AseptoTWIN

MAKING THE INVISIBLE VISIBLE

WHITE PAPER
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FLEXIBLE PLANT DESIGN · ASEPTIC BUFFER TANKS

De-risking multi-product aseptic manufacturing

A quantitative engineering approach to flexible plant design — finding performance risk before steel is fabricated.

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CFD · MATERIAL COMPATIBILITY · PREDICTIVE ANALYTICS

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01 · EXECUTIVE SUMMARY

Multi-product flexibility maximises capital utilisation — but it moves severe performance uncertainty into the investment and engineering phase.

Shifting consumer preferences have accelerated recipe diversification. Processing lines are now expected to run dairy, plant-based milks and functional beverages within the same hygienic footprint. Unforeseen fluid interactions, localised thermal stresses and cleaning-in-place (CIP) incompatibilities then surface as commissioning delays, mechanical wear and food-safety vulnerabilities.

This paper examines the engineering risks of multi-product buffering in aseptic tanks and introduces AseptoTWIN: an assessment framework that combines high-fidelity CFD, material–fluid compatibility mapping and predictive analytics to remove performance uncertainty **before steel is fabricated**.

4
product matrices sharing one aseptic buffer tank in the case examined

3
risk families: hydrodynamic, aseptic barrier, material compatibility

> 1.5 Pa
wall shear stress verified across internal geometry during CIP

INDUSTRY PAIN POINTS

02 The cost of multi-product uncertainty

2.1

The dynamic recipe dilemma

Modern lines are rarely dedicated to a single product: dairy, plant-based milks and functional beverages now share the same hygienic footprint.

Traditional plant design relies on static safety margins and historical rules of thumb. Modern fluid dynamics and aggressive cleaning regimes demand a higher level of precision.

Rapid formulation changes mean that equipment specified for a baseline product — standard pasteurised milk, for example — is frequently repurposed for highly viscous, particulate-laden or chemically aggressive alternatives such as oat milk, high-protein chocolate milk or acidic isotonic drinks.

> **“Waiting until commissioning to discover operational limitations is economically catastrophic.”**
>
> ASEPTOTWIN ENGINEERING

WHEN FLEXIBLE-USE ASSETS FAIL, THE FAILURES CASCADE

01

Commissioning bottlenecks

Prolonged ramp-up caused by unexpected hydrodynamic dead zones or inadequate thermal transfer.

02

Component degradation

Premature wear on seals, valves and agitators from unpredicted chemical or mechanical stress.

03

Food-safety vulnerabilities

Cross-contamination risk, sub-optimal cleaning routing and microbial harbour points in critical aseptic barriers.

CASE STUDY IN RISK

03 Multi-product buffering in aseptic tanks

Consider a high-flexibility aseptic buffer tank that routes four divergent product matrices in sequence. Each fluid leaves a distinct physical and chemical footprint on the system.

