WJTA WaterJet Technology Association

Jet News

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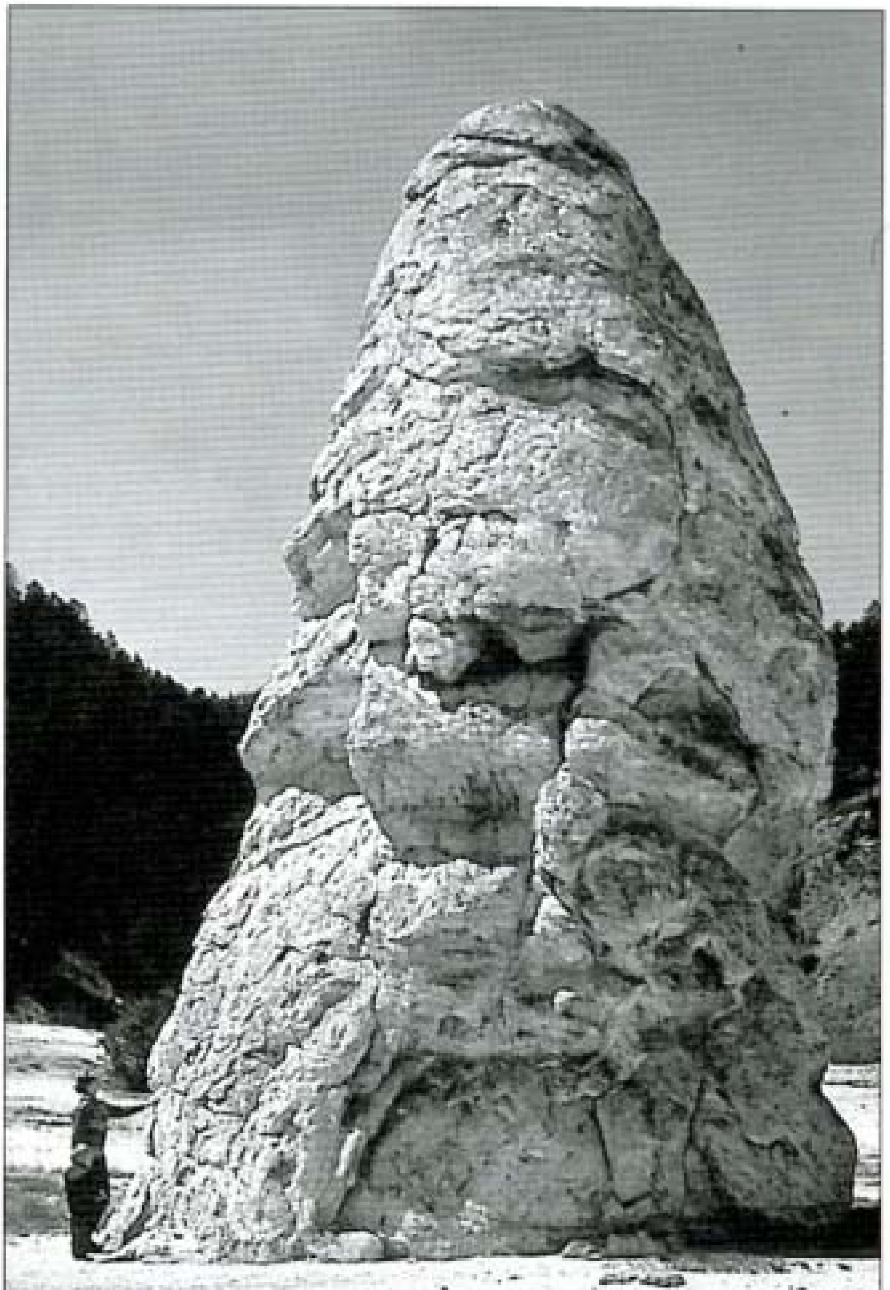
A Petrified Waterjet

Yellowstone National Park contains many wonders, including geysers, mud volcanoes, petrified trees and hot springs. Among the wonders is Liberty Cap at Mammoth Hot Springs located in the northwest sector of Yellowstone Park.

Liberty Cap is a 37-foot (11-meter) high tower of calcium carbonate created by a hot spring that was active in one location for a long time. The hot spring arose because there is a series of fissures beneath Mammoth Hot Springs which reach from the surface to hot magma deep within the earth. These fissures form a series of natural conduits through which hot water can reach the surface. The water comes from rain and snow that falls on the surrounding terrain and seeps into the earth. There it is heated and rises to the surface.

The hot water contacts limestone in the earth and takes calcium carbonate into the solution. When the water reaches the surface the calcium carbonate is deposited creating such formations as Liberty Cap.

In the case of Liberty Cap the pressure in the fissures connecting an orifice in the cap was sufficient to lift the water at least 37 feet vertically. The water was discharged through Liberty Cap and as it ran down the sides of the tower it cooled and precipitated calcium carbonate. Thus we have the discharge of a vertical pressurized waterjet preserved in rock.



Liberty Cap at Mammoth Hot Springs, Yellowstone National Park. ***Photograph courtesy of the National Park Service.***

Water Droplet Analysis of Spray Nozzles Using Phase Doppler Particle Analysis:

New Technology to Evaluate a Spray Nozzle's Performance Characteristics

By: Daniel R. Steppan, Underwriters Laboratories, Inc. E-mail: Daniel.Steppan@us.ul.com

Introduction

The understanding of a spray nozzle's performance is dependent on the individual water droplet's size and velocity attributes. Spray nozzle performance can be improved by designing the nozzle with droplet size and velocity characteristics appropriate for the application.

There are several examples of how optimization of droplet size and velocity may assist in heat and mass transfer applications. These include increasing cooling efficiency for cooling towers, improving control and suppression of fire using automatic sprinklers, sprays in pharmaceutical products and optimizing velocity of waterjet nozzles.

In this article, the typical methods of droplet characterization will be briefly described. A particular method using a phase doppler particle analyzer will be presented in detail with emphasis on how the data may be interpreted.

