DYNAFLOW, INC. provides Research & Development in Applied Sciences. Our capabilities span the spectrum of software development, analysis, numerical simulation, experimentation, testing, and experience in:

- Water Jet Technology
- Acoustics
- Flow Oscillation, Vibration & Sound Generation
- Dynamic Materials Properties
- Material Erosion due to Drop Impact
- Fluid-Structure Interactions
- Materials Science
- Multiphase Flows
- Material Erosion due to Cavitation
- Underwater Explosions
- Flow Visualization
- Liquid & Air Filtration
- Computational Fluid Dynamics
- Computed Tomography
- Fluid Mechanics
- Software for Science

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DYNAJETS™
Cavitation: Intense, repeated, localized impact due to the collapse of a multitude of minute cavitation bubbles on the target.

Jet Interruption: Intense, cyclic water hammer impact of liquid slugs and drops in contrast to continuous jets.

Jet Structuring: Collection of jet turbulence into large structures, resulting in intense cavity collapse or dense compact liquid slug impact.

DYNAFLOW employs a number of techniques to enhance the erosivity of water jets. These include:

- Pulsing of the jet
- Deliberate introduction of cavitation
- Passive acoustic resonance

The resulting patented jet technologies enable greatly increased cleaning and cutting at a given pressure, or a substantial reduction in pressure for the same cleaning and cutting rates of conventional jets. Whether operating in air or submerged, DYNAFLOW can design a jet with improved performance.

DYNAJETS™ Concepts Improve Jet Efficiency in Most Applications

DYNAJETS™ enhance jet effectiveness in cutting, cleaning, and material removal by taking advantage of three phenomena:

Cavitation:
Intense, repeated, localized impact due to the collapse of a multitude of minute cavitation bubbles on the target.

Jet Interruption:
Intense, cyclic water hammer impact of liquid slugs and drops in contrast to continuous jets.

Jet Structuring:
Collection of jet turbulence into large structures, resulting in intense cavity collapse or dense compact liquid slug impact.

DYNAFLOW, Inc. conducts a full range of research, development, and consulting services on jets, cavitation, and their effects on materials including analytical, numerical and experimental work.

DYNAFLOW, Inc. can provide a complete package of fundamental and applied capabilities, including model development, simulation, analysis, experimentation, and testing.
formation of large vortical ring cavities which collapse on the target. These jets:

- Employ no moving parts
- Greatly enhance jet erosive power resulting in reduced pumping power requirements
- Cavitate at high ambient pressures and are thus particularly effective in applications such as deep hole drilling.

STRATOJET® SELF RESONATING CAVITATING JETS

The STRATOJET® technology utilizes a passive acoustic resonance created by flow interaction with the nozzle and upstream chambers to induce the formation of large vortical ring cavities which collapse on the target. These jets:

- Employ no moving parts
- Greatly enhance jet erosive power resulting in reduced pumping power requirements
- Cavitate at high ambient pressures and are thus particularly effective in applications such as deep hole drilling.

Comparison of erosion of aluminum samples under the same conditions. STRATOJET® nozzle (left), conventional nozzle (right). Vol = Volume Removal, H = Depth of Erosion. DP = 8,000 psi, Pamb = 1,500 psi, time = 5min.

Vol = 0.79cc H=229mils Vol = 0.08cc H=48mils

Jet velocity fluctuations of excited and conventional submerged jets.

Acoustic resonance is achieved by matching the turbulent jet natural frequency with that of the specially designed nozzle assembly, resulting in organized vortical ring structures.

FACILITIES

The jet laboratory facilities include:

- A 10,000 psi - 20 gpm diesel pump
- Test tanks, hydraulic nozzle translator, and flow visualization facilities
- High ambient pressure cell (2,800 psi)
- Air jet test facility
- Acoustic, pressure and flow measurement equipment.
- High speed photography
- Bubble dynamics simulation facility
- Erosion test facilities

Diesel pump: 150 hp, 10,000 psi, 20 gpm.

Jet visualization cell.

High ambient pressure cell capable of ambient pressure up to 2,800 psi. Includes quartz view ports and variable speed rock motion fixture.

Jet translation chamber.

