The Official Publication of the U. S. Water Jet Technology Association

U.S. Water Jet Technology Association

JET NEWS

JULY, 1988

5629 Minnehaha Ave. South • Minneapolis, MN 55417, USA • 612/725-4543

From the President's Desk...

The Fifth American Water Jet Conference and Short Course on Water Jet Technology will be held at the Inn on the Park in Toronto, Ontario, during the period of August 28–31, 1989. Note that the title of the conference has been changed from U. S. Water Jet Conference to American Water Jet Conference in recognition of the significant number of Canadian members in our organization. We are cosponsoring this conference with the National Research Council of Canada. I am confident that we will be informed and entertained during our stay in Toronto.

The Board of Directors has scheduled a meeting for August 5, 1988, at the University of Wisconsin–Parkside in Kenosha. At this meeting, we will discuss the conference in Toronto and some housekeeping matters, but the main focus of the meeting will be on a business plan for the Association.

"...business plan... what we are selling, and to whom we wish to sell it."

This was identified as the main need of the organization by the Membership Committee that met in Houston on June 3. The Committee felt that a clearly defined business plan should be drafted which defines what we are selling and to whom we wish to sell it. We should also develop a succinct statement of the benefits of membership in the Association.

The Board of Directors and Membership Committee welcome any suggestions from members. Address your comments to me at the Association office.

Dr. Summers to Lead International Industrial Study Mission to Japan on "Waterjet Applications in Industry"

This study team, organized by the Technology Transfer Institute (TTI) should be of interest to those involved in product research, development, design and manufacturing processes that use waterjet technology. Mission lasts from Sept. 24 to Oct. 7, 1988.

Study team participants will meet with industry and government officials in Japan to examine their polymer industry. They will be introduced to some of the most recent developments of Japan's top companies and universities. There will be ample time for participants to make industry connections with engineering, manufacturing and marketing personnel from Japanese firms.

Objectives and Scope of Study Mission

Many American companies now use high pressure waterjet technology to fabricate parts made from composite materials, advanced ceramic materials and difficult–to–cut metals. The light nature of the cutting tool gives it a major advantage when robotic manipulation is required. The development of this new technology can be expected to have a major impact on the competitive postures of all industries that use it.

Members will have an opportunity to attend the the International Symposium on Jet Cutting Technology in Sendai, Japan, from October 4–6, 1988.

Suggested Host Organizations:

- Asahi—Chemical Construction Materials Co.
- Tokyo University of Agriculture/Technology
- Coal Mining Research Center
- Japan Atomic Energy Research Institute
- Kajima Institute of Construction Technology
- Kawasaki Heavy Industries Co., Ltd.
- Kumagai Gumi Co., Ltd.
- Taiheiyo Coal Mining Co., Ltd.
- Tokyo Institute of Technology
- Diesel Kiki Co., Ltd.
- Komatsu, Ltd.
- Hitachi, Ltd.
- Taisei Corp.
- JDC Corp.
- Tohoku University
- Tokyo Electric Power
- Tokyo Engineering University
- Yokohama National University

This study team will be led by Dr. David Summers. Dave is a Curators' Professor at the University of Missouri–Rolla where he directs the activities of the High Pressure Waterjet Laboratory. He is a founding member of the U.S. Water Jet Technology Association, and after serving as President of the Association, is now Chairman of the Board of Directors.

Beginning in 1965, Dave has been active in researching high pressure waterjet system applications. The research which his group has performed, both for government and private interests, has stimulated a number of new industrial applications and encouraged progress both in the laboratory and in the workplace. In the move toward industrial applications, concerns for safety and product reliability have caused him to become Chairman of the Association's Standards Committee. He has also served on Standards Committees relating to water jetting for the Cleaning Equipment Manufacturers Association and the ASTM. He is an honorary member of the British Hydromechanics Research Association.

