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Enclosed Ultrasonic Wet post-processing Conveyor / non-conveyor version

Rapid Ultrasonic–Vacuum Continuous Post-Processing System for HP MJF Polymer Parts . *1200 form factor.

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1. Concept Overview

This system introduces a **continuous, closed-loop post-processing line** for HP Multi Jet Fusion (MJF) polymer parts, designed to replace traditional bead blasting and batch cleaning methods.

User Experience:

Cobot / human places parts on single layer conveyor / non-conveyor version > immersion-bath, > hot air convection drying > parts ready and sorted.

The process integrates:

- **Ultrasonic-assisted immersion bath (15–30 sec exposure)**
- **Inline filtered fluid circulation**
- **Immediate transition to vacuum hot-air convection drying (60–80°C)**
- **Conveyor-based / non-conveyor version continuous transport system**

Objective: achieve **near-complete powder/residual polymer removal (<2 min total cycle time)** while maintaining **pre-process dimensional tolerances**.

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2. Process Flow Architecture

A. Continuous Conveyor Version

1. **Load Zone**
    - Parts enter on precision conveyor after depowdering stage.
2. **Ultrasonic Bath Stage (Wet Cleaning)**
    - Submerged 15–30 seconds
    - Low-temperature deionized water + optional surfactant

    - Ultrasonic cavitation dislodges trapped powder from complex features
    - Inline filtration maintains bath cleanliness
3. **Transfer Zone**
    - Minimal drip carryover (<5–10 sec exposure)
4. **Vacuum Hot-Air Drying Stage**
    - 60–80°C controlled convection
    - Mild vacuum accelerates moisture removal
    - Target moisture level achieved in approximately 60–90 seconds
5. **Exit Zone**
    - Clean, dry, dimensionally stable finished part

***B. Manual Non-Conveyor Version**

1. **Load Rack**
    - Parts are placed on a reusable **horizontal handled rack/tray** after depowdering.
2. **Ultrasonic Bath**
    - Entire rack manually submerged for **15–30 seconds**.
3. **Drain Station**
    - Rack briefly drains to minimize liquid carryover.
4. **Vacuum Hot-Air Drying**
    - The **same handled rack/tray** is transferred directly into a separate hot circulating vacuum convection dryer.
5. **Unload**
    - Parts exit clean, dry, and dimensionally stable with minimal handling throughout the process.

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3. Material Behavior Considerations (PA6/12-GB)

- **Short-term water absorption (≤30 sec):** negligible (<0.01 wt%)
- **Critical risk window:** prolonged exposure (hours–days), not seconds
- **Dimensional stability:** preserved if drying is immediate and controlled
- **Glass bead reinforcement:** reduces swelling sensitivity further vs unfilled nylon

Key insight:
Moisture uptake is **time-dependent diffusion**, not instantaneous saturation → enables ultra-short wet exposure without tolerance drift.

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4. Key Innovation Advantages

- Eliminates abrasive bead blasting variability
- Reduces labor-intensive batch handling
- Enables **continuous-flow manufacturing line integration**
- Improves internal channel cleaning (lattices, lattice infill geometries)
- Maintains **tight dimensional stability via controlled moisture exposure window**

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5. Engineering Constraints & Risks

- Ultrasonic intensity must avoid micro-surface erosion on fine features
- Vacuum drying must prevent thermal distortion (ΔT control critical)
- Conveyor dwell time synchronization required for repeatability
- Filtration system must maintain sub-micron particle capture
- Water carryover control between stages is critical (<seconds scale)

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6. *Form Factor & System Integration (HP MJF 1200-Class Companion Unit)

- The processing station is envisioned as a **compact, production-floor deployable module** with a footprint and service envelope comparable to the **HP MJF 1200 system**, enabling direct adjacency integration to any MJF printer in the series.
- Designed as a **plug-in companion post-processing line**, it can be deployed alongside MJF 4200/5200-class production cells or newer 1200-series installations, maintaining a unified print-to-finish workflow without expanding facility complexity.

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7. Conclusion

A tightly controlled **ultrasonic + vacuum continuous conveyor / non-conveyor version system** provides a viable high-throughput alternative to conventional MJF post-processing. By restricting water exposure to seconds and coupling it with immediate low-pressure thermal drying, the system leverages the **slow diffusion kinetics of PA6/12-GB** to maintain dimensional integrity while dramatically improving cleaning efficiency and cycle time.

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*Manual Non-Conveyor Version

- A simplified, lower-cost configuration uses a **removable horizontal parts rack/tray with integrated handles**. The operator manually transfers the

tray through a **short ultrasonic immersion**, **drain station**, and **separate hot circulating vacuum convection dryer**, using the **same rack throughout the process**.

- This approach preserves the core advantages of rapid powder removal, minimal part handling, controlled moisture exposure, and dimensional stability while providing an economical companion post-processing station compatible with any HP MJF production environment.

