WJTA Jet News

WaterJet Technology Association

APRIL 2005

Published by the WaterJet Technology Association for the benefit of its members

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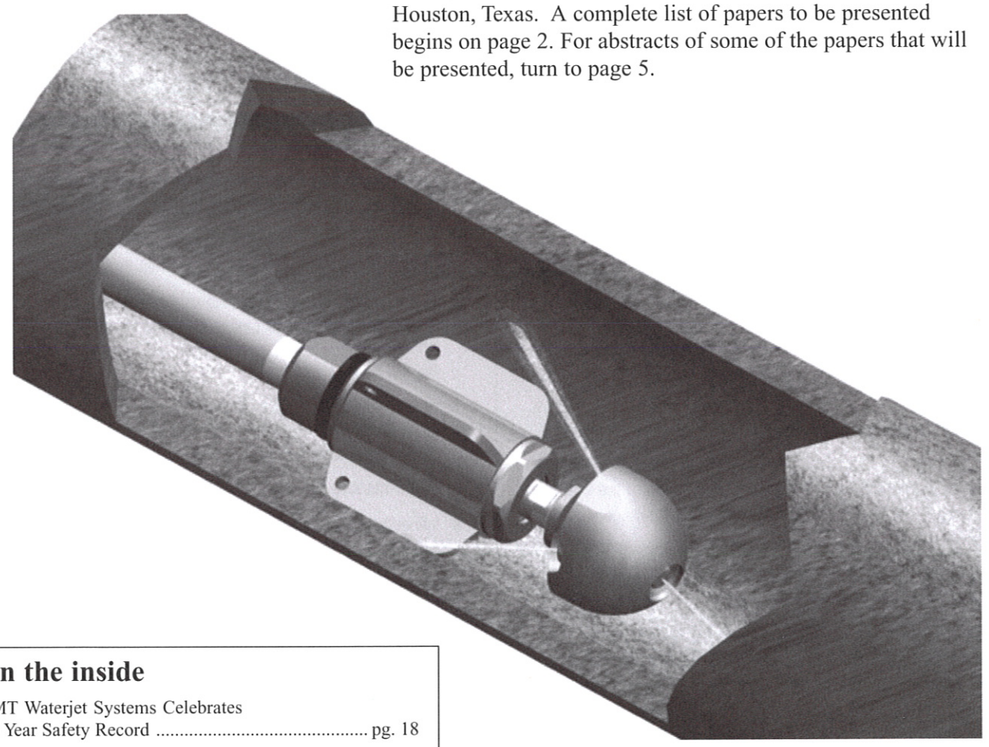
Safe Waterjet Cleaning Of Sewer Pipe

"Safe Waterjet Cleaning Of Sewer Pipe" is one of many papers that will be presented at the 2005 WJTA American Waterjet Conference. The Conference will be held on August 21-23, 2005 at the Marriott Houston Westchase Hotel in Houston, Texas. A complete list of papers to be presented begins on page 2. For abstracts of some of the papers that will be presented, turn to page 5.



On the inside

WJTA 2005 American Waterjet Conference August 21-23, 2005

Papers To Be Presented At The WJTA 2005 American Waterjet Conference

August 21-23, 2005, Marriott Westchase Hotel, Houston, Texas

- A Two-Dimensional Cellular Automata Model of Abrasive Water Jet Cutting, Henri Orbanic and Mihael Junkar
- Abrasive-Entrained Forced Pulsed Waterjet: Basic Study, Mohan Vijay
- Abrasive Waterjet Cutting Beyond 400 Mpa, T. Susuzlu, A.M. Hoogstrate and B. Karpuschewski
- Abrasive Waterjet Cutting in Orthopedic Surgery – A Report About In-Vitro and In-Vivo Studies, F. Pude, H. Louis, C. Biskup, L. Kirsch, M. Honl, K. Schwieger, S. Schmolke, S. Krömer, and A. Andreae
- Abrasive Waterjet Cutting of Microelectronic Components, Mohamed Hashish
- Accurate Hole Drilling Using an Abrasive Water Jet in Titanium, S. Zhang, P. Nanbiath, G. Galecki, D.A. Summers and D. Bowden
- Advanced Component AWJ Machining Using a Rotating Axis Motion Control, Gustav Holmqvist and Ulf Andersson
- An Experimental Study on Dual-Jet Flow with PIV Method, Gensheng Li, Jian Song, Jilei Niu, Zongwei Huang and Can Yi
- Analysis of the Abrasive Waterjet Drilling Process Models, M. Ramulu, I. Conner, P. Posinasetti and M. Hashish
- Analysis of the Cutting Front in Abrasive Waterjet Cutting, Axel Henning and Engelbert Westkämper
- Analytical Characterization of Flash Rust Formed on Carbon Steel After UHP Waterjetting, Moavin Islam, Wayne McGaulley and Mike Evans
- Application of Cutting Edge Studies to Prediction of Abrasive Jet Cutting Efficiency and Quality, Libor M. Hlavác, Jan Valícek, Vilém Mádr and Eva Janurová
- Application of Ice Powder in Biomedical and Food Industries, K. Kluz and E.S. Geskin
- Application of Numerical Techniques for Optimization of the Water Cannon Design, O.P. Petrenko, T. Bitadze, E.S. Geskin, O. Rusanova and A.N. Semko
- Application of Waterjet to Soil Remediation, A. Bortolussi, R. Ciccu, M. Cigagna, B. Grosso and P. Tronci
- Autofrettage – Basic Information and Practical Application on Components for Waterjet Cutting, Franz Trieb, Johannes Schedelmaier and Manfred Poelzl
- Brazilian Focus Tubes and Abrasives Research on Rock Cutting in AWJ Systems, Wildor Theodoro Hennies, Carlos Tadeu Lauand, Amilton Sinatora and Jean Carlo C. de Paola
- Concrete Surface Preparation, Todd Shawver
- Controlled HVOF Hard Coatings Removal Method, Kimmo Ruusuvuori, Kari Lahdenperä, Maria Oksa, Erja Turunen, Juha Kauppila and Marcel van Wonderen
- Cutting Capability Equation of ASJ, Shan Jiang, Ross Popescu, Clarence Tamargo, Frank Magana, Doug Battaglia and Kim Tan
- Desulfurization of Coal Based on High Pressure Water Jet Comminution, Weili Gong, Longlian Cui and Liqian An
- Determination of Abrasive Particle Velocity Using Laser-Induced Fluorescence and Particle Tracking Methods in Abrasive Water Jets, Basil Zweifel, Kurt C. Heiniger, Stephan Bühler, Patrick Coray, Reto Kägi and Dominik Sommer
- Development of a Detecting and Demining Vehicle, Katsuhiko Shimizu, Ken Ishiryu and Hiroshi Katakura
- Economics of Abrasive –Waterjet Cutting at 600 MPA Pressure, Mohamed Hashish
- Effects of Polymeric and Surfactant Additives on Waterjet Performance, M. Annoni, M. Monno and V. Bertola
- Estimation of Abrasive Mass Flow Rate by Measuring Feed Line Vacuum During Jet On-Off Cycling, M. Ramulu and I. Conner
- Experimental Analysis of the Spatial and Temporal Fluctuations in a Cavitating Water Jet, Charles Fairfield and Scott Campbell
- Experiments with Fluids in Magnetohydrodynamic Channel, Libor M. Hlavác and Irena M. Hlavácová
- Flexible and Mobile Abrasive Waterjet Cutting System for Dismantling Applications, Hartmut Louis, Dirk Peter, Frank Pude and Ralf Versemann
- Genetically Evolved Artifcial Neural Networks Built with Sparse Data for Predicting Depth of Cut in Abrasive Water Jet Cutting, D.S. Srinivasu, N. Ramesh Babu, Y.G. Srinivasa, Hartmut Louis, Dirk Peter and Ralf Versemann
- High Precision and High Power ASJ Singulations for Semiconductor Manufacturing, Shan Jiang, Ross Popescu, Clarence Tamargo, Frank Magana, Doug Battaglia and Kim Tan
- High Pressure Pumps & Systems, Michael T. Gracey
- Influence of Rotational Water Jet Kinematics on Effectiveness of Flat Surface Treatment, Przemyslaw Borkowski
- Innovative Jetbased Material Processing Technology, V. Samardzic, O.P. Petrenko, E.S. Geskin, G.A. Atanov, A.N. Semko and A. Kovaliov
- Investigation of the Effect of Fluid Compressibility on the Formation of the Impulsive Jets, O.P. Petrenko, E.S. Geskin and A.N. Semko
- Medical Applications of the High Powered Parallel Waterjet, Mark Granick, Ramazi Datiashvili and Parham Ganchi
- New Abrasive Waterjet Systems to Compete with Laser Machining Systems, Don Miller
- New Results of Underwater Rock Cutting by Pure Waterjet, Libor M. Hlavác, Milena Kušnerová, Vilém Mádr and Richard Dvorský

(continued on page 4)

2005 WJTA Conference Registration Form

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Join the WaterJet Technology Association now and receive a substantial discount off Conference registration fees.

