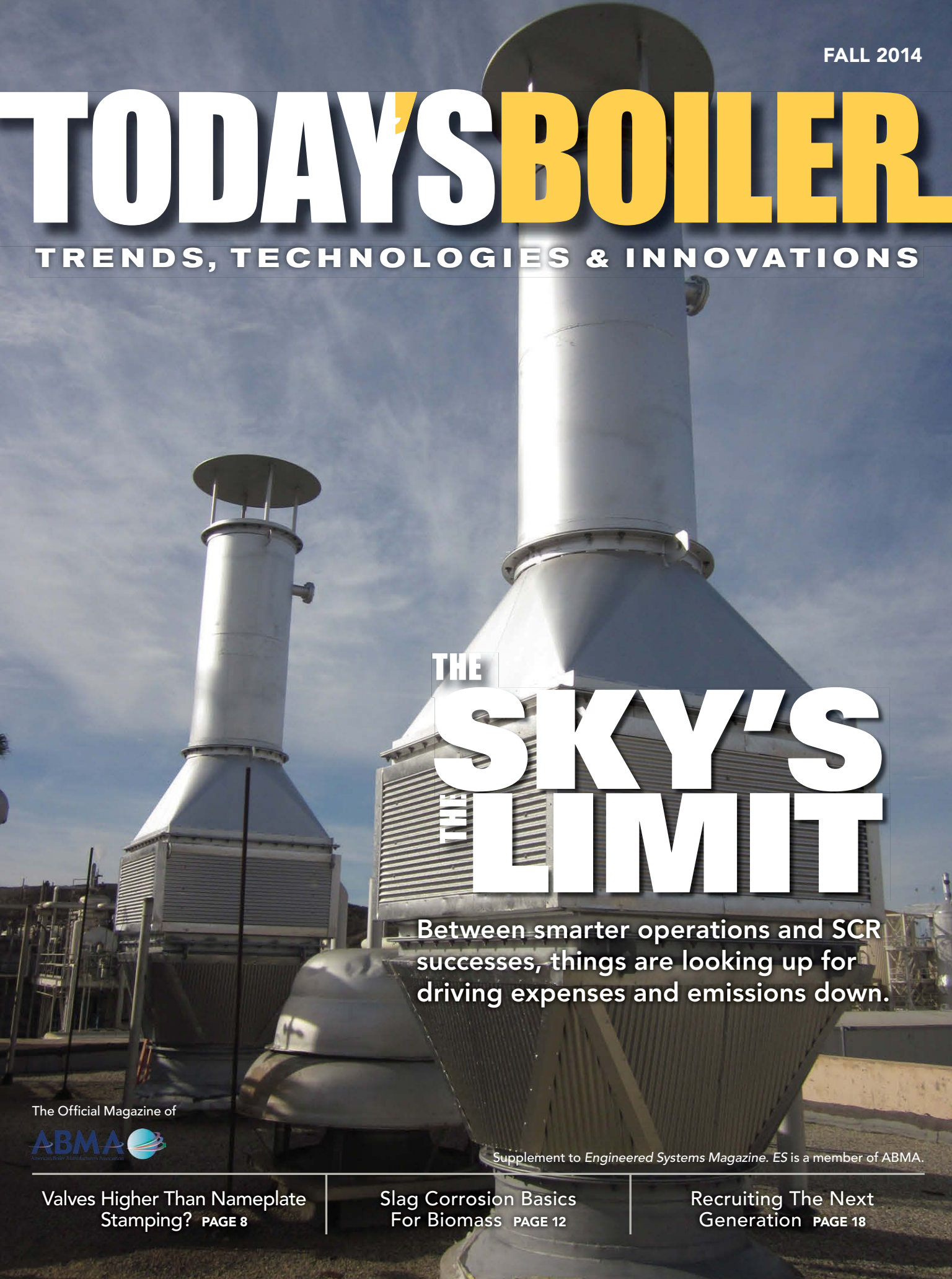
FALL 2014

TODAY'S BOILER

TRENDS, TECHNOLOGIES & INNOVATIONS



THE SKY'S THE LIMIT

Between smarter operations and SCR successes, things are looking up for driving expenses and emissions down.

The Official Magazine of ABMA

Supplement to *Engineered Systems Magazine*. *ES* is a member of ABMA.

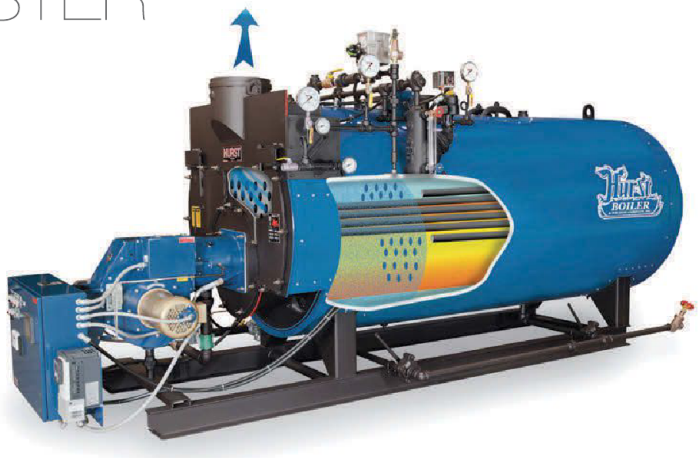
hot water Steam Boilers

WORLD LEADERS IN STEAM AND HOT WATER BOILER MANUFACTURING

HURST SERIES THERMALMASTER

Hurst Boiler is pleased to announce patent approval of the revolutionary new Hurst Boiler Thermal Master Counter-Flow Boiler, engineered with features to improve boiler efficiency.

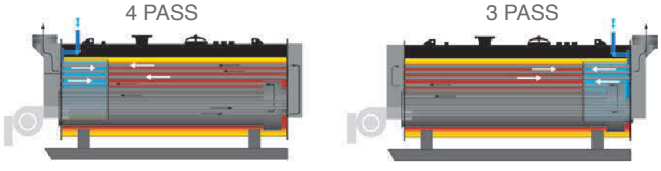
"Advanced design aids in lowering stack temperatures by utilizing make-up feedwater and exhaust gases in a whole new way as a means to increase overall boiler efficiency."



This optional counter-flow device is a revolutionary advancement in the design of conventional fire tube steam boilers, and Hurst has received a patent confirming this design for improving boiler efficiency.

The advanced design and engineering developed by Hurst aids in lowering stack temperatures by utilizing make-up feedwater and exhaust gases in a whole new way as a means to increase overall boiler efficiency. Our patented *Thermal Counter Flow* concept utilizes a unique water-to-flue gas counter-flow design.

This cost saving optional device is integrated inside of the pressure vessel, and factory-built into our exclusive new Counter Flow Boiler Series. It requires no external support, and therefore does not require installation and labor costs that typical external economizers require. Fuel-to-steam efficiencies can be increased by 3-5%, depending on working conditions. This design feature can be added to any of our packaged Fire Tube Series and Heat Recovery Boiler Systems, depending upon your individual level of desired efficiency requirements.



The Hurst product line includes packaged boilers: 6 to 2000 hp, pressures to 450 psi. Fire-tube, water-tube & feedwater equipment for all heating & process applications including: schools, dry cleaning, hospitals, universities, military & all commercial/industrial operations.

POWER-GEN INTERNATIONAL

2014 Power Gen
Orlando, Florida
December 9-11

Booth 1459

Join the Conversation

2015 AHR Expo
Chicago, IL
January 26-28

AHR EXPO 2014 booth #4066

Hurst BOILER & WELDING COMPANY, INC

hurstboiler.com

HURST BOILER
100 Boilermaker Lane • Coolidge, GA 31738-0530
Tel: (229) 346-3545 • Fax: (229) 346-3874
email: info@hurstboiler.com

XTherm®

ULTRA HIGH EFFICIENCY

- **Up to 99%**
  Thermal Efficiency
- **7:1 up to 12.5:1**
  Turndown (varies per unit)
- **Versa IC Control**
  Control and Diagnostic Center
  3.5" LCD screen
  Cascade up to 4 boilers
  Built-in Equal Run Time Rotation
- **Optional Gateways**
  BACnet®, Metasys®,
  Modbus®, LONworks®
- **Vent Certified for**
  PVC, Centrotherm Polypropylene
  and CAT IV Stainless Steel Venting
- **Intelligent Integral**
  Variable flow pumping
  with up to 25:1 turndown
- **7 Sizes**
  1.0•1.5•2.0
  2.5•3.0•3.5•4.0 MMBTU
- **Low Lead Compliant**

New, larger sizes 2.5 to 4.0MMBTU!

