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An Ingersoll Rand Business

Enhancing Biopharmaceutical Production Through Advanced Mixing: Boosting Performance With EZ JetFlo™ Technology

Levitronix® BioProcessing Conference

Paulo Bento | June 2026 | Boston, USA

Our company

ILC Dover An Ingersoll Rand Business

For **more than 165 years, we have been waking up** every day with the goal of Making Life Better for our employees, our customers, our shareholders, and our planet.

For our **Employees**

For our **Customers**

For our **Shareholders**

For our **Planet**

IRCO global in-region, for-region footprint

We leverage our robust global in-region, for region manufacturing capabilities and pivot towards favorable end markets

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>5 million installed assets[2]

= Lifecycle revenue opportunity

& Data/insights/intelligence

5K+
Sales, service, and support employees

150+
Customer and service centers

70+
Major manufacturing sites[1]

[1] Site totals represent major manufacturing locations. [2] Map of installed asset base is illustrative only.

ILC Dover: Powder Handling Excellence Center

ILC Dover SA (former Jetsolutions) is located in Fribourg, an idyllic region on the Pre-Alps region with an easy access at 1.30h from Geneva or 1.45h from Zurich airports.

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Powder Handling Challenges

Powder Handling Complexity in Biopharmaceutical Facilities

Monoclonal Antibody Market Growth
mAbs are a leading biopharmaceutical segment driving demand for increased production capacity and efficiency.

Process Intensification Strategies
Higher cell densities and perfusion cultures improve productivity but require precise media and buffer preparation.

Challenges in Mixing and Control
Traditional batch mixing struggles with fast, homogeneous mixing needed for intensified processes, risking variability.

Impact on Process Consistency
Hygroscopic materials tend to create inconsistent powder flow causes inaccurate recipes and yield loss, complicating product changeovers.

Challenges of Powder Properties
Powders are often hygroscopic and cohesive, causing bridging and lumps that disrupt consistent transfer.

Operational Safety Risks
Manual powder handling involves heavy lifting and dust exposure, increasing injury and inhalation hazards.

Electro-charge and Explosion Risk
Powder discharge results on friction of particles generating adhesion of powder to bags and risk of explosion.

Need for Technological Solutions
Innovative technologies can reduce manual intervention, enhance safety, and ensure reliable powder delivery.

Cross-Contamination as a Regulatory Priority

Focus on Contamination

Regulators emphasize minimizing human intervention and enforcing contamination control in biopharmaceutical production.

Risks from Manual Powder Charging

Manual powder handling increases contamination risks through foreign material ingress and residue carryover.

EU GMP Annex 1 Updates

Regulatory updates require closed systems, segregation, and documented contamination control strategies.

Containment as Compliance Benefit

Closed, single-use systems mitigate contamination risks, supporting compliance and improving production reliability.

Mixing: A Batch Preparation Challenge

Consistent dissolution

Some raw materials tend to form lumps (fisheyes), hydrophobic clumps floating on the surface of the vessels.

Low-density powders

That tend to float on the surface resisting to wetting and extending dissolution time.

Limitations of Traditional Mixing

Conventional methods require high energy, can generate heat, and depend on manual operation, unsuitable for flexible manufacturing.

Innovative Solutions

EZJetFlo™ technology offers automated, energy-efficient, and contained mixing to enhance safety and efficiency.