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❑ **OPTIONAL TRIP** to NASA's Johnson Center	$ 30	$ 30	$ 30	$ 30	= $ _____

Seven Ways To Register

❑ **Full Conference** ONLY	$ 495	$ 555	$ 555	$ 615	= $ _____
❑ **Combo** (Full Conference PLUS Pre-Conference Workshop)	$ 665	$ 725	$ 725	$ 785	= $ _____
❑ **Daily**					
❑ Sunday - Pre-Conference Workshop (includes lunch)	$ 280	$ 340	$ 340	$ 400	= $ _____
❑ Monday (includes Luncheon in Exhibit Hall)	$ 265	$ 295	$ 295	$ 325	= $ _____
❑ Tuesday (includes Luncheon in Exhibit Hall)	$ 265	$ 295	$ 295	$ 325	= $ _____
❑ **Exhibit Hall/Live Demo Pass**					
❑ Monday (does NOT include Luncheon in Exhibit Hall)	$ 25	$ 25	$ 25	$ 25	= $ _____
❑ Tuesday (does NOT include Luncheon in Exhibit Hall)	$ 25	$ 25	$ 25	$ 25	= $ _____
❑ **Student** (WJTA members ONLY)	$ 20	$ 20	N/A	N/A	= $ _____

MULTIPLE CORPORATE REGISTRATIONS (Applies to third and subsequent registrants from same company)

❑ **Full Conference** ONLY	$ 445	$ 505	$ 505	$ 565	= $ _____
❑ **Combo** (Full Conference PLUS Preconference Seminar)	$ 615	$ 675	$ 675	$ 735	= $ _____

WJTA MEMBERSHIP (US, Mexico, Canada)	❑ $60 Individual	❑ $20 Student	❑ $400 Corporate	= $ _____
WJTA MEMBERSHIP - International (all other countries)	❑ $80 Individual	❑ $40 Student	❑ $460 Corporate	= $ _____

❑ **Conference Proceedings** ____ Copies x $89.00 = $ _____
2005 WJTA Conference registrants may purchase extra copies of the Conference *Proceedings* on CD-ROM for only $89. Regularly priced at $109, you will **SAVE $20. Offer valid through 8/31/05.**

SPECIAL OFFER!

→ **EXTRA TICKETS** — The Full and Combo registrations include one ticket per registration for the Exhibit Hall Luncheons (Monday and Tuesday), Welcoming Reception in Exhibit Hall (Sunday evening) and Awards Presentation/Party (Monday evening). Each Daily registration includes a luncheon ticket for the day registered: Sunday, Monday and/or Tuesday. Sunday daily includes Welcoming Reception in Exhibit Hall. Additional tickets may be purchased as follows:

❑ **Welcoming Reception in Exhibit Hall** - Sunday	$ 60	$ 60	$ 60	$ 60	= $ _____
❑ **Luncheon in Exhibit Hall** - Monday or Tuesday or both ($70)	$ 35	$ 35	$ 35	$ 35	= $ _____
❑ **WJTA Awards Presentation/Party** - Monday	$ 75	$ 75	$ 75	$ 75	= $ _____

TOTAL ENCLOSED $ _____

Seven Easy Ways To Attend The 2005 Waterjet Conference

1. FULL CONFERENCE

Includes admission to all research and applications sessions (except Pre-Conference Workshop on Sunday, August 21), onsite live demonstrations, pass to Welcoming Reception in Exhibit Hall (Sunday, August 21), exhibits, luncheon on Monday, August 22, and Tuesday, August 23, coffee breaks, and WJTA Party on Monday, August 22. **Each full registration also receives one copy of the Conference *Proceedings* on CD-ROM.**

2. COMBO

Includes everything listed under Full Conference **PLUS** a Pre-Conference Workshop on Sunday, August 21.

3. SAVE $ ON MULTIPLE EMPLOYEE FULL/COMBO REGISTRATIONS

Companies that purchase three or more full or combo registrations receive a special discount for each additional employee registered after the first two. To take advantage of the special discount, register the first two (2) employees from your company at the regular FULL/COMBO rates and receive the discounted rate for the third and subsequent employee registrations.

4. DAILY ATTENDANCE

Includes admission to all research and applications sessions, onsite live demonstrations, exhibit hall, coffee breaks, and luncheon on that day. Register for one day and receive a "50% off" coupon for the *2005 Conference Proceedings* on CD-ROM. Register for two days and the *Proceedings* are included. **NOTE:** Admission to the WJTA Party on Monday is **NOT** included in the daily registration fee, and tickets for this event must be purchased separately.

5. PRE-CONFERENCE WORKSHOP

Waterjet Technology - Basics and Beyond

Includes handout materials for workshop, coffee breaks, luncheon, and August 21 Welcoming Reception in Exhibit Hall.

6. EXHIBIT HALL and/or LIVE DEMO PASS

A $25 exhibit hall and/or live demonstration pass for one day includes admission to the WJTA Exhibit Hall where you'll see waterjet equipment, supplies, and services, onsite live demonstrations between the hours of 8:00 a.m.-10:00 a.m., and designated contractor programs. Passes do **NOT** include luncheon in the exhibit hall. Tickets for lunch can be purchased separately.

You must purchase a ticket to attend the Welcoming Reception in the Exhibit Hall on Sunday, August 21, if you are not registered as a Full or Combo, or you are not registered for the Pre-Conference Workshop.

7. STUDENTS

The registration fee for WJTA student members is $20. Student registration includes admittance to technical programs, onsite live demonstrations, and the exhibit hall on Monday and Tuesday, but does **NOT** include copies of the *Proceedings*, Welcoming Reception in Exhibit Hall on Sunday, August 21, or admittance to any food/social functions. **NO** discount is available for students that are not members of the WJTA. WJTA student members must be enrolled **full-time** in a university graduate or undergraduate program.

CANCELLATION POLICY

Fees will be refunded in full for cancellations received at least four weeks prior to the Conference. Cancellations received more than 10 days and less than four weeks prior to the Conference will be subject to a $50 charge. No refund will be made for cancellations received less than 10 days prior to the Conference. However, substitutions may be made at anytime. Refunds will not be processed until after the Conference.

WJTA members and early-bird registrants SAVE up to $120!

WJTA members receive a special discount off the regular registration fees. You will also receive a discount if your registration is postmarked or received in the WJTA office by **August 1, 2005**. Total Savings: Up to $120!

OPTIONAL TRIP - NASA'S JOHNSON SPACE CENTER

An optional trip to NASA's Johnson Space Center is scheduled for Saturday, August 20, from 9:30 a.m.-4:30 p.m. Buses will begin boarding a half-hour prior to departure times listed. Trip includes bus transportation, entrance to the space center and 1-1/2 hour tram tour. Lunch is not included and will be on your own.

2005 WJTA AMERICAN WATERJET CONFERENCE PROCEEDINGS

The *Conference Proceedings* for 2005 will be on CD-ROM only. The two-volume books that were available in past years will not be produced.

Hotel Reservations

It's not too early to make hotel reservations for the 2005 WJTA American Waterjet Conference to be held August 21-23, 2005, at the Marriott Houston Westchase Hotel, Houston, Texas, USA. For room reservations call the Marriott toll free at (800)228-9290 or direct at (713)978-7400. Be sure to identify yourself as a participant in the WJTA Conference.