Our ultra high efficiency, ultra low NOx boiler is designed with the LEED® certified professional in mind. Every unit comes with a built-in, pre-plumbed cold water run system that prevents condensation damage to the primary heat exchanger. Our hybrid design allows condensation to form only in the pre-plumbed and piped stainless steel secondary heat exchanger. This complete system is contained inside our rugged, powder coated cabinet. Take advantage of our built-in freeze protection that can save you thousands on venting material by allowing you to install the boiler outdoors. The firing rate is seamlessly controlled by our Versa IC® control allowing up to a 12.5:1 turndown rate, depending on model size.

Let Raypak be the company you trust to handle your heating needs. We're green, inside and out, and have been for 65 years.

Xtreme performance powered by

Raypak® A Rheem® Company

2151Eastman Ave•Oxnard CA•805-278-5300

www.raypak.com

BY **SCOTT LYNCH**

ONLY THE RESILIENT SURVIVE

Welcome to the Fall 2014 issue of *Today's Boiler*. I am excited to take the helm of the ABMA and bullish about the future of the association and the boiler industry.

The American Boiler Manufacturers Association was founded in 1888 and can stake claim to the oldest continuous manufacturing trade association in the United States. It takes an organization with insightful leaders, forward-thinking companies, and dedicated volunteers to remain relevant for more than 125 years.

The boiler industry has come a long way in last century, and I have been amazed to learn the resilience of this industry during my short tenure. One thing is clear: the boiler industry has many challenges but can also be very rewarding.

Recently, I had the opportunity to visit ABMA Founding Member Johnston Boiler, who has its signed ABMA charter hanging in its board room. Seeing the charter from 1889 and reading the document brought out a lot of pride in the torch I am carrying.

During our discussions, it was evident that Johnston was always preparing and willing to change to stay relevant and continue to be profitable. No company gets it right 100% of time, but you need to be on the right side of history most of the time to be relevant more than 125 years later. Some may say the boiler industry is like catching the perfect wave in surfing, knowing that you need to stay focused because at any point, the wave might die out and you need to catch the next one. In today's boiler industry, companies must anticipate and be prepared for market shifts to catch the next wave.

The boiler industry has come a long way in last century, and I have been amazed to learn the resilience of this industry during my short tenure. One thing is clear: the boiler industry has many challenges but can also be very rewarding.

But this story is not unique to Johnston. My travels have also taken me to Chanute Manufacturing, where I met with ABMA Past Chairman Scott Lewis. He talked about a time when the HRS&G business was thriving but then turned off like a faucet after ENRON and the downturn in the economy. Some companies would not be able to recover, but Chanute was able to weather the storm and shift their product focus.

Trade associations are unlikely to completely shift focus, but associations like ABMA need to regularly assess their value and relevance to ensure they are addressing evolving member needs. Over the coming months, I will be working closely with ABMA leadership to ensure that we continue to enhance the value of membership in this great organization.

For more information ABMA programs and services along with member companies, please visit www.abma.com. TB

Scott Lynch is president and chief executive officer of the American Boiler Manufacturers Association (ABMA). Contact him at scott@abma.com.

AD INDEX

Another open invitation for our competition to try to copy us.

Introducing the new Benchmark 6000 high-efficiency boiler.

There are always leaders and followers in any industry. And once again, our new Benchmark 6000 high-efficiency boiler puts us way out in front of our competition. Here are just a few reasons why:

- AER-Trim AERCO's patented O_2 trim technology
- Lifetime thermal shock warranty
- 15:1 turndown
- Unmatched compact footprint (79"H x 34"W x 109"D)

The new AERCO Benchmark 6000 boiler.
High-efficiency with a higher IQ.

Scan for technical data

Available in 7 Sizes.

AERCO

AERCO International Inc.
800.526.0288 • info@aerco.com

INSIDE TODAY'S BOILER

BNP Custom Media GROUP

www.bnpmedia.com
2401 W. Big Beaver Rd., Ste. 700,
Troy, MI 48084
248/244-8264

IN PARTNERSHIP WITH
ABMA American Boiler Manufacturers Association
www.abma.com

SCOTT LYNCH
President and Chief Executive Officer, ABMA // scott@abma.com

PETER MORAN
Publisher // moranp@bnpmedia.com

ROBERT BEVERLY
Senior Editor // beverlyr@bnpmedia.com

JAMES SIEGEL
Editor // siegelj@bnpmedia.com

DEAN DIMITRIESKI
Midwest Advertising Manager // dimitrieskid@bnpmedia.com

RUSSELL BARONE JR.
West Coast Advertising Manager // baroner@bnpmedia.com

CHRIS WILSON
Director Custom Media // wilsonc@bnpmedia.com

MELANIE KUCHMA
Project Manager // kuchmam@bnpmedia.com

KELLY SOUTHARD-MITCHELL
Production Manager // southardk@bnpmedia.com

CHRISTOPHER PIRRONE
Art Director // pirronec@bnpmedia.com

VIC BURRISS
Eastern Advertising Manager // burrisv@bnpmedia.com

HARNESS THE POWER

OF MANUFACTURING INNOVATION

RENTECH engineers build unmatched power and performance into every boiler we deliver. Our 80-acre manufacturing facility—the industry's most technologically advanced—includes heavy bay and light bay areas with direct access to rail, cross-country trucking routes and shipping facilities. We master every detail to deliver elemental power for clients worldwide. Take an expanded tour of our facilities today at **www.rentechboilers.com/facilities**

HARNESS THE POWER WITH RENTECH.

HEAT RECOVERY STEAM GENERATORS
WASTE HEAT BOILERS
FIRED PACKAGED WATERTUBE BOILERS
SPECIALTY BOILERS

RENTECH

BOILERS FOR PEOPLE WHO KNOW AND CARE ®

WWW.RENTECHBOILERS.COM

BY **THOMAS P. BEIRNE, P.E.,**
TECHNICAL MANAGER OF THE PRESSURE RELIEF DEPARTMENT AT THE NATIONAL BOARD OF BOILER AND PRESSURE VESSEL INSPECTORS

PURPOSELY SETTING A VALVE HIGHER THAN NAMEPLATE STAMPING:

ACCEPTABLE OR NOT?

Can a valve be purposely set higher than its nameplate stamped set pressure? This question has been posed to the National Board Pressure Relief Department a few times in the last year. The answer is not as simple as one would think.

Set pressure is determined by the maximum allowable working pressure (MAWP) of the equipment the valve is protecting. For the purpose of providing an example, let us assume we have an *ASME Boiler & Pressure Vessel Code*, Section VIII, pressure relief valve for which the nameplate stamped set pressure is 100 psi. The production set pressure tolerance in this case per UG-134(d)(1) is +/- 3%, making the allowable set pressure range 97 psi to 103 psi.

The question of setting a valve higher than the set pressure stamped on its nameplate poses itself most often when ASME/NB and/or VR certificate holders are asked by their customers to set a valve at the high end of the tolerance (in this case, 103 psi, to make sure the valve does not leak or go off early), but still stamp it at 100 psi. Typically, the user of the valve wants to operate their equipment as close to the MAWP as possible. By requesting a higher (but within tolerance) set pressure on the valve, it will improve their chances of the valve not leaking or going off as the pressure approaches MAWP.

Interestingly enough, the ASME code does not specifically prohibit the certificate holder from doing this, as it does not mention how the +/- 3% tolerance gets used. It merely says the final set pressure shall not go outside +/- 3% of the stamped set pressure. However, tolerances are built into the code for a number of reasons, none of which is the willful intent of the certificate holder.

Some ASME/NB and/or VR certificate holders will actually specify tighter tolerances in their quality control programs so that even though there may be differences in measurement techniques and test gage tolerances, the code tolerances will still be met once the valve is shipped. Keep in mind that code requirements are minimum requirements. Going above and beyond the minimum is always encouraged.