Characterization Techniques:

There are several techniques available to measure the droplet size of water sprays. These include:

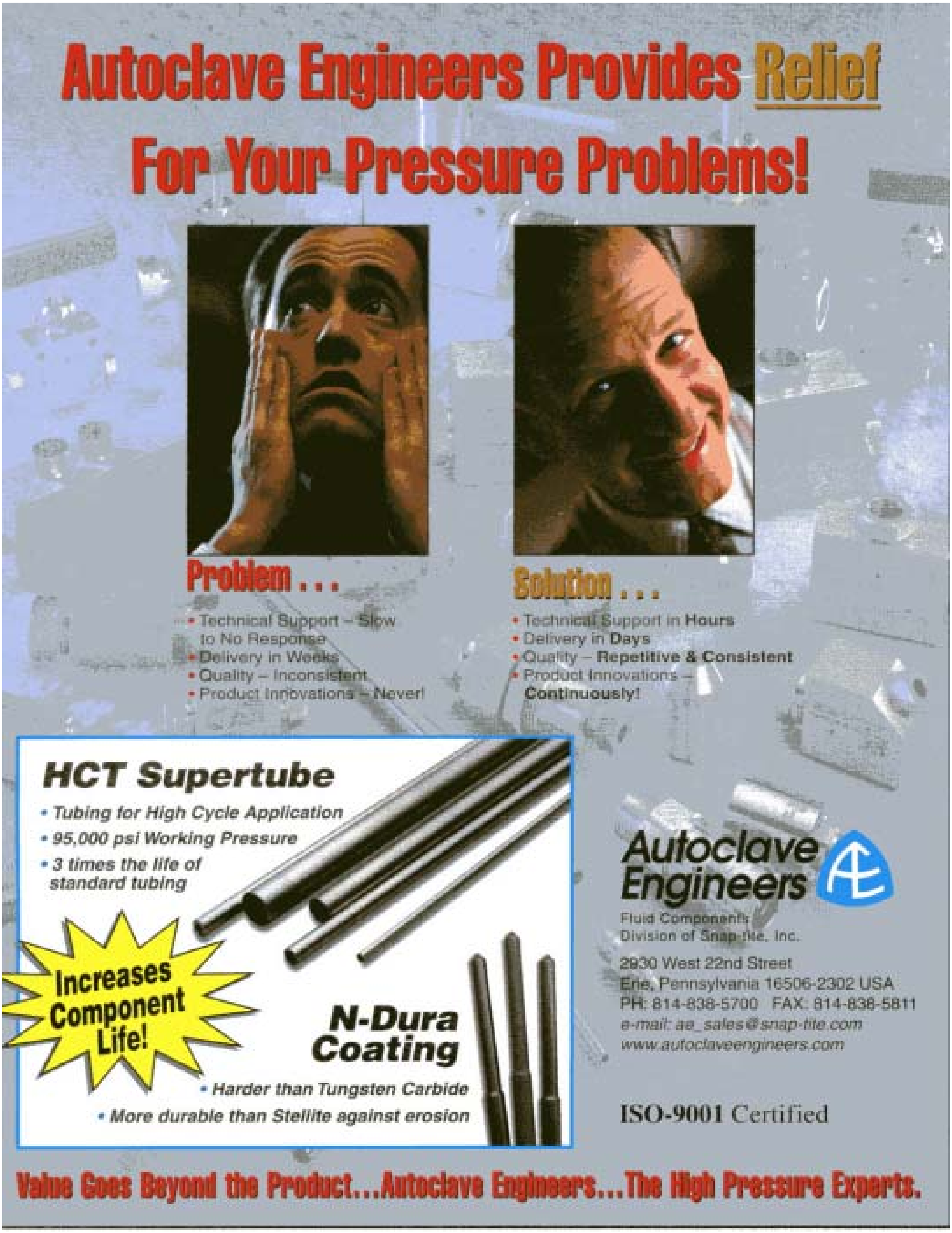
1. Manual collection of droplets in partially melted wax: This method is one of the earliest methods for direct droplet characterization. It was very labor intensive and involved collecting droplets in a small dish containing molten wax. The collected drops were then analyzed with a microscope, adding the number of drops within discrete ranges which quantified the minimum and maximum size. Statistical calculations were then performed by hand to determine the droplet size distribution.

2. Optical imaging: This method incorporates optical technology to image the droplets in a two dimensional plane within a small portion of the spray. Computer based programs then analyze the information to provide drop size distributions.

3. Diffraction techniques: A collimated light source is passed through a portion of the spray. The

(continued on page 4)

Contents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amount of diffracted light is sensed on strategically positioned photodetectors and the relative diffraction angle is then correlated to droplet size distribution bands.

4. Laser doppler refraction: A pair (or multiple pairs) of crossed laser beams establish a small sample volume, through which droplets pass. The laser light is transmitted through the droplets and this refracted light is collected and processed to determine the droplet size distribution at the sample volume. One advantage to this method is that it can also calculate the droplet's velocity.

The last three methods described above can be described as "non-intrusive." In a non-intrusive method, a spray nozzle's water droplets within a spray pattern may be characterized without disturbing the flow field. This method has advantages over the first method described, by not disturbing the flow field to take measurements. This means a more accurate representation of the flow field can be attained. Also, the methods are less labor intensive since computer based methods are used.

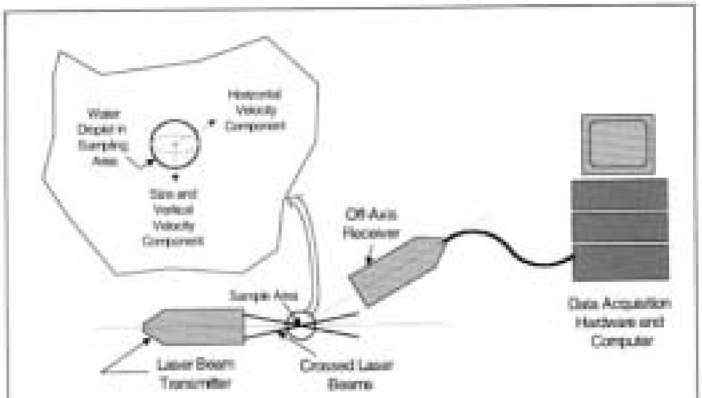

Figure I - General PDPA Arrangement

The second and third methods described may have trouble accurately measuring droplets deep within a dense flow field. The last method is less susceptible to this problem since the detectors are gathering information from the discrete wavelength of the incoming laser light. If the lasers are powerful enough, accurate measurements may be attained in this problematic area.

Underwriters Laboratories (UL) currently uses a phase doppler refraction method further described herein.

