WJTA Jet News

Water Jet Technology Association

MAY 1994

Published by the Water Jet Technology Association for the benefit of its members

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Liquid Nitrogen Jets Remove Rocket Propellant

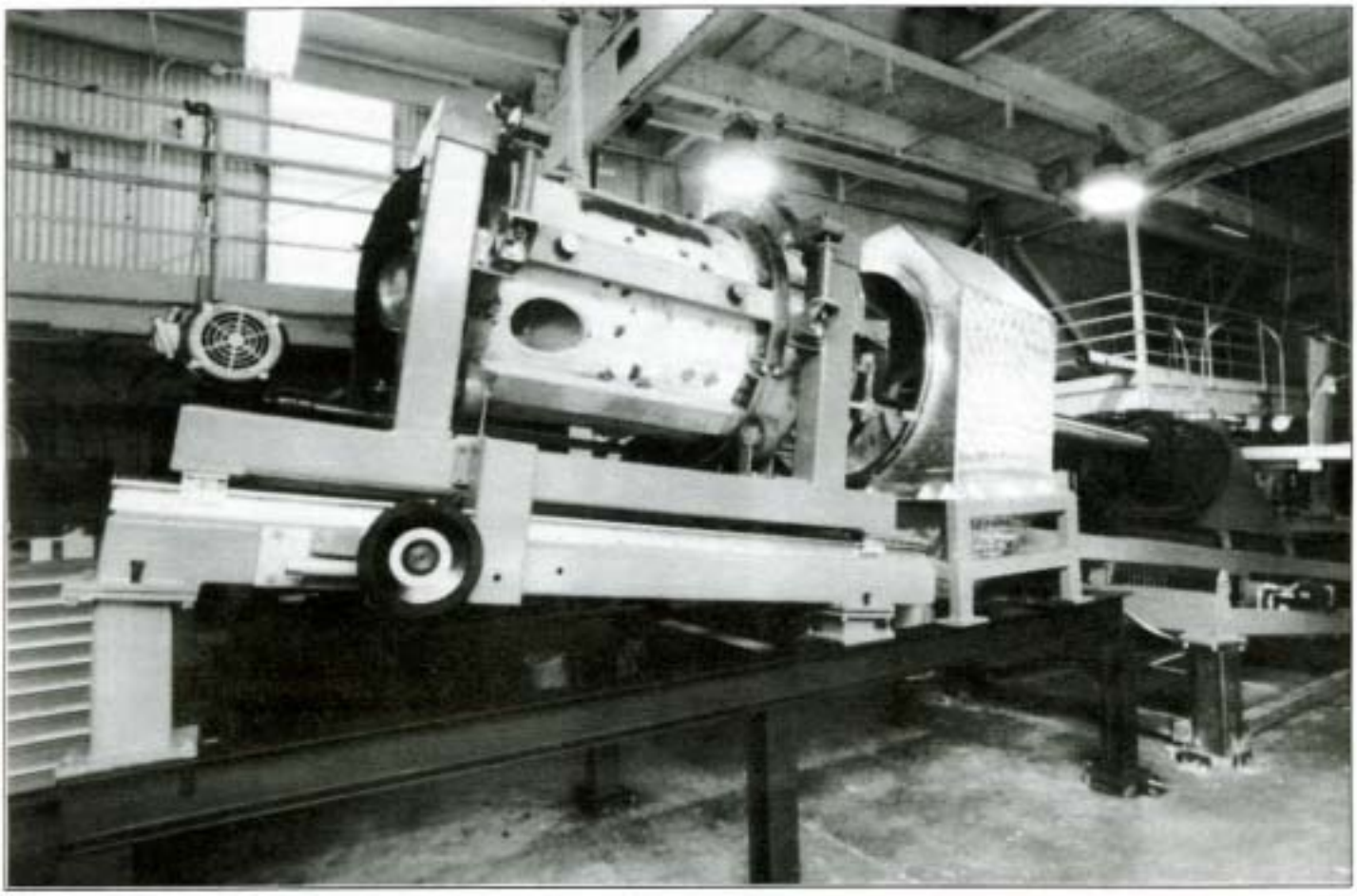

Figure 1. Prototype Cryogenic Washout System for Propellant Removal from Large Rocket Motors. The system is shown undergoing in-factory examination prior to being transported to the field test site. The jetting lance extends from the right and terminates in the rocket motor in the center of the photograph.