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EZ JetFlo™

EZ JetFlo™

Closed and Single-use

Minimizes exposure, reduces risk of inhalation or contact with hazardous materials. Eliminates the need for cleaning and validation, reducing downtime & operational costs while increasing productivity

Improved Safety

Allowing operators to remain at floor level, avoiding climbing stairs and accessing higher charging nozzles or manholes

Smart Plug & Play Design

Easy to use, requiring minimal set-up and no maintenance. Small footprint

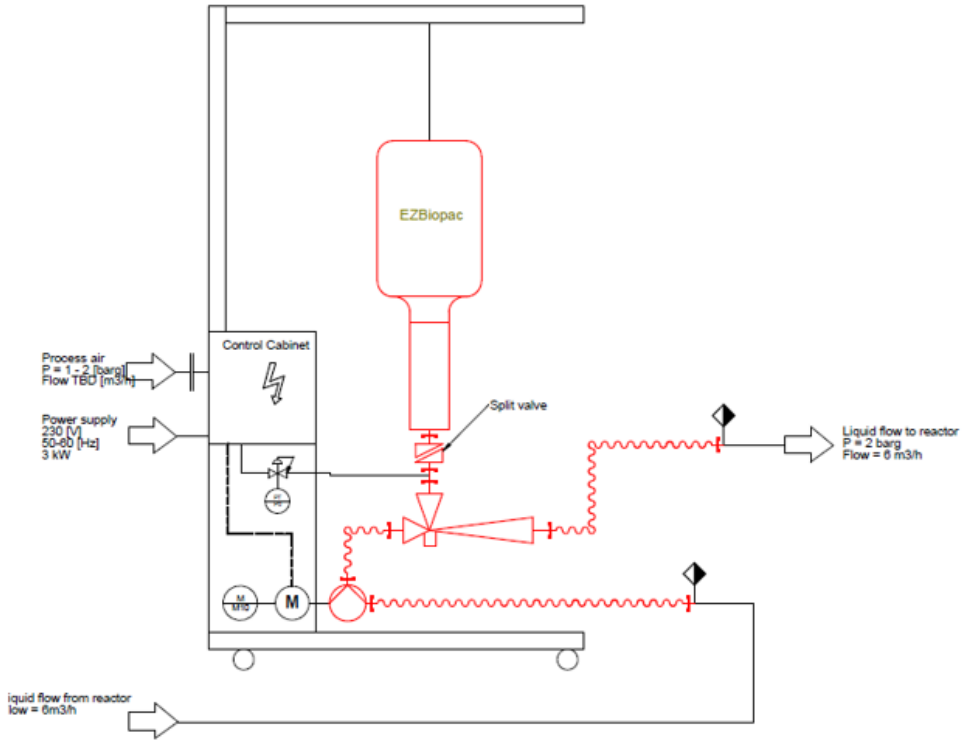
No Shear-Related Heat

Preserves sensitive powders while in-line recirculation ensures consistent, clump-free mixing

Venturi Principle based on the JetMixer™ Technology

Creating high turbulence for rapid and uniform dissolution. Ideal for mixing even poorly flowing powders without lumping, ensuring consistent batch quality.

EZ JetFlo™: Innovative In-Line Mixing Solution



Single Use

Product contact materials are single-use and assemble without tools

Integrated Lifting System

Supports volumes up to 50kg bags

EZBioPac® Compatible

Flexible film wall prevents common flow issues associated with hoppers

One Moving Part

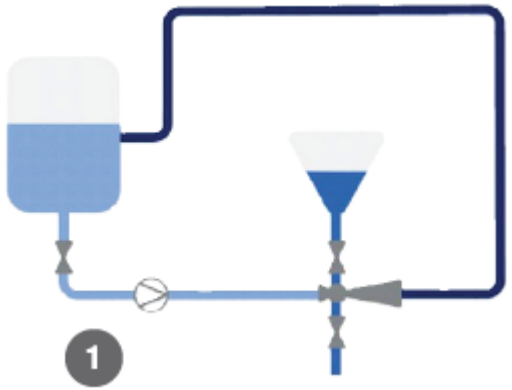
The pump is the only moving part, simplifying operation and maintenance