Phase Doppler Particle Analyzer (PDPA)

The PDPA is a technique used by UL to characterize the water spray from nozzles and sprinklers. In this technique, four separate laser beams in two pairs pierce through a spray nozzle's flow field and converge to establish a relatively small sampling area. This can be seen in illustrations 1 and 2. The measurement of droplet sizes and velocities are performed in this area.

When a droplet passes through the sampling area, it's size and velocity components are determined as shown in figure 1. Each droplet that travels through the probe volume has it's size and velocity information determined simultaneously through a "Real Time Signal Analyzer (RSA)" data acquisition system developed by Aerometrics, Inc.[1] Using the RSA, up to 120,000 samples can be measured in one second.

Typically, around 15,000 samples are measured at any one point in a nozzle's flow field prior to moving to the next position to be analyzed. The 15,000 samples are actually 15,000 separate events that link a single droplet's size to two components of velocity in ortho-gonal axes as depicted in figure 1. Using this information, a water droplet's mass can be determined by knowing the droplet's diameter. Also a velocity vector can be established by knowing that individual droplet's two dimensional velocity information (assuming the third component to be negligible[2]).

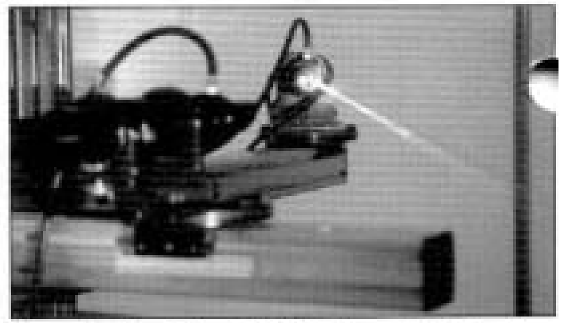

Illustration 1 – View of PDPA Transmitter Showing Beams Crossing Over to Form Sampling Area, Receiver In Foreground. Photograph by Mary Patricia Phillips, Underwriters Laboratories, Inc

With the mass and velocity information determined, an average momentum vector (mass times velocity trajectory) can be established at any one point in a nozzle's flow field. The probe volume (measurement location) described earlier can be traversed through the nozzle's flow field to determine data at significant positions within the flow field as determined by the nozzle manufacturer or accepted test methodologies.

A traversing system can be used to maneuver the PDPA's convergent sampling area within the spray pattern. The traverse UL incorporates allows a vertical plane of up to 10 by 10 feet to be traversed with repeatability within +/- 0.1 inch. See illustration 3 on page 20 for a photograph of the traverse. The resolution of the measurement system for the traverse can be positioned to within 0.001 inch that would allow for traversing of very thin streams of water for waterjet type analysis. Droplet diameters of between 1 and 13,000

[1] Aerometrics, Inc. – Sunnyvale CA – now TSI Incorporated, St. Paul, MN

[2] Careful orientation of the measurement plane as shown in figure 1 can typically be used to minimize the magnitude of the third component of velocity not measured.

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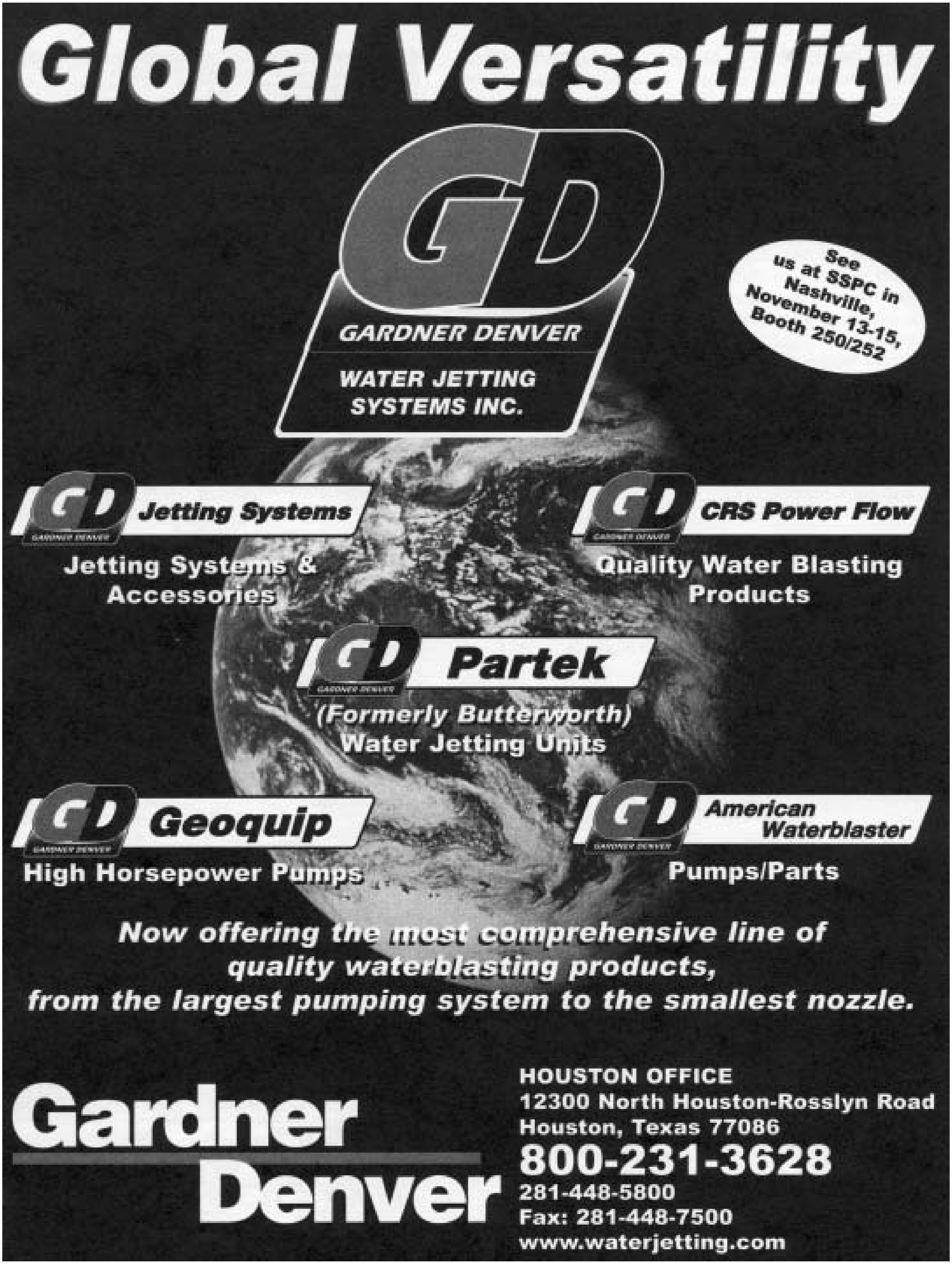
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Water Droplet Analysis of Spray Nozzles Using Phase Doppler Particle Analysis, from page 4

microns[3] (0.00003937 and 0.512 inch) can theoretically be measured along with velocities up to 800 m/s (2625 ft./sec.).

