Advancing UHT Sterilization: Smarter Solutions for Dairy Processing

Introduction

Ultra-high temperature (UHT) sterilization is essential for producing safe, long-life dairy products. At its core, UHT technology combines heat exchangers, automation, and aseptic handling to ensure product integrity while meeting consumer expectations for quality and convenience. However, as processors face rising sustainability demands and operational challenges, a key question emerges: how can UHT systems be made more efficient, reliable, and future-ready?

This article explores the fundamentals of UHT sterilization, compares traditional heat exchanger designs, and highlights innovations that help dairy processors achieve longer run times, lower energy consumption, and improved product quality.

Heat Exchangers: The Heart of UHT Systems

Heat exchangers transfer heat between the product and the heating or cooling media, enabling rapid sterilization and cooling. Two main designs dominate the industry:

Plate Heat Exchangers (PHEs):

Compact and cost-effective, PHEs offer high heat transfer efficiency. However, their narrow gaps can trap fibers and particulates, leading to fouling and frequent cleaning. Thin plates are also prone to pinhole leaks, requiring rigorous integrity checks.

Tubular Heat Exchangers:

Straight-tube and multi-tube designs handle viscous products and particulates better than PHEs. Nevertheless, they present challenges such as dead spots, uneven flow distribution, thermal expansion stresses, and large floor space requirements for maintenance. Frequent cleaning cycles increase water and chemical consumption, affecting sustainability.

Design Challenges

Across both heat exchanger designs, processors face several common issues:

- Fouling and flow variations reduce efficiency and shorten production runs.
- Thermal expansion and vibration cause metal fatigue and leaks.
- Complex assembly and disassembly increase maintenance time and space requirements.
- Gasket integrity remains a critical concern for aseptic assurance.

Together, these factors increase operating costs and downtime risks-making innovation essential.

The JBT Marel Solution: Helical Coil Heat Exchangers for Liquid and Particulate Products

Helical coil technology addresses many of the limitations associated with traditional straight-tube and plate designs. Key advantages include:

Enhanced Heat Transfer:

The coiled geometry creates natural turbulence and eddy currents, improving mixing and heat exchange while reducing fouling. This results in longer production runs and fewer cleaning cycles (the so-called Dean effect).

Built-in Flexibility:

The spring-like structure of helical coils absorbs thermal expansion and dampens pulsations, minimizing mechanical stress and extending equipment life.

Compact Footprint:

Helical coils require less floor space and can be removed vertically, simplifying maintenance and plant layout.

Fewer Critical Points:

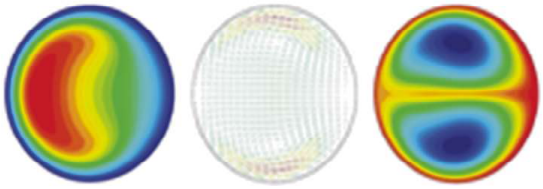
Continuous coil lengths eliminate dead spots and significantly reduce gasket usage, lowering the risk of contamination.

Long coil lengths-up to 200 m and beyond by connecting multiple coils-allow performance measurement and comparison of parallel tubes. This capability makes helical coils particularly suitable for processing products with particulates, including particles up to 10 mm in diameter. Applications extend to single-strength, low-viscosity products containing 5-20% particulates, as well as high-viscosity slurries with particulate content of up to 50%.

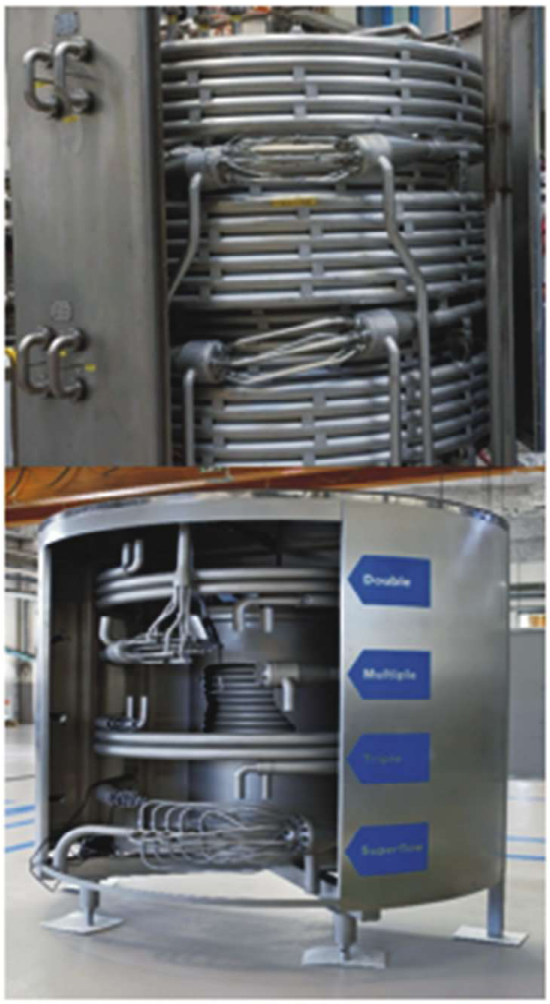
Connecting Two or More Sections

By connecting two or more sections, JBT Marel enables precise control of heat penetration into the particle core. A mathematical approach is applied to validate the lethal effect within particulates. The in-house developed ASEPTICAL tool supports this validation and is FDA approved.

The result is higher efficiency, reduced energy consumption, and improved sustainability-without compromising product safety. In addition, a wider range of applications becomes feasible, covering low- and high-viscosity products, with or without particulates.



Axial velocity Dean vortices Temperature



Connection 2 and more Sections together

Ensuring Aseptic Integrity

Sterility is non-negotiable in UHT processing. Advanced systems incorporate:

- Pressure monitoring to maintain overpressure on the product side
- Leak detection ports and vacuum testing for early fault identification
- Media-side cleaning and passivation to prevent biofilm formation

Combined with microbiological testing and product-hold protocols, these measures ensure commercial sterility and maintain consumer trust.

Driving Dairy Forward

As dairy processors respond to evolving market demands, UHT technology must deliver more than heat- it must deliver confidence, efficiency, and sustainability. Helical coil heat exchangers represent a significant advancement in design, helping processors reduce waste, optimize uptime, and prepare for the future.

To learn how advanced UHT solutions can transform your operations, visit

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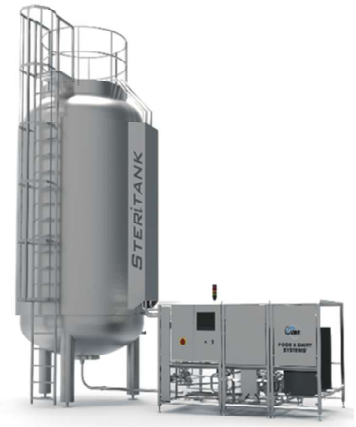

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