A WAH CHANG / ATI PUBLICATION | THIRD QUARTER 2004 | VOLUME 25 NUMBER 3

OUTLOOK

PRODUCERS AND FABRICATORS OF REACTIVE AND REFRACTORY METALS AND CHEMICALS

ALLEGHENY TECHNOLOGIES

Allegheny Technologies
Specialty Materials That Make Our World

Machine Shop Relies on In-depth Experience to Make Special Products

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Rob Nichols, Special Products Group, holds a niobium alloy thrust chamber, one of many high-quality engineered products that Wah Chang's Machine Shop produces.

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Wah Chang s Unique Machine Shop Taps Wealth of Knowledge to Meet Customer Challenges

BY: BETH GILLETTE *Wah Chang*

As a major manufacturer of reactive and refractory metals, Wah Chang has a thorough knowledge of the properties and applications of the materials it produces. Many customers understand this and take advantage of the resources Wah Chang provides, such as its annual Reactive Metals Welding Workshops and biennial Corrosion Solutions© Conference, forums that provide industry with information that helps solve real-world challenges back at the plant.

What customers might not know, however, is Wah Chang's breadth of knowledge and ability to help customers in a broader range of markets. A prime example of this is one of the company's best-kept secrets, its unique Machine Shop. Part of Wah Chang's Special Products Group, this shop offers a whole lot more than the equipment needed to produce net shape products; its most valuable asset is the staff's wealth of knowledge and ability to provide engineering solutions.

Our machinists posses tremendous experience at working with Wah Chang-produced materials, particularly infiltrated tungsten, niobium and tantalum alloys, explains Rob Nichols, Machine Shop General Supervisor at Wah Chang. Finished parts can be very difficult to produce from these alloys without a significant amount of fabrication parameter development time. Our craftsmen have developed these skills over many years of on-the-job training, giving our customers today the best product possible.

Although the most attractive quality of the materials (many of which are used for aerospace projects) might be that they can indeed be manufactured, machining and forming them can be very complicated. Normal machining techniques may be used for niobium, but because it has a tendency to gall, tear, and weld to the face of cutting tools, careful selection of tool design and lubricant is very important. It is precisely the need for this type of knowledge that makes the Wah Chang machinists' combined 80 years of experience and specified know-how so important.

For example, these machinists know how specific metals will machine, form and weld, so they adjust their processes accordingly. They know the optimum cutting tool grade and geometry needed to efficiently machine these exotic metals. Wah Chang machinists are comfortable making close tolerance parts which is the norm rather than the exception in the Machine Shop. Over years they have learned the best machining feeds and speeds needed to optimize production and meet customer quality requirements. Other examples of experience-driven tricks-of-the-trade include:

- The custom grinding of carbide inserts is necessary because tooling manufacturers do not produce a cutting tool that efficiently machines niobium alloys. These custom tools decrease machining time and improve surface finishes, an essential asset for machining C-103 thrusters.
- As standard drilling processes do not meet the extremely tight tolerance for a 0.5" diameter hole (+/- 0.00015") on a copper-infiltrated jet vane, Wah Chang's machinists developed a two-step procedure that includes drilling an undersized hole and using a Swiss jig bore to bring the hole into tolerance.
- Silver-infiltrated tungsten material is very brittle and prone to chipping. Through experience, machinists know tapping threads is not an option; they commonly use single-point thread milling to overcome this material issue.
- In precision inside diameter (I.D.) boring operations, harmonic vibrations are commonly an issue. Experience has led machinists to wrap the outside diameter (O.D.) of the part with rubber to deaden these vibrations, significantly improving machining accuracy and surface finish.

Additionally, Wah Chang's machinists have worked with customer engineers to develop and fabricate prototype parts and have the ability to develop a manufacturing procedure or process from customers' drawings.

Developing and fabricating customers' net-shaped products on site allows Wah Chang to closely monitor the quality and delivery of the final parts produced while also providing customers with competitive costs. Several of the many products developed by the Machine Shop include copper-infiltrated tungsten jet vanes, impingement plates, scraper rings and fasteners.

Wah Chang uses its alloys to make products such as fastening rivets (titanium), wire (titanium and niobium), and rocket combustion chambers (niobium) for aerospace applications. Customers use these products in projects such as commercial aircraft, satellite launch systems, and other aircraft propulsion systems where consistent quality is paramount.

