OUTLOOK

Wah Chang
An Allegheny Technologies Company

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Zr-702 Scrubber Components Resist pH Swings for 15 years

By **Randy Scheel and Kirk Richardson**

Wah Chang is well known in the process industries for its corrosion resistant metal products. Niobium, titanium, and zirconium are stalwarts in severe chemical and mineral processing environments. In media that normally corrodes other materials rapidly, zirconium and titanium last for years. In some cases, the company's flagship product, Zircadyne® Zirconium, has outlived the chemical plant it served.

It should come as no surprise, then, that Wah Chang turns to its own products in making chemical and metal products. In fact, zirconium is used in many corrosive applications in its own production.

Technical Services Representative and long-time plant engineer Randy Scheel discussed a few of the places the company uses its own metals during a presentation at the recent International Corrosion Solutions Conference in Sunriver, Oregon.

In the following excerpt, he describes the use of zirconium equipment in the sand chlorination process, specifically in the scrubber. Scheel notes that prior to this important step, zircon is ground in a ball mill with calcined petroleum coke to make a feed suitable for carbo-chlorination. The feed mixture, about the same particle size as flour, is then ready to be pneumatically

Figure 1. Zirconium Recirculation Pumps on Water Scrubber

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Niobium Coin Commemorates a First in Flight

When aviator Charles A. Lindbergh landed his custom-built Spirit of St. Louis just outside Paris, France in 1927, he ushered in a new age in flight. Lindbergh became the first person ever to successfully complete the non-stop transatlantic voyage solo. The grueling flight from New York took 33 hours 39 minutes. By comparison, today's Concorde can make the same trip in under four hours. Lindbergh's feat looms as one of the great achievements in the history of aviation.

To commemorate this accomplishment, Wah Chang in conjunction with The Great Western Mint (Provo, Utah), has created a 99.9 percent pure niobium coin, depicting Lindbergh and the Spirit of St. Louis. Great Western minted a limited-edition run of 2,390 coins. (Ordering info on page 6.)

The Lindbergh coin is the second niobium commemorative that Wah Chang has collaborated on. In 1994, the company teamed with Liberty Mint to create a coin celebrating the 25th Anniversary of the successful Apollo 11 mission. Wah

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Firsthand

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conveyed to the first chemical process step, sand chlorination.

Following is an excerpted from "The Applications of Zr and Ti in the Zirconium Extraction Process" by Randy Scheel, P.E.

The chlorination of zircon involves the reaction of three molecules. The current process uses a fluidized bed to react the feed with chlorine at 1000 °C. The reaction occurs in a graphite reactor.

$$ZrSiO_4 + 4C + 4Cl_2 \rightarrow ZrCl_4 + SiCl_4 + 4CO$$

The purpose of this process step is to separate the zirconium from the silicon. The silicon tetrachloride is recovered and purified by distillation. The purified silicon tetrachloride is sold to customers who make fumed silica, fiber optic cables and other products.

One area of corrosion in this process step is the scrubber for unreacted chlorine. The first stage of the scrubber is a spray tower to capture silicon tetrachloride in the off gas. The water is highly acidic as hydrochloric acid and silica are formed. The recirculating water stream is both erosive and corrosive and, Zr702 has proven to be the best choice for the pump (see Figure 1).

Many different alloys were tried in this application before selecting Zr702. The zirconium oxide coating on the pump is very abrasion resistant to the silica, and the Zr702 is not corroded by the hydrochloric acid. The next stage in the scrubber uses sodium hydroxide to react with the chlorine. This produces sodium hypo chloride, and there is significant attack on fiberglass and nearly all metals. As the scrubber cycles, it can swing from basic, pH 11, to acidic, pH 2. Zirconium has proven to be the metal of choice here as it resists both the extremes. Figure 2 shows the Zr702 distribution trays at the top of the scrubber packing. These zirconium pumps and trays have been in service for 15 years without corrosion.

Figure 2. Zirconium in caustic scrubber—no corrosion after 15 years of service.

Figure 3. Scrubber blower, with Zirconium or Titanium wheels

The output of the scrubber goes through large blowers to generate the suction for the unit. (See Figure 3). The blowers follow the scrubber in the process and normally encounter clean gas, but occasionally there is blow-over mist from the scrubber. Coated metal and all metal wheels have been used. The coated wheels tend to lose pieces of the coating and result in unbalancing of the wheel. Other metals can be used for the wheels, but the use of Zr702 and titanium has eliminated all maintenance problems on the wheels (See Figure 3). With the close attention by government environmental control agencies, this critical piece of equipment must be as dependable as possible.