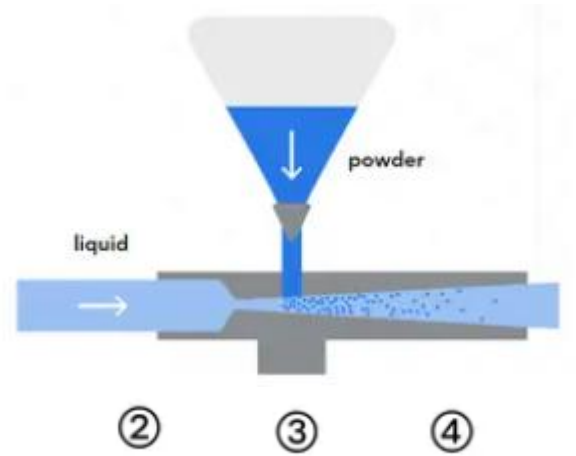
Contained at the Source

Connections safeguard both the process and personnel

Component	Materials	FDA	USP Class VI	ADI Free
Injector	Marlex 9018	✓	✓	✓
Hoses	Silicone	✓	✓	✓
Powder Valve	Cycoloy HC1204HF	✓	✓	✓
Levitronix Pump	PP	✓	✓	✓

EZ JetFlo™: How It Works?





① Liquid Recirculated Through a Closed Loop

Ensuring a consistent flow and optimal mixing conditions

② In-Let Chamber - Unique Geometry

The nozzle dramatically accelerates the liquid without creating any splashing to avoid clogging

③ Venturi Effect

The vacuum generated (~-900mbar) draws the particles into the jet stream for seamless integration

④ High-Turbulence – Efficient Dissolution

The intense turbulence that occures on the expansion chamber, rapidly dissolves the powder, resulting in a fast and efficient mixing process

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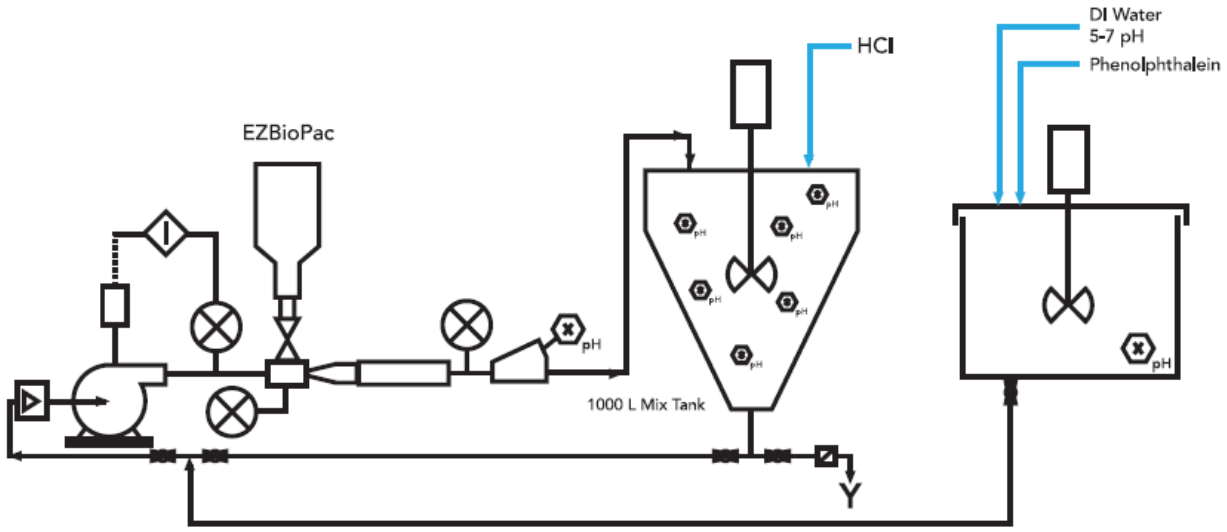
Validated Performance