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Papers To Be Presented At The WJTA 2005 American Waterjet Conference, from page 2

- New Tungsten Carbide Material with Nanoscale Grain Size for Focusing Tubes, Laurent Bourgeois and Rolf Koesters
- Numeric Simulation of Ultra-High Pressure Rotary Atomizing Waterjet Flow Field, S. X. Xue, J.Y. Li, H.J. Peng, Z.W. Chen and Y.Q. Wang
- Numerical Simulation and Flow Analysis of Submerged Abrasive Waterjet, Yu-Feng Yang, Shou-Gen Hu, Zong-Long Wang
- Off Shore Washdown Pump Unit: A Manufacturing Case Study, Weimin Dai and Michael T. Gracey
- On the Residual Energy for Cutting Plastic Materials with Abrasive Water Injection Jet, Chuwen Guo, Hiroshi Katakura and Lang Liu
- Porous Liquid Mixing Tube (PLMT) Retro-Fit, Joseph P. Katz and John B. Murphy
- Prediction of a Single Impact Crater Shape in AWJ Machining Using FEA, M. Junkar, M. Grah and B. Jurisevic
- Research on Ultrafine Comminution of Minerals by Thermally Assisted High Pressure Water Jet, Fu Sheng, Li Hong and Shi Zhaoyao
- Rock Drilling with Abrasive Suspension Swirling Jet and Effects of Additive Polyacrylamide, Yongyin Yang, Zhonghou Sheng, Ruihe Wang and Weidong Zhou
- Safe Waterjet Cleaning of Sewer Pipe, Doug Wright, John Wolgamott and Jerry Zink
- Safe Waterjet Cleaning of Steel Process Lines, Doug Wright, John Wolgamott and Jerry Zink
- Strategies for Cost- and Time-Effective Use of Abrasive Waterjet Cutting, Ulf Andersson and Gustav Holmqvist
- Strategies for Introducing New Abrasive Waterjet Technologies, Don Miller
- Study of Inherent Frequency of Helmholtz Resonator, Weili Gong, Longlian Cui and Liqian An
- Study on the Temperature Distributions of Water Jet By Infrared Thermal Testing and Image Processing Technology, Weili Gong, Longlian Cui and Liqian An
- Taper-Free Abrasive Waterjet Cutting with a Tilting Head, Jay Zeng, John Olsen, Carl Olsen and Brian Guglielmetti
- The Effectiveness of Hydroabrasive, Suspensive Waterjet Cutting of Rocks, Andrzej Perec
- The Efficiency Analysis of Rotating Nozzle with Handheld on Flat Surface Cleaning Work, Zhou Den and Wang Qingguo
- The Experimental Study on Eroding Properties of Submerged Abrasive Low Pressure Waterjet, Zong-Long Wang, Shou-Gen Hu, Yu-Feng Yang
- The Influence of the Pressure Fluctuations and the Cutting Head Vibrations on the Kerf Realized by AWJ, H. Louis, M. Monno, C. Ravasio and C. Scheer
- Waterjet Cutting Beyond 400 MPa, T. Susuzlu, A.M. Hoogstrate and B. Karpuschewski
- Windows-Based Process Monitoring of Abrasive Waterjet Shape Cutting, M. Ramulu, I. Conner and P. Liu

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		WJTA Member Price	Non Member Price	Shipping & Handling	
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____	**Proceedings Book & CD-ROM of The 2001 WJTA American Waterjet Conference** (2001)	@ $ 10.00	$ 30.00	$ 8.00	= $_____
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____	**An Overview of Waterjet Fundamentals And Applications,** Fifth Edition (2001)	@ $ 55.00	$ 70.00	$ 8.00	= $_____
____	**An Overview of Waterjet Fundamentals And Applications** 8/17/03 PowerPoint presentations in printed format	@ $ 30.00	$ 35.00	$ 8.00	= $_____

Minimum charge of $8 per order. $8 for 1-3 sets; $16 for 4-7 sets; for 8 or more sets, contact the WJTA office.

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1 - 10 copies	_____ # of copies	x $ 5.00 ea.	$ 10.00 ea.		= $_____
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Instructions: Complete sections below and submit a narrative (300-word maximum) to support your nomination on a separate sheet of paper. Please print or type all information.

I nominate the following company, organization, or person as a candidate to receive a 2005 WJTA Award (please print or type full individual, company or organization name):

_____

company, organization, or person

❒ Distinguished Pioneer Award

The nominee must:

- Have made contributions to the waterjet industry;
- Have made contributions to the achievement of the goals of WJTA;
- Have high moral character;
- Have strong personal and business ethics;
- Be dedicated to the future of the waterjet industry and to the growth of WJTA.

❒ Service Award

How has the nominated company, organization or individual contributed in time and talent toward improvement in the WaterJet Technology Association?

❒ Technology Award

What has the nominated company, organization or individual done to introduce new and innovative ideas in engineering or manufacturing? This could include, but is not limited to, new products, new manufacturing techniques, patents . . . any unique activity that advanced the technology of the waterjet industry.

❒ Safety Award

What has the nominated company, organization or individual done to introduce new and innovative ideas in safety? This could include, but is not limited to new products, new concepts, new safety techniques . . . any unique activity which increases the overall safety of waterjet equipment.

CANDIDATE: _____ Company: _____

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Nominations must be received no later than July 2, 2005.

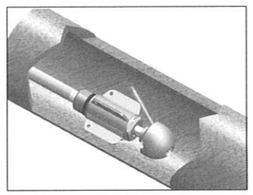
For a prompt response, fax completed form to (314)241-1449, or mail to the WJTA, 906 Olive Street, Suite 1200, St. Louis, MO 63101-1434, USA.

Abstracts Of Papers To Be Presented At The American Waterjet Conference

Safe Waterjet Cleaning Of Sewer Pipe

D. Wright, J. Wolgamott and G. Zink
StoneAge, Inc.
Durango, Colorado, USA

Sewer lines are commonly cleaned using waterjet systems with pressures up to 6000 psi. There is a risk of damaging these lines depending on operating parameters and pipe material. Sewer and drain line systems

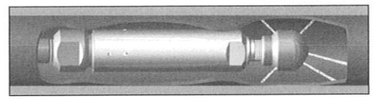


can be composed of vitrified clay, PVC, cast iron, or concrete. Vitrified clay pipe has been in use for sewer and storm drains since before 1900. PVC pipe came into widespread use in the late 1960s and early 1970s, and is being used for many current installations. Other materials such as fiberglass/epoxy resins and HDPE are being used in rehabilitation of old lines. The purpose of these tests was to determine waterjet operating parameters below which no damage would be caused to vitrified clay pipe or PVC pipe, two of the most common materials, as well as HDPE, a material used for slip lining of existing pipes.

Safe Waterjet Cleaning Of Steel Process Lines

D. Wright, J. Wolgamott and G. Zink
StoneAge, Inc.
Durango, Colorado, USA

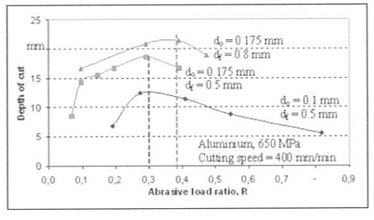
Steel process lines and tubes are commonly cleaned using waterjet systems with pressures up to 40,000 psi. There is a risk of damaging these



lines depending on operating parameters such as jet pressure, angle, rotation and rate of traverse. These lines vary from small diameter heat exchanger tubes to larger pipes. The highest energy concentrations with greatest risk typically occur in the small diameter tubes. Testing was performed to identify the operating parameters below which no damage would be caused to steel process lines.

Abrasive Waterjet Cutting Beyond 400 MPa

A.M. Hoogstrate, T. Susuzlu and B. Karpuschewski
Delft University of Technology, PMA, Laboratory for Precision Manufacturing and Assembly
The Netherlands



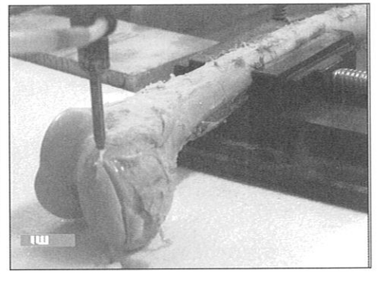
This paper discusses the abrasive waterjet cutting (AWJ) beyond 400 MPa (=4000 bar), which is the pressure limit of the most of the waterjet cutting systems. AWJ cutting process is well-established up to 400 MPa. Many cutting models were developed based on different principles, and they are validated by the cutting data generated at the current pressure limits. Various researches were also published about the selection of cutting process parameters. In this study, validity of the previous cutting models were tested up to 700 MPa and the process parameters were adjusted to the higher pressures. The abrasive consumption was discussed in detail.

It as figured out that the available cutting models are capable of describing the cutting process beyond 400 MPa. Optimum abrasive flow rate increases as the pressure increases to keep the abrasive load ratio constant. It is also possible to reduce the abrasive usage around 50% while maintaining the cutting speed and the surface roughness. The cutting speed does not increase at the same order as it does at the plain waterjet.

