The Official Publication of the Water Jet Technology Association

Water Jet Technology Association

818 Olive Street, Suite 918 • St. Louis, MO 63101, USA • 314/241-1445

JET NEWS

OCTOBER 1989

From the President's Desk

The Fifth American Water Jet Technology Conference was held at The Inn On The Park in Toronto, Canada, August 28-31, 1989. The conference was a scientific, artistic, and financial success thanks largely to the efforts of the organizing committee and in particular Mohan Vijay and his colleagues at the National Research Council of Canada.

There were 235 attendees from 16 countries including Austria, Australia, Canada, China, Czechoslovakia, The Federal Republic of Germany, France, India, Italy, Japan, Poland, Sweden, Switzerland, Taiwan, the United Kingdom, and the United States. There were 22 exhibitors of water-jetting equipment and supplies.

Studying water jetting equipment

A field trip was held to a water jet cutting job shop of the Atomic Energy Corporation of Canada and to an underground parking garage where Indescor equipment was performing hydrodemolition.

Hydrodemolition

(continued on page 3)

Plant And Construction Applications Of Water Jetting

by John Wolgamott, Stone Age Inc., Durango, CO

I. Introduction

There are many applications for waterblasting outside the factory. They are found in a variety of industries: mining, civil engineering, petroleum, chemical and power plants. Waterblasting is used to clean, cut, drill, and demolish. It is effective on concrete, asphalt, rock, paint, refractory and rubber corrosion, etc.

This large range of applications is due to waterblasting's versatility and acceptability. The same equipment can be used on a variety of materials and surfaces. Environmentally, waterblasting has significant advantages over sandblasting or chemical cleaning. No harmful dust or fumes are generated and it is easy to clean up.

Waterblasting is evolving into a sophisticated industry. The equipment is becoming more reliable and capable. The predominance of minimum-wage operators with hand lances is shrinking. More automated equipment is being developed.

II. Civil Engineering Applications

Waterblasting offers benefits to the many diverse civil engineering projects. Whether it be to excavate, construct, repair, support or demolish---water jets have proven their value.

Excavation

Waterjet-assisted boring machines are used to install utility lines under existing roads and highways. They are compact, very powerful and can be steered to follow a precise path.

Excavation projects have used water jets to assist tunnel-boring machines, perform smooth-wall blasting, sink vertical shafts in sandstone, and line drill for quarry operation. Portability of equipment and high power to weight ratio of the cutting tool are the important aspects. Notching of drill holes in rock with water jets prior to blasting is an effective technique to achieve fracture controlled blasting.

Waterblasting has been used successfully for trenching in soil and soft rock. These trenches are used for laying buried cable underwater, as cut-off barriers under earth dams and around landfills.

Support

Waterjet-assisted drills offer distinct advantages in the installation of tiebacks in soil slopes. Typically, the holes are drilled three inches in diameter and 40 to 80 feet deep. Waterjet power allows the use of lightweight, easily-portable equipment into crowded or areas of poor accessibility. Dewatering holes, or drain holes, can also easily be made in most soils and soft rock formations.

Highways and Runways

Hydrodemolition is an exciting new application of waterblasting to cut, mill, or demolish concrete and pavement. Damaged bridge-deck surfaces can be selectively removed. A clean rough surface remains that provides good bonding. Waterblasting does not damage the underlying rebar or create additional cracks as jack hammers sometimes do. The equipment is quite powerful, usually a few hundred horsepower. It is also fast, quiet, and dust free---important considerations in an urban environment.

(continued on page 6)

Administration

Association Office

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Jet News is published by the Water Jet Technology Association and is a benefit of membership in the Association.

When we are depressed or
discouraged or anxious,
When we are embarrassed or
ashamed,
When we are taken by surprise,
These are the three surest signs,
That we are in a situation,
That offers opportunity for growth.

Anonymous

Accident Case Study – U.S. Petrochemical Plant

by Paddy Swan, S.P.D. Swan Consultants, Derbyshire, U.K.

An operator aged 22 years with approximately 3 years of experience was working as a team member in a three-man team cleaning the tube side of an extracted heat exchanger in a petrochemical plant.