EZ JetFlo™: Mixing Performance in Biopharmaceutical Applications



Sodium Hydroxide (NaOH) Buffer

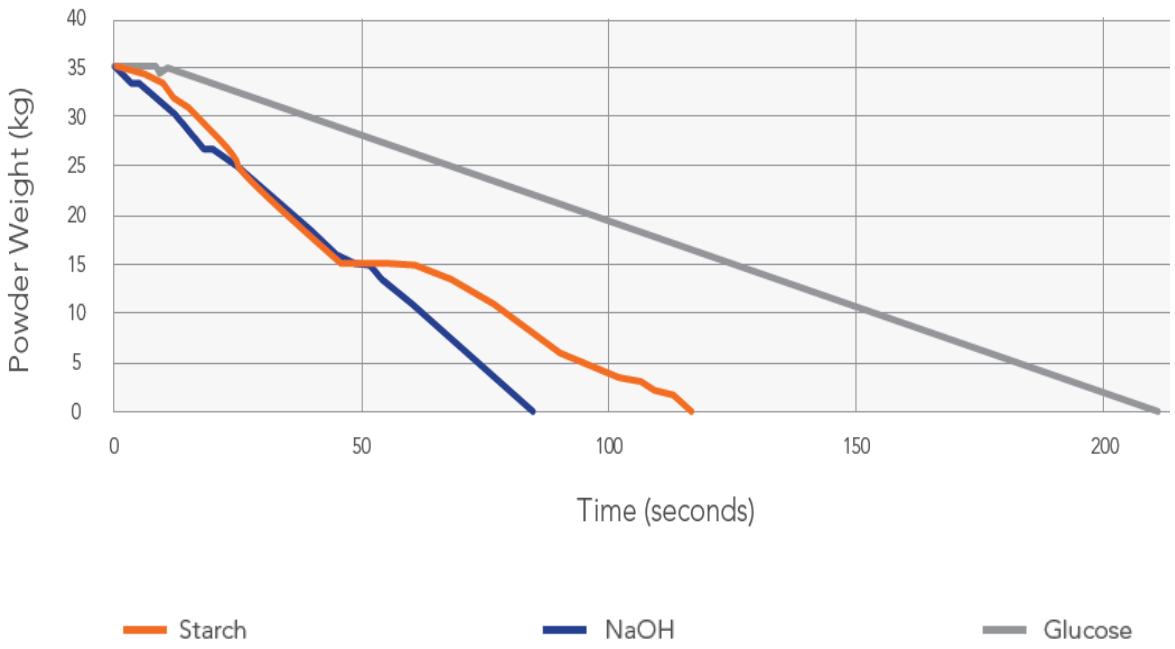
Selected as worst-case scnario due to its exothermic dissolution behavior

Glucose & Corn Starch

Validate ability to disperse and disolve carbohydrate-based powders which can exhibit poor wettability, clumping or swelling during hydration

Several mixing tests realized, including different flow rates for evaluating system performance. The test was done with 900L of deionized water withing 36kg of solids.