Abrasive Waterjet Cutting in Orthopedic Surgery – A Report About In-Vitro and In-Vivo Studies

F. Pude, H. Louis, C. Biskup, L. Kirsch, M. Honl, K. Schwieger, S. Schmolke, S. Krömer and A. Andreae

The use of waterjets for medical applications is well established since *Papachristou et al.* published their first results in 1982 on the use of a waterjet scalpel for cutting of liver tissue. In the last twenty years more and more medical disciplines found out a beneficial use on this innovative tool. Nevertheless in medicine the waterjet



(continued on page 6)

Abstracts Of Papers To Be Presented At The American Waterjet Conference, from page 5

technology is actually limited to soft tissue cutting. The pure waterjet has not the cutting performance to be applied on biological hard tissue (bone, teeth).

In the last five years there have been intensive research activities on the use of abrasive waterjets at the Centre of Biomedical Engineering at University of Hannover, Germany. With partners from Technical University Hamburg-Harburg various projects with the goal to develop the abrasive waterjet to a tool for orthopedic surgeons have been undertaken. This includes biophysical experiments on the interaction of biocompatible abrasives (e.g. sugar) and somatic cells.

In this paper results out of two projects will be presented.

- Cutting (removing) of bone cement for the use in hip prostheses revision surgery,
- Cutting of femoral bone for generating an osseous endo-prosthesis interface at the knee.

In March 2003 the worldwide first in-vivo application of abrasive waterjets for cutting of bone took place at School of Veterinary Medicine in Hannover. The results regarding the operation risk due to possible embolism phenomena will also be discussed in this paper.

Abrasive Waterjet Cutting of Microelectronic Components

Mohamed Hashish
Flow International Corporation
Kent, WA

Abrasive waterjets were used to cut and singulate electronic chips such as those used for flash memory cards found in digital cameras, cell phones, and USB storage devices. Cutting these components require high cutting speed, high edge quality, accuracy, and precision. For example, a minimal accuracy needed is about 0.1-mm and a minimum C_{pk} of 1.33.

A relatively small AWJ (~ 0.4 mm) was successfully used to accurately cut chips at speeds of 20 mm/s to 60 mm/s. It was determined that the use of machine vision is critical to meeting the accuracy requirements. The cutting process consisted of piercing starting holes and then cutting shaped pattern cuts to contour the chip components. Drilling holes was performed without delamination and the cutting speed was optimized to meet the intricate chip geometry.

Because of the relatively high volume of components to be cut, requiring around the clock duty, process and machine reliability are of critical importance. This paper discusses the results and observation of the cutting process as well as the performance of the high pressure components.

Advanced Component AWJ Machining Using A Rotating Axis Motion Control

Gustav Holmqvist and Ulf Andersson
Chalmers University of Technology
Department of Materials and Manufacturing Engineering
Göteborg, Sweden

In this paper the use of a 4-axis motion control in which one axis is a rotating B-axis is discussed. The B-axis is in this case defined as an axis with rotation around an axis linear with the y-axis and controlling the motion of the work-piece. This type of motion control has for many cutting technologies, including abrasive waterjet machining, traditionally been used for machining of tubes. Operations then include making of holes and cutting-off of tubes.

In the paper is discussed manufacturing of solid parts from a bulk piece of material fixtured in a chuck. Different applications, including an industrial application will be presented in the paper. Operations include indexing the part using the B-axis, machining the part from different angles. Also is presented the possibility of producing curved surfaces continuously rotating the B-axis at a certain rotational speed. Surface characteristics are presented in the paper. An interesting aspect of the curved surfaces produced is that they can show the lowest striation amplitude in the mid-section of the surface.

The advantages of manipulating the work-piece in the manner described, instead of the nozzle, are discussed outgoing from practical experiences as well as from theoretical considerations. A difficulty in this type of

(continued on page 7)

WJTA Conference Sponsors

(sponsor list as of April 11, 2005)

Barton Mines Company, LLC
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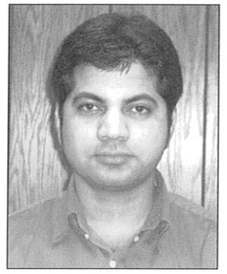
High Pressure Equipment
Jetstream of Houston, LLP
Parker Polyflex
Universal Minerals
VLN Advanced Technologies Inc.

Federal Signal EPG Names Nayanar As Industrial Product Manager

Federal Signal Environmental Products Group (EPG) is pleased to announce the hiring of Deepesh Nayanar as Industrial Product Manager. Nayanar will be responsible for the Guzzler industrial vacuum and Vactor HXX hydroexcavator product lines.



Deepesh Nayanar

With multiple years of experience, Nayanar has worked at Mahindra & Mahindra in strategy and product management, OSBI Consulting as the director for strategic initiatives and at the University of Illinois as a technology commercialization analyst.

Nayanar holds a B.S. degree in Engineering from the University of Pune and a Master of Management Studies from the University of Bombay, both in India. He also has a Master of Business Administration from the University of Illinois.

The Federal Signal Environmental Products Group includes Elgin Sweeper, Guzzler Manufacturing, Leach, Jetstream and Vactor Manufacturing. Federal Signal Corporation is listed on the New York Stock Exchange under the symbol FSS.

For more information, visit Federal Signal at www.federalsignal.com.

Waterjet Cutting Techniques Course, May 15-17, 2005

RICHEL, Inc. has scheduled two Waterjet Cutting Techniques Courses at is corporate offices in Kent, Ohio. The courses will be held Sunday-Tuesday, May 15-17, and Sunday-Tuesday, July 17-19.

All existing waterjet operators and owners will want to attend as well as anyone looking to buy or install a system but is not sure if waterjet is the solution for the application. RICHEL, Inc. is the world leader in the field of reselling used waterjet equipment, which is more accessible as the industry matures. Learn what one needs to keep up with the changes in hardware and software.

Richard Ward, instructor of the Waterjet Cutting Techniques Course

Many practical solutions to standard issues are discussed throughout the course with other attendees who operate various models of waterjetting equipment. Attendees will strip and rebuild an intensifier in our shop; discover the advantages of multiple head cutting along with when and when not to use multiple heads; prepare and program a job for waterjet cutting (raster to vector conversion and CAD/CAM); find shortcuts to make the cutting process easier and more efficient; physically run a waterjet system (loading a program, clamping and fixturing, changing nozzles and orifices) and perform general maintenance on the machine.

To register call **330-677-9100** or e-mail **richel@richel.com**. The instructor, Richard Ward, is a professional engineer who has specialized in waterjet cutting since 1992. He has conducted over 40 seminars worldwide on waterjet cutting and has authored dozens of articles for publication.

Abstracts Of Papers To Be Presented At The American Waterjet Conference, from page 6

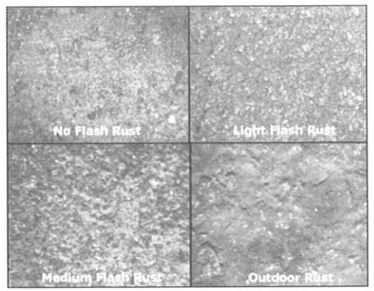
machining is the accessibility of the jet which can require a larger stand-off distance than normally used. This aspect is investigated experimentally in the paper.

The manufacturing preparation for complex parts is discussed. A CAM postprocessor for the mentioned waterjet machine configuration has been developed. Experiences from this development as well as the practical use of the CAM software and the postprocessor are discussed briefly in the paper.

Analytical Characterization Of Flash Rust Formed On Carbon Steel After UHP Waterjetting

Moavin Islam and Wayne McGaulley
Corrpro Companies, Inc.
Washington, DC

Mike Evans
NAVSEA 05M1
Washington, DC



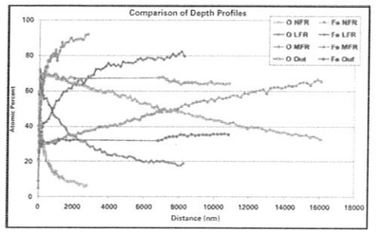
Low Magnification (x16) Optical Micrographs of Flash Rusted Surfaces after UHP Waterjetting and Outdoor Rusted Surface

It is well established that when steel components are cleaned by high-pressure (HP) or ultra high pressure (UHP) water jetting the surface begins to oxidize or 'flash rust' within a short period of time. Rusting per se is also observed after mechanical cleaning (abrasive blasting) of steel surfaces. However, it has been postulated that the rusting observed with the two cleaning methods are 'different' in nature.