Information obtained:

Once a nozzle has been tested and proven in an application, new nozzle designs can be readily compared against this "baseline" nozzle to determine if equivalent performance characteristics exist for a less costly design. The effects of a range of pressures can be determined if a nozzle's end use application has a significant range. This information can be used to optimize a design for the orifice and nozzle component combination.

In addition, nozzle maintenance issues can be tracked with data obtained by such a system. Statistical quality control charts can be developed for trend analysis of critical nozzle performance parameters. Using an active maintenance schedule, a particular nozzle's performance can be analyzed with respect to time in service to determine when replacement may be necessary, prior to performance degradation of the end use application.

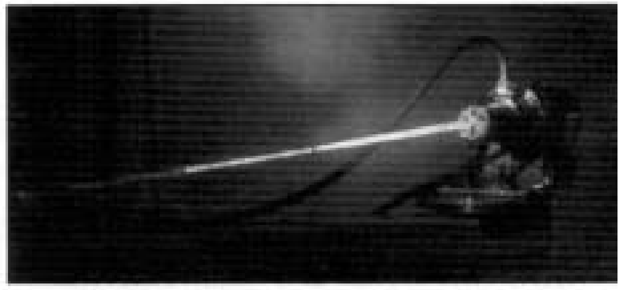


Illustration 2 – PDPA Transmitter, Showing Four Beams Crossing Over to Form Sampling Area. Photograph by Mary Patricia Phillips, Underwriters Laboratories, Inc.

The effects of different maintenance techniques can be analyzed to determine their effectiveness when compared against a particular nozzle's data prior to introduction to service (baseline data).

Conclusion:

The Phase Doppler Particle Analyzer (PDPA) can provide important information in a spray nozzle's performance characteristics that are critical to processes' end-use application.

The PDPA not only performs it's analysis non-intrusively so as to not disturb the flow field prior to measurement for more accurate data, but can perform this analysis within a dense flow field. The PDPA also

(continued on page 20)

[3] A micron equals one millionth of a meter or 0.00003937 inch.

Runway Cleaning At Shanghai's New Airport

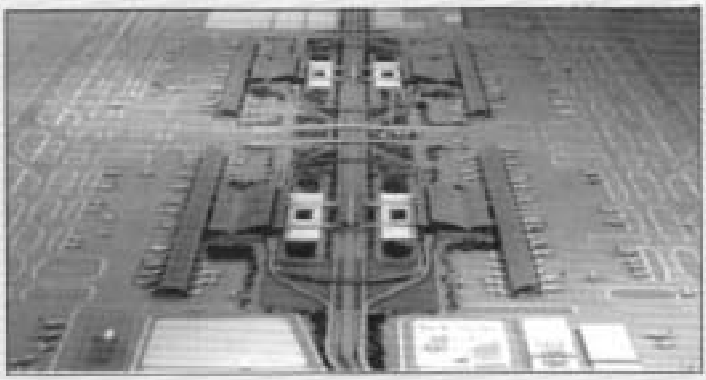
The frequent removal of rubber from runways is a major requirement for safe airport management. For years now, WOMA high pressure waterjetting systems have been used to solve this problem. World-wide, WOMA systems have efficiently and reliably cleaned millions of square feet of runways with production rates as high as 27,986 sq.ft./hr. WOMA waterjetting systems remove rubber deposits from runways without generating heat, dust or fumes.

After having equipped many of the major airports in Europe and the Americas, WOMA now steps into the Asian market. Very recently, WOMA supplied another of its innovative high-pressure waterjet runway cleaning systems to the Shanghai Airport Authority. This airport authority is responsible for the management of the Shanghai Pudong International Airport and the Hong Kong International Airport. Next to Hong Kong's new airport, Pudong is China's largest and most modern airport. The airport, put into operation in 1999, has a runway 2.5 miles (4000m) long and 197 ft. (60m) wide with two parallel slide ways, six rapid taxi ways, and six vertical contact ways. It can handle 126,000 flights, 20 million passengers and 750,000 tons of cargo annually.

When it came time to purchase a runway cleaning system, the requirements were very stringent: the system purchased had to be first, reliable, have a high degree of flexibility, high production rates, high quality manufacturing, 24-hour-service, experience at manufacturing runway cleaning systems and references from other international airports were all must requirements. After having reviewed bids by many other waterjetting equipment manufacturers the airport authority issued the order to WOMA.

The WOMA system for Pudong Airport consists of a WOMA high-pressure plunger pump type 325Z operating at a pressure of 11,000 psi (750 bar), generating a flow rate of 47.5 gpm (180 l/min). The pump is driven by a Volvo diesel engine, and cleaning heads are hydraulically driven. Control over the cleaning process is remotely controlled via an operators console in the truck cabin.

Further information on the system and its application are available through Mr. Zhou Dan, WOMA-Dalong Super High Pressure Equipment Co., Ltd. He can be reached at 0086/21-62034263 or send an e-mail: showmadl@public1.sta.net.cn



Shanghai's New Pudong International Airport

Operating Center at Pudong International Airport

Runway Cleaning With WOMA's High-Pressure System

Photographs provided courtesy of WOMA Corporation.

Hydrodemolition

Automated waterblasting robots are excellent equipment for bridge and parking deck repair

Corroding reinforcing steel in bridge and parking decks often cracks and spalls the concrete surface. Minor deterioration usually requires only localized patching, but extensive damage often requires complete removal of the concrete surface and installation of an overlay.

Contractors typically use mechanical methods, such as rotomilling and jackhammering, to remove the concrete surface to the specified depth. For example, a common procedure on bridge decks is to use a rotomill to remove concrete to the top of the rebar, then use jackhammers to remove concrete next to and below the rebar. In recent years, however, more and more contractors have been using hydrodemolition in conjunction with, or as a replacement for, rotomills and jackhammers.