Wah Chang has used its own materials successfully in many other applications within its own plant. Future *Outlooks* will contain other "FIRSTHAND" articles detailing these success stories. For more information on how our Zr702 might work in your scrubber application or to inquire about other uses for our corrosion resistant alloys, contact us at 541-967-6977. ■

Field Testing Zr Corrosion Coupons

Often, one of the first steps toward specification of zirconium (or any other corrosion resistant metal) for a processing application is testing of a sample in the targeted environment. In this issue's Q&A column, Technical Service's Mike Abraham discusses procedures, collection and analysis of data, as well as other details concerning field-testing of zirconium coupons. Mr. Abraham is a former Nuclear Propulsion Engineering Officer in the U.S. Navy and has a degree in Chemical Engineering from Cornell University.

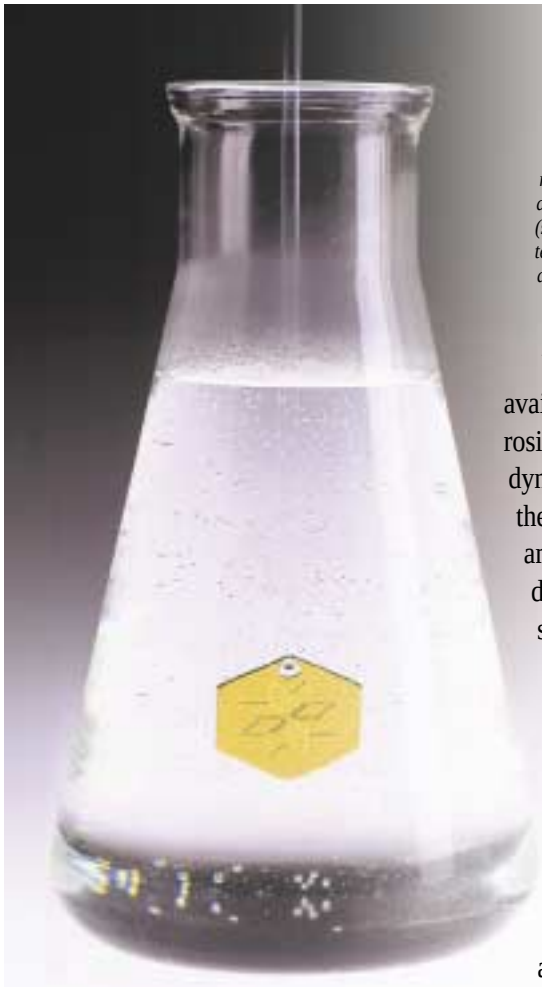
QUESTION:

What are the special procedures for field-testing zirconium corrosion coupons in actual process environments?

ANSWER:

The superior corrosion resistance of zirconium is well documented and has led to its widespread use throughout the chemical processing industry. Increasingly, plant and equipment design engineers are discovering the overall cost advantage of using zirconium, and new applications for using zirconium are continually being explored and developed. A key part of this material selection process is accurately measuring zirconium's corrosion performance in a particular environment, and then deciding if it is a suitable choice.

Corrosion coupon testing has been used for decades to collect data and prove the corrosion resistance of zirconium in all types of chemical environments. The standard experimental method requires a material sample, of known weight and surface area, to be placed in the test environment for a given period of time. At the conclusion of the test period, the sample is re-weighed and the corrosion rate is calculated based on the weight change. Although the general guidelines for corrosion coupon testing are followed, there are special procedures and additional precautions unique to zirconium testing.



Zr-702 is well-suited for use in nitric, sulfuric, hydrochloric and phosphoric acids. It also endures in most organic acids, including formic and acetic, strong alkalis, and molten salts and is one of the few materials that works well in applications requiring alternate contact with strong acids and basic environments (see cover article). Put Wah Chang's zirconium to the test. Refer to the information below right, for details about our corrosion test kits.

Wah Chang has extensive facilities available for conducting laboratory corrosion experiments; however, flow dynamics, temperature gradients, and the presence of unknown impurities are among the many variables that can be difficult to reproduce in a laboratory setting. The best results are obtained by field-testing zirconium corrosion coupons under actual operating conditions, where the test coupon is subject to all phases of the process environment. Following the specific procedures for performing these corrosion tests in the field is critical to ensure the accuracy of the results.