There seems to be a paucity of data regarding the exact composition of flash rust formed subsequent to waterjetting. The present paper provides results of an in-depth investigation dealing with the composition, the thickness and other characteristics of the flash rust formed on steel

(continued on page 8)

Abstracts Of Papers To Be Presented At The American Waterjet Conference, from page 7



X-ray Photon Spectroscopic (XPS) Analysis of Flash Rusted and Outdoor Rusted Surfaces

surfaces after water jetting. Three levels of flash rusting; no flash rust (NFR), light flash rust (LFR), and moderate flash rust (MFR) were examined, using different surface analytical techniques. These included: (a) SEM examination to characterize the morphology of the oxide, (b) EDAX analysis to determine elemental composition of the specimen surface, (c) XPS (or ESCA) analysis to obtain quantitative information about the composition and depth profile of the oxide layer, and (d) Raman Spectroscopy for characterizing the type of oxide. For comparison, an atmospherically corroded steel sample was also analyzed using the same techniques.

Based on XPS and Raman Spectroscopy data the composition of the oxide film on flash rusted samples is a complex mixture of different forms of stoichiometric and non-stoichiometric oxides of iron but mainly FeO, Fe_2O_3, Fe_3O_4, hydrated Fe_3O_4 and FeOOH. Based on the depth profile data, the approximate average oxide thickness as found to be 473 nm (0.5 µm) for the NFR specimen, 2398 nm (2.4 µm) for the LFR specimen, and 18209 nm (18.2 µm) for the MFR specimen. The oxide on the atmospherically corroded sample is of a similar composition but different distribution and proportion.

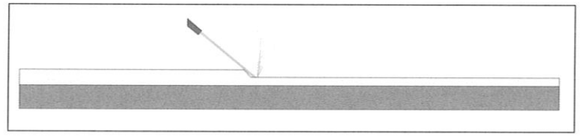
Controlled HVOF Hard Coatings Removal Method

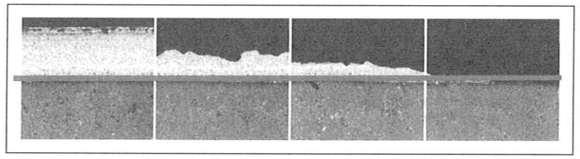
K. Ruusuvuori, K. Lahdenperä,
M. Oksa and E. Turunen
VTT Industrial Systems
Espoo, Finland

J. Kauppila
HT Lasertekniikka
Tampere, Finland

M. van Wonderen
KLM
Amsterdam, Netherlands

There is an increasing demand for recoating of the most expensive coated components like turbine blades, rollers and pumps. The prerequisite of economical recoating is an efficient stripping method to remove the old coating. This paper presents the development of the adaptive Abrasive Water Jet (AWJ) stripping method. For the abrasives Al_2O_3 powder was used. The method was applied to remove the WC-CoCr and Cr_3C_2-NiCr HVOF coatings in a controlled manner. The coating thickness was reduced down to 10-20 µm without damaging the base material. With this novel method the use of the environmentally problematic chemicals can be reduced or avoided.





To control the stripping process and to prevent the unwanted base material erosion, a fast measuring system capable of measuring the coating thickness non-destructively with adequate accuracy was integrated with the AWJ removal cell. The applied measuring technique depends on the coating and base materials. The applied technique is based on the eddy current or X-ray fluorescence methods. The measurement results of samples with nonmagnetic substrate are described. Two industrial applications of the AWJ method are given, one focusing on the method validation and the future prospects in the aircraft industry (KLM) and the other on the coating removal of the components applied in the process industry (HT Lasertekniikka).

(continued on page 11)

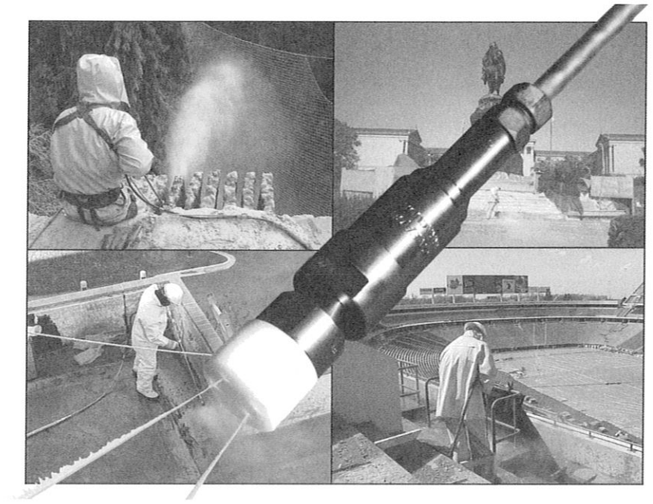
CORRECTION

A headline in the February 2005 *Jet News* incorrectly referred to **CCS-Cobra** as CSS-Cobra. CCS-Cobra, a rescue and firefighting tool, was developed by Cold Cut Systems (CCS) AB, Järnvägsgatan 36 A, SE- 434 40 Kingsbacka, Sweden, www.ccs-cobra.com.

International Waterjet Parts' (IWP) correct web address is www.iwpwaterjet.com. The .com extension was inadvertently omitted from an advertisement in the February 2005 *Jet News*.

StoneAge Adds To Its 40,000 psi Barracuda Line

StoneAge is introducing the low flow Barracuda to compliment their line of 40 kpsi self rotary shotgun tools. The low flow model will allow operators the ability to utilize this tool from 2.9 gpm to 3.7 gpm while the standard 40 kpsi Barracuda operates from 3.6 gpm to 7.1 gpm. The Barracuda line of self-rotary shotgun tools eliminates the need for powered rotary guns while improving efficiency and productivity. For more information, visit www.stoneagetools.com or call 970-259-2869.



WJTA Welcomes New Members, from page 20

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Fax: (360)782-4279

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Fax: (262) 884-6338

American Waterjet Conference

Preliminary Schedule Of Events

Saturday, August 20, 2005

9:30 a.m. - 4:30 p.m.	Optional Trip to Space Center Houston, NASA's Johnson Space Center

Sunday, August 21, 2005

9:00 a.m. - Noon	Pre-Conference Workshop: Waterjet Technology - Basics and Beyond*
Noon - 1:00 p.m.	Luncheon For Workshop Participants*
1:00 p.m. - 5:00 p.m.	Workshop (continued)
6:30 p.m. - 9:30 p.m.	Welcoming Reception In The Exhibit Hall -- Exhibit Officially Opens*

Monday, August 22, 2005

8:00 a.m. - 10:00 a.m.	Onsite Live Demonstrations
10:00 a.m. - 11:30 a.m.	Poster Session in Exhibit Hall
10:00 a.m. - 5:00 p.m.	Exhibits Open
11:30 a.m. - 1:00 p.m.	Lunch In Exhibit Hall*
1:30 p.m. - 5:00 p.m.	Research, Development, New Technology: Paper Presentations
5:00 p.m. - 6:00 p.m.	WJTA Membership Meeting
7:30 p.m. - 10:30 p.m.	Awards Presentation/ Party*

Tuesday, August 23, 2005

8:00 a.m. - 10:00 a.m.	Onsite Live Demonstrations
10:00 a.m. - 11:30 a.m.	Poster Session in Exhibit Hall
10:30 a.m. - 5:00 p.m.	Exhibits Open
11:30 a.m. - 1:00 p.m.	Luncheon In Exhibit Hall*
1:30 p.m. - 5:30 p.m.	Research, Development, New Technology: Paper Presentations

*Ticket will be required.

WJTA Welcomes New Members

Corporate

Advanced Quality Water Jet Cutting
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Fax: (805)484-0788

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Stefan Schroth
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Fax: (281)337-7270

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Keith Alexander
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Alan H. Bryden
Colin Tedman
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Sharjah
U.A.E.
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Fax: [971](6)5280830

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Juan Jose Aguilar Morales
Jose Alfredo Lara Rivera
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Fax: (734) 942-9335

(continued on page 21)

Safety Committee Solicits Comments On Improvements To Recommended Practices

The WJTA Safety Committee hereby solicits comments regarding improvements to the publication, Recommended Practices for the Use of Manually Operated High Pressure Waterjetting Equipment. While Recommended Practices is reviewed periodically at the biennial conferences of the WaterJet Technology Association, your comments and suggestions for improving the publication are invited and welcome anytime.