In the 15 years that Wah Chang's Machine Shop has been producing finished products for aerospace and other applications, a variety of innovative and high quality products have been designed, developed, and produced. The aerospace industry is very important, not only for Wah Chang, but for our entire corporation, says Parry Walborn, Vice President of Commercial at Wah Chang. The product quality requirements necessary in the aerospace industry shape our quality, production and engineering processes across all of our product lines.

With seemingly unquenchable desire to reach greater heights and to solve industry s toughest materials challenges, the demand for state-of-the-art metal products and next generation alloys is promising. Wah Chang s knowledgeable Special Products Group and Allegheny Technologies are well positioned to meet current customer needs and develop an even wider range of products to meet future needs.

For more information about Wah Chang's near net shape product line and other special products as well as the full range of Allegheny Technologies metals, visit www.alleghenytechnologies.com.

Silver-infiltrated tungsten machined part.

EIML Staff Displays Dedication... and a Sense of Humor

BY: KIRK RICHARDSON *Wah Chang*

In an ordinary-looking office park located in the Chicago suburb of Northbrook, sits a very unordinary business. The shelves of its mammoth industrial-strength refrigerator are stocked with milk, yet it s not a grocery store. Its storage rooms house a generous inventory of containers filled with a variety of soils, grass, and other vegetation, but it's not a nursery. The place even has jugs of supposedly salubrious Noni Juice from French Polynesia, yet it s not a health food store. Truth is, all of these items (and plenty more) are part of the daily parade of samples that march through Environmental Inc. Midwest Laboratory (EIML), a business unit of Wah Chang.

The laboratory's specialty is monitoring for radiological contamination, namely: gross alpha, gross beta, total radium, total uranium, Ra-226, Ra-228, I-131, Sr-89, Sr-90, Fe-55, C-14, Tc-99, Pb-210, and other isotopes. EIML uses gamma-ray spectroscopy to monitor fission products, activation products, natural radioisotopes and radioisotopes used in research and medical treatment. The staff searches everything from water to Noni Juice for contamination. Laboratory Supervisor Rimma Amromin jokes that they have even monitored road kill . It looked like road kill anyway, she laughs.

It really is an outrageous mix of samples. When asked to name the strangest items that the lab has tested, Laboratory Manager Bronia Grob, doesn't hesitate: First place goes to a muskrat. The samples receiving clerk almost fainted when she opened the cooler and the pair of dead eyes looked at her. She lists other strange items that the lab has tested, including pieces of church parking lot pavement, caribou meat that triggered sensors on the entrance to the nuclear power plant, spices from Turkey, beef concentrate from Brazil, and last but not least, whisky.

Though the EIML crew displays a great sense of humor, it takes monitoring and analysis tasks seriously. And laboratory personnel are good at what they do. So good that, during the Chernobyl nuclear fallout crisis in the 1980s, the lab was one of a select group asked by the US Government to help monitor imports, including a lot of hams from Eastern Europe, says Grob. Quality Assurance Manager

Barbara Michalik, lab technician, tests drinking water for gross alpha and gross beta.

and 22-year laboratory veteran Anthony Coorlim adds imported meat and other goods were held at port, until the labs reports cleared the way.

Today, EIML follows stringent guidelines. We have sets of SOPs (Standard Operating Procedures) based on EPA and ASTM procedures, explains Grob. In addition, the laboratory's Quality Control Program complies with 10 CFR part 50, Appendix B. This program relies on:

- Blind duplicate analysis of routine samples for statistical evaluation of precision and reproducibility within the laboratory
- Analysis of split samples prepared by outside laboratories to assess comparability of results
- Periodic processing of blind, blank, and spiked samples to determine the accuracy of routine procedures.
- Participation in the Interlaboratory Comparison Program.

The most ordinary tests her team performs are gross beta in air and iodine-131 in charcoal canisters, states Grob. Those samples come from air stations around nuclear power plants, she explains. The most common media is water: surface water (lakes, rivers, streams, and ponds),

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About EIML

Environmental, Inc., Midwest Laboratory, a business unit of Wah Chang, has conducted radiological monitoring programs since 1969. The programs have included the analysis of ambient gamma radiation (TLD), air, water, milk, soil, vegetables, fauna and flora, eggs, and bottom sediments for a variety of radioactive isotopes.

The laboratory is staffed and equipped to provide a full spectrum of radiometric analysis with the most current procedures and techniques. Midwest Laboratory performs analysis of samples collected near nuclear facilities and environmental sites, monitoring them for potential releases of radioactivity.