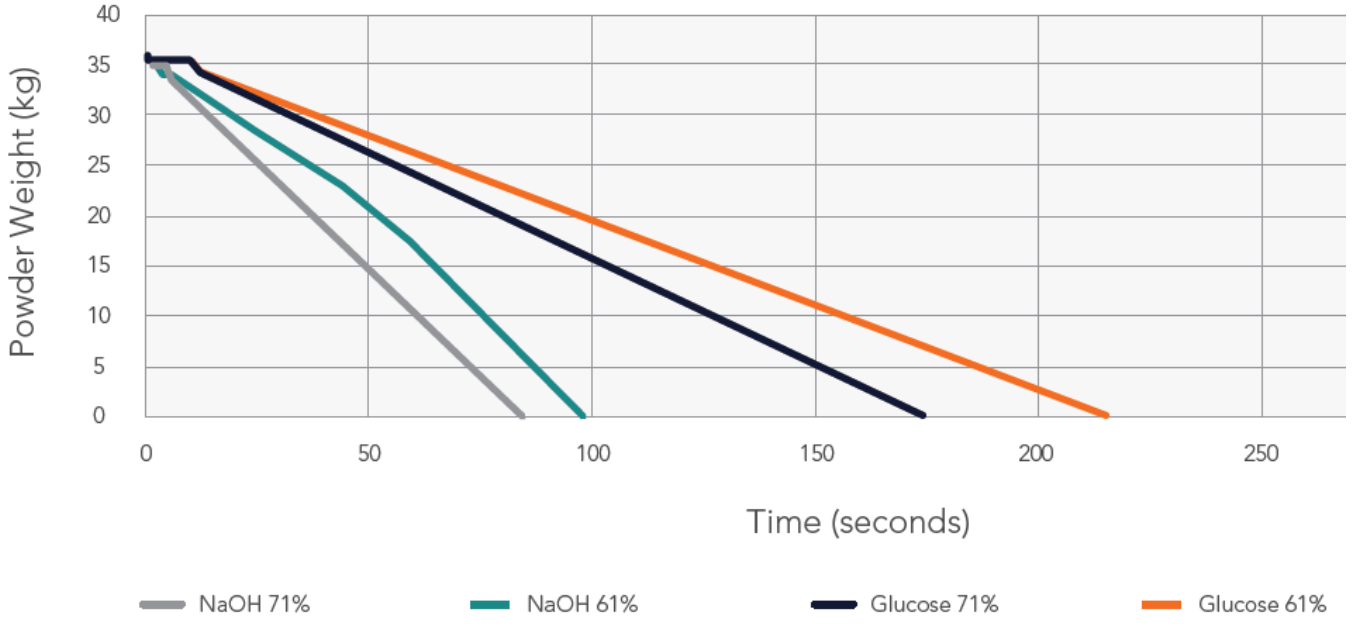
EZ JetFlo™: Weight-Loss Powder Flow Rate Comparison (kg/s)



- Powder throughput depends on flowability
- Higher Flowability → faster powder delivery
- NaOH shows higher powder flow rate when compared to Glucose or Starch
- Negative pressure ensures stable powder suction and prevents lump formation

Data extracted from Single Use Mixer SS JetMixerTM Technical Report, May 27, 2021 by Jacobs Engineering

EZ JetFlo™: Test Influence of the Pump Speed on Powder Flow Rate (kg/s)