A research and development program is underway at Armstrong Laboratory, Tyndall AFB to develop a high-pressure, liquid nitrogen (LN_2) jet washout system for removing propellant from large, Hazard Class 1.1 rocket motors. Large quantities of propellant, requiring disposal, result from aged and off-spec motors, arms control treaties, manufacturing operations, and the conclusion of motor life-cycle. Hazard Class (HC) 1.1 propellant, composed of ammonium perchlorate, HMX, nitroglycerin, nitrocellulose, and aluminum, is complex and difficult to dispose of safely. Processes which use high-pressure water jets have been successfully used on HC 1.3 rocket motors (less complex propellant) for many years. A safe, cost effective propellant removal method has not been developed to date for HC 1.1 motors, currently disposed of by open detonation or static firing methods which have become environmentally unacceptable.

Basics of Hydrodemolition

Andreas Momber of the University of Kentucky, Center of Robotics and Manufacturing Systems, has published in German a handbook of high pressure water jetting techniques with the emphasis on hydrodemolition. This handbook was published in 1993 by Beton-Verlag Gmbh. Its International Standard Book number is ISBN 3-7640-0315-4.

The handbook is 224 pages long. It deals with practical problems in concrete disaggregation. It is addressed to engineers in civil engineering, maintenance, and environmental engineering.

The table of contents are in German and English as are the titles of all tables, figures and photos. It will be a valuable addition to the library of water jetters who read German.

WJTA Administration

Training Water Blast Laborers

***Larry Moers* - Manager of Training**
MPW Industrial Services, Inc.
Hebron, Ohio

It should be common knowledge that the industry's best pumps, hoses, nozzles and peripheral equipment are all valueless until you add one missing ingredient to the mix – an operator who uses the equipment effectively, efficiently and safely. To develop that operator most companies recognize that specific training is necessary.

Indeed, moral issues aside, training of water blast personnel is mandated by the federal government. Section 5(a)(1) of the Occupational Safety and Health Act of 1970 states, "Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees." As soon as it is recognized that the power of a water blast stream can cause serious damage or physical harm, training becomes no longer an option.

To assist in the operator's initial training, companies offering water jetting services are offered a variety of aids, the most common being videos and manuals, and while each of these formats have their place as training media, each also has significant draw backs.

Studies have shown that while many methods can be used to present trainees with information, the amount of information retained varies greatly with the format. (See chart.)

Type of Input	Long Term Retention
Reading	10%
Hearing	20%
Seeing	30%
Discussing	70%
Doing	90%

This indicates that, while manuals are beneficial as technical resources, trainees will forget 90% of what they read in them. Videos are another alternative. They are relatively inexpensive and deliver a consistent message to each and every trainee. Unfortunately, combining both **hearing** and **seeing** a message (as the video format does) will result in retention of only 50% of the information presented. While this is significantly better than using training manuals alone, results will still be far short of the ideal. (If I told my boss that I could guarantee that trainees would remember half of what I have to tell them, I would quickly be looking for a new job.) Again, according to the chart, it seem that for meaningful, long lasting training to occur, trainees must **talk** about concepts such as dangers posed by this equipment, and **experience appropriate procedures** first hand.

(continued on page 10)

Thomas Labus Appointed MSOE Professor

Thomas Labus of Fontana, Wisconsin, has been promoted from associate professor to professor at the Milwaukee School of Engineering (MSOE), announced MSOE Senior Vice president of Academics and Dean of Faculty, Thomas W. Davis.

Thomas Labus joined MSOE in 1990. He earned a bachelor's degree in aeronautical engineering from Purdue University in 1971 and a master's degree in theoretical and applied mechanics from the University of Illinois in 1974. He completed additional work at Northern Illinois University in mathematics and Illinois Institute of Technology in mechanics. Before joining MSOE, he taught at the University of Wisconsin-Parkside.