So to answer the question: Is it acceptable to purposely set the valve higher than the nameplate set pressure? Technically, yes. However, it is not in the spirit of the code to do so. As a certificate holder, a company is making a commitment to the overall goal of public safety; therefore, the certificate holder should make every effort to set the valve as close to the nameplate set pressure as is feasible. TB

Reprinted from the summer 2014 issue of the National Board BULLETIN.

We've Re-Ignited Ourselves.

WEBSTER
COMBUSTION
A Selas Heat Technology Company

Webster Engineering is now Webster Combustion, a Selas Heat Technology Company.

Webster, a leading manufacturer of multi-fuel boiler burners for over 30 years, combines established combustion technologies, advanced control systems and energy efficiency innovations to help commercial and industrial customers reduce fuel consumption and lower emission levels.

As part of the expanding technology portfolio of Selas Heat Technology Company, Webster is in a stronger position than ever to serve the boiler burner market.

To make your boiler room more efficient, call Webster today or visit us online at:

Ph: 620-221-7464 / www.webster-engineering.com

THE ADVANTAGES OF Full System Integration

BY DR. JIANHUI HONG

A boiler system is often a critical piece of equipment to the continuous operation of a facility. The loss of a boiler can cause disruption of operation and significant loss. It is important to maintain safe, reliable, and efficient operation and minimize downtime of the boiler system.

A boiler system consists of many subsystems working in harmony, such as the boiler, the burner and its control, boiler control including feed water and draft control, fuel oil handling system (if burning oil is required), water treatment, fuel gas booster system (for areas with low supply gas pressure), etc. These subsystems are sometimes procured from multiple sources. In order to deliver the safe, reliable, and efficient service that the enduser expects, it is advantageous to adopt a "full system integration" approach.

MYSTERY RUMBLES

A boiler system in general could have many modes of failures. Failures in water level control have serious implications on the longevity of the boiler and in safety (the sudden inrush of feedwater to a baked-dry boiler could lead to a steam explosion). Water treatment failures can decrease the longevity and efficiency of the boiler. Boiler operators need to understand these dangers. Among all subsystems, the burner system is by far the most sophisticated subsystem in a boiler system. The burner system has many modes of failure that require extensive training and/or experience for the boiler operators to fully understand.

When a boiler system is not delivering satisfactory performance to the enduser, it is sometimes difficult to pinpoint the exact cause of the problem. The following example illustrates this difficulty. Sometimes a burner makes a low-frequency noise, often called a combustion rumble. The rumble could be a nuisance or discomfort to the operators and residents nearby, or could even cause damage to property. Potential causes of the rumble include, but are not limited to:

1) The burner has poor stability at certain firing rates, or the burner's window of operation is too narrow. This could be related to the design or manufacturing of the burner.
2) The air/fuel ratio is improper due to poor commissioning or lack of maintenance.
3) The servos used by the burner control may have poor accuracy or repeatability.
4) The linkage between servos and dampers may be loose.
5) The system does not have oxygen trim to ensure consistent excess air levels. Any variation in draft, ambient temperature, fuel gas composition, building ventilation (affecting building inside pressure vs. outside ambient pressure), or wind speed blowing on outlet of chimney, can affect the amount of combustion air supplied by the fan.
6) Lack of draft control. Severe draft variation may cause the air/fuel ratio to go out of range. This is definitely a challenge if the system does not have an oxygen trim system; it can be a problem even with an oxygen trim, if the draft variation is too severe for the oxygen trim to compensate.
7) The "acoustic coupling" between the burner and the boiler's fire chamber and the subsequent space the flue gas flows through.
8) The fuel gas booster could surge and cause the gas pressure to oscillate beyond the pressure regulator's ability to regulate.
9) The boiler room's ventilation system could be improperly designed. When windows and doors are shut, a significant negative pressure can develop in the boiler room, causing a drop in combustion air supply and air/fuel ratio.
10) Fuel gas supply pressure and composition can fluctuate, especially if the fuel gas is from an alternative fuel source, such as land fill gas (or, to a lesser degree, digester gas).
11) Burner components may not work well together. For example, the gas regulator may be oversized for the flow rates of the burner.

When the subsystems are procured from many different vendors piecemeal (by the general contractor or the enduser) and no engineering firm is taking responsibility for integrating these subsystems, it may be difficult to identify the party responsible for correcting the problem, resulting in blame-shifting among different parties and frustration to the enduser.

For example, in a piece-meal approach, the burner may be supplied by a burner company, but the controls may be supplied by a company that is solely dedicated to burner controls and knows little about the combustion behaviors of the particular burner. The specifications do not call for a draft control or oxygen trim, when in reality one or both of those may be required for the site conditions and requirements. The booster, if there is one for the job, may be supplied by yet another vendor; the commissioning may be done by a contractor; the ventilation system of the boiler room may not have been designed properly to avoid high negative building pressure. The troubleshooting process itself is further complicated by the diverging interests of the different parties involved.

The most important advantage of the full-system integration approach is that the integrator must accept sole source responsibility. If the burner system does not perform, the integrator is responsible for correcting the problem. There is no blame-shifting among different suppliers.

A burner system supplier that adopts the full system integration approach is inclined to build a long-term relationship whenever it sells a job. The supplier would look at the specific conditions and requirements of the customer and look for the best solution tailored for the job, instead of chasing the latest trendy requirement in specifications. For example, it may be tempting to ask for a 12:1 or higher turndown from the burner system, but can the non-condensing boiler operate at 12:1 or higher turndown without condensation and corrosion problems? Is 10:1 or 8:1 turndown enough for the job? In another example, does the system require a draft control device to work? Can the burner deliver satisfactory performance without the draft control system?

A supplier adopting the full-system integration approach would look at total costs of ownership (the fixed costs and the operating costs) for the boiler system, instead of focusing on the fixed costs. In today's corporate procurement practices, too often the one responsible for buying the boiler system is not the one paying the energy bill, and hence is less incentivized to consider the total costs of ownership.

For example, a burner capable of operating at 1.5-2.5% oxygen during the majority of its operation time can lead to significant savings in fuel costs. If a vendor offers a burner system without use of oxygen trim, is the burner operating at consistent excess air levels all year round? Does the lack of oxygen trim mean conservatively high excess air levels? In another example, a fiber mesh burner may be used to meet 9 ppm NOx requirements without FGR, but the additional costs of fuel due to the very high excess air levels (typically 8-9% oxygen dry volume based in flue gas) and the costs of replacing filters and fiber mesh combustion heads need to be factored in when purchasing a burner system. In yet another example, a burner constructed with flimsy, low grade sheet metals may need frequent service and replacement parts, while a burner constructed out of durable steel can provide years of service beyond the normal warranty periods.

The "full system integration" approach requires an integrator to have in-depth understanding and strong product offerings in all of the following areas:

1) Boiler controls. The boiler controls ensure safe and smooth operation (water level control, burner firing rate based on temperature or pressure, draft control if necessary). It should have the capability to manage the lead-lag control of multiple boilers to ensure each of the boilers is operating at its maximum efficiency.
2) Fuel oil handling systems (main tank, day tank, pump sets, filtration, leak detection, etc.)
3) Burners, especially those designed for both high efficiency and low emissions at the same time. The enduser should not be forced to choose between high efficiency and low NOx. High turndown (such as 10:1) helps avoid cycling of the boiler, and low excess air minimizes loss of heat to flue gas. Use of FGR is acceptable, but the incremental costs of running a larger motor due to FGR should be factored in. Advanced designs of burners can achieve mandated NOx emissions with less, little, or no FGR, depending on the NOx levels required.

4) Burner controls. The burner must be equipped with the latest Burner Management/ Combustion Control Systems (BMS/CCS) to assure that safety aspects are in accordance with the latest requirements of NFPA 85 and CSD-1. When high-efficiency or tight emission is required, an oxygen trim system should be included, and parallel positioning or fully metered control should be used in lieu of jackshaft. The combustion control and the servos should be designed to modulate the controlled fluids (air, fuel, FGR etc.) in a coordinated manner. For example, if the air servo cannot move fast enough to be in sync with the fuel servo, then the fuel servo needs to be slowed down in modulation, and vice versa.
5) Commissioning and maintenance. The burner system is commissioned and maintained by qualified service technicians that are knowledgeable about all the subsystems.
6) Technical support and spare parts. These should be available from nearby locations. **TB**

BY **JUSTIN TEIKEN AND LEN KRIETZ**

REFRACTORY/SLAG CORROSION BASICS IN BIOMASS BOILERS

EXTENSIVE SLAG CORROSION ON BOILER DOOR.