The other team members were a 47-year-old supervisor with 20+ years of experience and a 19-year-old trainee operator with 3 months on-the-job experience.

The supervisor chose the normal equipment used for cleaning the tube bundle which contained "dope" in a petrochemical plant. The bundle was some 8 ft. in length with 250 tubes 3/4-inch in diameter.

The equipment chosen to carry out the job was as follows:

Pump with diesel prime mover producing 550 bar at approximately 50 liters/minute (8,000 psi at 11gpm). The pump had an unloader, a correctly working gauge and the safety valve had been set at 600 bar (9,000 psi).

A flexible lance was used with a multi-jet nozzle and correctly sized jets, one forward and four back. The length of the solid metal section at the end of the flexible lance, including the nozzle, was 4.5 inches. The hydraulic hose used was wire spiral wound with a minimum burst pressure of 30,000 psi. A footvalve of the shut-off type was placed in line with the flexible lance and this was under the control of the 22-year-old operator during tube cleaning. A sump gun was used during the preparation of the exchanger face prior to tube cleaning.

The supervisor prepared the site with a barrier 10 meters around the workplace with clear hazard signs; he also obtained a permit to work and supervised the gunning of the exchanger to ensure clear entry into the tubes. He then left the site, the job being a regular weekly occurrence which the trained operator had carried out some 1000 times before. The trainee was put on the pump with the instruction to shut down if anything out of the ordinary happened or if an unauthorized person entered the working area.

The equipment was set up for tube cleaning, the footvalve and the flexible lance replacing the gun. The trainee took the revolutions of the diesel up under the experienced operator's instructions until working pressure was achieved.

The operator began to clean the tubes, working only about 4,000 psi/280 bar. After cleaning eight tubes, the trainee heard a thud, and the operator at the exchanger staggered and fell to the ground. He was dead on arrival at the hospital.

On investigation, it was found that :

a) The dead operator had been killed by the flexible lance penetrating 14 inches into his body between the collarbone and the shoulder blade alongside his neck and penetrating the heart. There was very little water found in his body.

b) The equipment appeared to have been tested in the last month, though records were not good and the workplace was properly set out, although the floor was slippery.

CAN YOU INDICATE THE POSSIBLE CAUSES OF THIS ACCIDENT?

(see answer on page 7)

Conference Proceedings Available

A limited supply of the official Proceedings of the 5th American Water Jet Conference, held August 27-31, 1989, in Toronto, Ontario, Canada are now available in a single hard cover volume. A variety of presentations relating to the following general topics are included: Rock Cutting, Basic Studies, Concrete and Construction, Industrial Uses, Coal and Soil Cutting, Medical Applications and Safety Considerations.

The Proceedings are available for $75.00 each plus $5.00 for shipping and handling (in continental U.S.). **Additional shipping charges may apply for destinations outside the U.S.** To order, contact:

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Waterjet Cutting And Safety

by: Dr. David A. Summers, University of Missouri–Rolla, Rolla, MO

At the BHRA waterjet meeting held in the United Kingdom in 1983, a medical doctor was discussing the safety of waterjet cutting operations. He commented that this had to be one of the safest of new technologies, since during his preparation for the paper, he had found only three recorded incidents in the literature. Unfortunately, when the chairman of the meeting then polled the audience, he found that over half the audience had sent one of their employees to a hospital with a waterjet related injury. There have been reports of deaths from waterjet related accidents. It is, therefore, appropriate that the safety aspects of this new technology be discussed.

In a number of factories the advantages of waterjets in cutting applications have led to their incorporation into the product line. At one recent demonstration, the operator showed the "safety" of the tool by backing the nozzle out of the workplace and holding his hand in the jet at a distance of some 6 inches from the nozzle. He was not wearing any discernible safety equipment (including safety glasses) during this demonstration. This is an extremely hazardous and foolish practice, and should be strongly discouraged. A variety of different injuries may result for a number of reasons.

To make an initial point in seeking to discourage the practice, the operator was accustomed to working with a 50,000 psi jet issuing through an orifice of roughly 0.007-inches diameter. Had a larger nozzle been placed in the jet, and the pump operated at a lower pressure, then the jet would have remained coherent for more than 1 foot. The operator, in such an instance, might have sustained a severe injury.