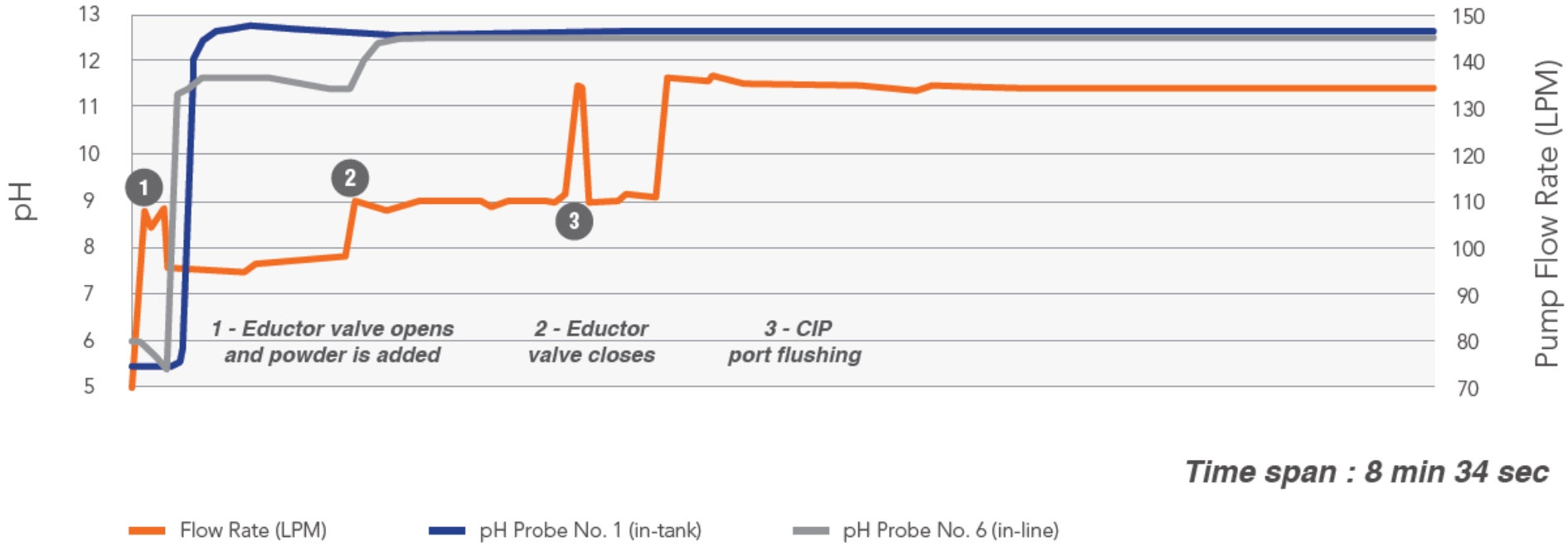


Accelerating the pump from **61% to 71%,** delivered powder **up to 25% faster.**

Flow jet is carefully **controlled by design** to avoid splashes.

Data extracted from Single Use Mixer SS JetMixerTM Technical Report, May 27, 2021 by Jacobs Engineering

EZ JetFlo™: Mixing Performance of NaOH with Levitronix pump at 61%



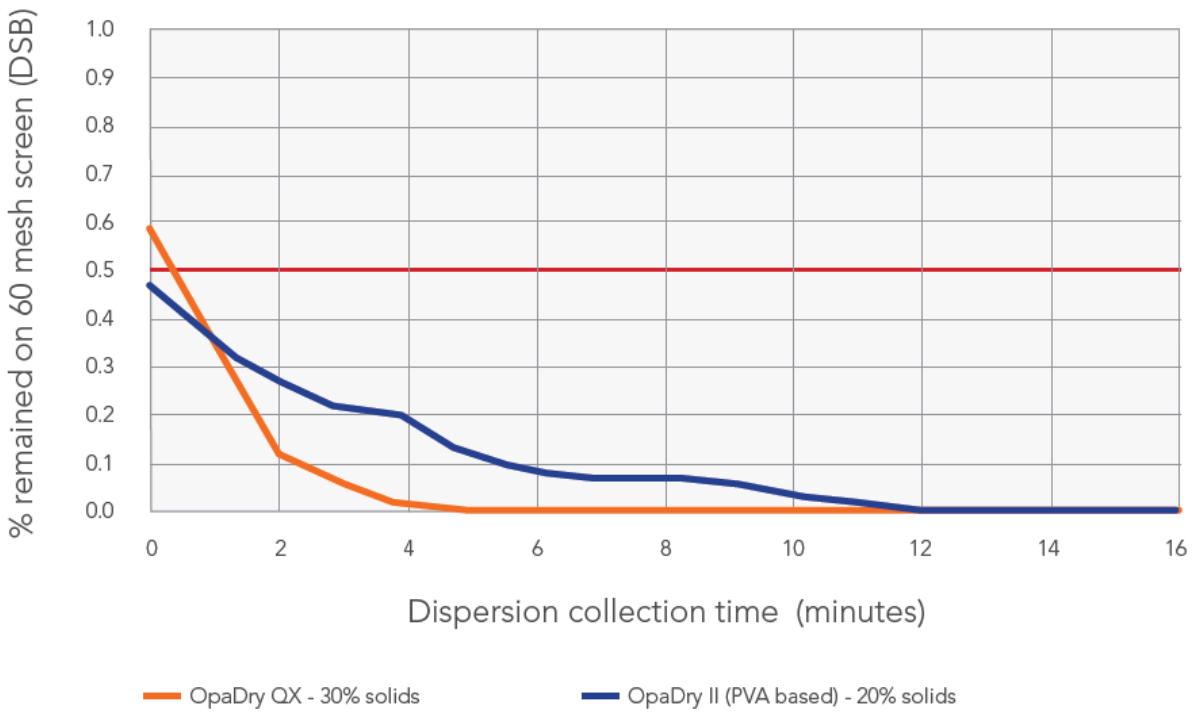
pH Mixing efficiency assessed via pH profiling during NaOH addition