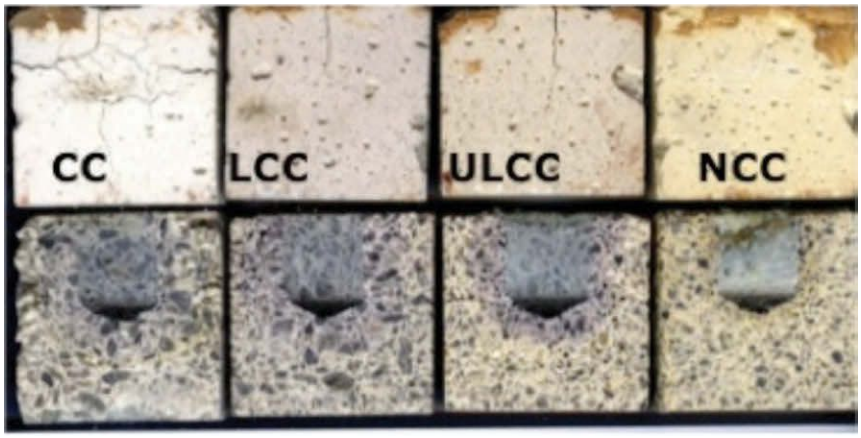
With increasing energy demands and heavy dependence on non-renewable sources, renewable energy has been gaining interest and viability. One option is biomass. Currently, the world's use of biomass accounts for the creation of 6-8% of our energy. Biomass, mainly wood, was the primary energy source until coal emerged in the late 1800s. Coal was king until huge reserves of petroleum from the Middle East flooded the world with a cheap energy source in the 1950s. We've been reliant on petroleum ever since.

Cost-effective energy is critical to industry. With cheap petroleum, biomass is many times not cost-effective, but if the biomass source is a waste by-product, it can actually be cheaper. There will always be a wide variety of biomass by-products available, and many are underutilized. As our supplies of non-renewables decrease over the decades, biomass use will be vital to ensure we reach our ever-increasing energy demands.

Petroleum, coal, and natural gas sources are consistent fuels, and the impurities are known and have been studied and understood for decades. With biomass, there is a wide variety of options, and each source is unique in the type and level of impurities.

Over time, corrosive compounds can accumulate after the biomass combusts, forming slags. Slag will be created when natural occurring silica in the biomass is fluxed heavily with alkalis at temperatures above 1500°F (815°C). As temperatures reach 1800°-2000°+F (980°-1090°+C), these slags become more viscous and reactive. Porosity levels play a major role, as capillary suction from the pores draw the slag into the refractory. Biomass typically needs higher combustion temperatures than coal or petroleum, so the slag penetration due to capillary action is enhanced with the increased viscosity.

We can picture a chemist mixing test tubes of a liquid acid and base resulting in a foamy oozing mass — or worse, an explosion. Refractories and slags have a less dramatic reaction, but in the end it can be very destructive over time. Refractories, like all materials, have a surface chemistry, which is acidic or basic in nature. Ideally, the refractory aggregate and slag pH should be similar to minimize corrosion.



ALKALI CUP TESTING

Nature does not favor acids or bases; it would prefer surfaces be neutral. An acid slag (such as a silica slag) will try to neutralize basic components as it penetrates a refractory. Many refractories in boilers use acidic/neutral aggregates (silica, alumino-silicate, and alumina are typical aggregate components). These aggregates are most commonly bonded with calcium aluminate cements. These cements are composed of three primary oxides: Al_2O_3-SiO_2-CaO or two oxides, Al_2O_3-CaO. Calcia (CaO) is the active phase in these cements and is basic. A silica slag will seek out CaO in a refractory and slowly corrode the binder. In a well operated boiler, slag formation is minimal, but if there are large variations in biomass source, and combustion temperatures slag, corrosion may accelerate.

Early refractory castables (conventional type) used large amounts of cement (20% or more), and thus there were high amounts of basic CaO present. In the 1980s, low cement castables created materials with greatly reduced amounts of CaO. These materials also utilized water reducers, reactive fine aluminas, and fume silicas to create much denser packing. This denser packing creates a lower porosity material (less permeable) with reduced CaO, creating a more slag/alkali-resistant structure. Further advancements include ultra-low cement and no cement castable options that utilize lower cement amounts or alternate binders.

Refractory performance for alkali rich slags can be predicted with alkali cup testing. This is done with a 2x2x2-in. refractory cube sample with a center core drilled out. The core is filled with an alkali salt. A number of standard refractory options were compared to predict performance. (NOTE: CC = conventional castable, LCC = Low cement castables, ULCC = Ultra-low cement castable, NCC = no cement castable.)

Alkali testing was performed on castables made with a synthetic mullite aggregate. Binders varied in CaO content from high levels (conventional castable) to no CaO (no cement castable). As the CaO is reduced (from left to right) the alkali reaction depth, the grey area, is decreased, with the no cement seeing very little reaction and no cracking (alkali bursting) on the cast surface of the cube.

SUMMARY

Biomass boilers use solid waste for fuel, with a wide variety and amount of impurities. These impurities typically include silica and high levels of alkali. Biomass combusts at higher temperatures than petroleum, which can lead to the formation of viscous alkali rich silica slags. These slags are corrosive to standard refractories. In extreme applications, alternate materials are needed. An alkali cup test is a good gauge for material selection. In alkali testing of synthetic mullite aggregates with various binders, reducing cement content improved alkali reaction and corrosion. TB

AN INDUSTRY EVOLVED:

THE RISE AND REIGN OF THE MODULAR BOILER

BY **DOUG MACMASTER**

Since the late 1700s, steam boilers have evolved from a large kettle-like tube that burned lump coal with minimal pressure output to modern-day designs that generate high-pressure steam using natural gas, propane, fuel oil, or biogas. A significant part of this boiler evolution can be attributed to modular, on-demand systems. These kinds of boilers are becoming increasingly popular due to their high-pressure output, lower energy consumption, and unique compact design.

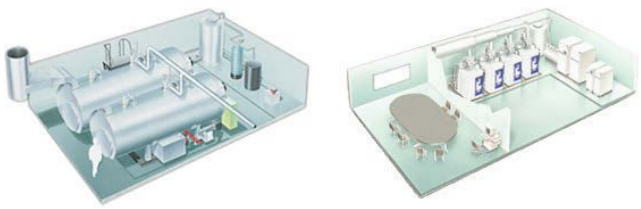
Fuel costs, space design, and energy consumption are just a few key factors to consider when selecting an appropriate boiler system for a facility. Modular on-demand systems are on the rise, and are engineered to reduce energy consumption and meet varying load demands while occupying a minimal amount of space.

WHAT ARE MODULAR SYSTEMS, AND WHY ARE THEY IMPORTANT

Compared to conventional boiler systems, modular on-demand boiler systems reduce energy consumption required to meet variable loads by dividing output capacity among multiple small units. For example, a conventional boiler is rated at 240,000 Btu/hr of energy lost through the boiler's exterior. Energy losses through on-demand boilers are rated only at 60,000 Btu/hr when fully operational.

The energy-efficient, on-demand boiler system is managed by a master controller, which monitors steam demand through a sensor and automatically brings the boilers online, regulates output, and shuts down boilers as needed. Utilizing sophisticated software, the master controller sends commands to individual terminals to adjust the boilers' operation for optimal system efficiency.

A recent bulletin on commercial boilers from the Federal Energy Management Program (FEMP) states, *"If building loads are highly variable, as is common in commercial buildings, designers should consider installing multiple small (modular) boilers. … Modular systems are more efficient because they allow each boiler to operate at or close to full rated load most of the time, with reduced standby losses."*



MODULAR BOILERS GENERATE THE EQUIVALENT AMOUNT OF STEAM IN HALF THE SPACE. THIS SAVES MONEY IN NEW CONSTRUCTION COSTS AND OPENS UP EXISTING SPACE TO OTHER USES.