From the President's Desk, *from page 1*

Many attendees visited the attractions of Toronto including the revolving restaurant of the World's tallest structure, the Canadian National Tower, or to watch a baseball game at the new domed stadium.

Papers were presented, 46 in total, on many aspects of water jetting including safety, robotic applications, and the fluid mechanics of abrasive jets. These papers are published in a volume of proceedings which are available from the Water Jet Technology Association or the National Research Council of Canada.

Dick Paseman (r.) receives the Pioneer Award from Dr. David Summers

Water jetters participate in banquet festivities

A banquet was held where the Pioneer Award of the Association was awarded to Dick Paseman of Houston, Texas, for his contributions to the water jet cleaning industry.

A short course on the Fundamentals and Applications of Fluid Jet Technology was presented in conjunction with the conference. Instruction was given on the history of water jetting, fluid mechanics of jets, abrasive jets, high-pressure equipment and safety, and the industrial applications of water jetting. The Association hereby thanks Thomas Labus for organizing the course and his co-lecturers; David Summers, Mohamed Hashish, Ray Jordan, Charles Taylor, John Wolgamott, and Don Fryer for an interesting and informative day.

A meeting of the membership of the Association was held wherein officers and directors were elected for the 1989-1991 biennium. The new administration is listed on page 2. The membership decided that the Association should be known as the "Water Jet Technology Association" rather than the "U.S. Water Jet Technology Association." The membership also voted to provide financial support to the International Journal of Water Jet Technology, to change the Association logo, and to hold the 1991 convention in Houston, Texas.

– Dr. George A. Savanick

Letter To The Editor

Dear Jet News:

There are a lot of different warning signs in use. For instance, high voltage, strong wind, open trench, etc., but we do not have any sign to warn people that a high-pressure waterjet is in use. People use written information as "Warning: High-Pressure Waterjet in Use," but in my opinion this is not enough. We as Water jet Technology Association members believe we should establish our own standards to cover the needs of the waterjet technology. Therefore, we would like to suggest the use of the following combination for a warning sign about high-pressure waterjets: High Pressure (fig. 1) and Water Spray (fig. 2), both logos are recommended by ISO. The idea to establish a warning sign was created by the staff of the High Pressure Waterjet Laboratory at the University of Missouri-Rolla.

Fig. 1 – High Pressure

Fig. 2 – Water Spray

The proposed warning sign is presented by the author in figure 3. This is a proposition only and I would like to know your opinion about the proposed idea. It may also be very useful to know the opinion of other Water jet Technology Association members.

Fig. 3 – Proposed warning sign

S/Dr. G. Galecki
University of Missouri-Rolla
High Pressure Waterjet Laboratory
Rock Mechanics Laboratory
Rolla, MO 65401-0249

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Plant And Construction Applications, *from page 1*

Similar, but smaller, equipment can be used in the repair of any concrete structure. The action of the waterjets selectively seeks out the weak or damaged areas and removes them effectively without damaging the remaining structure.

By concentrating the waterjet power, openings and access holes can be effectively created through asphalt and concrete layers. The process can be used in difficult to access areas, to make irregular openings and can be faster than conventional diamond sawing. When abrasive entrained water jets are employed, the same process can also cut cleanly through the aggregate and reinforcing steel.

Another large-scale application of waterblasting is the cleaning of airport runways. A thick layer of rubber builds up from tires scraping during landing. Water jets are used routinely to remove this unwanted buildup and leave a fresh-textured surface.

The same concept is used on a smaller scale to remove the paint stripes on roads. A spinning water-jet head is very effective at removing the tough-bonded paint. Most coatings applied to concrete and asphalt surfaces are good candidates for water-jet removal. One contractor specializes in removing old surfaces from tennis courts.

Municipal Works

The cleaning of sewers, aqueducts, pipelines, and water wells and storage tanks is ideal for waterblasting.

Sewer and drainline clean out is easily accomplished with high-pressure jetting heads. By concentrating the jet power into a couple of rotating jets, blockages can be cleared and the entire inner surface can be uniformly and effectively cleaned.