Why hydrodemolition?

Removing concrete with rotomills and jackhammers has many potential draw-backs. Rotomills and impact hammers often remove sound concrete as well as deteriorated concrete. Mechanical vibrations produced by this equipment can cause residual damage to the remaining structure. Jackhammers can damage rebar, and microfractures may develop in the surface of the remaining concrete, weakening its bond to the overlay. In addition, these removal methods produce a lot of noise and dust.

Hydrodemolition reduces or eliminates many of these problems. The high-pressure water stream used in hydrodemolition selectively removes deteriorated concrete and leaves good concrete intact. It also removes rust from reinforcing bars without damaging them. Hydrodemolition produces no mechanical vibration and, therefore, does not inflict residual damage to the remaining structure. In

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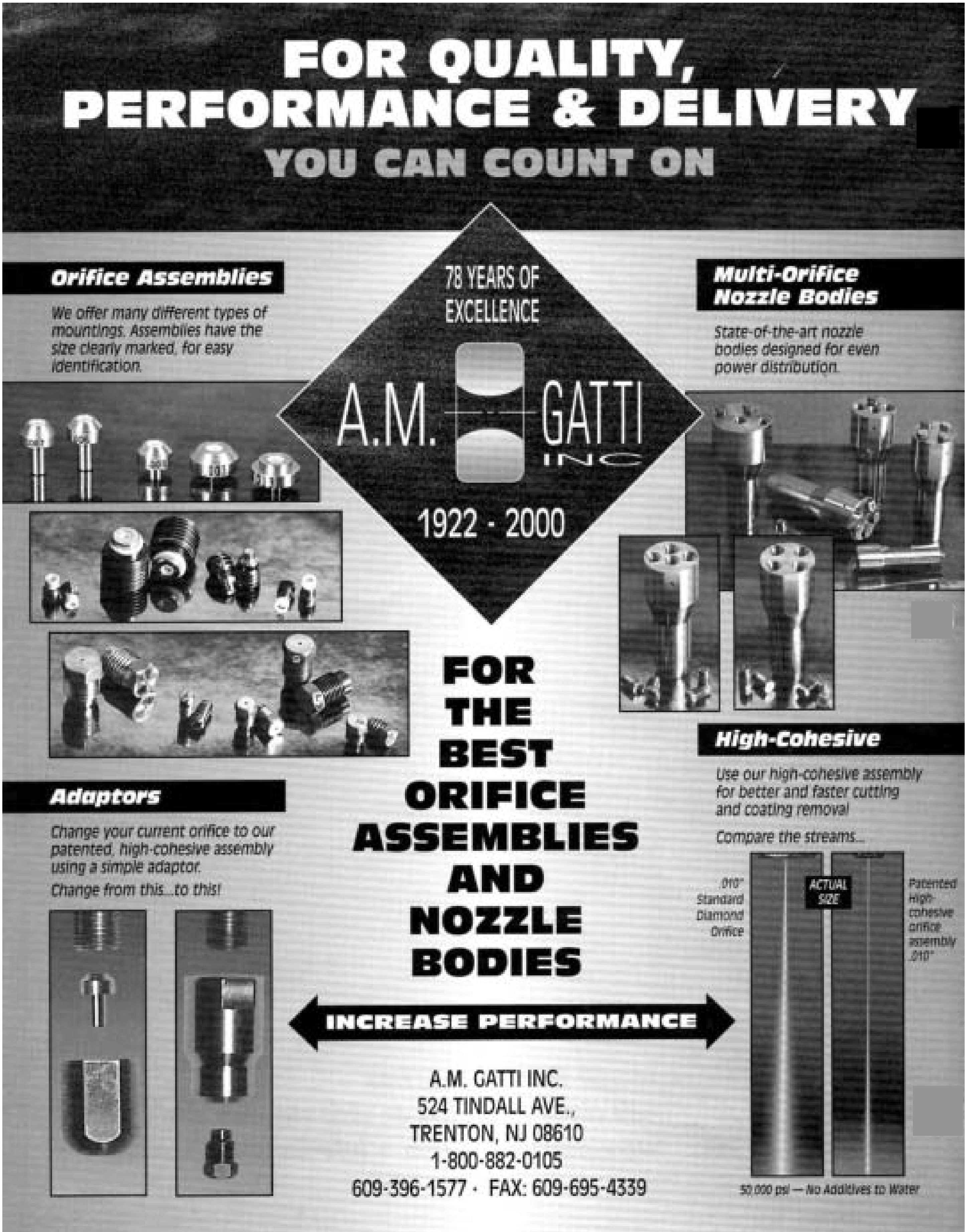
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First Announcement and Call for Papers

Impressive progress and a fast-growing understanding of the diversified applications of waterjet technology are generating a growing excitement in the industry. New techniques and applications are being developed and current ones are being improved. Waterjet technology, now being used in nearly all types of industry — manufacturing, mining, construction, concrete, stone, aerospace, engineering, process, and medical industries — continues to expand at a rapid pace.

The **2001 WJTA American Waterjet Conference** will focus, from a practical and scientific viewpoint, on the most up-to-date industry advances in waterjetting equipment, techniques, and applications. The areas to be addressed include but are not limited to:

- **Abrasives, Water, and the Environment**
- **Advanced Industrial Applications**
- **Advances in High Pressure Technology**
- **Automotive Applications**
- **Cleaning and Coating Removal**
- **Components and Systems**
- **Construction and Non-Manufacturing Applications**
- **Contractor Applications and Processes**
- **Demilitarization, including removal of land mines (demining).**
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- **High Pressure Equipment and Systems**
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- **Market and Future Needs**
- **Novel Jets and Applications**
- **Process Modeling and Control Studies**
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- **Safety, Training, and Environmental Protection**

Commercial and academic authors are encouraged to submit titles and abstracts for consideration. To submit an abstract(s), please complete the abstract submission form on the back of this sheet, attach a copy of your abstract(s), and forward to the attention of the Conference Coordinator at the WaterJet Technology Association. **The deadline date for submission of abstracts is December 1, 2000.**

An Abstract Review Committee consisting of four referees, chosen from the Organizing Committee and the International Advisors, will review the abstracts. Authors will be advised by February 19, 2001, regarding the decision of the Abstract Review Committee.