REAL-WORLD APPLICATIONS

Whether for small, point-of-use functions, or a larger, district energy application using more than a dozen units, the benefits of on-demand systems are being realized across the globe. For instance, Duke University's East Campus Steam Plant recently installed 15 Miura 300 HP LX series gas-fired boilers, replacing the dated, bulky coal-fired boilers to heat

campus buildings. This retrofit — part of a $25 million renovation for the university to become more energy efficient — resulted in a 35% increase in steam capacity to the campus and is significantly reducing their environmental impact.

"From a total production standpoint, we have gone from producing 95% of our steam with coal to producing 85% of our steam with natural gas," explained Russell Thompson, director of utilities and engineering for Duke Facilities Management.

That reduced coal usage translates to a reduction of 30,000 metric tons of CO_2. "It is our first big step in our Climate Commitment Challenge to reduce our carbon footprint," Thompson added.

The university's new on-demand boilers feature a "once through" vertical-tube design that allows for production of steam in just five minutes compared to conventional boilers with a 60- to 90-min startup.

"We can have them on cold standby and have the boilers come on as necessary, which creates a significant reduction in the energy losses associated with a typical startup, purge, and warm-up cycle of a boiler," Thompson further expounded.

REALIZING CHANGE: POSITIVE IMPACTS ON THE ENVIRONMENT AND YOUR BOTTOM LINE

Modular on-demand systems are now widely used in facilities such as breweries, distilleries, hospitals, laundry services, chemical plants, and food processing plants, to name a few. Due to the innovative technology and design of modular systems like those purring happily at Duke University, facilities are saving up to 20% on fuel costs over traditional boiler designs.

In addition to reducing energy consumption and minimizing fuel costs, on-demand boiler systems offer the design flexibility and compact footprint that is not possible with their larger cousins. Utilizing only half the space as compared to conventional boilers, modular boilers also eliminate standard tube pull and door swing space requirements typical of traditional boiler designs. These features enabled Duke to replace three old units with an impressive 15 Miura boilers without having to expand any part of their physical steam plant.

Fuel costs, space design, and energy consumption are just a few key factors to consider when selecting an appropriate boiler system for a facility. Modular on-demand systems are on the rise, and are engineered to reduce energy consumption and meet varying load demands while occupying a minimal amount of space. These features allow facility managers to run production more efficiently and save 20% or more in operating costs. With these benefits in mind, we fully expect to see on demand boiler systems continue to increase in popularity. TB

Doug is Senior Director of Eastern US Operations, Miura Boilers. After a 15-year tenure in the energy industry, Doug MacMaster joined Miura North America in 2014 as the Senior Director of Eastern US Operations & National Account Manager. An expert on alternative energy applications in the automotive industry, MacMaster is a vital component in distributing Miura's energy-efficient technologies to companies and government agencies across the country. As the largest industrial steam boiler manufacturer in the world, MacMaster's group is aggressively adapting the technical expertise developed by Miura in Japan in order to expand the company's capabilities in providing complete boiler room solutions for all industrial users. Doug has a B.S. in Hospitality Management from Widener University and has taken MBA courses at Blue Ridge Technical College.

COe OPTIMIZATION CONTROL:

THE "NEW KID ON THE BLOCK"

Today, COe optimization control produces additional fuel efficiency over that of traditional O_2 trim by enabling the burner to maintain a safe fuel/air mixture closer to stoichiometric conditions.

Oxygen trim (O_2 trim) is widely acknowledged as an essential element of burner control that allows boiler operators to reduce both energy costs and associated harmful emissions. Over the past two decades O_2 trim has evolved from basic systems that adjusted mechanical linkage characterising cams through to today's microprocessor-controlled electronic linkageless burner management systems that employ highly accurate and repeatable servo motors to position air dampers and fuel drives.

The concept of fast-response O_2 trim control was the result of the development of in-situ zirconia based flue gas measuring technology. Efficient and safe combustion requires a precise mixture of fuel and air. Too much air results in energy being wasted up the chimney; too little air results in incomplete combustion. Incomplete combustion is particularly undesirable and results in the formation of dangerous by-products including carbon monoxide (CO), CH_4 & hydrogen in the form of H_2 (collectively referred to as "COe").

To combat the chances of incomplete combustion, burners are always commissioned with an amount of "excess air." Combustion is complex, and there are many variables such as air temperature, humidity, barometric pressure, and fuel quality that affect the whole process. Excess air ensures that even if the combustion variables change detrimentally, the combustion process will remain safe.

O_2 sensors allow combustion systems to become "closed loop." This means that any changes or disturbances in the combustion variables or controlling elements are detected and can be corrected accordingly.

So, how does traditional O_2 trim work? The answer is fairly simple in that it adds or reduces either fuel or air to compensate for changes in the combustion variables. For each point on the combustion firing-rate profile there is an O_2 setpoint. If the O_2 measurement for any firing-rate point increases, then air is reduced, or fuel added, to bring the O_2 process variable back to the setpoint. If the O_2 measurement decreases, the opposite happens. Most systems work by adding or subtracting air, as this has less effect on the power output. Decreasing air will improve efficiency, while adding air will compromise efficiency. Control systems must ensure that the combustion process remains safe and that CO/H_2 (COe) is not produced.

In an ideal world, combustion without excess air would result in the best efficiency possible; this is called stoichiometric combustion and is a theoretical state where exactly the right amount of oxygen molecules combine with available fuel molecules to complete the combustion reaction.

$CH_4 + 2O_2 = CO_2 + 2\ H_2O$ + Heat

New COe sensors use a unique version of zirconia sensors that enables them to accurately detect very low levels of these dangerous COe byproducts of incomplete combustion. The rapid response of these in-situ COe sensors provides the additional safety level of incomplete combustion detection.

COe optimization control is a self-adapting algorithm that learns each point on the fuel-air ratio curves by reducing combustion air to the threshold where COe is detected, and then it "adds back" combustion air to establish a safe and fuel-efficient operating ratio. After the learning process has been completed, if at any time incombustibles are detected, the system thoughtfully readapts by re-calculating the safe operating position automatically. Each "learned" operating curve has a lifetime of eight hours, after which it is "re-learned." This ensures that if external conditions have improved, then the COe optimization control will safely readapt to compensate for increased efficiency.

COe optimization control has been widely adopted in Europe since 2004, with over 1,500 systems installed, but its benefits are just now being implemented in North America. For more information, contact your local Lamtec and Hays Cleveland combustion control representative. TB

Hays Cleveland
Div. of UniControl Inc.

Find out more about Hays Cleveland at www.hayscleveland.com. Readers can also call (216) 398-4414 or write salescombustion@hayscleveland.com.

BUBBLE TESTS & BEYOND:

HOW GAS TRAINS CONTRIBUTE TO SAFE BOILER FUNCTION

Boilers are great tools. They are able to generate steam in a manner that helps industrial and commercial industries flourish while keeping households comfortable. However, when not maintained or operated properly, boilers can be dangerous. One aspect of keeping a boiler safe is an effective gas train.

A gas train is the apparatus of a boiler that feeds fuel into the burner. Gas trains usually consist of multiple components. The first of these components is the sediment trap; it serves as a filter for the gas entering the gas train and traps any sediment or impurities so that they are unable to enter the gas train.

The gas train also consists of a series of valves and switches. The manual shutoff valve (MSOV) shuts down the fuel supply to the boiler so that maintenance may be done by boiler professionals. The gas pressure regulator ensures that the pressure of the gas is maintained at the manufacturer's recommended level. The low pressure gas switch lets the boiler operator know when the pressure of the gas in the fuel train is below what it needs to be in order to operate. The safety shutoff valves (SSOV) work with the vent valve to ensure that gas cannot enter the boiler during emergency situations. The high gas pressure switch automatically shuts down the burner when it senses that the gas pressure is too high. The gas train also contains firing rate valves, which ensure that a steady amount of fuel is sent to the burner, and test valves, which enable the operator to test for leaks in the safety shutoff valves.

These valves and switches work together to ensure safety in boiler operation. They either enable the boiler operator to shut down operation or simply shut down operation on their own. Making sure that these components function properly is highly important to safety in any boiler room. This is because these components are often the keys to preventing a catastrophic boiler explosion.