High pressure cell.
DYNAFLOW Jet Technologies include:

- **CAVIJET®**: Cavitating, both submerged and non-submerged jets.
- **STRATOJET®**: Cavitating, self-resonating, submerged jets.
- **SERVOJET®**: Pulsed, self-resonating, both submerged and non-submerged jets.
- **DYNASWIRL™**: Cavitating, swirling, submerged jets.

*CAVIJET®, STRATOJET®, SERVOJET® and DYNASWIRL™ are trademarks of DYNAFLOW’s patented jet technology.*

**DYNAFLOW INC.**

Jet Technologies for Enhanced Erosivity

DYNAFLOW capabilities cover the range of basic and applied research, development, testing, and fabrication of water jet technology and systems. This includes:

- Development of cavitating and resonating nozzles for improved cutting, cleaning, and drilling applications
- Custom nozzle design and fabrication
- Development of specialized prototype systems
- Test and evaluation
- Erosion testing of materials
- Experimental, numerical, applied, and fundamental studies
- Scale model design and testing
- Investigation of high ambient pressure applications
- Consulting
CAVIJET® CAVITATING LIQUID JETS

The CAVIJET® technology deliberately induces cavitation in front of the nozzle to produce extremely high, very localized stresses on a surface due to bubble cavity collapse in the jet stagnation region. This provides:

• Greatly enhanced erosive power for cutting and cleaning
• Greatly reduced pumping power requirements

The CAVIJET® technology employs a variety of nozzle geometries to induce cavitation in shear layers in various portions of the jet. Versions of these jets can be operated under both submerged and non-submerged conditions.

Applications

• Deep hole drilling in hard rock
• Pavement cutting
• Cement removal from drill pipes
• Marine fouling removal: underwater and dry dock
• Diver held tools for underwater cleaning
• Concrete removal
• Removal of explosives and propellant from shells and rocket motors
• Paint stripping
• Scale, rust, asbestos, non-skid coating removal
• Material cavitation erosion testing
• Underwater sound generation
• Material droplet impact testing
• Nozzles for specialized applications
• Decontamination
• Oxide Reduction

Stripping barnacles from ships hulls.

Limestone Drilling cut.

Multi orifice cleaning tool.

Paint removal.

Steam generator fouling removal.

Erosion on steel plate.

Velocity field obtained at two successive times in a computational fluid dynamic simulation of the microjet created during bubble collapse.

Sandstone cut by CAVIJET® Centerbody waterjet, operating at Dp= 10,000 psi, at a translation speed of 0.25 in/s.
**DynaSwirl™ Cavitating Swirling Jet**

A new concept under development achieves cavitation at relatively low jet velocities by employing a swirling flow. This jet requires much lower pressures and pumping power and minimizes the potential of damage to the underlying surface being cleaned.

**ServoJet® Self Resonating Pulsed Jets**

The **ServoJet®** nozzle employs passive acoustic resonance to create a series of high speed liquid drops, slugs, or vortex rings. This nozzle has several advantages:

- The **ServoJet®** provides enhanced erosive power for both submerged and nonsubmerged (in-air) applications and employs no moving parts with minimal internal losses.
- Creates water hammer type pressure pulses due to drop impact.
- Removes various layers of surface contamination, coatings, or paint without damage to underlying surfaces.
- Creates cyclic short duration loading at high frequencies.
- Produces larger outflow velocities and impact areas than continuous jets.

**Comparison of paint removal results for conventional and DynaSwirl™ nozzles for a jet pressure of 200psi**

A is the conventional jet at 480 seconds with no erosion,
B is the DynaSwirl™ Jet at 120 seconds,
C is the DynaSwirl™ Jet at 90 seconds, and
D is the DynaSwirl™ Jet at 45 seconds.

**Strobe photo of a ServoJet® showing slug formation.**

**Impact pressure of a steady jet compared with that of an excited interrupted jet.**

**Comparison of ServoJet® (A) and conventional jet (B) volume removal in simulated nuclear reactor steam generator fouling.**

**Helicoidal cavitating vortex core of a DynaSwirl™ jet.**

**DynaSwirl™ nozzle for dental cleaning application.**