EIML's capabilities include a full range of highly sophisticated instrumentation available for radiochemical analyses, maintained in a specially designed, climate-controlled laboratory. These systems provide for the highest quality data with a minimum of handling, thus reducing the chance for errors and providing more cost-effective services.

PEOPLE

William K. McDonald Receives Ogden Award

William K. McDonald, retired president of the company previously known as Teledyne Wah Chang Huntsville (Huntsville, Alabama), recently received the ASTM International H.R. Russ Ogden Award recognizing outstanding accomplishment in the science and technology of reactive and refractory metals and alloys. ASTM's Committee B10 on Reactive and Refractory Metals and Alloys, one of 136 ASTM technical standards-writing committees, presented the award.

A graduate of Stanford University with a B.S. in Physical Metallurgy, McDonald continues to be involved with metals and technology as a participant in the Applied Superconductivity Conference and the Low Temperature Superconductivity Workshop.

McDonald worked at Teledyne for the majority of his career, beginning as a metallurgist in Albany, Oregon, and concentrated on the processing and development of niobium alloys for superconductivity and high temperature aerospace applications.

He highlights the work environment at Teledyne Wah Chang as a contributor to his success. The technology and results for which I was recognized were developed, encouraged and supported by the leadership at Wah Chang, McDonald explains. We had a unique and fast moving technology group who worked together with ideas and experiments, including people from top management, metallurgists and chemists, technicians and operators and sales people, he says.

Wah Chang Albany was and is a unique operation in the world of refractory metals, according to McDonald. In my opinion, this country should recognize Wah Chang as a national treasure. Anyone who thinks about it will know that superconductivity throughout the globe has developed because of the unique approach to the metals business, which has been the hallmark of Wah Chang. I started there in 1962, and all progress with superconductors for practical use was enabled by the entrepreneurial approach to metals processing and development encouraged by the leadership there.

McDonald moved to Wah Chang's Huntsville, Alabama location in 1984 to focus on the manufacture of superconductor materials. He commends Lynn Davis, current President of Wah Chang, for his role in the construction and acquisition of equipment, installation, set-ups and shakedowns that allowed the Huntsville plant to make process changes that reduced processing costs, reducing labor and improving yields.

CALL FOR PAPERS

2005 Corrosion Solutions© Conference

Wah Chang is pleased to announce its fifth international Corrosion Solutions© Conference, which will be held September 11-15, 2005 at Sunriver, Oregon. This conference follows the successful Corrosion Applications Conference held in September 2003 that covered topics ranging from the performance of zirconium, titanium, tantalum, niobium, and specialty steels in corrosive environments to various aspects concerning the design, fabrication, and maintenance of processing equipment. Attendees represented companies spanning 15 countries and included participants from end-users, fabricators, equipment manufacturers, engineering contractors, and academia.

The 2005 event will provide the latest information on working with various materials of construction, such as specialty stainless steels, nickel alloys, titanium, niobium, tantalum, and zirconium, and will cover an even broader spectrum of aqueous corrosive applications. At this time, we have preliminary commitments for technical papers from some of the world s premier chemical companies and major fabricators.

Wah Chang invites you to participate in this unique event by submitting a paper for presentation or joining the conference as an attendee. We are looking for abstracts discussing the application of alloys in chemical process environments. Potential topics and areas of interest include, but are not limited to:

- Corrosion Applications
- Corrosion Challenges
- Formic Acid
- Organic Acids
- Nitric Acid and Urea
- Sulfuric Acid
- Hydrochloric Acid
- Pharmaceuticals
- Biomass
- Preventive Maintenance and Repairs
- Material Developments
- Design and Engineering
- Fabrication Advancements
- Equipment Advancements

Interested authors should submit an abstract with the title and author's name by April 30, 2005 to richard.sutherlin@wahchang.com or submit by fax at 541-924-6892 (attention Rick Sutherlin).

Final manuscripts will be due to Wah Chang no later than June 1, 2005. All selected papers submitted within the deadlines will be included in the conference proceedings. Presenters registration as well as selected event fees will be waived. Contact Mr. Sutherlin at 541-967-6924 for more information or to discuss a potential topic.

If you do not plan to present a paper at the conference, but would like to register or reserve a booth for the exhibit hall, contact Ms. Sheryl Renzoni at sheryl.renzoni@wahchang.com, by fax at 541-924-6892, or by phone at 541-926-4211 x6280 for details. Check out corrosionsolutions.com during the coming months for registration and updates for this one-of-a-kind event!

