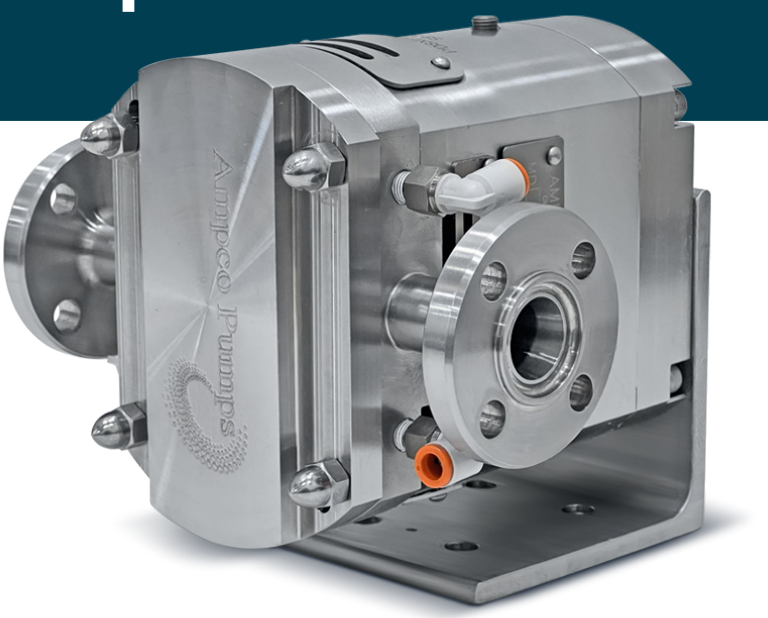
TECHNICAL CASE STUDY & PRODUCT EVALUATION

Ampco Pumps GmbH
A Member of the KRONES Group

ZP4 Series Low-Flow Dosing Pump

Category: Precision Lecithin Dosing in Whole Milk Powder Production



Executive Summary

Modern dairy powder manufacturing demands extreme accuracy, hygiene, and reliability when processing high-viscosity emulsifiers. This case study evaluates the deployment of the **Ampco Pumps Company ZP4 Series** low-flow dosing pump within an industrial spray-drying system, demonstrating its capacity to solve surface hydrophobicity issues in whole milk powder through micro-dosing precision.

1. Why is Lecithin Dosed? (The Core Challenge)

Natural whole milk powder contains milk fat. When the powder is spray-dried, some of this fat migrates to the surface of the individual powder particles, creating a hydrophobic (water-repelling) free-fat barrier. If you try to reconstitute standard whole milk powder in cold water, it floats on top, lumps up, and refuses to wet.

Solution: Lecithin as an Emulsifier
Lecithin is a phospholipid with an amphiphilic structure — it has a **hydrophilic (water-loving) head** and a **lipophilic (fat-loving) tail.** By coating the powder particle with a microscopic layer of lecithin, you bridge the gap between the surface fat and the water. The lipophilic tails bind to the surface fat of the powder, leaving the hydrophilic heads facing outward, ready to pull water in when the consumer mixes it.

2. The Dosing Process into the Fluid Bed

Dosing occurs at the external fluid bed (or the integrated fluid bed at the bottom of a wide-body dryer) rather than the main drying chamber. If lecithin were sprayed at the top nozzle, the high heat would degrade the oil, foul the chamber walls, and disrupt the core atomization.

PROCESS FLOW: POWDER COATING SEQUENCE

Heated Lecithin Tank	ZP4 Series Low-Flow Pump	Stationary Spray Nozzles / Balls	External Fluid Bed Suspension
Oil Conditioned at 50°C - 60°C to minimize viscosity	VFD-controlled positive displacement proportional to mass flow meter	Fine atomization over the moving turbulent powder layer	Violent particle tumbling creates thin, uniform lipid film coat

Step-by-Step Mechanical Operation

1. **Conditioning the Oil:** Lecithin oil is highly viscous at room temperature. To pump and atomize it effectively, it is typically heated in a jacketed tank to between **50°Cand 60°C** to drop its viscosity to a workable range. It is often blended with a carrier (like a small amount of anhydrous milk fat or vegetable oil) to achieve a consistent 1:1 or 1:2 ratio.

2. **The ZP4 Pump Delivery:** The Ampco ZP4 circumferential piston pump excels in this application by providing low-shear, positive-displacement flow accuracy. Because delivery must respond dynamically to shifting milk powder throughput, the ZP4 is integrated with a Variable Frequency Drive (VFD) closed-loop tied to active inline mass flow meters.

