Capabilities and Advancements in Waterjet Technology
Waterjet Technology

- One of the fastest growing major machine tool processes of the past 15 years
- Regarded as the most versatile process in the world, and also as a cold cutting process
- First production waterjets were in the early 70's
- Flow is the world leading provider of waterjet systems, invented the abrasive waterjet in 1979, and commercialized it in 1984
Waterjet Technology

Waterjet Overview
- Pure Waterjet
- Abrasive Waterjet
- Pump Types
- Waterjet Capabilities

Common Waterjet Applications

Latest Advancements
- Pressure Increase
- CAD/CAM

Comparison to other technologies
- Laser, plasma, EDM
A Waterjet System

1. THE ULTRAHIGH-PRESSURE SYSTEM

2. THE CONTROL SYSTEM

3. THE MACHINE
Two Types of Waterjets

Pure waterjet is:
~0.005” in diameter

Abrasive waterjet is:
~0.030” in diameter
Two Types of Waterjets

- **Pure Waterjet**
  - gasket
  - foam
  - carpet
  - plastic

- **Abrasive Waterjet**
  - metal
  - composite
  - glass
  - ceramic
  - stone
Waterjet Pumps

- **HYPLEX**
  - 55,000 PSI [3,800 BAR]
  - Direct drive pump

- **INTENSIFIER**
  - 60,000 PSI [4,150 BAR]
  - Intensifier pump

- **HYPERJET**
  - 94,000 PSI [6,500 BAR]
  - Intensifier pump
Waterjet Pump Technology

Intensifier
Linear Pump

Direct Drive
Rotary Pump
The Cutting Head

A abrasive Waterjet Cutting Head

- Water Body
- Abrasive Inlet
- Orifice
- Abrasive Body
- Abrasive Assist Port
- Mixing Tube
- Workpiece
How Abrasive Waterjet Works

1. Ultrahigh-pressure hydraulic driven pump generates a stream of water with rated pressure of up to 94,000 PSI.

2. Pressure is converted to velocity via tiny jewel orifice creating a stream as small as a human hair and cuts soft materials.

3. Cutting power is increased by adding garnet sand into the supersonic waterjet stream, now the system can cut virtually any hard material.

4. Water and garnet exit at nearly four times the speed of sound, capable of cutting any metal, stone, composite over one foot thick.
Where Are Waterjets Used?

**aerospace**
- Composite wings, spars, struts
- Small composite clips
- Exotic metals & aluminum

**defense**
- Steel
- Armor
- Ordinates *(decommissioning)*
- Ballistic glass

**automotive**
- Interior carpet, headliner, dashboard
- Car carrier paint removal
- Composite structures

**signs**
- Metals
- Stone, glass
- Plastics
- Incredible detail

**food processing**
- Meats
- Cakes & prepared foods
- Vegetables
- Pressure pasteurization

**housing**
- Stone countertop
- Ornate inlays
- Glass
- Structural steel

**oil & gas**
- Metal maintenance parts
- Paint removal on platforms
- Refinery cleaning
- BOP Valve testing

**marine**
- Metal cutting
- Ship coating removal
- New ship construction
- Tank farm repair

In addition to these end markets, waterjets are very common in job shops that serve these and other end markets.
Versatility is our biggest asset.

With a Flow waterjet you can cut virtually...

- **Extremely Versatile**
  Nearly any material from very soft to super hard and very thin to over 10 inches thick. Precision cutting down to +/- 0.002” with more advanced systems.

- **Cold Cutting Process**
  No heat affected zone, no mechanical stress: the best edge

- **Very Simple Operation**
  Only cut speed is varied for most applications; the other parameters remain the same.

- **Affordable Systems**
  System price is $70 to $350k, most commonly $150k.
Why Waterjet?

**WATERJET MAKES THE BEST EDGE.**

- Waterjet cutting is a cold cutting process. That means no heat or stress is imparted into your cut material.
- You can expect a satin smooth edge directly off the table. No heat affected zone (HAZ) means no secondary finishing.
- Minimal kerfs and high accuracy combined with the ability to cut virtually any material you need means more opportunities.

With a waterjet you have a machine tool that can cut virtually any material that comes your way, allowing you to handle tough applications or expand your business into processing more advanced, and often more profitable, materials.
Latest Advancements

- Pressure Increase – HyperPressure™
- CAD/CAM – Intelligent Controls
Most other waterjets operate at 50,000 to 60,000 psi. Since 2004 Flow provides the highest pressure rated pumps at 94,000 psi, and today it is our most popular pump.
HyperPressure Advancement

*Flow's first commercial waterjet intensifier at 30,000 psi, 1972*

*Flow's HyperPressure™ pump rated at 94,000 psi*
The goal is all about jet speed:
Efficiency is increased by cutting faster with less abrasive.
HyperPressure Advancement

PSI →

POWER DENSITY
HP/SQ. IN. →

50 HP →

JET DIA. →

JET TAPER →

ABRASIVE RATE
LBS/MIN. →

40K

218K

0.060

.010

2.1

401K

0.045

.005

1.24

737K

0.030

.003

.8
Comparing HyperPressure to Standard Waterjet Pumps

1. With cutting head parameters (orifice, mixing tube, abrasive flow rate) held constant, cut speed goes up with pressure. With improved cut speed comes better throughput and lowering cost per part.

2. With horsepower held constant, cut speed is just a little faster, but abrasive usage is drastically reduced, reducing cost per part (abrasive is 50% of the machine operating cost).

