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ctor of Market & Business Development, Extrude Hone Group

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Diverter rendering
Extrude Hone proprietary
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Advanced Finishing for Hydraulic and Pneumatic Circuits

There are 3 key technologies that address these challenges in complex, miniature fluid and gas components: Abrasive Flow Machining (AFM), MICROFLOW, and Electrochemical Machining (ECM). These processes are particularly effective where passages have no line of sight and micro holes intersect with long bores. They're also optimal when multiple channels converge in compact manifolds, or high-pressure/controlled pneumatic dosing demands repeatable, calibrated flow. Together, they deliver deburring, edge rounding, and surface improvement in internal geometries that conventional tools cannot reach.

AFM for Flow Paths and Edges

AFM was developed to polish internal flow paths that conventional tools cannot effectively reach. A viscous, non-Newtonian medium loaded with abrasive grits is pushed back and forth through the passages under pressure, gently removing high spots and burrs while improving surface finish.

Process performance depends on fixture design and gap control around the part. Media recipe comes into play, inclusive of polymer viscosity, abrasive type, grit size, and abrasive loading. Process parameters, such as volume, flow rate, pressure, and operating temperature, are important. With the right combination of these factors, AFM provides the surface consistency and edge quality needed for stable hydraulic and pneumatic performance in medical devices.

AFM Configurations

Two-Way Flow AFM uses 2 opposing media cylinders to alternately push media through the tooling and working areas. One-Way Flow AFM drives media continuously in a single direction and is suited to applications requiring large media volumes, such as hot runner blocks or large pump impellers that condition fluid flow. MICROFLOW extends AFM principles to very small orifices, enabling flow tuning and micro-deburring in holes down to about 40 µm. This is ideal for nozzles, spray features, and calibrated restrictions in medical dosing systems where both liquids and gases must be metered accurately.

HPLC Tubing as a Hydraulic Benchmark

HPLC tubes act as precision hydraulic conduits, ensuring consistent flow of the mobile phase and sample mixture under high pressure. Inside the tube, often called a column or cartridge. The internal surface quality directly affects flow stability, separation performance, and analytical repeatability.

Poor finishing can lead to turbulence from rough surfaces that distort separation, along with contamination or residue buildup in dead zones. In addition, premature wear under repeated high-pressure cycles, and chemical interaction or corrosion that affects long-term integrity, can also occur.

AFM in HPLC Tubes

AFM is well-suited for polishing the internal surfaces of cannular tubes used in chromatography. By flowing abrasive-laden media through the tube under controlled pressure, AFM removes microscopic peaks and smooths the bore at the micron level, improving hydraulic behavior and flow uniformity. Manufacturers can adjust media composition, pressure, and flow rate to reach a defined roughness range that supports stable back-pressure profiles. It reduces turbulence in liquid paths and improves reproducibility in production batches. These same principles translate directly into other medical hydraulic circuits, where accurate liquid dosing, flushing, or sampling depends on stable internal geometry and surface finish.

Ion Blocks in Gas and Vapor Paths

Ion blocks in mass spectrometers also function as precision gas handling structures in a controlled vacuum and flow environment. Their internal surfaces and transitions influence how ions, carried by gas flows and electric fields, move through the instrument. Even minor irregularities can disturb ion trajectories, reduce sensitivity, or introduce noise into the measurement. For medical and pharmaceutical use, this directly impacts the reliability of analytical results.

AFM can be applied to critical channels and cavities in the ion block to remove burrs at internal edges and transitions. It can smooth surfaces to reduce scattering and stagnation zones, and improve repeatability of gas and vapor flow conditions. The same AFM control strategies used for liquid systems help stabilize gas handling in these high-precision analytical assemblies.

Hypotube Shafts in Hydraulic Actuation

Hypotube shafts used in Minimally Invasive Surgery (MIS) are hollow, thin-walled tubes that combine flexibility and pushability while routing fluids or instruments. Many designs include multiple micro holes intersecting a central bore, creating complex internal hydraulics in a very small envelope. These intersecting holes must be burr-free to ensure clean passage for flushing or infusion fluids. This also guarantees reliable performance of guidewires and devices passing through, along with an absence of loose particles in sensitive vascular environments. Manufacturing processes such as laser cutting, EDM, and micromachining routinely leave micro burrs at hole intersections. Given the scale and geometry, conventional finishing often cannot reach or control these features.

ECM for Hypotube Micro Holes

ECM is particularly effective for hypotubes with micro holes that have a direct line of sight. It is a selective electrochemical process in which a cathode tool and an external DC power source dissolve metal from targeted areas. In a typical shaft configuration, a small-diameter cathode is introduced into the central bore to the region where perpendicular micro holes intersect. An FDA-approved electrolyte carries a charge through the working gap. From there, dissolved material is flushed away as hydroxide, leaving clean, rounded edges at the intersections. This approach removes burrs without mechanical contact, preserves thin walls, and produces repeatable internal geometry needed for controlled hydraulic flow through the hypotube.

Diverters With Micro Holes in Fluid Circuits

Diverters used in micro-pumping systems for medical fluids feature multiple micro holes grouped around a central passage. Hole diameters can be as small as 0.15 mm, making them extremely sensitive to burrs and surface defects. In fluid circuits where contamination and cavitation must be avoided, every edge and intersection in these micro passages must be free of burrs and loose particles. Traditional deburring methods cannot access such small, densely packed passages.

MICROFLOW for Diverter Micro Holes

MICROFLOW uses a low-viscosity, pourable liquid filled with abrasive particles to reach tiny channels and holes. In a 2-way MICROFLOW configuration, media is pumped through the part in both directions, creating a radius and removing burrs at both ends of each passage. Key benefits in diverter applications include complete micro-deburring at the inlet and outlet edges of angled holes. Formation of small, controlled radii to reduce cavitation, along with Improved surface quality within the channels that stabilize flow and minimize stagnation zones, also proves beneficial. All of this directly reinforces reliability in hydraulic medical circuits where precise volume and pressure control depend on unobstructed micro passages.

Manifolds in Anesthesia Gas Delivery

In anesthesia machines, manifolds distribute oxygen and anesthetic agents within a compact pneumatic network. What appears to be a simple block is, in practice, a critical gas-handling component with multiple intersecting channels and valve pockets. Each machined intersection can generate micro burrs, which are unacceptable in systems that must maintain clean, stable gas flows to life-support equipment. The geometry, thin walls, and density of internal features make these manifolds hard to deburr using conventional methods.

Thermal Deburring (TEM) for Medical Gas Manifolds

TEM removes burrs by exposing the part to a transient, extremely hot combustion wave in a closed chamber. Temperatures can reach roughly 3,300 °C in milliseconds, burning away burrs and small protrusions in all internal passages simultaneously.

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