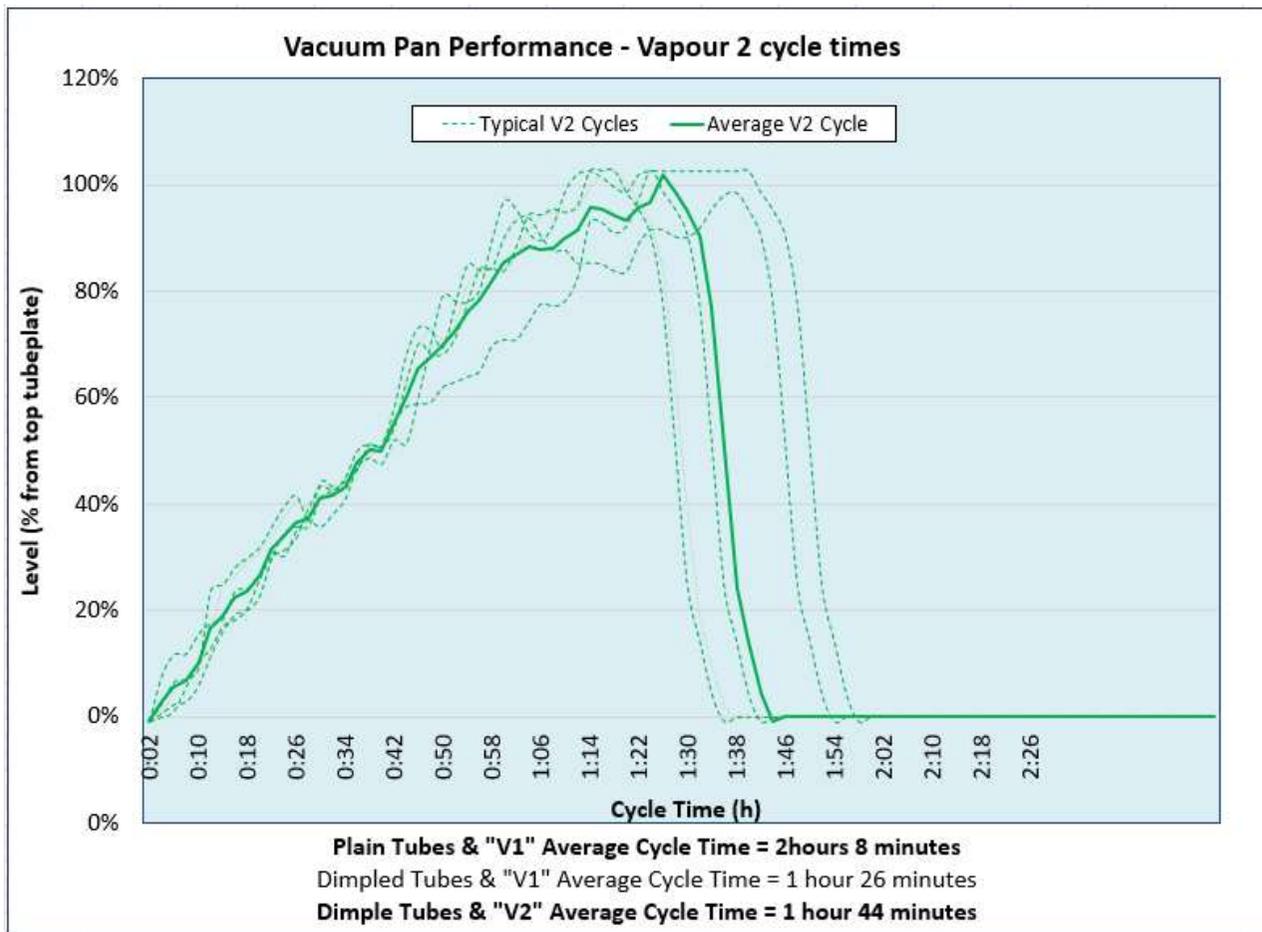


Throughput: Real-World Performance Analyses



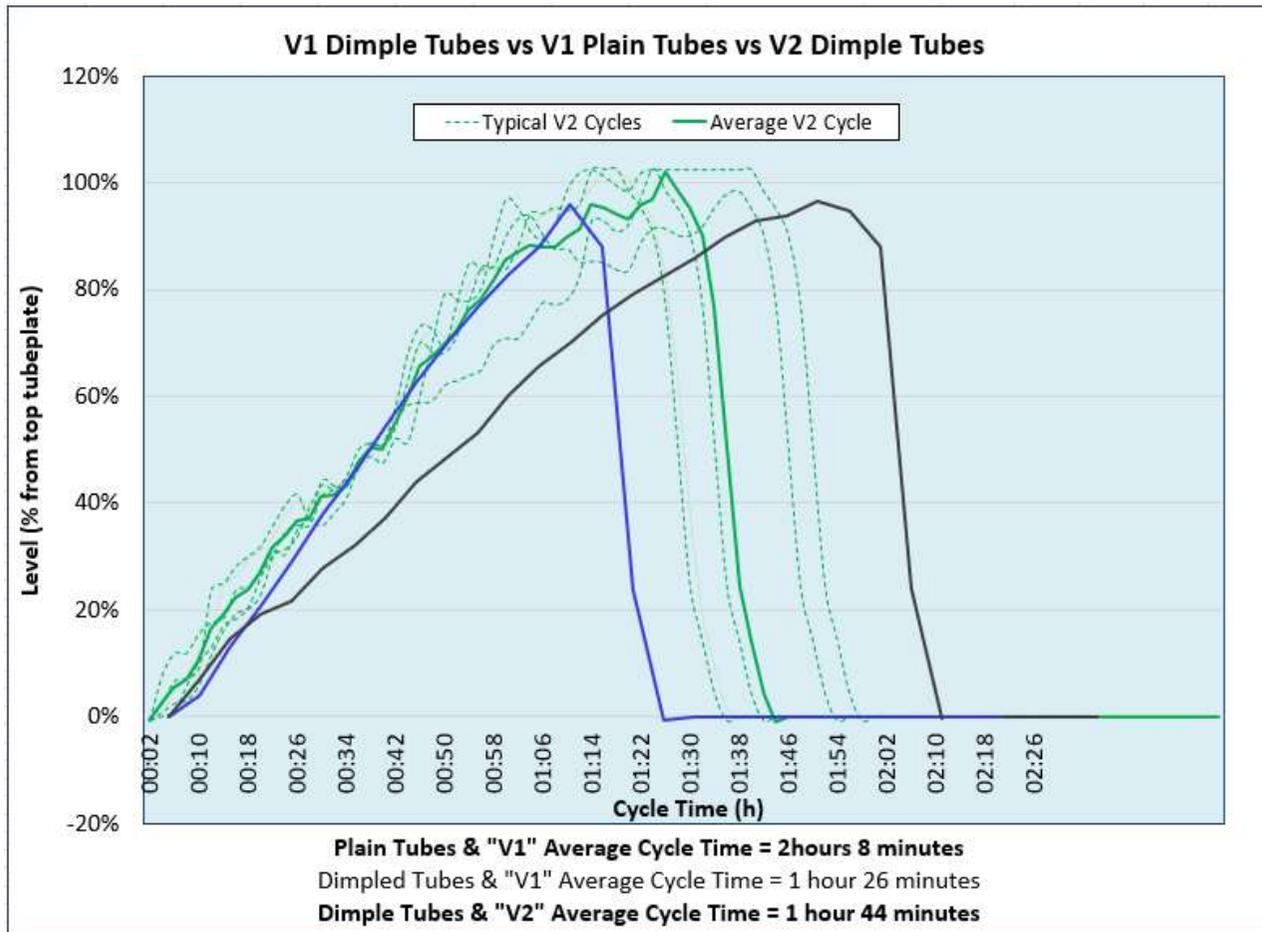
- Two months of data comparing 2022 season (plain tubes) with 2023 season (Dimple Tubes)
- 525 individual 'A' pan cycles were compared
- Low purity early in the '23 season, still yielded impressive results
- Average Weekly pan cycle time improvement of between **26% and 36%** - Average of **32.6%**
- No fouling, encrustation or build-up, no special cleaning required.

Vapor grade: Real-World Performance Analyses



- “Vapor 2” steam was utilized to determine options to reduce factory steam consumption due to improved HTC’s with dimple tubes.
- This particular vacuum pan operates on vapor 1 steam (average pressure 148 kPa(a)/21.4psi(a))
- Test conducted utilized “Vapor 2” steam (110kPa(a)/15.95psi(a))
- Equivalent/slightly improved cycle times/productivity even with lower vapor grade.

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Implementation

Commercial production

- Dimple Tube manufacturing equipment has been designed, developed and commissioned in-house
- Fully operational, automated manufacturing
- Bespoke dimensions to suite existing or new tube lengths
- Centralised with stringent quality control and traceability



Implementation

Simple Installation

- The Dimple Tubes are easily retrofitted to existing batch or continuous pans by a simple retube
- No costly and timely vessel modifications/rebuilds are required as with alternative options or technologies



Cost and Benefit

- 30% improvement in batch pan cycle times/capacity