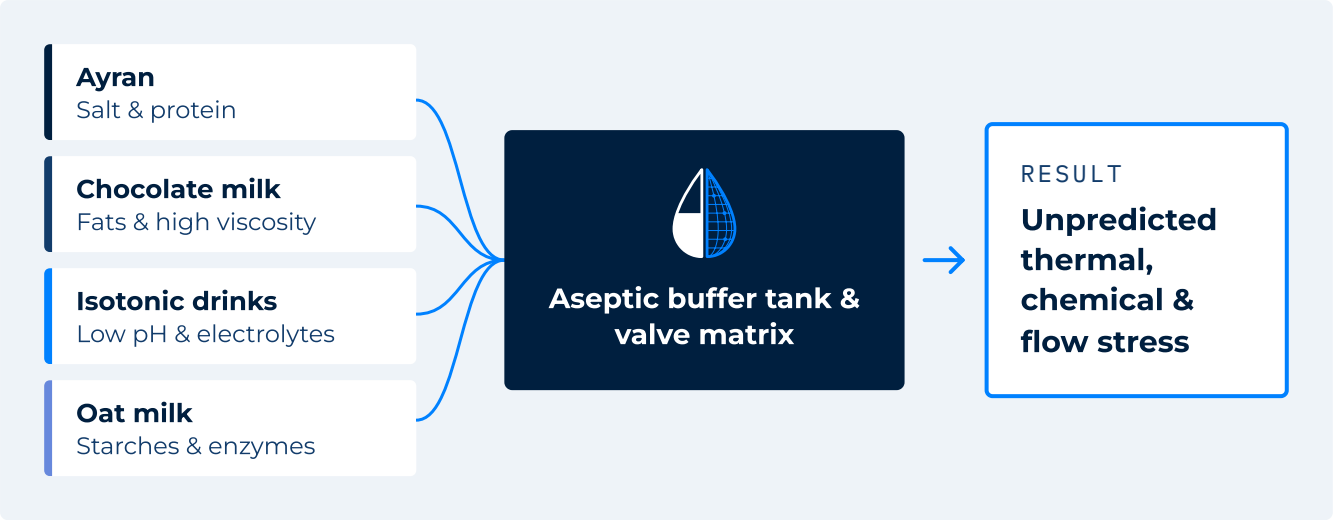


Figure 1 Four product matrices routed sequentially through one aseptic buffer tank and its valve matrix.

THREE RISK FAMILIES

01

Hydrodynamic & agitation discrepancies

An agitator designed for low-viscosity isotonic beverages will not adequately shear and mix high-viscosity chocolate milk or oat-based suspensions. The result: thermal stratification, localised fouling and uneven residence times.

02

Aseptic barrier & valve matrix vulnerabilities

Double-seat mix-proof valves with steam barriers behave differently under varied thermal and pressure cycles. A seal alternating between acidic isotonic drinks and high-protein dairy is exposed to accelerated micro-cracking and elastomer swelling.

03

Material–fluid compatibility & corrosion

An EPDM seal that performs well with dairy may react adversely to the saline and organic-acid profiles of fermented or isotonic products. 316L surfaces exposed to alternating cleaning agents and residual salts face a higher risk of pitting and crevice corrosion if passivation is compromised.

04 THE ASEPTOTWIN APPROACH
Predictive engineering

AseptoTWIN replaces guesswork with multi-physics simulation and empirical analytics, built on three core pillars.

PILLAR I

High-fidelity process simulation (CFD & FEA)

Maps the exact geometry of tank, agitator and valve matrix against the rheology of each fluid to visualise operational risk before fabrication.

Velocity vector mapping
Dead zones, stagnation points and shear-stress distribution across viscosities.

Thermal & CIP dynamics
Cleaning-fluid trajectories checked for wall shear stress > 1.5 Pa, leaving no residue pockets.

PILLAR II

Material–fluid interaction matrix

Analyses elastomer and metal behaviour under multi-recipe conditions: how alternating high-fat matrices, thermal shocks and aggressive chemical sterilants affect seal life and surface integrity.

1.5 % NaOH → HNO_3 → Pure steam barrier

PILLAR III

AI-driven operational analytics

Combines historical plant failure records with machine-learning models to predict maintenance intervals, optimise CIP cycle times and flag potential micro-contamination vectors for your specific product transition matrix.

Maintenance intervals	CIP cycle times	Contamination vectors

05 · CONCLUSION & STRATEGIC VALUE

Validate every recipe virtually — before procurement.

Integrating AseptoTWIN application and product assessment packages into the early investment phase gives processing plants three outcomes:

01 **Elimination of capital risk**
Virtual validation of multi-product recipes before equipment is procured.

02 **Maximised asset uptime**
Longer seal and component life through optimised material selection.

03 **Aseptic integrity by design**
A design basis checked against EHEDG and 3-A sanitary guidelines for every intended product line.

Book an application assessment

info@aseptotwin.com

ABOUT ASEPTOTWIN

AseptoTWIN is an engineering solutions company that combines digital twins, aseptic processing know-how and simulation to show whether a product fits a processing machine — before the design is frozen.

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