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Administration

Water Jet Cutting Seminar at UWM October 13-14, 1988

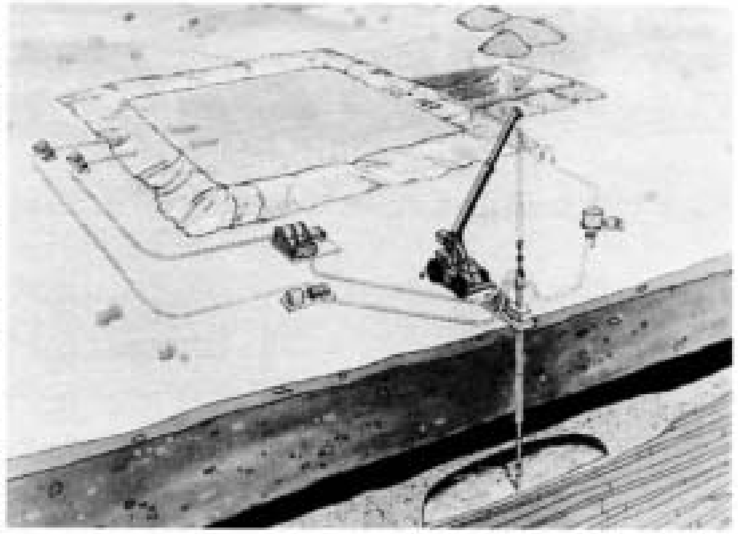
The Center for Continuing Engineering Education of the University of Wisconsin–Milwaukee is offering a two-day seminar there on October 13–14, 1988 entitled "Water Jet Cutting."

This seminar will provide you with practical technical information on water jet technology, including basic fundamentals, advantages and disadvantages, application, integration with robotic systems, and economic feasibility. The seminar will include a demonstration of the Water Jet Lab at UW Milwaukee and also a tour of an industrial water jet installation.

For more information, please call or write to:

Roger W. Hirons
UW Milwaukee
Continuing Engineering Education
929 North Sixth Street
Milwaukee, WI 53203
414/227-3105

Water Jet Mining of Deep Phosphate Ore Through Boreholes



Objective

The objective of this work was to test the feasibility of hydraulic borehole mining for the recovery of phosphate ore from the deep, water-saturated deposits of northeastern Florida.

Approach

Phosphate ore is remotely extracted through a Bureau of Mines-developed hydraulic mining system. Hydraulic borehole mining can remove underground ore deposits that cannot be economically mined by the usual open pit or underground methods. It is environmentally compatible, causing none of the surface disruption or ground water pollution usually associated with other methods of mining. Selectivity of the borehole mining system also allows economical recovery of small or discontinuous ore deposits while minimizing the removal of host rock. The hydraulic borehole mining system has been used successfully in the past to mine uranium ore and oil sands.

How it Works

A 16-inch diameter borehole is drilled from the surface down into the buried mineral deposit, and the mining tool is installed. The borehole mining tool consists of a 12-inch-diameter pipe string and accessories capped with a three-passage swivel, and ending with a mining section. The mining section has four slurry inlets and an eductor located near the bottom of the section and a single cutting nozzle located near the top. The tool generates a high velocity water jet that erodes and slurrifies the ore. The slurry is drawn through the inlet into the eductor which lifts it to the surface where it is deposited into a slurry discharge sump. All the support equipment is located and operated on the surface; only the mining tool portion of the system is underground during the recovery operation (see photo).

Test Results

The Bureau of Mines borehole mining system was successfully field-tested at a site near St. Augustine in St. Johns County, Florida, in cooperation with Agrico Mining Company. The phosphate zone was located between 232 and 250 feet below the land surface and consisted approximately of equal proportions of fine-grained phosphate, sand and clay.

A total of 1,700 tons of phosphate ore was mined at an average rate of 40 tons per hour in three successive mining tests. Each test used a different borehole well and employed modified mining techniques.

One borehole was used to test the concept of borehole mining with a submerged jet. Good mining results were obtained but when water was pumped from the cavity, the roof of the cavity collapsed, indicating that the hydrostatic head is required to keep the cavity open.