The 2001 WJTA American Waterjet Conference is organized by the **WaterJet Technology Association** and is endorsed by the **International Society of Water Jet Technology**. The WaterJet Technology Association looks forward to providing this forum and to your involvement and participation.

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For each paper to be submitted for consideration, please complete this form, **attach a copy of the abstract**, and mail or fax to WJTA by December 1, 2000. Authors will be advised by February 19, 2001, regarding the decision of the Abstract Review Committee. Please send this form even if you email your abstract.

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*August 18 is reserved for the Waterjet "Short Course," safety seminar, and Conference Welcoming Reception.

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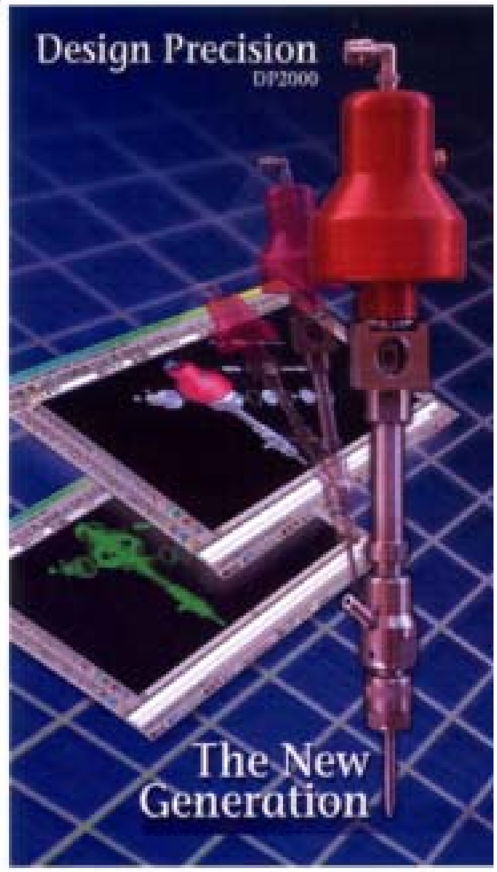

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Hydrodemolition Plays Key Role In Florida Bridge Rehabilitation

Increased traffic between Tampa and St. Petersburg has prompted the Florida Department of Transportation (FDOT) to undertake a major renovation project on the Howard Frankland Bridge that connects the two cities along Interstate 275.

Originally a two-way, four-lane bridge, the Howard Frankland is being converted to a one-way, five-lane bridge that has two emergency shoulders. A recently completed adjacent bridge carries southbound traffic, while the original 3-mile bridge is being converted to carry northbound traffic. The project required creating a new riding surface, removing the median barrier, and installing new edge barriers.

Project specifications prohibited the use of impact hammers for demolition. All concrete was removed by hydrodemolition equipment using 35,000-psi cutting pressure at a volume of 26 gallons per minute.

Removing the deck surface

To prepare the bridge deck surface for a 2-1/2-inch-thick overlay, specifications called for removing a nominal half inch of concrete. The contractor used an automated hydrodemolition robot to remove the deck surface in 13-1/2-foot-wide passes. The robot removed a total of 829,242 square feet of the deck at a rate of 300 to 500 square feet per hour.

FDOT required the overlay to develop an average 28-day shear-bond strength of 760 psi to the existing concrete. Tests resulted in an average shear-bond strength of 1039 psi.

Removing the median barrier

Workers used diamond saws to cut through the 7-inch-thick reinforced concrete bridge deck along both sides of the median barrier. Then, a hydrodemolition robot followed next to the sawcuts, removing a 3-inch-wide section of concrete to the full 7-inch depth. This exposed the rebar to allow installation of mechanical-crimped rebar splices, which provided load transfer to the new concrete. It also roughened the concrete surface to improve the bond. The robot removed 32,752 lineal feet at a rate of 50 to 100 feet per hour. The robot also was used to cut across the existing median, creating 40-foot-long sections that were removed by crane.

To prepare the bridge deck for a 2-1/2-inch overlay, the contractor used a hydrodemolition robot to remove a 13-1/2-foot-wide lane to a nominal depth of 1/2 inch. Photo courtesy of Blasters, Inc.

Expansion joints replaced

A 16-inch-wide, 6-inch-deep groove was hydrocut at each expansion joint to remove the sealant and provide the depth needed for proper edge support of the overlay. Each 26-foot-long expansion joint took about 1-1/2 hours to cut. A total of 5,883 feet of expansion joints was removed.

New edge barriers installed

Existing post and rail guards were replaced by Jersey barrier guard rails along both sides of the bridge. To expose the bridge deck rebar to tie in the new barrier rebar, 3-inch-wide, 3-1/2 -inch-deep channels were hydrocut. A total of 31,252 feet were hydrocut along the entire length of both sides of the bridge. New overlay and guard rail rebar were attached to the exposed deck steel using mechanical-crimped splices.

See related article, page 8.

Denmark Travel Designated Official 2001 WJTA Conference Travel Agent

Denmark Travel in St. Louis, Missouri, has been designated as the official travel agent for the 2001 WJTA American Waterjet Conference to be held August 18-21, 2001, at the Hyatt Regency Minneapolis on Nicollet Mall in Minneapolis, Minnesota. To make airline reservations, contact Gloria Morgan toll-free at 1-888-221-9042. If you are calling from St. Louis, Missouri, area codes 314 or 636, dial Gloria direct at 991-3563.

Be sure to mention that you are attending the 2001 WJTA American Waterjet Conference.

Minneapolis Skyline

11th American Waterjet Conference

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Hydrodemolition, from page 8

addition, hydrodemolition virtually eliminates dust and reduces noise. Manufacturers say the noise level 50 feet from hydrodemolition machines is about 80 to 90 decibels. The level for jackhammers is about 110 to 120 decibels.

Hydrodemolition equipment

Hydrodemolition equipment used for bridge and parking deck repair often consists of a programmable robot and a high-pressure pump unit.

The robot. Most robots have a waterjet mounted on their underside that moves back and forth along a beam. The maximum width of cut for most machines is 6-1/2 feet, but one contractor uses a robot capable of removing a 15-foot-wide lane. After the jet has traversed the beam a preset number of times, the robot rolls forward slightly to cut a new area.