With Demand for Ethanol Rising, the Need for Dependable Materials of Construction Escalates

BY: JEFF KERR *Wah Chang*

The use of ethanol as an automobile fuel in the United States dates as far back as 1908 to the Ford Model T. Henry Ford was a supporter of homegrown renewable fuels, and his Model T could be modified to run on either gasoline or pure alcohol.

Today, ethanol production is reaching unprecedented levels in the United States. According to the U.S. DOE Information Administration, in 2003, a record 2.81 billion gallons of ethanol was produced in the U.S. The rapid growth of this industry is clear considering that in 1980, annual domestic production was only about 50 million gallons.

In 2004, U.S. ethanol facilities will continue to set new production records exceeding 3.25 billion gallons of ethanol, primarily to be used by consumers as a gasoline additive. The demand for ethanol is driven by the high cost of oil, the banning of methyl tertiary butyl ether (MTBE), and by the number of ethanol production facilities set to begin operations.

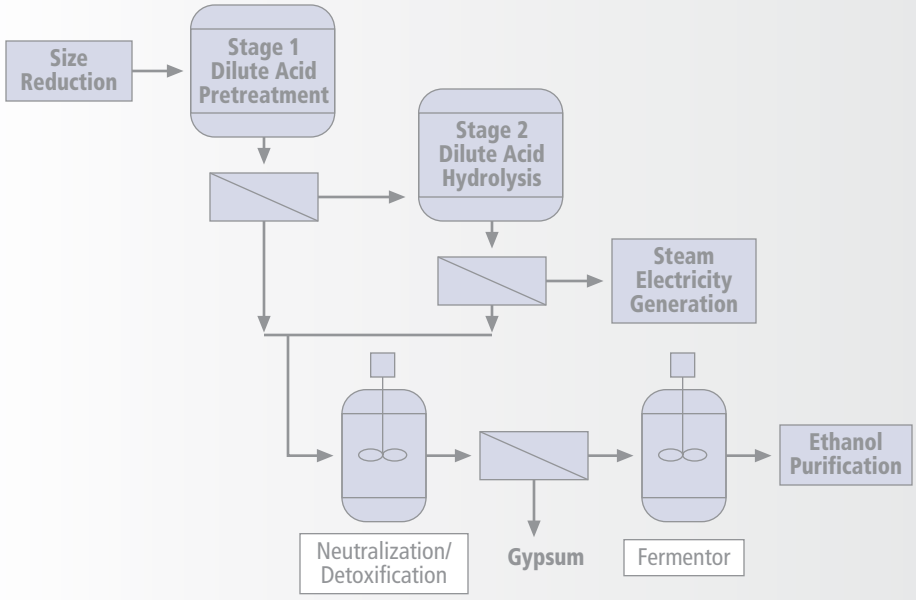
Although corn is used as the feedstock for 95 percent of all U.S. ethanol production today, cellulosic biomass will be playing an ever-expanding role as an alternate feedstock. Cellulosic feedstocks include rice hulls, bagasse (e.g.: fibrous residue from sugar cane), small diameter trees, wood chips, and switch grass. In fact, the majority of plant material consists of cellulose, hemicellulose, and lignin, which far outweigh the starch and sugar that industry currently converts to ethanol for food and feed products. Another promising source of biomass for ethanol production is paper, wood, and plant fibers found in municipal waste or in recycled products.

In most cellulose-to-ethanol conversion processes, acids and enzymes are used to catalyze the reaction that converts cellulose and hemicellulose into simple sugars. This process is often referred to as the pretreatment or hydrolysis step, and sulfuric acid is primarily used as the hydrolyzing agent.

Next, the simple sugars are converted to ethanol through fermentation processes similar to those used in making alcoholic beverages.

[continued on page 6]

FIGURE 1. *Typical Dilute Acid Hydrolysis Process.*



A Biomass Future?

In addition to reducing dependence on foreign oil, the DOE Biomass Program's other primary objective is fostering a domestic biorefinery industry. The goal is to develop new industries that convert lignocellulosic biomass into a wide range of products, including ones that would otherwise be made from petrochemicals. As with petrochemical refineries, the vision is that the biorefinery would produce both high-volume liquid transportation fuels that meet national energy needs (like ethanol) and high-value chemicals that enhance operation economics.