Mixing performance depends on **powder solubility & dissolution kinetics**

Hydrodynamics enable **rapid dissolution & homogenization**, no extra agitation required

Near-instant pH shift (≈6 → 12) across all pump speeds

Technology test using a second analytical method on Opadry



Opadry coating powder used

Powder added to the tank @ **2 concentration levels**

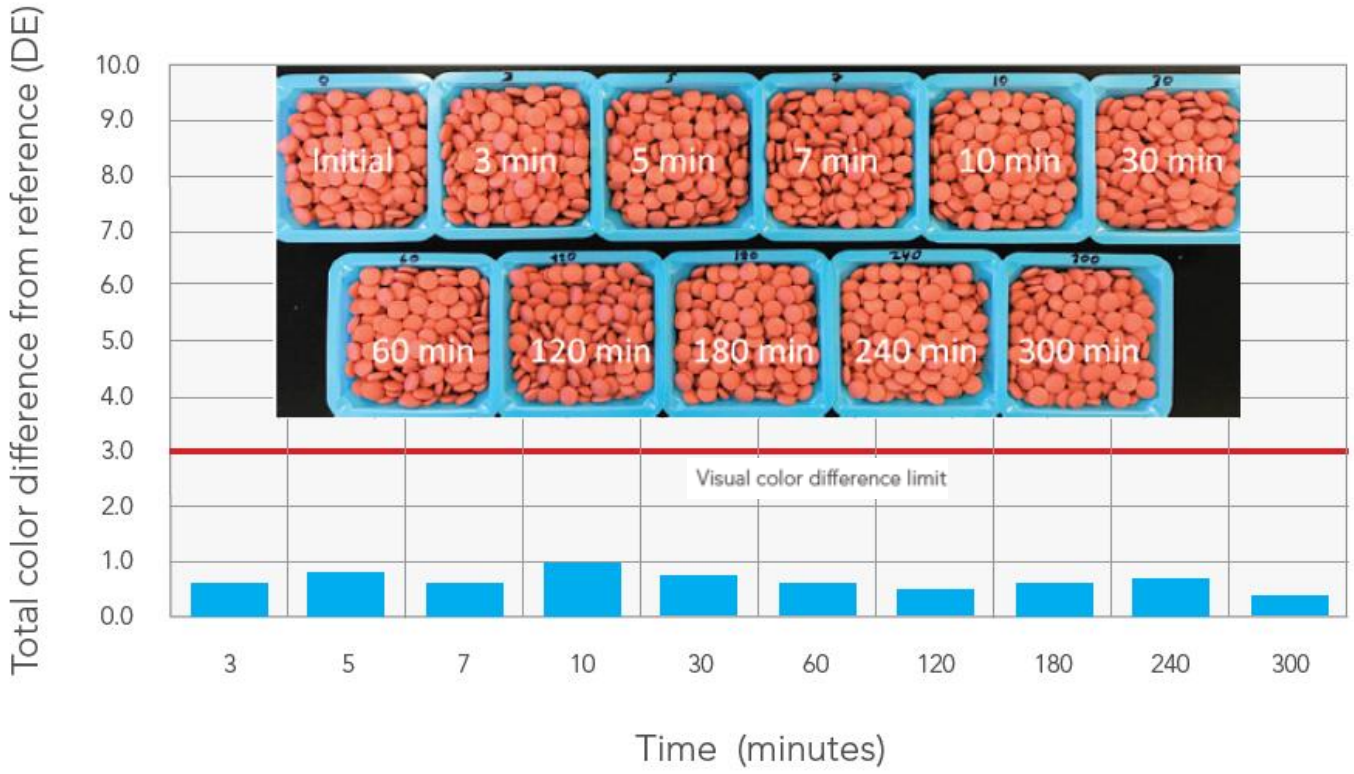
Used **mesh screen over time** – Powder was dispersed immediately reaching **full solubilization within minutes**