For example: if the gas valves on a boiler do not shut off, they can leak gas into the boiler while it is not running. Then, when the boiler is started, the high amount of unnecessary gas causes an explosion. The gas train system also helps control the flow and pressure of fuel within the fuel train. In doing this, it keeps the fuel pressure consistent, rather than unstable; an unstable fuel pressure can also lead to a boiler explosion.

Boiler operators can test to see if their gas train is functioning properly by administering a leak test, sometimes known as a bubble test. These two names describe the process of connecting a hose to a test valve and placing the end of the hose in a container of water, which enables pressure to come through the valve, and then counting the number of bubbles in the container of water. Generally, less than five bubbles per minute is considered safe; any more than that means that the valve is not functioning properly and needs to be repaired. TB

Ware is able to administer these tests for customers and provides this service on a set schedule for customers with whom we have a Preventative Maintenance contract. We are also able to test the high and low pressure switches in order to ensure that they are operating properly. Conducting monthly maintenance on your gas train system will ensure that your boiler is functioning not only efficiently, but safely as well.

RECRUITING THE NEXT GENERATION

BY **DREW ROBB**

American industry needs a continuing supply of skilled workers to provide for growth and to replace those who are approaching retirement age. However, companies can't rely on the educational system or government job training programs to deliver a qualified workforce.

"Boiler manufacturers, like those in other industries, need to take a hands-on approach to developing the next generation of workers," says Jack Rentz, president of Rentech Boiler Systems, Inc.

His company has taken steps to begin filling the void of skilled trade workers in the U.S. While the shortage of teachers and nurses gets most of the media attention, it turns out that employers struggle the most to fill engineer and technician positions.

SKILLED SHORTAGES

This country spends, on average, more than $100,000 to get a child from kindergarten through high school. College can more than double that figure. According to some studies, a good portion of that money is misspent.

A recent *Wall Street Journal* report found that 70% of students graduating from a four-year college this year had taken student loans, and for those who did, the average amount due was $33,000. For too many, spending four years at school and piling up the debt didn't lead to a viable career. Economist Richard Vedder, director of the Center for College Affordability and Productivity, says that Bureau of Labor Statistics (BLS) data shows that almost half (48%) of employed college graduates are in jobs that don't require a bachelor's degree, and 37% are in jobs that don't require more than a high school diploma. In fact, many are in jobs that don't even require a high school diploma: 24.6% of retail sales persons, 14% of waiters and waitresses, 16.5% of bartenders, 18% of telemarketers, and 15% of cab drivers now have college degrees.

"We're lending money we don't have, to kids who will never be able to pay it back, for jobs that no longer exist," said Mike Rowe, famous for starring in the hit TV show "Dirty Jobs" in an interview with Glenn Beck last year. "That's crazy, right? That's what we've been doing for the last 40 years."

But, while many college graduates are underemployed, there is a huge lack of personnel qualified to hold other types of jobs. Manpower Group produces an annual *Talent Shortage Survey* which lists the top ten hardest jobs for employers to fill. Despite all the news about the need for more nurses or IT staff, Manpower's 2014 survey found, for the third year in a row, skilled trade workers were the jobs that employers were having the most difficulty filling, followed by engineers and technicians.

This shortage is affecting a wide variety of industries. *PennEnergy* magazine ran an article in April 2014 titled, "Skills shortage main challenge for oil & gas employers in 2014." *The*

Financial Times' headline was a bit more dramatic "'Terrifying' oil skills shortage delays projects and raises risks." HSBC analyst James Steel published an article titled "Skills shortage hits mining."

The Precision Metalforming Association (PMA) and the National Tooling and Machining Association (NTMA) issued a joint paper stating that "Nearly 75% of NTMA and PMA members report they currently have job openings in their manufacturing plants. Of those, 90% say they are having severe or moderate challenges recruiting qualified employees ... 600,000 skilled manufacturing jobs are currently unfilled and 2.7 million manufacturing employees are expected to retire in the next decade."

"Today, skilled trades are in demand," said Rowe. "In fact, there are 3 million jobs out there that companies are having a hard time filling."

SEEKING SOLUTIONS

The skilled workers shortage isn't due to a lack of government programs or funding: a 2011 study by the Government Accountability Office (GAO) found that "In fiscal year 2009, 9 federal agencies spent approximately $18 billion to administer 47 programs—an increase of 3 programs and roughly $5 billion since our 2003 report."

States and local governments spent billions more. While one can debate the merits and results of any particular program, if they were effective, then we wouldn't be seeing things like the Accenture *2014 Manufacturing Skills and Training Study*, conducted in collaboration with The Manufacturing Institute, reporting that "More than 75% of manufacturers report a moderate to severe shortage of skilled resources. U.S. manufacturers face reduced earnings of up to 11% annually due to increased production costs and revenue losses resulting from skills shortages."

The fact is that a business can't really rely on the educational system or a government program to produce employees with the exact skill sets that they need. The only true way to address a skills shortage is to take direct control. This can be done either through training employees directly, cooperating with local educational institutions, or a combination of the two.

PROGRAM TURNS INTERNS INTO PROS

Rentech Boiler Systems, Inc. serves as an example of how a company can work with local schools to get the skills it needs, while providing students with a valuable career upon graduation. Founded in 1996, Rentech designs, manufactures, and repairs boilers in a variety of applications for refining and petro-chemical industries, power generation businesses, and other industries. From its 170,000-sq-ft facility in Abilene, TX, the company serves customers in five continents. The company employs about 200 welders and continually needs more to meet growing demand.

The company has established a working partnership with the Abilene Independent School District (AISD) to provide a supply of trained welders. The AISD has a welding program as part of its Career and Technical Education program, and for the last several years Rentech has donated scrap metal to be used in the classroom training. But it also includes a more direct relationship in helping the students achieve proficiency by providing onsite internships. Starting out with a single student intern, the partnership had grown ten-fold by the last school year. Those interns were seniors taking advanced welding coursework at all three of the AISD high schools offering a welding program.

This summer, Rentech upped its contribution to the AISD's welding program. In July, Rentech president Jack Rentz presented a $10,000 check to Gaile Thompson, the AISD's Executive Director for Career and Technical Education. This money went for the purchase of a new state-of-the-art Miller PipeWorx welding system so the AISD students can train on the latest type of equipment that is actually used in a manufacturing plant.

The partnership between Rentech and the AISD helps the school district, Rentech, and the students. The school gets the benefit of access to Rentech's materials, equipment, and expertise so they can train their students for full participation as a skilled member of the workforce. The students gain by learning professional skills at a level that can't be taught in the classroom. Finally, both Rentech and the students benefit after graduation: eight of last year's interns are now employed as welders at Rentech.

"It's a great program that benefits everyone involved," says Rentz. TB

ABILENE SCHOOL DISTRICT RECOGNIZING RENTECH FOR SUPPORT OF THEIR WELDING PROGRAM.

Drew Robb is a freelance writer living in Florida who specializes in engineering and technology.

DETENTION CENTER KEEPS NOx IN WITH AMMONIA-FREE SCR SYSTEM

BY **DAVID SPAIN, P.E.**

Emission reduction projects in the media are highly focused on large industrial source emitters. Companies that fall in this category include refineries, petrochemical producers, pulp and paper mills, and major food and agricultural processors. Large-scale energy producers, predominately plants that operate coal-fired boilers and are regulated under Boiler MACT, are also highly publicized in mainstream America. Smaller commercial and institutional plants, known collectively as area source emitters, are less likely to be targeted in the national headlines. These types of facilities, however, face the same challenges in air pollution controls as their major emitter counter parts, specifically for NOx and CO emission reduction requirements. Collectively, they can make major impacts in the goal of reducing greenhouse gases and air pollution.