- 30% improvement in evaporation rate in continuous vacuum pans
- Costs are estimated at 30% to 40% of the implementation cost of alternative tube technologies
- Significantly reduce implementation time and operational interruption: ± 2 -week installation period
- Graining volume does not increase as opposed to other tube options
- Power saving in comparison to a stirred pan
- Vapor grade change due to lower required ΔT , energy savings

Comparison of Options

Description	Relative Cost	Performance Benefit	Comments
Mechanical circulation	3 to 3,5	Varies, +20 to +30%	<ul style="list-style-type: none"> • Electrical energy requirement • Complexity of vacuum leaks • Requires stirrer drive access and infrastructure • Often requires roof modifications • Additional maintenance
Calandria replacement or honeycomb type calandrias – increased HSA	3 to 4	+15%	<ul style="list-style-type: none"> • Vacuum Pan calandria rebuild • Longer operational interruptions • Susceptible to weld leaks • High installation cost • Increases graining volume
New vacuum pans and pan floor reconfiguration	Project Specific 10+	Project specific	<ul style="list-style-type: none"> • Case-by-case basis • Major project/intervention and operational changes required • Often not feasible
Dimple Tubes upgrade	1	+30%	<ul style="list-style-type: none"> • Simple installation • No change to the vessel for tube installation • Bespoke design to suite each vacuum pan • No issues with leaks

Thank You



Questions and Discussions



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