<0.5% retained material on a 60-mesh screen within 2-3 minutes of powder addition

No visible lumps or undissolved particulates

Data extracted from Whitepaper “On-Demand Film Coating Dispersion Preparation by Charles Cunningham, Chris Neely, Scott Patterson, Colorcon Inc., ILC Dover LP

Five-hour Recirculation Test - Visual and Instrumental Color Uniformity



Consistent coating quality
over 5 h recirculation (no color variation)

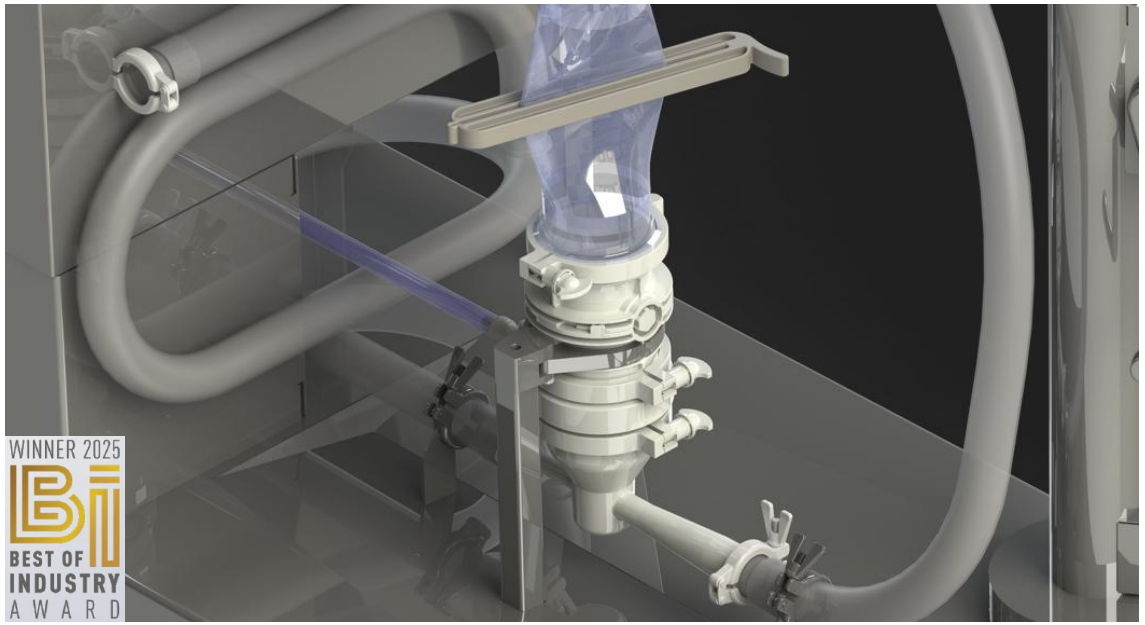
Gentle process
Low shear environment preserves pigment integrity

On-demand / continuous processing
Validated for small volumes (15–43 kg)

Optimal visual color difference
Validated with fast-hydrating Opadry II & QX formulations

Data extracted from Whitepaper “On-Demand Film Coating Dispersion Preparation by Charles Cunningham, Chris Neely, Scott Patterson, Colorcon Inc., ILC Dover LP

Conclusions



System **Designed to Improve Efficiency** and **Process Agility** in plant operations

Demonstrated **robust mixing** even without agitation

Provides **strong proof of concept** for biopharmaceutical powder handling

Enables on-demand mixing, extending beyond biopharma to broader solids handling applications

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