Labus has over 24 years of industrial experience, including chief engineer for Hydro-line Manufacturing Co., Rockford, IL; engineering manager for EG&G Sealol, Chicago; senior research engineer for IIT Research Institute, Chicago; and project engineer for Sundstrand Corporation, Aviation Division, Rockford. He also has consulted with many industrial companies in the areas of fluid jet technology and fluid power, provided expert witness services in cases involving high pressure equipment, mechanical seals, and fluid dynamics of fluid pumping systems, and has published more than 39 articles.

Labus is a Registered Professional Engineer in Illinois, a member of the American Society of Mechanical Engineers, and vice president and member of the Board of Directors of the Water Jet Technology Association.

Water-Jet Tube Lancing System Cleans Quickly, Effectively

A new, automated waterblast system from **National Liquid Blasting Corporation** (NLB) cleans heat exchanger tubes three times faster than other methods. The NLB Model ATL-3000 is compact, lightweight and easy to set up.

The ATL-3000 uses high-pressure water (up to 15,000 psi) to clear tubes – even bent tubes – of oil, scale, catalyst, minerals, and other deposits. Water flow rates range from 5 to 30 gpm, depending on the lance size and the type of nozzle used. A single operator, using a remote control, runs the entire system.

Three flexible lances are pushed into the tubes at adjustable speeds of from one to four feet per second. They are driven pneumatically, not by water pressure, so 100 percent of the water pressure generated by the high-pressure pump can be used for cleaning. Stroke is also adjustable, up to 29 feet, to suit bundle length. NLB's automated tube lancer features X and Y axis movement to align the lances with the tubes. The unit's versatile design allows it to clean horizontally or vertically. It weighs just 1,500 pounds, so it can easily be transported by trailer or small truck.

For more information, contact NLB Corporation, 29830 Beck Road, Wixom, MI 48393-2824, phone: (810)624-5555, fax: (810)624-0908.

New Ultra-Clean 36® Is 36,000 PSI Water-Jet System

National Liquid Blasting Corporation (NLB) has introduced an ultra-high pressure water-jet cleaning system which delivers pressures of up to 36,000 psi. Low flows (up to 6 gpm) simplify disposal after cleaning. The Ultra-Clean 36 quickly cleans concrete, steel and other surfaces, easily stripping coatings, epoxies, lead paint, and other tough substances. It is equally suitable for heavy-duty equipment cleaning and abrasive cutting applications.

The Ultra-Clean 36® system uses the NLB plunger pump design and the operating and service procedures are the same as for NLB's 10,000 and 20,000 psi pressure pumps.

The unit comes mounted on a heavy-duty steel skid with a sound-attenuating enclosure. It can also be mounted on a trailer for mobile applications. A 200 hp diesel engine drives the triplex plunger pump, while a self-contained 22 cfm air system powers an NLB rotating lance and other accessories. A Gear-Pac drive and on-board water filtration (to six microns) help assure long pump life.

Contact NLB Corporation, 29830 Beck Road, Wixom, MI 48393-2824, phone: (810)624-5555, fax: (810)624-0908.

Liquid Nitrogen Jets Remove Rocket Propellant, from page 1

The use of LN_2 has several advantages over water which include:

1. no secondary waste streams are generated,
2. removed propellant is chemically unaltered, and
3. removed propellant may be destroyed or is suitable for alternative uses.

Having mitigated secondary waste streams, the process remains relatively simple and simplifies the environmental permit process. Since the propellant is unaltered chemically after removal, a suitable destruction or conversion method can be selected or the propellant may be used as a product for an alternative use such as explosives for mining and quarrying operations.

A sub-scale test facility has been used to successfully demonstrate high-pressure LN_2 jet removal of HC 1.1 propellant from a 40 pound analog motor. After three years of testing and process development, a prototype system is under construction at a scale to process a 4000 pound Minuteman II Stage III missile motor. The prime contractor for process development and construction and operation of the prototype system is General Atomics, Inc., La Jolla, California.