A large aqueduct in the Los Angeles area was recently cleaned using waterjets. In this case, a 20-ft-diameter, concrete tunnel was cleaned for a length of 3,000 ft. The resulting surface needed to be capable of bonding to a new surface. A custom rotary cleaning unit was built and used with a 10,000 psi, 20-gpm pump. The entire length was cleaned in 9 days, operating at 24-hours per day.

Downhole water wells offer another application of water jets. Well screens routinely become plugged by the buildup of minerals in the water. Lowering a self-rotating nozzle head 2,000 ft into the well is a relatively simple task. A few hours of rotation of the nozzle head can restore the screen openings and improve well production significantly.

III. Petroleum and Chemical Industry

Waterblasting has been important to the petroleum industry for a long time. Much of the early development of pump technology was driven by the need for high pressures to fracture oil-bearing formations. This familiarity with and availability of the equipment has resulted in the development of several useful applications of water jets.

Production

Drill rigs operate in dirty, messy conditions. Waterblasting is a simple and effective means of keeping the work platform clean and providing safe footing. Offshore rigs also use water jets to clean their underwater support columns prior to inspection and testing. Sometimes during the cementing process, the tubulars may become filled with cement grout. Rotary waterblasting has become the preferred method for removal of the cement plug. It is a fast operation that does not damage the tubular and leaves it very clean.

Transport

Underground pipelines are inherently difficult to access. Small, but powerful rotary waterblast heads can be used to clear and clean long underground sections (up to 1,000 ft). This procedure has been used successfully in 4-inch- and 8-inch-diameter lines to remove cement lining. These linings deteriorate after time and need to be removed before relining can take place.

Waterjets can assist with cleaning the outside of pipelines also. This is very effective for the removal of mastic and coating prior to inspection and testing. Complete automated equipment has been developed to accomplish this task.

Cargo ship hulls, railroad tank cars and tanker trucks all benefit from water-jet technology to clean them. These applications usually require large volumes of water at relatively low pressures.

Refineries and Chemical Plants

The largest use of waterblasting cleaning is in the refinery and chemical production industries. In the U.S. alone, this market represents over $100 million per year in contract work.

The cleaning of heat exchangers is a routine operation in all of these plants. Waterblasting is very effective in unplugging and removing scale and deposits from the typical tube-and-shell heat exchangers. The inside of the tubes, as well as the outside, can be cleaned by waterblasting. This has been done manually for years with flex lances and hand stabbing. Recently, however, the availability of more automated equipment is improving the operation. It becomes a safer, and more effective operation that minimizes manpower requirements and risk.

The other tasks where water jets are used are in cleaning: storage tanks, transfer lines, fractioning towers, mixing tanks, reaction vessels, work decks, etc. Some plants have their own waterblasting crew to handle the routine work. They will bring in contractors to help with "turn arounds" or major cleanings when entire sections of a plant will shut down for maintenance. Other plants bid all the waterblasting work.

A variety of equipment is used in these cleaning tasks. A hand lancer or "shotgun" is the basic tool for any crew. It is easy to use, inexpensive and flexible in application. Besides needle jets or fan jets, there are now rotating heads that will fit on the end of these hand lancers for improved performance.

(continued on page 7)

Plant and Construction Applications, *from page 6*

For tank or vessel cleaning, there are also rotation nozzle heads. These are large robust units capable of throwing a powerful stream of water several feet to cut and clean. They can be air or hydraulic powered, or reaction powered by the jets. Some units are designed for pressures up to 15,000 psi, while others handle flows of 500 gpm or greater.

Pipelines are cleaned with multi-jet line moles, rotary nozzle heads, and powered-line moles. The manual method of feeding a "pineapple" nozzle head with pulsing jets works well in short, easy-to-clean lines. For longer lines or harder cleaning jobs, automation is the answer. Machines that have power to feed in and rotate the hose/nozzle head can accomplish several hundred feet of tough cleaning. Abrasive entrained water jets are the perfect tool for cutting through steel structures.

IV. Power Plants

There are routine waterblasting jobs in every operating power plant. Less so in the gas and oil plants, but a lot in the coal fired and even in the nuclear generating stations.

Fossil Fuel

Improving heat convection, cleaning blockages and build-ups, and removing deteriorated linings are major waterblasting tasks. These are found in boilers, superheaters, cyclones, air preheaters, heat exchangers, and evaporator tubes.