The first step is preparing the zirconium coupon. Proper preparation of the coupon is essential; inadequate cleaning or mishandling could lead to false or misleading test results. Wah Chang supplies standard zirconium corrosion coupons in 1 inch by 2 inch rectangles, both welded and non-welded. Each coupon has machined edges and is stamped with an identification number. A small hole is drilled in one corner for securing the coupon in the test equipment with a piece

of zirconium wire (also provided); it is important to use wire made of the same material as the coupon to prevent galvanic effects.

Prior to placing the coupon in the test environment, it must be cleaned. This can be done in a solution of 5 to 10% aqueous ammonia or using an ultrasonic device; nylon or non-metallic brushes may be used if necessary. The coupon should be rinsed with DI water and air dried prior to its pre-test weight measurement. At this point, careful handling is necessary to prevent contamination or mechanical damage to the coupon that may affect the test; clean, lint-free gloves or Teflon-coated forceps work well. When not being used, zirconium test coupons should be stored in a clean container or wrapped in cloth, plastic or clean paper.

Although most tests are done on zirconium with a clean, as-manufactured surface, some additional treatment, such as pickling or thick oxide formation, may also be desired. Pickling is necessary if the surface conditions of the coupon are very poor, if the effects of pickling are being studied, or if the coupon will be treated to form a thick oxide film. The benefits of a thicker-than-normal oxide film include increased electrical insulation and improved corrosion and friction resistance. Detailed instructions for pickling zirconium and forming a thick oxide film are available from Wah Chang.

Once the coupon has been cleaned, it is ready for placement in the test environment. It is recommended that zirconium not be tested alongside other metals; however, if other metal coupons are being tested at the same time, the zirconium coupon should be placed as close to the inlet of the process solution as possible. This limits the potential contamination of the solution by the corrosion products of these other metals, which may affect the corrosion resistance of zirconium. All metal-to-metal contact with the test coupon should be eliminated to prevent galvanic effects.

The duration of zirconium corrosion testing varies, depending on the severity of the corrosive media and the accessibility of the coupon in the operating equipment. At the end of the test, the coupon should be carefully removed from the test environment, cleaned, dried and re-weighed. Also, the physical appearance of the coupon should be observed for the presence of any pitting, as well as the method and location of any other corrosion attack. One note on safety: corrosion of zirconium can produce a pyrophoric film in limited instances, such as in cases of severe corrosion (>200 mpy). Treating the zirconium coupon in air or steam at 250°C for 30 minutes will eliminate this pyrophoric tendency. Lower temperature treatments for longer times have also been successful in neutralizing the pyrophoric film.

The corrosion rate can be calculated using a simple formula based on the weight change, the time duration of the test, the density of zirconium, and the initial surface area of the coupon:

Corrosion Rate (in mils per year) = (534 x DW) / A x T x D

DW = Weight loss of test coupon (in milligrams)

A = Surface area of the test coupon (in square inches)

T = Total exposure time (in hours)

D = Density of coupon material (in grams per cubic centimeter) (D = 6.49 for Zircadyne 702 and 6.53 for Zircadyne 705)

Tested coupons can also be examined microscopically or analyzed metallographically to determine the type and severity of corrosion attack, if any has occurred. Simple bend tests can also be used to check for potential embrittlement. Field-tested samples can be sent back to Wah Chang for help with these analyses.

If you would like to request a zirconium coupon corrosion kit, have any questions regarding zirconium corrosion coupon testing or would like further assistance, please call Wah Chang at 541-967-6977. Mr. Abraham can be reached at 541-926-4211 ext: 6521 or at mike.abraham@wahchang.com. ■

Wah Chang's new Corrosion Test Kit is available by calling 541-967-6977 and includes complete instructions and sample coupons for a variety of metals.

OUTLOOK

EVENTS

Stainless Steel World 2001

November 13th – 15th, 2001
in The Hague, The Netherlands

Allegheny Technologies Incorporated is a proud sponsor of the 2nd Biennial Stainless Steel World Conference & Expo, which will be held November 13-15, 2001 in The Hague, The Netherlands. This year's conference theme, "Meeting Challenges", focuses on the development of new fields of applications, increasing requirements from the process industries, and the ongoing drive to reduce maintenance costs and improve plant performance.