Please address your comments and suggestions to: Safety Committee, c/o WJTA, 906 Olive Street, Suite 1200, St. Louis, MO 63101-14134, fax: (314)241-1449, e-mail: wjta@wjta.org, web site: www.wjta.org.

Pre-Conference Workshop • Sunday, August 21, 2005 • Preliminary Program

WATERJET TECHNOLOGY – THE BASICS

8:00 a.m. – 9:00 a.m.
Registration

9:00 a.m. – 9:30 a.m.
History
By: George A. Savanick, Ph.D.

9:30 a.m. – 10:10 a.m.
Equipment
By: David A. Summers, Ph.D.

10:10 a.m. – 10:20 a.m.
Break

10:20 a.m. – 11:10 a.m.
Applications
By: John Wolgamott

11:10 a.m. – Noon
Safety
By: Tim Bonvillian

Noon – 1:00 p.m.
Lunch

WATERJET TECHNOLOGY – BEYOND THE BASICS

1:00 p.m. – 3:00 p.m.
Concurrent Sessions

- **Surface Prep Applications I**
  By: Lydia M. Frenzel, Ph.D.
  - Coatings cleaning
  - Coatings removal
  - Surface condition and preparation
  - How clean is clean?
  - Interfacing with the customer issues
- **Cleaning Applications II**
  By: John Wolgamott
  - Fan and round jets
  - The use of heat as a supplement
  - The use of chemicals as a supplement
  - Dealing with fragile surfaces
  - Health and safety issues
- **Cutting Applications**
  By: Mohamed Hashish, Ph.D.
  - Accuracy and precision
  - Improved process techniques
  - Advanced capabilities (drilling, milling, peening, etc.)
  - General non-obvious improvements
  - Ancillary hardware (recycling, vision, sensors)

3:00 p.m. – 3:20 p.m.
Break

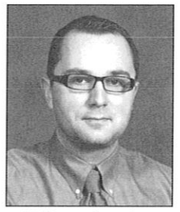
3:20 p.m. – 5:00 p.m.
Concurrent Sessions: "Ask the Experts" Panels

- **Surface Prep Applications I**
  Chaired by: L. Frenzel
- **Cleaning Applications II**
  Chaired by: J. Wolgamott
- **Cutting Applications**
  Chaired by: M. Hashish

KMT Waterjet Systems Announces New Vice President Of Sales And Marketing

KMT Waterjet Systems has appointed Wiktor Stepien as vice president of sales and marketing. He is responsible for all sales, marketing, customer service, and technical service departments of KMT Waterjet based in Baxter Springs, KS.

Most recently, Stepien was the European Sales Manager for KMT Waterjet Systems GmbH in Bad Nauheim, Germany. He has worked for KMT since 1998. Stepien has been a sales manager with Waterjet in Scandinavia, Eastern and Central Europe. In addition to being a sales manager, he has experience as a project manager, marketing research consultant, customer service engineer, and as an engineering assistant.


Wiktor Stepien

Stepien has an MBA from Butler University in Indianapolis, IN, and a Bachelor of Science in Mechanical Engineering Technology from Purdue University in West Lafayette, IN. He is fluent in English, Polish, Spanish, Russian, and German.

KMT Waterjet delivers hyper-pressure waterjet systems which have greater reliability and ease of use at pressures up to 60,000 psi.

For more information, contact: Michelle Patterson, KMT Waterjet Systems, 635 West 12th Street, Baxter Springs, Kansas 66713, Tel: 620-856-2151, Fax: 620-856-5050 www.kmtwaterjet.com

IMPORTANT NOTICE REGARDING SPAM

Email addresses and other member contact information published in the WJTA Membership Directory is meant to encourage helpful, informative communication between members. The information is not provided to circulate spam or junk mail.

The WJTA leadership requests that members respect the contact information of fellow members and not use that information for the dissemination of spam or junk email. Membership information is not meant to be circulated beyond the WJTA membership.

WJTA Conference Exhibitors

(exhibitor list as of April 14, 2005)

Accustream Inc.
Ameri-Force Labor Services
Aqua-Dyne, L.P.
Autoclave Engineers
Barton Mines Company, LLC
Boatman Industries Inc.
Boride Products
Burny
Business & Industry Connection (BIC) Magazine
BuTech Pressure Systems
Cleaner Times Magazine
EBBCO Inc.
Enz USA Inc.
Flow International Corp.
G.T. Brentmark
Gardner Denver Water Jetting Systems
General Pump
H2O Jet, Inc.
Hagen International/Cadcraft
Hammelmann Corp.
Heintzmann Corporation
High Pressure Equipment
HoldTight Solutions, Inc.
Hydro-Engineering, Inc.
Idrojet S.r.l.
JETECH, Inc.
Jetstream of Houston, LLP
Kiwon Entec Co., Ltd.
LaPlace Equipment Co., Inc.
Microlap Technologies, Inc.
NLB Corp.
Parker Polyflex
Powertrack International Inc.
SPIR STAR
Sprague Products
StoneAge, Inc.
Terydon Inc.
Turtleskin WaterArmor
UltraChem LLC/Sharp Performance Products
Universal Minerals
University of Missouri-Rolla
VLN Advanced Technologies Inc.
WGI Heavy Minerals Inc.
Wilco Supply L.P.
WOMA Corporation

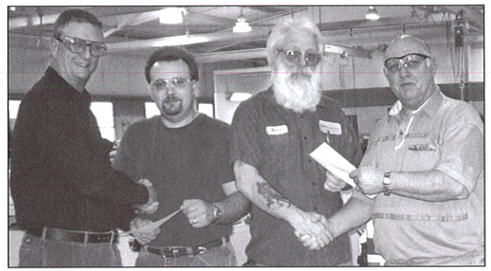
KMT Waterjet Systems Celebrates 5 Year Safety Record

On February 1, 2005, KMT Waterjet Systems celebrated five years without any lost time accidents. In a manufacturing facility, 1,322,283 working hours without lost time is quite amazing. On top of reaching this milestone with a high number of working hours, sales have been increasing at double digit rates. An active safety committee, regular safety meetings, monthly safety department inspections, positive employee involvement, and proactive management support have all proven to be key ingredients to the successful safety program.

Safety is a top priority in the eyes of all the employees. Positive attitudes and safety awareness are also directly related to the five year success, and as a result, the company is planning a steak dinner for all employees. Celebration programs for successful safety achievements create a positive environment where safety is a top priority.

KMT Waterjet delivers ultra-high pressure waterjet systems which have reliability and ease of use at pressures up to 60,000 psi. The company is focused on designed precision for waterjet cutting.

KMT Waterjet is part of the KMT Group which markets, develops and manufactures advanced production solutions related to precision grinding, sheet metal working, tube forming, and waterjet cutting. The KMT holding company, Karolin Machine Tool AB, is quoted on the O list of the Stockholm Stock Exchange.



KMT Waterjet gives Safety Awards each month to randomly selected employees. For the monthly drawing which coincided with the 5-year anniversary, Lee Davis, VP of Operations (far left), and Ben Smith, HR and Safety Manager (far right), presented $250 checks to John Mate and Wayne Sloan (L-R). Bill Depratt, not pictured, also received an award.

For more information, contact: Michelle Patterson, KMT Waterjet Systems, 635 West 12th Street, Baxter Springs, Kansas 66713, Tel: 620-856-2151, Fax: 620-856-5050, www.kmtwaterjet.com

Abstracts Of Papers To Be Presented At The American Waterjet Conference,

from page 8

Economics Of Abrasive Waterjet Cutting at 600 MPA Pressure

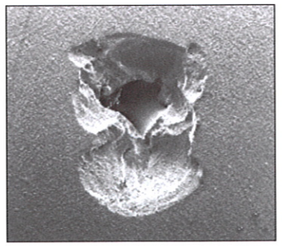
Mohamed Hashish
Flow International Corporation
Kent, WA

The economics of cutting at 600 MPA using abrasive waterjets is discussed in this paper. The operating cost of the AWJ process consists mainly of the costs of abrasives, nozzle wear, utility, and maintenance of equipment. The cost per unit length of material (specific cost) is determined based on the cutting speed. It was found that increasing the pressure at fixed power or fixed orifice size will increase the cutting speed. In the first case, this increase is due to increased jet power density which is more suitable for thin materials. In the second case, the cutting speed increase is due to increase in the power and the power density, and thus thicket materials can be cut efficiently. The main advantage of increasing pressure in either case is reducing the abrasive consumption per unit time or length of cut. Even if the pump maintenance cost increases by a factor of 2, the cost per unit length will decrease for most common parameters. The reduction in abrasive consumption and the possible increase in maintenance cost were found to be beneficial even if the hourly cost increased.