Sugar Platform biorefineries would likely break biomass down into different types of component sugars for fermentation or other biological processing into various fuels and chemicals. Thermochemical Platform biorefineries would likely convert biomass to synthesis gas (i.e. hydrogen and carbon monoxide) or pyrolysis oil, the various components of which could be directly used as fuel or converted to other fuels, solvents, and chemicals by chemical catalysis.

There are many products other than ethanol that can be derived from biomass feedstocks, including organic chemicals, plastics, lubricants, acids and solvents. For example, the DOE reports that DuPont recently developed a biobased method that uses corn instead of petroleum-based processes to produce a polymer platform for use in clothing, carpets and automobile interiors. Similarly, Cargill Dow's biorefinery in Blair, Nebraska is reportedly producing polylactide (PLA) polymers from corn sugar. Other products that can be produced from biomass feedstocks include 1,3 propandiol, isosorbide, lactic acid, and citric acid.

Resource

1. *U.S.D.O.E. Biomass Program, www.eere.energy.gov/biomass.*

[continued from page 5]

FIGURE 2. *Typical Concentrated Acid Hydrolysis Process.*

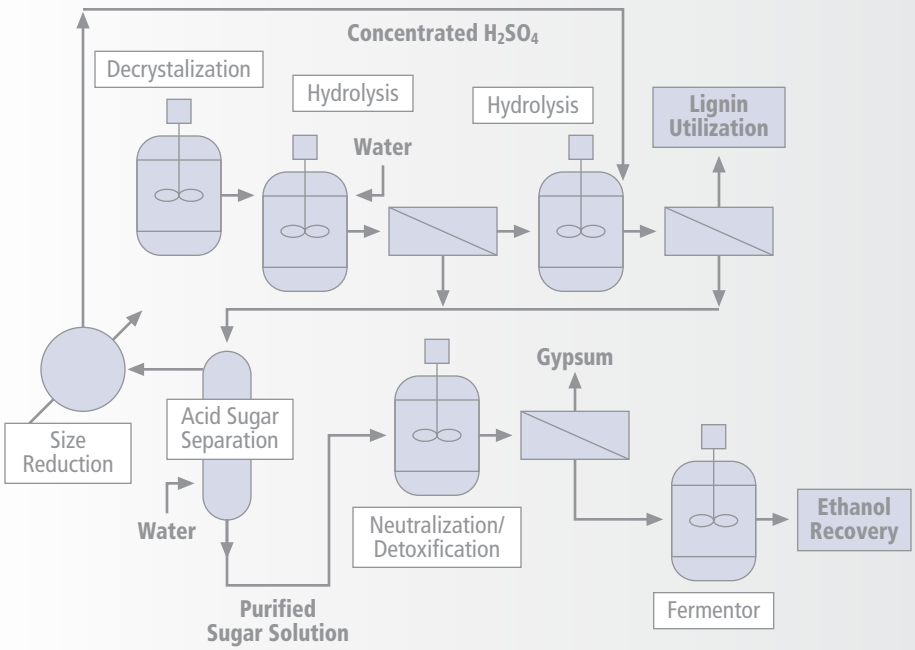
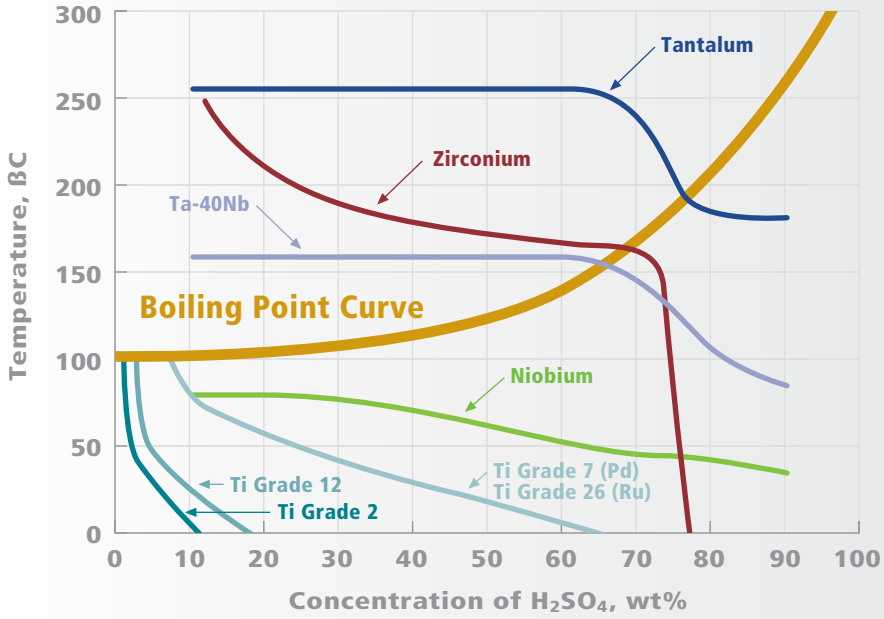