3. With hyperpressure, a single head machine can outperform a dual head machine through simpler operation, no need to keep both heads operating identically, and better material utilization.
10 quick facts - HyperPressure

1. HyperPressure is 75,000 psi and above. Standard pressure waterjet pumps are 40 to 75 kpsi.
2. Velocity matters – HyperPressure pumps deliver >500 mph faster stream than standard 60k pumps.
3. Pressures from all WJ suppliers have always gone up, never down, simply because higher pressure is more efficient → higher velocity stream, smaller stream, less abrasive per horsepower, and faster cutting.
4. Flow customers have made the HyperPressure pump, the HyperJet®, the largest selling pump in the world.
5. HyperJet pumps are faster and easier to maintain than 60 kpsi intensifiers or HyPlex® pumps. 500 hr. PM.
6. HyperJet uses 40 to 60% less abrasive than standard pressure pumps. Abrasive is 50% of the operating cost of an abrasive waterjet.
7. HyperJets can be operated at 60 kpsi, but a 60 kpsi cannot be operated at HyperPressure levels.
8. HyperJets can cut just as thick as standard pressure waterjet pumps – over 10 inches in almost any material.
9. HyperJet stream diameter for equal horsepower is 25 to 35% smaller, which delivers greater detail.
10. HyperJets work extremely well on certain pure waterjet applications too – the harder to cut the better.
Latest Advancements

- Pressure Increase – HyperPressure™
- CAD/CAM – Intelligent Controls
Why intelligent controls?

- Since the mid 1990’s, Flow has led the machine tool industry with PC-Windows based intelligent control.
  - Programmer/Operator enters Material Type, Thickness, Quality, and Pattern. The machine knows how to start and stop the jet, slow down at corners, speed up on straights, and even angle the head over to eliminate edge taper and corner washout.
Why intelligent controls?

Understanding taper and stream lag

1. Early FlowMaster® Intelligent Control systems slowed down on corners to compensate for stream lag.

2. In 2001, Flow released Dynamic Waterjet® (patented) to compensate for taper.
Why intelligent controls?

Ideal for flat plate, the intelligent controls with Dynamic Waterjet® improved accuracy and slashed part cut time.
Intelligent controls in 3D

- Our customers typically cut 2D parts, and they are constantly pushed to lower production costs and increase quality. 
  
  These demands are handled by FlowMaster with Dynamic Waterjet.

- Next most common is bevel cutting of flat plate, and then lastly is 3D cutting. Our customers need to be able to have very fast art to part and high quality for these complex shapes.
  
  These demands are handled by FlowXpert® with Dynamic Waterjet® XD.
FlowXpert® 2015 is the world’s first fully integrated 3D modeling and waterjet pathing software package. Expanding on the 2D FlowMaster® Intelligent Software Suite, FlowXpert can import, create, modify and path 3D geometry all in one single program.
Comparing processes
<table>
<thead>
<tr>
<th></th>
<th>Waterjet</th>
<th>Plasma</th>
<th>Laser</th>
<th>EDM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Process</strong></td>
<td>Erosion</td>
<td>Burning/Melting</td>
<td>Melting</td>
<td>Erosion</td>
</tr>
<tr>
<td></td>
<td>Using high speed liquid</td>
<td>Using a high temperature</td>
<td>Using a concentrated laser</td>
<td>Using an electrical</td>
</tr>
<tr>
<td></td>
<td>sandpaper</td>
<td>ionized gas arc</td>
<td>light beam</td>
<td>discharge</td>
</tr>
<tr>
<td><strong>Secondary Processing</strong></td>
<td>Usually None. Waterjet</td>
<td>Typically yes. Slag</td>
<td>Sometimes yes. Removal</td>
<td>Usually None. Very shallow</td>
</tr>
<tr>
<td></td>
<td>is a cold-cutting process</td>
<td>grinding for removal of</td>
<td>of oxidized edge and HAZ.</td>
<td>HAZ imported</td>
</tr>
<tr>
<td></td>
<td>that leaves a satin</td>
<td>heat affected zone) &amp;</td>
<td>Gases used impact depth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>smooth edge.</td>
<td>flattening to eliminate</td>
<td>of HAZ.</td>
<td></td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td>Virtually any material.</td>
<td>Primarily steel,</td>
<td>A variety of materials,</td>
<td>Conductive materials only.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>stainless steel and</td>
<td>but primarily steel,</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>aluminum.</td>
<td>stainless steel and</td>
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<td></td>
<td></td>
<td></td>
<td>aluminum.</td>
<td></td>
</tr>
<tr>
<td><strong>Thickness</strong></td>
<td>Up to 24 inches, virtually</td>
<td>Up to 2−3 inches,</td>
<td>Generally 1 inch or less,</td>
<td>Generally 12 inches or</td>
</tr>
<tr>
<td></td>
<td>any material.</td>
<td>depending on the material.</td>
<td>depending on the material.</td>
<td>less.</td>
</tr>
<tr>
<td><strong>Part Accuracy</strong></td>
<td>Up to .001 inch</td>
<td>Up to .010 inch</td>
<td>Up to .001 inch</td>
<td>Up to .0001 inch</td>
</tr>
<tr>
<td><strong>Capital Investment</strong></td>
<td>$50k−$300k +</td>
<td>$50k−$300k +</td>
<td>$200−$1M +</td>
<td>$100−$400k +</td>
</tr>
<tr>
<td><strong>Machine Setup</strong></td>
<td>Same setup for all</td>
<td>Different setup for</td>
<td>Different gases and</td>
<td>Different wire types for</td>
</tr>
<tr>
<td></td>
<td>materials.</td>
<td>different jobs.</td>
<td>parameters for different</td>
<td>different jobs.</td>
</tr>
<tr>
<td></td>
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<td>jobs.</td>
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Thank you
I hope this was of value to you. Please write us with questions and we will promptly respond.

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