Hydrodemolition robots have been used in applications ranging from membrane and coating removal to concrete removal to depths of up to 12 inches. On bridge and parking decks, removal depths of 2 to 3 inches are common.

Removal depth is controlled by adjusting the water pressure and flow rate, width of spray, speed at which the jet moves along the beam, and the number of passes the jet makes before the robot advances. The water pressure and flow rate are adjusted at the pump unit, which can be placed in a remote location away from the robot. The other parameters can be set at a control panel mounted on the robot. One manufacturer has a removable control panel.

Most manufacturers recommend fixing the water pressure and flow rate and adjusting the other variables to control the depth of cut. Making several passes over an area at a slow traversing speed will produce a deeper cut. A wider spray produces a shallower cut.

The pump unit. The horsepower of pump units ranges from 335 to 750 horsepower. If necessary, smaller units can be used together to supply the needed power. Most pump units are stored in insulated trailers that reduce the noise level.

The pump unit's power is based on pressure times flow rate. The higher the pressure, the lower the flow rate, and vice versa. Manufacturers differ about the water pressure and flow rate that produce the best results. Some manufacturers recommend using the lowest pressure possible that still penetrates the concrete, then increasing the flow rate for greater productivity. For example, one manufacturer says that about 14,000-psi water pressure will cut most concrete. Setting the pressure at this level leaves enough power in the unit to pump 66 gallons per minute. Another

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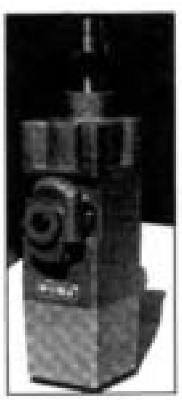
New Products

WOMA Introduces 3-D Tank Cleaning Head

Recently WOMA introduced the latest addition to its already extensive line of water blasting accessories: the Model TRD 1250/15 3-D tank cleaning head.

Mounted on one of WOMA's positioning devices, this high-efficiency tool can be used for cleaning tanks, containers and vessels as well as most chemical processing tanks such as autoclaves, mixers and agitators.

The TRD 1250/15 can be used by a variety of industries including chemical processing, biotechnology, transportation, construction materials, oil and gas, and power generation.



WOMA's new tank cleaning head features the following advantages:

- Optimization of cleaning results due to special rear drive design
- Long nozzle life due to proven sealing system and hardened gears
- Rotational speed control via magnetic brake system
- Housing and all parts subjected to high pressure water made of stainless steel

Technical Information:

Operation pressure:
18,000 psi (125 Mpa)

Nominal volumetric flow rate:
66 gpm (250 l/min)

Rotational speed:
10 to 60 rpm

Weight:
39.6 lbs. (18 kg)

For additional information, contact: WOMA Corporation, P.O. Box 6793, Edison, NJ 08818, telephone: (800)258-5530, fax: (732)417-0015, email: womacorp@bellatlantic.net, web site: www.womacorp.com

Full-Time Students Invited To Apply For Complimentary Conference Registrations

The WaterJet Technology Association (WJTA) has available three (3) complimentary combo registrations for full time students who are also members of the WJTA at the time of application. The complimentary registrations are for the 2001 WJTA American Waterjet Conference to be held August 18-21, 2001, at the Hyatt Regency Minneapolis on Nicollet Mall in Minneapolis, Minnesota.

Each complimentary registration covers the pre-conference seminars, presentation sessions, party, tour and luncheons. It does not include room or travel. Applications will be taken up to April 18, 2001. Preference will be given first to students and then to other visitors traveling the furthest distance. The complimentary registrations will be awarded on or before May 18, 2001.

For more information, contact the WJTA office.

Jet Edge And ABB Form A Partnership

Jet Edge, a leading waterjet equipment manufacturer, has formed a partnership with ABB Flexible Automation on all robotic waterjet applications in North America. "This partnership shows the respect that each company has for one another and we can now concentrate our efforts together to build quality systems that our customers can depend on," stated Tom Luckemeyer, vice president of sales and marketing for Jet Edge.

Robotic waterjet applications are commonly found in automotive, aerospace, foundry, and nuclear facilities. Jet Edge and ABB Flexible Automation will offer 6-axis pedestal robots to meet all robotic waterjet applications.

For more information contact Jet Edge at (800)538-3343.

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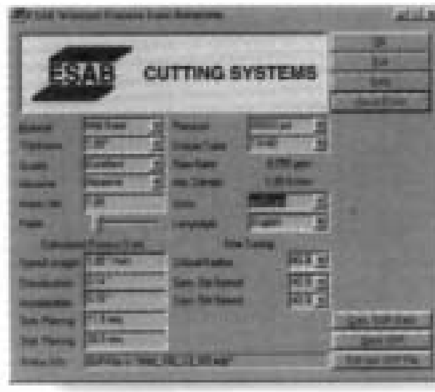
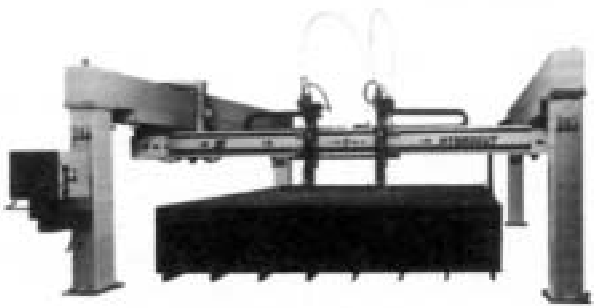
Reduce Set-Up Time, Eliminate Guesswork

ESAB Vision Controller with Data Generator automates process parameter programming to enhance repeatability, eliminate the need for special programs and allow customization. The Data Generator is a 32 bit Windows application that runs on the Vision PC in the background.

Available on ***new machines*** *or* ***may be retrofit*** *to your existing ESAB or competitive waterjet system.*



ESAB's **Vision PC** CNC controller for waterjet cutting combines remarkable ease of operation with powerful software tools like real-time tool path display and kerf-on-the-fly with kerf-override to offer the most technologically advanced control in the industry. This Windows-based controller features menu-driven operation, color LCD display, 8-position joystick, hand wheel, hard drive, 3.5" floppy drive, and speed potentiometer for easy operator use. Station and process control are integrated in a single ergonomic operator's panel. A 333 mHz processor and advanced features such as multi-level return, zoom while running, and program continue after power failure further add to the power of this control.



Rugged gantry design and AC brushless digital motors on ESAB's HydroCut provide precise motion control and positioning accuracy.