Much of the technique is similar to the cleaning in refineries and chemical plants. However, the water volumes used are often much greater due to the large size of the items to be cleaned. One-thousand-horsepower pumping units are sometimes used to clean the flyash out of the preheater baskets.

Specialized equipment has been developed, however, to handle specific powerplant applications. One of these is the rotary nozzle head that rides on a tight horizontal cable. It is used to clean cylindrical chambers that lie horizontally and have access at the ends. It is capable of removing bonded refractory linings from cyclones with 12,000 psi water while the operator safely controls it from outside the chamber.

Nuclear Power Plants

The applications in this industry can be categorized as: before, during, and after. Prior to assembly and use, many of the components in nuclear plants require extremely careful cleaning. Waterblasting can be controlled to provide the necessary amount and location of cleaning.

(continued on page 8)

Accident Case Study, *from page 2*

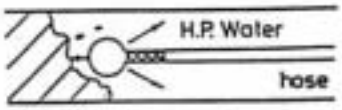
Answer to

POSSIBLE CAUSES OF ACCIDENT

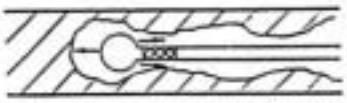
"Hydraulic lock" in small bore blocked tube with plastic deposit (see diagram below).

Hydraulic Lock

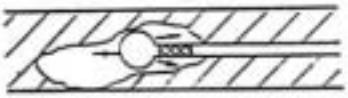
Blocked pipe nozzle



1. *Forward facing jet breaks into blockage.*



2. *Nozzle allowed to run forward, debris closes in behind.*



3. *Nozzle completely sealed in pocket of H.P. water.*

4. *Nozzle shot out explosively as lock is broken.*

BEWARE OF SMALL PIPES WITH PLASTIC/RUBBERY DEPOSITS.

MORAL – Always clean such tubes with a rigid or semi-flexible lance first.

One of several exhibit displays at the 5th American Water Jet Conference

Plant and Construction Applications, *from page 7*

During operations some areas and items of equipment are continuously exposed to radioactivity and require decontamination. Waterblasting is effective, adds no additional chemicals and can be collected and disposed of by simple, standard methods. Much of the critical Three Mile Island cleanup utilized robotically maneuvered water jets.

Decommissioning nuclear plants is a very involved and expensive undertaking. Again, water jets can be used to clean much of the structure and equipment sufficiently to lower the exposure risks. Conventional disposal means can then be used on much of the bulk.

V. Summary

Water-jet technology is a growth industry. It is useful in a wide variety of industries and not dependent on the health of any single segment of the economy. Water-jet technology is environmentally acceptable, extremely effective and capable of being custom tailored for specific tasks.

The hardware and practitioners are becoming more sophisticated. The equipment is continually improving to be more reliable and more capable. As experience is gained, less guess work is involved. Instead the proven methods are employed and refined.

The industry is maturing. There are some large companies heavily involved in water jetting. They are run by professionals and are capable of bigger and more involved projects. Long-term investments are being made in water-jetting skills and technology. Trade associations, conventions, newsletters, standards of practice, all of these are signs of an emerging profession.

The direction of growth is toward automation, which improves safety by removing the operator exposure to the powerful water jets and potentially dangerous splash back. Mechanical assistance allows the use of more power because it is not limited to the reaction force a man can hold. A safer, less strenuous work environment will attract employees who will take pride in the work, stay with the job longer, and thus become more skillful.

(Excerpted from "Fluid Jet Technology Fundamentals and Applications," a short course presented at the Fifth American Water Jet Conference, Aug. 28, 1989, Toronto, Ontario, Canada.)

WJTA Officers and Board of Directors for the 1989-1991 biennium. Back row, from left: Dr. Mohamed Hashish, Dr. Thomas Labus, Damon Schroter, Dr. George A. Savanick, John Wolgamott. Front row, from right: Dr. Mohan Vijay, Dr. Fun-Den Wang, Evette Steele, Dr. David Summers, Forrest A. Shook, and Dr. Andrew F. Conn. Not pictured: George Rankin.

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