FIGURE 3. *Corrosion of Niobium, Titanium, Zirconium and Tantalum in Pure Sulfuric Acid Iso-Corrosion Lines at 0.13 mm/yr.*



The fermentation reaction is caused by yeast or bacteria, which feed on the sugars. Ethanol and carbon dioxide are produced as the sugar is consumed. Finally, the ethanol is concentrated and purified through distillation and dehydration processes.

According to the DOE, there are multiple pretreatment technologies being used or developed, including dilute acid hydrolysis, concentrated acid hydrolysis, and enzymatic hydrolysis. Dilute acid hydrolysis processes employ solutions ranging from about 0.5% to 2.0% sulfuric acid. On the other end of the scale, concentrated acid hydrolysis processes utilize solutions with sulfuric acid concentrations as high as 77%. Typical flow diagrams for these processes are shown in Figures 1 and 2. In either case, equipment used in these processes is exposed to severe corrosive environments. The material of construction for this equipment must be selected wisely to minimize costs and maximize performance during the life of the project. Corrosion resistant materials of construction may have a higher initial cost, but will usually result in lower maintenance, downtime, and replacement costs through the life of the plant. The downstream effects of corrosion must also be considered, as catalysts, enzymes, yeasts, and other microorganisms used in ethanol production or wastewater treatment processes can be sensitive to metal impurities in solution.

Reactive metals (niobium, tantalum, titanium, and zirconium) and their alloys have been found to be the most cost effective material of construction for many sulfuric acid processes, including acid hydrolysis of cellulose. These metals form passive oxide films that are thermodynamically stable and chemically inert. The oxide film prevents corrosion from occurring.

The corrosion rate of the reactive metals is dependent upon many factors, including acid concentration, temperature, and impurities. Each metal responds differently, and when selecting the optimum metal, you must consider the operating conditions, the life cycle maintenance costs, and downtime costs over the life of the equipment. The process designer must also consider the

potential for temperature, concentration, and impurity excursions that can adversely affect the corrosion resistance of a metal.

No metal is cost effective over the entire concentration and temperature range. In sulfuric acid, tantalum exhibits low corrosion rates in almost all concentrations and temperatures, even above the boiling point. Zirconium performs well in sulfuric acid at temperatures above the boiling point up to about 70% concentration. Titanium is useful at low concentrations only, while niobium is useful across most of the concentration range if temperatures are held lower. Alloyed metals such as Nb7.5Ta and Ta40Nb also warrant consideration. These alloys resist corrosion across much of the concentration range at temperatures higher than niobium but lower than tantalum.

The iso-corrosion curves for these metals are shown in Figure 3. Each line on the curve represents the condition where the corrosion rate of 0.13mm/yr is expected for each respective material. This chart was developed using a sulfuric acid and water mixture without impurities. Impurities in the solution may have an effect, either positive or negative, depending upon the metal, the impurity, and other conditions. For that reason a corrosion coupon test should be performed in the process solution to be used for the application in order to confirm expected corrosion rates.

To request corrosion coupons or for more information concerning potential alloys for ethanol equipment applications, visit www.corrosionsolutions.com or contact Wah Chang at 541-967-6977.

Resources

1. U.S.D.O.E. Energy Information Administration, www.eia.doe.gsov.
2. U.S.D.O.E. Biomass Program, www.eere.energy.gov/biomass.
3. Reactive and Refractory Metals for use in Sulphuric Acid , Randy Scheel, Wah Chang, Sulphur 2002 Conference, Vienna, Austria, October 2002.
4. Synergy in Energy: Ethanol Industry Outlook 2004 , Renewable Fuels Association, February, 2004.

EIML Staff Displays Dedication... and a Sense of Humor

[continued from page 3]

ground water (wells) and drinking water.