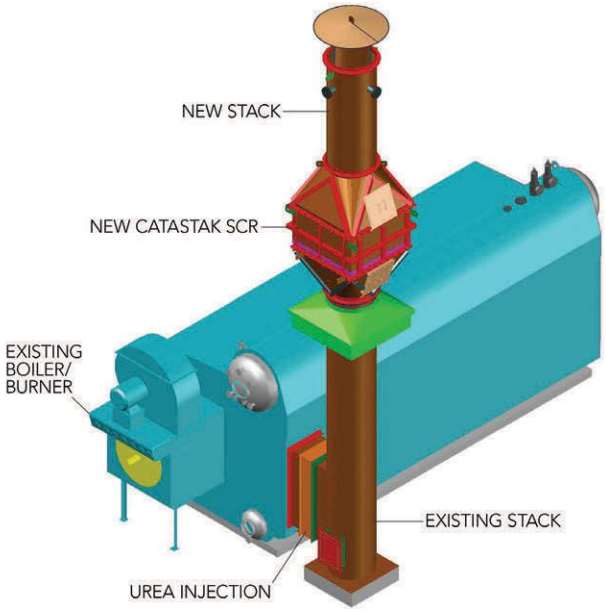
The Environmental Protection Agency (EPA) has estimated that there are 183,000 area source boilers compared to 14,000 major source boilers in the United States. Area sources include universities, hospitals, institutions, and commercial buildings. Similar to major source facilities, these facilities must also comply with stringent air requirements, and the potential to decrease emissions can be great.

The Peter J. Pitchess Detention Center (PDC, also known as the Wayside Jail), in Castaic, CA, (County of Los Angeles) is a prime example of a governmental, area source institution that was mandated by the South Coast Air Quality Management District (SCAQMD) to reduce two dual-fuel fired Keeler auxiliary boilers from NOx emission limits, on natural gas, of 30 ppmvd @ 3% O_2 to only 5 ppmvd @ 3% O_2. The facility specified a system that uses the safe and readily available urea product diesel exhaust fluid (DEF™), which eliminates the need for boiler operators to store and handle anhydrous ammonia.

Nationwide Boiler was selected to supply two Ammonia-Free CataStak™ SCR systems that utilized Combustion Components Associates (CCA) patented TRIM-NOX® LT urea injection systems. Nationwide Boiler contracted with California Boiler, Inc. for the installation of the SCR and the urea injection systems. The installation included removal of the top portion of each boiler's stack to facilitate the insertion of the SCR reactor housing, duct work, and support frames.

Overall, the SCR system easily reduced NOx emissions from 30 ppmvd @ 3% O_2 to actual source tested levels of 3 ppmvd @ 3% O_2 NOx, with ammonia slip under 2 ppmvd @ 3% O_2. The system also complied with Rule 1146 without concerns about meeting future NOx emission limits.

"Over the last several years air pollution requirements around the nation have become more and more strict, and Nationwide Boiler has seen a major shift in the demand for ammonia-free SCR systems for packaged boiler systems. Our alliance with CCA [CCA Combustion Systems, a division of Peerless Mfg. Co.] enables us to provide a



technologically advanced solution that, compared to traditional ammonia-free systems, is more cost-effective and has been proven as an energy-efficient alternative for all boiler operators," stated Larry Day, Executive Vice President of Nationwide Boiler.

"I believe that this SCR system will become the new standard for both major and area sources. It is a reliable solution that complies with the strictest NOx requirements mandated by local Air Quality Districts in the United States, and every installation has exceeded initial NOx guarantees and has met or surpassed minimal NH_3 slip requirements. In the long run, results like these will add up to significant positive effects to our environment and air quality."

Results similar to the PDC project are common. Nationwide Boiler's ammonia-free selective catalytic reduction (SCR) system eliminated the need to retrofit two boilers, operated by NRG San Francisco, with Ultra Low NOx (ULN) burners. This solution not only focused on green house gas reductions, but compared to ULN burner technology, SCR technology did not increase force draft fan horsepower electrical requirements or require the use of flue gas recirculation. It provided a higher, more efficient boiler operation. NRG's SCR system easily exceeded NOx requirements and reduced emissions from 30 ppmvd @ 3% O_2 to actual source tested levels of only 1 ppmvd @ 3% O_2 NOx throughout the entire firing range of the boiler. Comparable to the PDC project, the system remains to operate dependably without any performance issues or concerns about meeting future NOx emission limits.

Whether housing a major source or area source boiler, facilities located throughout the nation face similar goals, set forth by the EPA, regarding the improvement of air quality, safety, and concern for public health. Companies that design, manufacture, and supply boiler-related emissions-controls equipment will be called upon to provide products that meet the ever-changing compliance rules associated with air quality requirements specific to industrial and commercial users searching for clean, efficient, and fuel-flexible solutions. TB

BOILER LOAD MANAGEMENT: STIFLING THE SHORT-CYCLE

BY **KAI WONG,** EMERGENT ENERGY SOLUTIONS

Hydronic hot water heating is one of the most efficient forms of comfort heating, as water is a highly efficient heat transfer medium that can be easily conveyed throughout a building with a simple piping network. This is why hydronic heating boilers are a common fixture with school districts, government, and high-rise commercial buildings throughout the U.S. Installing one or more boilers and piping a two-pipe heating loop is significantly simpler, safer, and more efficient than having a plethora of combustion equipment throughout a building.

TWO PRIMARY OBSTACLES

With boilers supplying most if not all of an entire building's heat, proper system sizing is essential to maintaining occupant comfort throughout the year. On new construction projects, common practice is to size heating system to satisfy peak heating demand, while construction practices for the past 50 years have been to oversize systems to account for the unknown. After much investment and emphasis on reducing carbon emissions during the last 20 years through upgrading building infrastructure, buildings are now tighter, more efficient, and can consume 10-25% less energy than they were originally designed and constructed to. The end result is over 60% of existing boilers being oversized for their operations during peak heating periods. Even if a boiler is properly sized for peak heating demand, the boiler is still oversized for the other 95% of the time it is operating. When boiler heating supply is greater than demand, the net result is a less efficient heating plant with boilers that short cycle more often.

During purging, between four to seven air changes occur within the combustion chamber, heat is removed from the boiler, and the more purge cycles, the less efficient the cycle efficiency becomes as the purges will last between 30 seconds and several minutes.

Boiler short-cycling occurs when an oversized boiler quickly satisfies process or space heating demand and then shuts down until heat is again required.

A boiler cycle consists of a firing interval, a post-purge, an idle period, a pre-purge, and a return to firing. As the DOE states, "Boiler (cycle) efficiency is the useful heat provided by the boiler divided by the energy input (useful heat plus losses) over the cycle duration."

This efficiency decreases when short-cycling occurs or when multiple boilers are operating at low firing rates. In addition to radiation losses, pre and post-purge losses occur. In the pre-purge, the fan operates to force air through the boiler to flush out any combustion gas mixture that may have accumulated. The post-purge performs a similar function. During purging, between four to seven air changes occur within the combustion chamber, heat is removed from the boiler, and the more purge cycles, the less efficient the cycle efficiency becomes as the purges will last between 30 seconds and several minutes.

BREAKING THE SHORT-CYCLE

Commonplace paths to improve boiler cycle efficiency include:

1) Properly sizing new boilers dur-

ing a boiler replacement, rather than sizing a new boiler based on the existing boiler capacity. As previously noted, buildings have become more efficient, and new load calculations should be performed to determine actual peak heating demand.

2) Installing multiple boilers that stage boilers ON/OFF to meet heating demand.
3) Installation of modulating boilers or low/hi-lo boilers that modulate heat output to better match supply with the demand for heat.
4) Use of a BAS to monitor building conditions and start/stop HVAC equipment to maximize system efficiency. This includes the implementation of outside temperature resets that can modify boiler supply temperature set point based on outdoor temperature.
5) The use of O_2 trim systems to enhance air-fuel mixture.
6) Condensing boiler systems.

All of these system enhancements have helped to improve heating system efficiency, but none are able to fully address the challenges of having a boiler system that is sized for peak demand and will become oversized when heating demand decreases from non-peak heating outdoor conditions. Not to mention the significant number of boiler systems still in service at older commercial/multi-family buildings that lack any type of controls besides a straight ON/OFF operation.

Grouping the different technologies together based on benefits delivered: multi-boiler systems, modulating boilers, and BAS systems provide boiler operators with the ability to scale the supply of heat with the demand for heat. These systems are able to get us most of the way, as the limiting factor becomes the maximum turndown ratio on a modulating boiler or the actual number of boilers that a heating plant should realistically install in series. On a BAS system, the benefit is limited primarily by the technician/programmer implementing the controls and the expectations of what a proper setback might be, typically providing only one max setpoint and one setback setpoint.