ESAB's exclusive Process Parameter Programming features the unique **Data Generator Program** that automatically optimizes cutting speed and cornering based on material type, thickness and desired cut quality. These settings are saved as a file that can be recalled at will, greatly reducing set-up time on repeat runs. Kerf, speed, dynamic axial pierce times, corner deceleration and corner acceleration are all set automatically.

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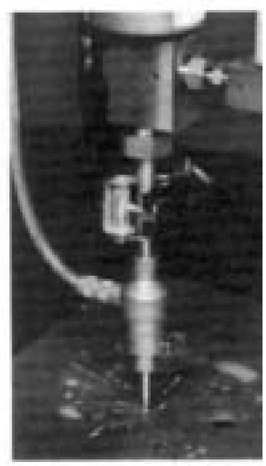

Contact ESAB today for more information on how the Vision PC can revolutionize your cutting applications.

See us at SCEC International 2000, Booth #1718 December 5-7, 2000, Chicago, Illinois.

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Telefax 52-83-50-5920

Hydrodemolition, from page 13

manufacturer has found that water pressure of about 3-1/2 times the compressive strength of concrete to be removed is adequate. ..owever, one contractor uses pressures of 35,000 psi at a flow rate of 13 to 16 gallons per minute, claiming that higher pressures produce better depth control and higher productivity.

Water supply and management

Water can be supplied to the pumps by a nearby fire hydrant or by water tankers. Some manufacturers include optional water tanks that hold about 1,200 to 1,650 gallons.

Most hydrodemolition equipment comes with a system that filters the water before it's pumped. This greatly extends the life of the spray nozzles. One manufacturer offers an additional filtering system that comes with a submersible pump that allows contractors to use river water on bridge projects.

Many jobs require the contractor to filter solids from the runoff water. Waste water can be removed by an industrial vacuum or it can be drained into settling tanks located underneath the workplace. Some contractors use sand bags to unnel the water through hay bails or piles of ne that filter out the solids.

Production rates

Production rates for hydrodemolishers are affected by the strength and condition of the concrete, and by rebar density. Previously repaired areas containing patches of high-strength concrete can be difficult to remove. Carbonation of concrete, particularly in parking garages, produces an extremely hard and low-porosity surface that can make initial penetration of the jets difficult. This slows production. On the other hand, delaminated or deteriorated concrete breaks out easily. Removal rates can range from 10 to nearly 30 cubic feet per hour. When the machines are used to scarify concrete (1/4-inch depth), reported productivity rates are 500 to 800 square feet per hour.

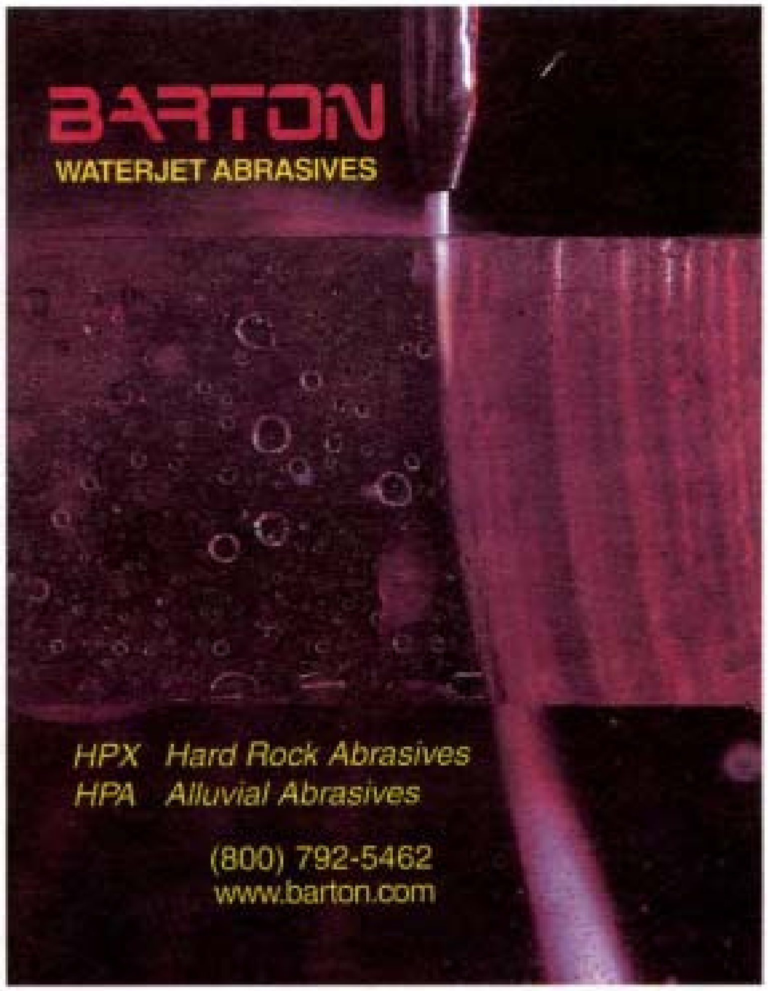
Cost

Because it is more expensive than rotomilling, hydrodemolition often is used for complete deck removal only when mechanical removal methods are prohibited. However, some contractors find hydrodemolition to be cost-effective when used in conjunction with mechanical methods. A typical concrete removal sequence involves rotomilling the surface down to the rebar, then using a hydrodemolisher to remove the concrete next to and below the rebar. Jackhammers are then used to remove any concrete beneath the rebar that the waterblasting missed.

The cost of a hydrodemolition robot and support equipment ranges from $400,000 to $700,000. The equipment also can be leased. Manufacturers supply training to customers and, if necessary, will send a service technician to the jobsite.

Because hydrodemolition equipment requires skilled operators, most work is contracted out to specialists. Some companies make their own hydrodemolition machines, but do not sell them, opting instead to use the machines for their own contracting services.

See related article, page 11.



Water Droplet Analysis of Spray Nozzles, from page 6

Illustration 3 – PDPA 10 ft. by 10 ft. Vertical Plane Traverse (PDPA laser and receiver near maximum vertical distance). Photograph by Mary Patricia Phillips, Underwriters Laboratories, Inc.

provides a match between a single droplet's size and velocity.

Combined with the traversing hardware and the aforementioned abilities, the significance of such an instrument to the spray nozzle industry can clearly be realized.

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