Grob says that the lab faces challenges on a daily basis and that dealing with matrixes is among the toughest tests. The composition of the sample can cause difficulty with analysis, she explains. This often results in a poor yield. Our lab is constantly trying new and innovative approaches to increase the yield and avoid any problems posed by the matrix.

Sometimes the laboratory has to develop a new methodology to get to an answer. We are a small lab, and we perform a variety of analyses on variety of different media, says Grob. Even after 23 years of work, I still encounter a challenging sample. I'm always excited to develop and test new procedures.

It's not hard to see why the laboratory has been so successful. The employees obviously enjoy what they are doing and understand the importance of their work. Grob says that, for her, it's the people and overall experience and atmosphere that have kept her going for 23 years. Our staff and the overall atmosphere make our lab an exciting and supportive community, she says. Everyone is incredibly dedicated and enthusiastic about their work. I think the sense of community our lab has strived to achieve has made an environment where everyone does their best and feels appreciated. Each of us realizes that we are providing a public service. For example: Through our testing (REMP), we ensure the safe operation of nuclear power plants, and through drinking water testing, safe drinking water.

Midwest Laboratories customers vary, but the largest segment is the aforementioned nuclear power plants. Grob sees the potential for growth. We are marketing our services, she says, ...the broad spectrum of radiochemical analyses. We also learn about new techniques, procedure challenges and regulations during user meetings. Judging from the laboratory's past experience, new samples will continue to stream through the doors. After all, when you can say that you've tested a dead muskrat, nothing sounds too far fetched.

For more information about Environmental Inc. Midwest Laboratory and a complete list of EIML s services, visit www.wahchanglabs.com, or contact Customer Service at 541-967-6977. Bronia Grob can be reached at bgrob@midwestlaboratory.com.

Jadwiga Grabowski, lab technician at EIML, perfoms iodine 131 testing.

Wah Chang Labs Launches New On-line Resource

Wah Chang is pleased to announce the launch of a new cool-looking (OK, so many web sites are), useful (unlike so many others) on-line resource, www.wahchanglabs.com, a web portal catering to customers seeking laboratory and technical services support.

The site was launched in June and now officially serves as the virtual hub for Wah Chang's four commercial laboratories: Analytical, Metallurgical, Corrosion, and Environmental Inc. Midwest Laboratory, Wah Chang s Radiochemical laboratory (see related article on page 3).

For those who are familiar with Wah Chang's metal products but would like to know more about its laboratory and technical services, wahchanglabs.com provides background information on laboratory capabilities, equipment, experience and qualifications, such as listings of relevant test specifications and the biographies of key laboratory and technical services team members.

The site features a number of useful online capabilities, including the ability to order or request tests and pay for them electronically. In addition, the site was designed and organized to help us improve our efficiency in responding to customer requests for technical support and needs for technical information, says Andrea Van, Business Development Manager for Wah Chang's Laboratory and Technical Services business. To this end, the site includes a newly developed set of automated technical services request forms that allow you to submit inquiries for:

- Failure analyses
- Material selection support
- Corrosion test coupons
- General technical questions for each laboratory

The requests are routed electronically to our new Technical Support Help Desk for prompt response by one of our Technical Services engineers or to the appropriate laboratory contact.

Other handy features include an online technical reference library, containing answers to the most frequently asked technical questions. The library includes up-to-date technical papers and information about the performance, corrosion resistance, welding, machining, and forming of reactive metals, all in electronic downloadable formats. I think that the new format will allow users to get to the information they need quickly and easily, says Steve Sparkowich, Corrosion Laboratory Manager and co-developer of the new web site.

A section of the site is devoted to Wah Chang's education and training offerings. It includes the latest scoop on Wah Chang's unique seminars and conferences. Visitors can even register on-line or sign up for updates on future corrosion or welding seminars and the nearly famous, biennial Corrosion Solutions© Conference (see related article on page 4). In addition, visitors can subscribe to our *Outlook* publication.

Wahchanglabs.com appears to be reaping rewards. We re very pleased with the response we ve had to the new site so far, says Pat Renouf, Analytical Laboratory Manager. We ve seen an increase in web traffic from search engines and a higher volume of inquiries that has resulted in more quote activity and new customers for our services. Sparkowich and Van promise more enhancements to the site, so stay tuned. Bookmark wahchanglabs.com and check back frequently it may prove to be a great help in answering your most perplexing technical questions. ✸

OUTLOOK

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