The Cryogenic washout process utilizes a motor driven jig for rotating the rocket motor and an x-y table is used to position and advance a single or double nozzle into the rotating motor. The high-pressure LN_2 jet impinges on the propellant, eroding it from the motor case; it is then collected and prepared for disposal. A cryogenic pump, manufactured by ACD, Inc., has been modified to achieve operating conditions of 17,000 to 30,000 psi pressure and 12 gpm flow of liquid nitrogen (-320 °F). The entire removal process is operated and monitored remotely from within a control bunker approximately 500 feet from the facility. The removed propellant, chemically unchanged, is inerted by chemical hydrolysis subsequent to disposal by supercritical water oxidation. A concurrent program is also underway to assess the feasibility of, and the demand for, HC 1.1 propellant for mining and quarrying applications as an alternative to destruction.

The remaining motor case is decontaminated and disposed of in a Resource Conservation and Recovery Act (RCRA) landfill. The entire process is closed-loop and all process streams result in environmentally acceptable discharges. The prototype cryogenic washout equipment will be completed July, 1994 and operational testing completed August, 1995. A Technical Data Package will be produced from which a full-scale process unit or facility may be designed and constructed for processing Air Force large rocket motors.

Rogan and Shanley, Inc.
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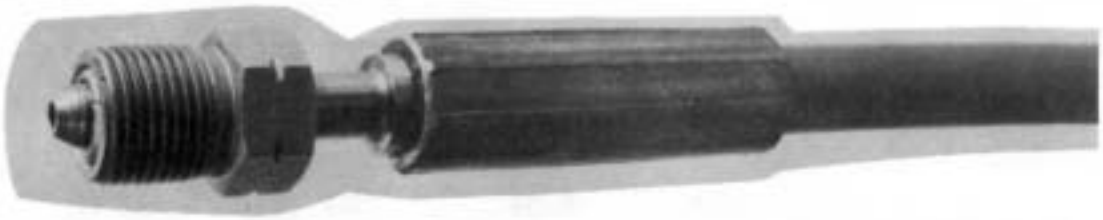
NEW!

Jet Cutting Hose

The new Polyflex 8005St Jet Cutting hose is now in stock and available for immediate delivery!

The new hose features extremely high burst pressure, outstanding fatigue resistance and excellent flexibility, and is highly recommended for extreme pressure applications such as ultra-high water jetting and jet cutting.



The New 8005St Jet Cutting Hose

Specifications

Burst Pressure:	**120,000 psi**
Max. Working Pressure:	**60,000 psi (with shield)**
Standard Working Pressure:	**48,000 psi**
Bore Diameter:	**0.17"**
Outside Diameter:	**0.57"**
Min. Bend Radius:	**12"**
Weight (lb/ft):	**0.35**
End Fittings:	**3/8" and 9/16" HP Tubing Nipples**

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Removing Coatings From Aluminum Vessels

Leeds Industries, Inc., an industrial cleaning and environmental services firm from Elizabethport, New Jersey, removed to bright metal, a 20 mil antifouling coating and scale from a fleet of aluminum survey vessels owned by the U.S. Government. This procedure was in preparation for the application of a new coating that was applied by Leeds. The photograph shows Leeds Industries personnel operating their FLOW Jetpac Quad Ultra High Pressure (35,000 psi) Pumping System at a marine repair facility in Florida.

Previously these vessels had undergone costly plate renewal because of metal loss from past coating removal that utilized grit blasting. Leeds demonstrated to the U.S. Government that coatings can be effectively removed and surfaces properly prepared without costly metal destruction by using water jetting.

Dust free coatings removal on aluminum without costly metal removal.

Spent water and coatings were effectively captured and recycled through Leeds' advanced filtration technologies. Other benefits were greatly reduced grit and spent coating disposal costs. In addition, other coatings applications in the yard were able to continue throughout the water jetting operations. This would not have been possible if grit blasting were used.