Experimental Analysis Of The Spatial And Temporal Fluctuations In A Cavitating Water Jet

C.A. Fairfield and S.A. Campbell
School of the Built Environment
Napier University
Edinburgh, United Kingdom

The application of experimental techniques to analyze the physical behavior of a cavitating water jet at pressures up to 10000 psi (68.95 MNm^{-2}) and flow rates up to 10.81 gallons (U.S.) *per* minute (6.82 x 10^{-4} m^3s^{-1}) is described. In British civil engineering practice, this range of pressures and flow rates covers that used in the routine cleaning and maintenance of drains or sewers, graffiti removal, and hydraulic pick excavation in soft



Polyetherimide sample damaged by a cavitating waterjet at 5000 psi for 60 seconds.

(continued on page 12)

soils. The techniques used were: high-speed video image analysis at up to 40000 frames *per* second, thermal image analysis of the nozzle, *vena contracta* and divergent jet, spectral analysis followed by fast Fourier transform analysis of the vibrations encountered in the system, and laser scattering analysis for spray droplet or bubble sizing in the jet. Correlations between the measured dynamic responses in the jet and the observed cyclic pressure fluctuations were drawn. Temporal and spatial variations in the jet's shape and size were measured and also related to these fluctuations. The jet was illuminated by coherent pulsed laser: the subsequent Mie scattering of the light was related to the size of bubbles, spray droplets, and the type of capitation nuclei forming in the jet. Subsequent work uses this physical characterization of the jet to evaluate the damage it caused to a range of typical drain and sewer materials.

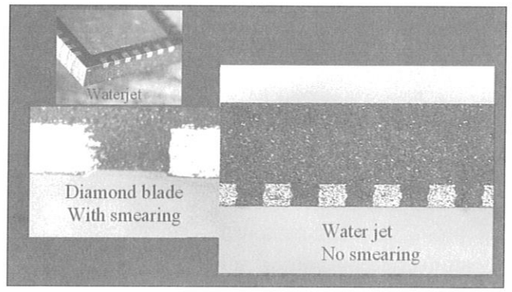
High Precision And High Power ASJ Singulations For Semiconductor Manufacturing

Shan Jiang, Ross Popescu,
Clarence Tamargo, Frank Magana,
Doug Battaglia and Kim Tan
Towa Intercon Technology, Inc.
Morgan Hill, CA

The semiconductor manufacturing employs diamond saw singulations to cut straight lines through device arrays, but the saw singulations cannot always be applied to hard devices, small devices and curvilinear devices.

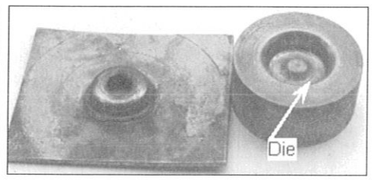
This paper explores a high precision and high power abrasive suspension jet (ASJ) and presents ASJ singulations for semiconductor manufacturing. The key issues and solutions around the developing of the technology are discussed, which include high pressure micro ASJ system, long life nozzle, recharging abrasive system, recycling abrasive system and continuous cutting technique, jet spreading, jet lag.

The ASJ singulations can cut substrates and wafers with widths down to 0.05mm and speeds up to 200mm/s, provide a cost-effective cutting process for any material with both straight line and curvilinear edges, make the highest quality cut: virtually no smearing, burring or chipping. The ASJ singulations can better serve the needs of semiconductor manufacturing.



Innovative Jetbased Material Processing Technology

V.Samardzic, O.P. Petrenko and
E.S.Geskin
New Jersey Institute of Technology
G.A. Atanovv, A.N. Semko and
A. Kovaliov
Donetsk National University, Ukraine



Formation of a 3D shape in the course of the liquid impact (h=2.5 mm, D=25 mm, max. depth 10 mm). Notice the compliance of geometries of the die and the generated part.

The feasibility of material processing using high speed (1400-1750) liquid impact was investigated. The demolition of the brittle materials and disintegration of the explosive devices was demonstrated during the previous study. The principal objective of these experiments was the investigation of jet based material forming. In the course of the performed experiments steel and aluminum samples supported by a die were impacted by the high speed impulsive jets. The jet was generated by the water cannon. The energy released in the course of the powder combustion was used for water acceleration. While the die geometry varied in a high range, the jet properties at the exit of the water cannon (water velocity, exit nozzle diameter) were almost identical. It was shown that the material forming can be precisely controlled by the die geometry and the impact conditions. For example, the feasibility of the formation of various openings in steel by the change of the die geometry was shown. Other experiments included material extrusion and forging. Particularly the feasibility of the precision forming (coining) was demonstrated.

(continued on page 13)

The *Jet News* is published by the WaterJet Technology Association (WJTA) and is a benefit of membership in the Association.

servomotors and harmonic drives as well as other precision components ensures high motion accuracy. Precision of the tilting head is further enhanced with error mapping on each individual tilting head assembly. In each cutting application, a built-in-taper model takes material and its thickness as well as radius of curve and other process parameters into consideration and accurately predicts the corresponding taper angle which is then removed by the tilting head. A taper offset feature is also available to offset the remaining taper if any. Cutting tests show that tilting head is able to produce virtually taper-free parts with ease.

The Experimental Study On Eroding Properties Of Submerged Abrasive Low Pressure Waterjet

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Yu-Feng Yang
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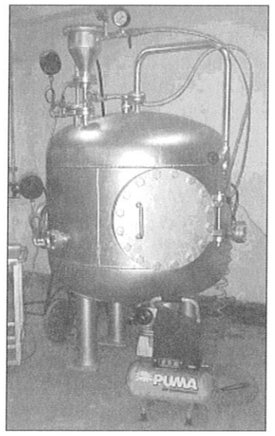
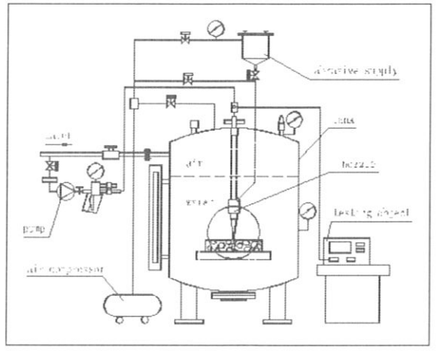
University of Shanghai for Science
and Technology
Shanghai, P.R. China

With the development of ocean engineering, the submerged abrasive waterjet will be widely applied as a cutting technology in underwater engineering. This article introduces the application of abrasive waterjet into underwater process projects. Submerged abrasive waterjets are adopted to conduct the investigation between eroding properties and some essential factors in the lab. The orthogonal experiment method is used to design the experiment and the data are analyzed with variance. The primary analyses show the trend that eroding capability of submerged abrasive waterjets is influenced by factors (such as water jet pressure, standard distance, simulating water depth, nozzle structure.) The study could provide some theoretical reference for further studies in this field.



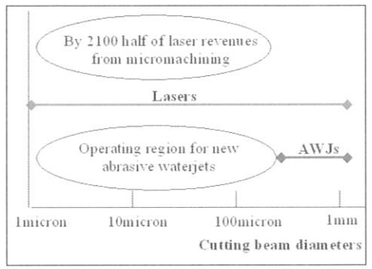


electronics industry and cosmetics nowadays. Requirements for powder have become more and more strict, such as the particle size, the size distribution and the cleanness. The paper puts forward a new way for ultrafine comminution of mineral powder, that is, we combine high pressure water jet with thermal for minerals ultrafine comminution. The mineral particles were damaged by thermal shock before they were comminuted finally by high pressure water jet. When heated and quenched, the particles are shocked thermally to produce thermal stress, cracks, and broken particles. Heating and then quenching reduces particle strength and makes later comminuting by the impact water easier. The impact water and cavitation of a high pressure waterjet could ultimately achieve comminuting for the mineral particles. Experiments on the ultrafine comminution of kaolin, coal, quartz powder have been carried out with a device in our laboratory. The experimental results show that it is an effective way for particles ultrafine comminution.

Strategies For Introducing New Abrasive Waterjet Technologies

D.S. Miller
Miller Innovations
Harrold, Bedford, UK

A new generation of abrasive waterjet machining systems is being developed that, in the longer term, could account for upwards of fifty percent of abrasive waterjet sales. However, entry into the market of these new machining systems is dependent on factors that are not immediately obvious and involve business structures that do



Abrasive quality assurance, packaging and distribution critical factors in exploitation of abrasive waterjets to compete with lasers.