In the second borehole, the water level in the borehole cavity was kept below the cutting jet to determine the mining rate and maximum cutting radius of the water jet in air. 'In air' mining increased the probability of cavity roof failure. Roof failure occurred in the second test after only limited production even though a substantial pillar was left to support the cavity roof.

The experiment conducted in the third borehole was designed to combine the long-distance cutting available through water jet cutting in air with the productivity and roof

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High Pressure Water Blasting: Overcoming Three Common Deficiencies

There are at least three deficiencies in high pressure water blasting. They are: 1) the nozzle pressure often is significantly lower than the pump pressure, 2) the lack of focusing of the water jet emerging from thenozzle and 3) the limitation of pressure available from a specific pump which in turn limits performance.

All of these problems are related to the chemical structure of water and each one can be ameliorated by modifying the basic physical chemistry of water. Except in ice (or as is more commonly recognized in snowflakes) water does not have sufficient structure for the maximum effectiveness one would wish for the ideal fluid that is to be used in high pressure blasting.

Water has the composition H_2O. It consists of a molecule in which one oxygen atom is individually attached to two hydrogen atoms. As in many materials, different parts of the water molecule have different electrical charges. In water the hydrogen atoms carry a partial positive charge while the oxygen atom carries a (double) partial negative charge. These positive and negative charges give rise to electrostatic interactions. As a consequence individual water molecules are attracted to one another. This attraction results in a limited structure and because of this, water is a liquid. Other approximately equivalent compounds, such as hydrogen sulfide (H_2S) are gasses at normal temperatures and pressures since they do not posses even this limited structure.

However, by dissolving a particular chemical in water it is possible to take advantage of the electrical charges and impart more structure to the water by modifying its physical chemistry.

This specific approach has been successfully employed in high pressure water blasting for the last eleven years. The "structure inducer" is called SUPER-WATER® concentrated industrial water blasting additive. This additive is soluble in water and is capable of attracting and binding water molecules in such a way that a more extensive and well-defined structure is obtained. Each individual (or in chemical terms, "monomeric") unit of SUPER-WATER® is capable of attaching to itself 13 to 14 water molecules. If the backbone of each SUPER-WATER® is regarded as linear, this results in sets of intertwined longitudinal structures with cylindrically oriented water sheaths.

SUPER-WATER® has a high molecular weight, so each of its molecules gives rise to a very extended structure within the water. Such extended structures stabilize laminar flow and decrease turbulence or the formation of vortices in boundary layers. This brings about so-called drag reduction and effectively takes care of the first deficiency mentioned in the opening paragraph. Now pressure obtained at the nozzle more nearly approaches pump pressure because friction losses are reduced by approximately 50 percent.

The second deficiency is that water diverges when emerging from even the best designed nozzle. This, too, is a direct consequence of the general lack of structure of water. The molecules have an inherent desire to "part company" in rapidly flowing jets. However, with SUPER-WATER®-induced structure present in the water, the integrity of the jet is maintained. When SUPER-WATER® solutions emerge from either cylindrical or fan jets, a remarkable difference in appearance is immediately observable. In cylindrical jets, where usually a cone of water is produced, SUPER-WATER® gives a cylindrical jet. With such a cylindrical jet, energy is not dissipated prior to reaching the target and also the effective stand-off distance is greatly increased. Additionally, water vapor pockets that lead to random damage by cavitation are not so readily formed.

Thirdly, when a jet of SUPER-WATER® impacts a target (at speeds which are usually supersonic) the extended structures act as though they were solid particles. This is because they have insufficient opportunity to relax; they behave as though they were molecular chains bombarding the surface. This "solid behavior" greatly enhances the effectiveness of the water jet and has been judged by many users to be equivalent to several additional thousand pounds of pressure.

These are the three steps used to explain the markedly increased efficiency of SUPER-WATER® solutions over plain water. Users claim that increased effectiveness of 2–50 times are obtained, depending upon the task.