New Diverter Valve Allows Alternating Port Selection

A new diverter valve allowing users to alternate the flow of pressurized fluids from one port to another has been developed by **Autoclave Engineers**. This new valve design provides positive shut-off of the opposite port, while incorporating the port selection function into a single valve, where two valves were previously required. The diverter valve will enable companies to save money by reducing the total number of valves required to complete a pressurized fluid system.

Autoclave Engineers' new diverter valve is designed to operate at temperatures from -423° to 650° F and pressures from vacuum to 15,000 psi. This valve line is available in O.D. tube sizes from 1/4" to 1" and a wide variety of corrosion resistant materials. Autoclave Engineers uses metal-to-metal seals to ensure reliable, effective sealing.

This new diverter valve addresses the requirements of nitrogen pumping equipment used in secondary recovery operations within the petroleum industry, as well as high pressure water blasting applications.

For more information, write **Autoclave Engineers Group, 2930 West 22nd Street, Box 5051, Erie, PA 16512 or call (814)838-5700.**

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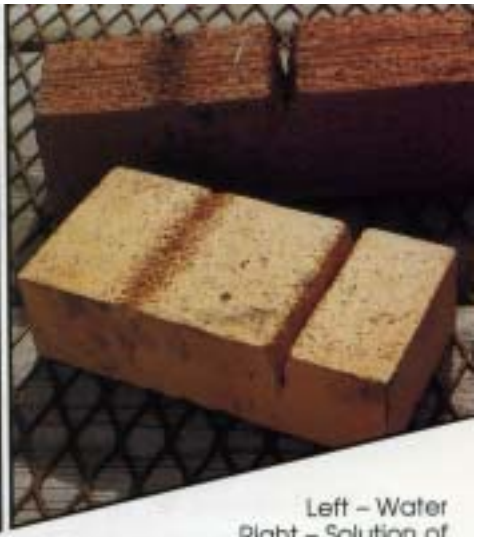

Left – Water
Right – Solution of
0.3% SUPER-WATER®

Top – Water,
Bottom – Solution of
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SUPER-WATER® IMPROVES CLEANING BY 2 TO 50 TIMES[1] SIMILAR IMPROVEMENTS ARE ACHIEVED IN DRILLING, CUTTING AND UNDER SUBMERGED CONDITIONS[2]

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- was first used for cleaning tube- and/or shell-sides of heat exchangers, furnace tubes, evaporators, condensers and reaction vessels.[3]
- more recently has been used to greatly increase performance in abrasive cutting and drilling[4] and for cutting natural, synthetic, silicone and foam rubber.
- dramatically increases cut quality of shoe soles at 50,000 psi with a 15% increase in production rate. Also operating expenses and maintenance costs are reduced, and nozzle life increased by 3 to 6 times.[5]
- is used for cutting/drilling concrete, for cleaning sewers, pipes, and oil-well liners (a fluid-submerged application)[6] and for drilling into oil- and gas-bearing rock formations to a depth of 10,000 feet.
- removed rubber from space shuttle booster motors and sludge (compressive strength 15,000 psi) from Ontario Hydro's nuclear power steam generators.[7]

(References on reverse side.)

IN EACH CASE DOWNTIME WAS REDUCED AND/OR OTHERWISE IMPOSSIBLE JOBS COMPLETED.[8,9]

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Some succeed because they are destined to, most succeed because they are determined to. Do not fear the winds of adversity. Remember: A kite rises against the wind rather than with it.

Flow Introduces New Low Cost X-Y Cutting Tool

Flow International Corporation (FLOW) has introduced the BADGER two-axes shapecutting table. With complete systems available for less than $100,000, the BADGER offers the performance and environmental benefits of an ultrahigh-pressure waterjet in an easy to use, affordable machine.

FLOW designed the BADGER as an user-friendly tool for companies machining large volumes of small parts. No knowledge of machine codes or CNC programming is necessary. Its PC-based 486/66 Mhz controller comes pre-programmed with information on the cutting speeds, flow rates, water pressures and surface qualities required for a wide range of materials. An icon-driven menu further simplifies operation of the machine for the operator.