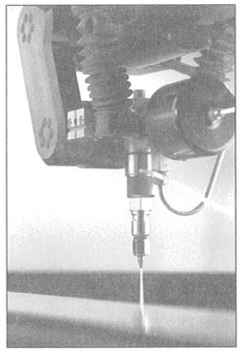
match those of the current abrasive waterjets industry and its suppliers.

The paper will look at the infrastructure needed for the successful commercialization of micro and fine abrasive waterjets. In particular the paper will discuss how the quality control over the abrasive becomes increasingly important as abrasive waterjet diameters are reduced. The implications of who takes responsibility for quality control and packaging of abrasive will be discussed in relation to the successful exploitation of fine and micro abrasive waterjets.

Taper-Free Abrasive Waterjet Cutting With A Tilting Head

Jay Zeng, John Olsen, Carl Olsen and Brian Guglielmetti

Tilting head facilitates tilting the nozzle while it is moving along the cutting path to achieve a taper-free cut. This paper will offer insight into the product development process of the tilting head. An innovative concept of tool tip tilting mechanism allows tilting about the jet entry point with small amount of compensation motions in X, Y and Z direction. Tilting and compensation motions are computed with a mathematical model of the 5-axis motion system and interpolated into motor steps along the cutting path. Use of



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WJTA Conference Onsite Live Demonstrations

(participant list as of April 11, 2005)

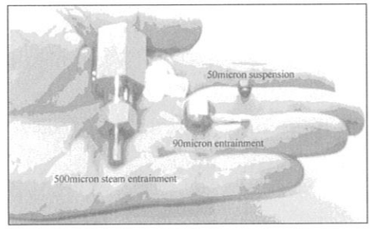
Aqua-Dyne, L.P.
Gardner Denver Water Jetting Systems
JETECH, Inc.
NLB Corp.
Turtleskin WaterArmor
Universal Minerals

It was suggested that the observed phenomena are due to the effect of the hydrostatic pressure on the material ductility (Bridgman effect). The feasibility of improvement existing and development of entirely new manufacturing technologies using high speed jets is discussed.

New Abrasive Waterjet Systems To Compete With Laser Machining Systems

D.S. Miller
Miller Innovations
Harrold, Bedford UK

AWJ machining systems could compete more successfully with lasers machining systems if alternative ways



Cutting Heads - 50 micron for abrasive/water suspension, 90 micron for entrainment of abrasive/water suspension, 500 micron for entrainment of abrasive/steam suspensions.

of generating abrasive waterjet cutting beams were exploited. Commercial exploitation of abrasive waterjets for machining started ten years after lasers and initially followed a similar exploitation route to lasers. However,

(continued on page 14)

lasers manufacturers have been able to exploit several cutting beam generation modes, whereas abrasive waterjet manufacturers have so far only exploited one beam generation mode – the entrainment of abrasive particles suspended in air into a high velocity waterjet. Entraining abrasive suspended in air is unsuitable for generating fine and micro abrasive waterjets. Also the presence of air prevents the focusing of water/abrasive flows to increase cutting speeds through higher jet energy densities and narrower cut widths.

The paper will discuss and compare the merits of four different methods of generating abrasive waterjets and how the exploitation of all four methods would allow abrasive waterjets to operate over the same cutting beam diameter range as lasers. In particular the paper will look at the best way of generating abrasive waterjets for:

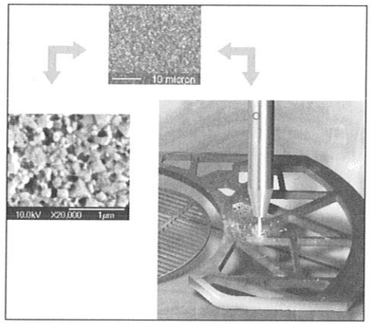
1. General machining involving abrasive waterjet diameters greater than 300 microns
2. Fine machining with abrasive waterjet diameters between 100 and 300 microns
3. Micromachining with abrasive waterjets diameters less than 100 microns.

New Tungsten Carbide Material With Nanoscale Grain Size For Focussing Tubes

Dr. Laurent Bourgeois
CERATIZIT Luxembourg Sàrl

Dr. Rolf Koesters
CERATIZIT Austria GmbH

Wear resistance of focussing tubes is an important factor influencing cutting quality and production costs in



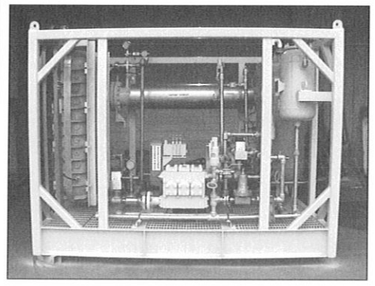
abrasive waterjet cutting. Due to their unique hardness-toughness properties, tungsten carbide focussing tubes show superior wear resistance, compared to even super-hard ceramic materials. CERATIZIT is the leading European producer for such tungsten carbide focussing nozzles. In this paper, a detailed literature review and a survey of parameters influencing lifetime and wear patterns in focussing tubes will be given. Additionally, a new tungsten carbide material will be presented, which has been specially designed for this application. With an average WC grain size of 150nm, hardness over 2800HV10 has been determined for this carbide material. This very high hardness for WC-based hardmetals leads to extreme abrasion resistance, far above other commercial available tungsten carbide materials.

Offshore Washdown Pump Unit – A Manufacturing Case Study

Weimin Dai and Michael T. Gracey
Weatherford International Ltd.
Houston, Texas

The proposed paper is a case study of a pump package built as part of a washdown system to be used on an offshore platform. The new way of doing business with this major oil company includes an increase in the scope of engineering and the amount of documentation required to complete the job. This is a trend that has received more attention recently and was mandated for the 2nd washdown unit by the same end customer. Other oil companies are demanding similar specifications and equipment requirements.

The proposed paper will discuss information that a pump supplier/ package builder needs to know to participate in bids to major oil companies.



The lessons learned on the first pump unit that were applied to the second identical unit and how to avoid mistakes, will also be discussed. Photos, diagrams and drawings will be used to illustrate the subject of the paper.

Porous Liquid Mixing Tube (PLMT) Retro-Fit

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The Johns Hopkins University
Baltimore, Maryland, USA

John B. Murphy, Ph.D.
Lubrijet, Inc.
Baltimore, Maryland, USA

To reduce nozzle wear in high pressure, abrasive suspension jet cutting, a method using a porous, lubricated nozzle was developed and demon-

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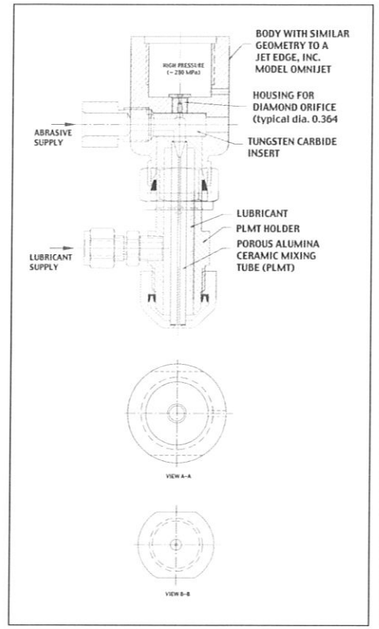

strated by Katz and Anand. This technique has shown success in wear reduction of the nozzle, improved accuracy of the jet and reduction in energy and raw material usage. The abrasive suspension jet system requires a complete redesign of the basic waterjet machine. The work presented here involves the same fundamental technology of lubricating a porous nozzle (mixing tube) in an abrasive waterjet system with the goal of achieving similar benefits. This system, a Porous Lubricated Mixing Tube (PLMT), is designed to be an easily adapted, retro-fit to existing abrasive waterjet cutting machines, and requires little peripheral equipment. Goals for the PLMT system are increased mixing tube life, decreased maintenance and equipment down time along with the possibility of cleaner cutting with respect to kerf shape. Wear characteristics of the lubricated mixing tube, jet cohesiveness, cutting efficiencies and waterjet/ particle interactions are the main topics of this work.

Research On Ultrafine Comminution Of Minerals by Thermally Assisted High Pressure Water Jet

Sheng Fu, Hong Li and Zhaoyao Shi
Beijing University of Technology
Beijing, China

Powder products are widely used in various fields such as papermaking,

(continued on page 16)