3. **Atomization via Spray Balls/Nozzles:** The pump forces the warm oil through specialized liquid spray nozzles or stationary spray balls positioned directly above the turbulent powder layer in the fluid bed. The fluid bed keeps the powder particles suspended in a warm airstream (fluidized), ensuring maximum surface area exposure.

4. **Coating and Conditioning:** As the powder violently tumbles through the fluid bed, the finely atomized lecithin droplets collide with the warm powder particles, spreading as a thin, uniform film. The warm air of the fluid bed helps the oil spread evenly across the particle geometry before the powder moves to the final cooling phase.

Viscosity Profile vs. Fluid Temperature (°C)

Room Temp (20°C) - High Viscosity (Difficult to Pump/Atomize)

Warm Blend (40°C) - Transitional Phase

Optimal Process Temp (55°C) - Low Viscosity (Perfect ZP4 Atomization)

3. Benefits on the Final Product

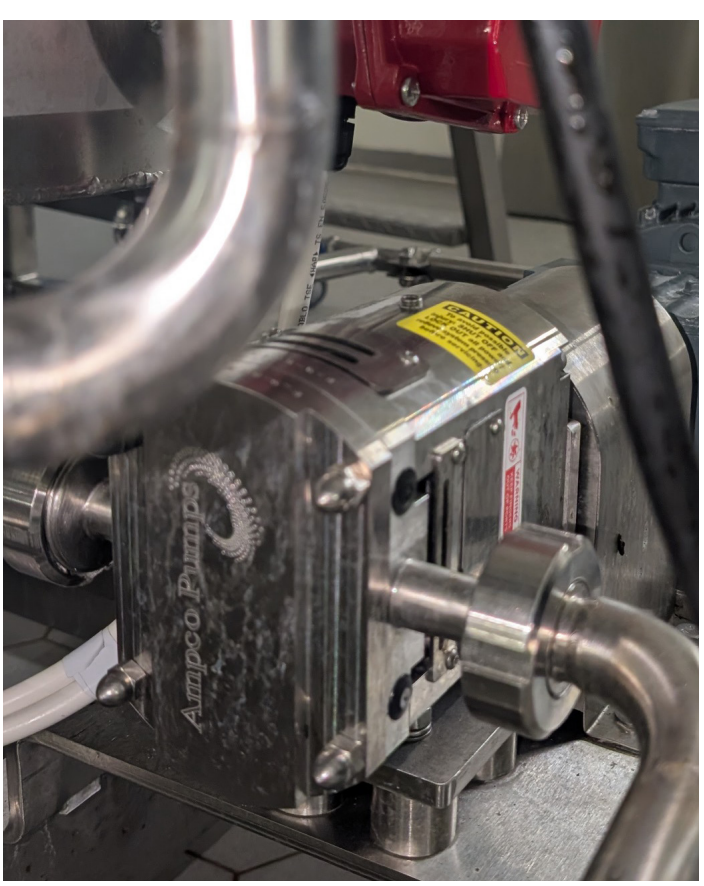
Dosing lecithin fundamentally changes the physical properties of the powder, yielding several commercial and functional benefits:

- **Instantaneous Wettability:** The powder breaks the surface tension of water immediately. Instead of floating, a lecithinated powder typically sinks and wets within a few seconds, even in cold water.

- **Rapid Dispersibility:** It prevents the formation of sticky, dry-cored lumps. The particles separate swiftly and disperse uniformly throughout the liquid with minimal stirring.

- **Reduced "Free Fat" Visual Defects:** It stabilizes the surface lipids, reducing the oily sheen or "fat ring" that can sometimes form at the top of a glass of reconstituted milk.

- **Improved Powder Flowability:** The thin lipid layer can actually reduce static charge and friction between particles, helping the powder flow better through packaging lines and reducing dustiness.



Performance Indicator	Standard Whole Milk Powder	ZP4 Opti-Dosed Powder
Cold Water Wetting Time	> 120 seconds (Floats/Lumps)	< 5 seconds (Instant)
Dispersibility Rate	Poor (Requires high agitation)	Excellent (Uniform dispersion)
Surface Free Fat Content	High (Uncontrolled migration)	Suppressed (Lecithin bound)
Packaging Flow Line Efficiency	Standard (Prone to static/dust)	+15% throughput improvement

Technical Inquiries & Engineering Support:

Ampco Pumps GmbH

Gewerbepark West II 7
76863 Herxheim, Germany

Email: info@ampcopumps.de • www.ampcopumps.com