Finally, SUPER-WATER® solutions are slippery and users are convinced that by imparting lubricity to the moving parts of pumps, the product extends pump and nozzle life.

Continued next column

Reprinted by permission from The Maintenance Journal, *December/January 1986. This article is a synopsis of* Polymer Blasting – A Chemist's Point of View *presented by Dr. W. Glenn Howells at the Second U. S. Water Jet Conference, May 24–26, 1983, Rolla, Missouri. Reprints of this paper are available upon request from Berkeley Chemical Research, Inc. P. O. Box 9264, Berkeley, California 94709, 415/526-6272.*

UMR to offer short course on waterjet technology

Registration deadline is June 30th.

A short course reviewing the current methods in waterjet cutting and cleaning will be offered August 8–9 at the University of Missouri–Rolla.

The course will discuss the development of waterjet technology and its most effective use. Participants will observe demonstrations of equipment and technology in the UMR High Pressure Waterjet Laboratory on the final afternoon of the course.

Instructors for the course will include Dr. David A. Summers, Curators' Professor of Mining Engineering and Director of the High Pressure Waterjet Laboratory.

The registration fee is $325 and includes program materials, two luncheons, coffee breaks and one evening meal.

For technical information about the short course, contact:

Jo Moutray
High Pressure Waterjet Laboratory
Rock Mechanics Facility
University of Missouri—Rolla
Rolla, MO 65401–0249
phone 314/341-4311

For registration information contact:

Delphia Ponder
Continuing Education
105 Mining Building
University of Missouri—Rolla
Rolla, MO 65401—0249
phone 314/341-4276

Sponsors

The course is sponsored by UMR, the U. S. Water Jet Technology Association and the ASME Mining and Excavation Research Institute.

We act as though comfort and luxury were the chief requirements of life, when all we need to make us really happy is something to be enthusiastic about.
Charles Kingsley

Is someone you know not on our mailing list? If you know of an interested person, who should be on our JET NEWS mailing list, please send his/her name to the return address below.

Study Mission to Japan continued from page 1

TTI is a Tokyo-based management consulting firm with offices around the world. It was established in 1969 to promote international exchanges of information and ideas in engineering, manufacturing, marketing and science. To date, it has organized over 1,500 successful study missions, business opportunity missions, technical forums, research studies and seminars.

Registration will be taken on a first-come, first-served basis, as the number of participants is limited to 20.

For more information on this technology exchange tour, including a complete brochure, please call or write Nakato Hirakubo, 516 Fifth Avenue, Suite 305, New York, NY 10036, phone 212/719-5771, FAX 212/719-5874.

Mining Through Boreholes continued from page 2

support advantages of a submerged jet. This was accomplished by fitting the cutting jet with an air shield and letting the borehole fill with water. Initial mining was done without the air shield to determine the effective radius of the unshielded cutting jet. Approx. 430 tons of ore were mined with an unshielded jet creating a cavity radius of 15 feet. When the solids content of the slurry decreased three to five percent, air shielding was initiated. This action resulted in a substantial increase of 15 to 20 percent in the solids content. An additional 176 tons of ore were mined with the cavity radius increasing from 15 to 18 feet. The cavity roof remained intact throughout this experiment.

The tests showed in-air mining to be impractical in this deposit because of the incidence of cavity roof failure. Submerged mining, however, was shown to be both technically and economically feasible, particularly with the tool in the air-shield cutting jet configuration.

After mining, the cavities were backfilled with sand to prevent ground subsidence. A ground level survey before and after mining indicated that the amount of ground subsidence which occurred after mining was negligible.

Ground water quality and hydrology were not adversely affected because local ground water was used, and the borehole cavity was kept full of water during the operation to avoid drawing down the local water table.

For More Information

The final report presenting the results of this test program and describing in more detail the several techniques tested is available. For a copy of this report, write to the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22151. Specify report number PB 82-257 841. Additional information is available from Dr. George Savanick, at the Association offices.

Postmaster: Please send Form 3579 to:
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