Users can download DXF files directly to the PC controller. A pre-installed CAD/CAM program enables users to create or revise drawings on-screen. An on-screen help menu provides assistance for programming and troubleshooting.

The standard BADGER package includes a FLOW 5X ultrahigh-pressure 55,000 psi pump, a waterjet or PASER™ abrasive waterjet cutting system and two-axes BADGER X-Y cutting table. Featuring a 2 feet x 3 feet or 2 feet by 1.5 feet work envelope, the BADGER cuts to accuracies of +/-.005 with repeatability of ±.003. The machine's compact frame proves advantageous to companies with smaller facilities. No special foundation is required.

FLOW developed the BADGER for the job shop, marble, stone and glass markets. Other applications for the BADGER include cutting metals, composites, plastics, foam and rubber.

For more information, contact FLOW, 23500 64th Avenue South, Kent Washington 98032, phone: (800)446-3569, fax: (206)813-3285.

Screw Thread Machining Of Composite Rod Using Abrasive Waterjet

Waterjet Lab of the University of Rhode Island

As part of the experimental studies on the water jet machinability of graphite/epoxy composite materials, the Waterjet Research Lab of the University of Rhode Island has recently conducted a feasibility study of screw thread machining of Composite Rods using a high pressure waterjet system. The objective of the study is to determine the feasibility of using an abrasive waterjet to machine high quality, standard dimension screw threads. Experimental trials were performed to identify optimal cutting conditions for machining threads in unidirectional, carbon/epoxy rods. Parameters including traverse speed, crossfeed and nozzle/orifice dimensions were varied and optimal conditions were determined. Scanning electron microscope (SEM) examinations of the machined threads revealed different surface characteristics at different locations along the thread profile. Evidence of several composite failure mechanisms, including fibermatrix interface failure, fiber pullout and fiber failure, was observed. It is concluded that through careful control of the abrasive waterjet machining parameters, high quality screw threads can be obtained.

Screw thread machining of a composite rod.

Overall, the machined thread profile very closely matches a standard ACME thread profile. ACME standard nuts are easily attached and the connection exhibits minimal free play. Future studies are planned in which the strength of the threaded joint is characterized for different thread geometries, tube diameters, and composite lay-ups. It is anticipated that waterjet machined threaded joints will provide an effective joining method for composite tubing components in a variety of applications.

Abrasive Waterjet Machined Graphite Composite Screw Thread

Nozzle/Orifice 0.1016/0.0381 cm Traverse .254 cm/sec Crossfeed 0.33 cm Angular Speed 1 rev/sec

Training Water Blast Laborers, from page 2

At **MPW Industrial Services Inc.**, a large industrial cleaning firm covering the Eastern United States, our training program for certifying water blast laborers (dubbed H.O.S.T. - Hands On Skills Training) consists of just that. We begin with class room training to discuss safety concerns – the destructive power of a water stream, mandatory personal protective equipment, safety concerns relating to water blasting in general, and then specifically to water blasting or lancing. We use colored overheads where applicable to reinforce points. We use marker boards to document and discuss these important issues.

Trainees are shown (via overheads) typical water blast set ups. We discuss issues ranging from respect for equipment to emergency procedures and necessary medical specialists to care for water blast injuries. Finally, we leave the classroom and proceed with the hands-on portion of the training.

Hands-on training begins with a tour of our parts facility where the differences in hoses, nozzles, guns, foot pedals and other peripheral equipment are **demonstrated and discussed**. Then, it's on to the training area where trainees (under supervision) gather necessary equipment, set up the water blast job, and finally, gun-to-shoulder, experience what water jetting is all about.

It is only in this way that the trainee can be properly prepared for his first true job experience. As the trainee pulls onto his first customer site, he may not know exactly what an evaporator, or condenser or economizer may be, but he does know what happens when the system comes up to pressure and he is asked to perform the service that he is there to offer.

Corollary issues of proper training site set up, trainer procedures and documentation issues will be discussed in a future issue.