According to organizers, the event will feature six keynote presentations and 36 paper presentations. Nine workshops cover a wide range of topics, from metallurgy, titanium, fabrication, and failure case histories to procurement and even power generation. A pre-conference visit to the Shell Plant in Pernis is also planned (November 12).

For more information on the event, contact Stainless Steel World at ssw2001@kci-world.com or visit www.stainless-steel-world.net. ■

Corrosion Solutions Conference Recap

September 10th – 13th, 2001
Sunriver, Oregon

Wah Chang held its third international Corrosion Solutions Conference at Sunriver, Oregon September 10-13, 2001. Keynote speeches by Brian Fitzgerald of Exxon-Mobil Chemical and Sheldon Dean of Air Products highlighted the event. In all, the conference featured 40 presentations and panel sessions.

Comments about the event have been very constructive and positive. Seventy-five percent of the participants rated the conference excellent, with no marks below "Good".

The Organizing Committee thanks its top-notch team of presenters and exhibitors for making the Corrosion Solutions Conference the great success that it was. Without all of you, it wouldn't have been possible. ■

From impromptu meetings (top left) to technical presentations (top right) to exhibit hall activities (bottom) the Corrosion Solutions Conference was well received.

Niobium Coin

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Chang plans future coins in the "Firsts in Flight" series, including one commemorating the 100-year anniversary of the Wright Brothers flight at Kittyhawk in 1903. Next year's piece will be introduced at the Northwest Art and Air Festival (Albany, Oregon, August 2002).

Niobium, named after Niobe, the Greek Goddess of Tears, makes a beautiful, silver-colored coin. In its pure state (refined from ore), niobium is rare enough that it would be difficult to counterfeit. This unique metal and its alloys exhibit strength at extremely high temperatures, corrosion resistance, and superconductivity (the ability to pass electricity with virtually no resistance). Niobium's melting point is approximately 4260 ºF (2468 ºC), and its density is 8.57 (g/cm3).

In aerospace, niobium alloys, such as C-103, have traveled to the moon in the form of components that perform at temperatures exceeding 1,300 ºC. Niobium is perhaps the most practical superconductor, enabling such technologies as magnetic resonance imaging (MRI), which allows the body's soft tissues to be scanned without X-rays. In physics research, niobium is at the heart of particle accelerators/colliders, helping to further our understanding of basic matter. In the last 20 years, jewelry makers have taken advantage of a process called anodization, electrochemically adding oxide layers to the metal that trap incoming light and create a range of lustrous colors.

For more information about niobium coins or to discuss coin-related applications, contact Kirk Richardson at 541-967-6955 or e-mail kirk.richardson@wahchang.com. ■

People

Wah Chang is pleased to announce that it recently added Andrea Van to its newly established Business Development Group. Ms. Van, who reports to Business Development Manager Andy Nichols, has taken on the role of Project Manager. As part of the team, she will be searching for new applications of existing technology, new market and product opportunities, as well as potential partnership and acquisition ventures. Ms. Van will also lead the Allegheny Technologies' Corporate Business Development team for the Chemical Process Industries, as well as participate on the Marine team.

Andrea Van

Ms. Van comes to Wah Chang with 15 years' experience in Business-to-Business Marketing. She spent 6 years in international marketing and sales management of investment casting products serving aerospace, power generation, and other industrial sectors, over half the time spent working in Europe. Ms. Van holds a Master of International Management degree, speaks French fluently, as well as some conversational German, Italian and Spanish. She is "excited to have returned to her home state of Oregon and an opportunity to contribute to the growth and prosperity of Wah Chang and the local community."

To contact Ms. Van, reach her by phone at 541-812-7054, by fax at 541-967-6994, or by e-mail at andrea.van@wahchang.com. We welcome her to the ATI family. ■

To order the limited edition Lindbergh Nb Commemorative, contact Sheryl Renzoni at 888-926-4211 (or 541-926-4211) ext: 6280. Each coin is $29.95 plus $3 shipping and handling. We accept Visa, MasterCard, and American Express.

OUTLOOK

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Outlook is published quarterly by Wah Chang (Albany, Oregon office). The newsletter contains information on reactive and refractory metals, including hafnium, niobium, titanium, vanadium, and zirconium, as well as chemicals. The properties listed herein are average values based on laboratory and field test data from a number of sources. They are indicative only of the results obtained in such tests and should not be considered as guaranteed maximums or minimums.

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