By measuring and logging the temperature band of each individual boiler, the system learns what a real demand for heat and what standby or possible short-cycling looks like within the measured temperature history.

O2 trim controls and condensing boilers optimize the system when the boiler is operating, as these systems enhance combustion and heat transfer efficiency.

Fireye Inc., a UTC company and a global leader in the boiler combustion controls industry, unveiled a new product that successfully takes boiler controls to the next level. Their NXM2G boiler controller is an intelligent boiler controller that measures the actual system demand for heat and reduces boiler cycling throughout the year. The controller is a self-learning controller that will take into account outside temperature resets, staged boilers, or modulation controls on a heating system as it measures the rate of temperature degradation in the supply and return header from each boiler at any operating temperature up to 257°F.

The system delivers savings through the following process:

1) It intelligently measures and learns the operating temperature range of the boiler system every time it fires. By measuring and logging the temperature band of each individual boiler, the system learns what a real demand for heat and what standby or possible short-cycling looks like within the measured temperature history.
2) Once equipped with this information, the system will prevent the boiler(s) from firing when it determines the demand for heat is low. The net result is a boiler system that runs longer when it does run and stays off longer when it is off. The benefits include reduced thermal losses from the boiler and supply/return loop as the boiler dead band increases. Reduced energy usage occurs by eliminating unnecessary boiler cycling and purging of the boiler in addition to reduced mechanical wear from system cycling.

A recent DOE study logged reduced boiler cycling ranging from 15-35%. This represents 15-35% fewer boiler cycles, valve actuations, motor starts, pre/post purges, and thermal stress on heat transfer surfaces. On average customers are able to achieve a 10% savings on their energy costs by incorporating this smart but independent controller into their hydronic boiler plant.

The NXM2G is UL & CE-listed and does not interfere with boiler safeties. If a system failure occurs, it will fail closed, which eliminates any possibility of the NXM2G's system failure having any possible negative impact on the boiler plant.

To learn more about how the Fireye NXM2G can help you reduce your heating bill and green house gas emissions by over 10%, visit *www.Flame-Controls.com* or email **Sales@Flame-Controls.com**. TB

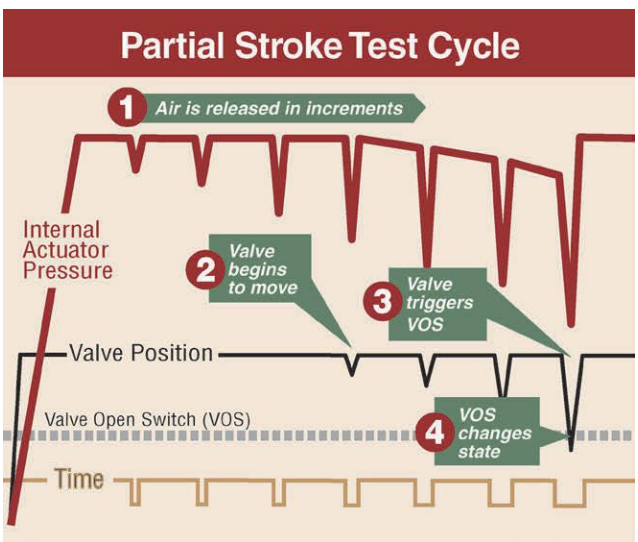
MAINTAINING SIL PERFORMANCE ON SAFETY SHUT-OFF VALVES

THE NECESSITY FOR PARTIAL STROKE TESTING ON ALL BOILER GAS SAFETY SHUT-OFF VALVES IS OF PARTICULAR IMPORTANCE IN HAZARDOUS LOCATIONS WHERE A SIL2 OR 3 RATING IS REQUIRED.

BY **MARK LAMPE**

"System shutdown" is not the phrase one wants to hear when starting a work shift. Unplanned and unexpected shutdowns of boiler operations are time consuming, expensive, and highly disruptive to operations, especially for those running 24/7. However untimely a shutdown, it is usually an indicator that the Safety Instrumented System (SIS) is functioning properly, stopping operations when an unsafe condition exists.

So what happens when the SIS needs to shut down and one of the most critical elements — the gas shut-off valve — is stuck open, preventing the safe shut down of a boiler system? The risk can be catastrophic and could cause accumulation of gas in the chamber where there is no flame, causing a devastating explosion or damage to equipment or workers.



A shutoff valve typically sits dormant for long periods of time, accumulating sludge and build-up from dirty fuels and contaminants that may prevent it from closing when needed. The degradation of performance is a normal aspect in the life of any valve. As a result, there are strict industry standards (IEC 61508 and 61511) designed to ensure that a valve will provide quick and reliable closure. These standards help determine the robustness of a safety system by predicting the probability of failure through statistics, which is the basis for safety integrity level (SIL) certification. Whether SIL is or is not mandated in your facility does not diminish the need to ensure that shutoff valves will perform in an emergency.

GAINING CONFIDENCE IN A VALVE

Historically, industry practice involves shutting down an operation at least once a year to conduct a full stroke of a valve to ensure that it will close. However, this may not be practical in 24/7 operations, and a manual, single-stroke test once a year may not indicate longer-term degradation levels and also may not be frequent enough to maintain the required SIL.

Best industry practice for achieving a SIL2/3 rating involves utilizing Partial Stroke Testing (PST) of the safety instrumented system shutoff valves and to exercise the valves on a frequent basis. Partial stroke testing is a relatively simple concept: move the valve just enough to confirm that it is not stuck. With this small movement, the PST system confirms that the valve is operating safely — all without any direct human intervention (a requirement for SIL certification), without a need for a system shutdown, or the expense and time to manually test each valve.

NFPA Standards (API 56/NFPA 87, 3.4.6.2: API556 Bypass Valves [around SSOVs]) state that a formal policy, permitting procedure, and signed authorization shall be required prior to opening the bypass valves. For facilities that have reservations with administrative control of bypass valves, an automated PST of the safety shutoff valves may be considered to meet proof test requirements without safety shutoff bypass valves.

One method for implementing a partial stroke based SIS is the use of a PLC-based system which pulses the power (on-off) to a pneumatic valve solenoid, resulting in the release of air pressure causing the partial movement of the valve. More air is released

in increments until enough backpressure is released to allow the valve to start to move. The valve will move in small increments until it triggers a switch indicating that the valve is moving toward a change in position. The diagnostic test for a normally functioning valve usually lasts less than five seconds (see chart); that time can depend on fuel pressure, the actuator spring force, instrument air pressure, and friction characteristics of the valve. The minute movements of the valve do not impair or change any of the flow characteristics and do not impede current operations.

Frequent stroke tests can often qualify a system for higher SIL ratings. This presents an interesting dilemma, however, since most ball-type safety shut-off valves use soft-seated materials that tend to wear with repeated cycling. A better solution is to use linear-acting valves that utilize metal-to-metal seats (that wear in, not out, with use) that actually *benefit* from frequent testing. Their self-cleaning feature makes corrective action possible for a degrading valve by simply increasing the test frequency, fully leveraging the valve's "wear in, not out" characteristics. With linear hard-seated safety shut-off valves, it is possible to conduct partial stroke tests on a much more frequent basis, ensuring that they are not stuck and will close on demand. In short, the more a hard-seated valve is cycled, the better the valve seals over time.

This data from partial stroke tests is tracked and trended, showing a regression in a valve's response time over months or years and sending out an alarm if the valve is degrading to the point where it may require service or replacement. Facilities and processes benefit greatly by being able to plan repair or replacement of the valve during regularly scheduled plant maintenance, avoiding interference with normal operations, and averting costly downtime.

This trending data can be made available through Ethernet for alarm and annunciation purposes, alerting boiler personnel about a need to plan ahead for service or replacement of faulty valves. PST systems can be designed as an integral part of a combustion system or easily retrofitted to an existing system.

PST is a proven, simple method for enhancing safe operation of a boiler system and should be considered part of every stringent safety program along with proper training, regular maintenance, and other recognized good safety practices. All of these inputs combine to reduce accidents, increase boiler uptime, and contribute to an increase in an operation's profitability. **TB**

Lampe is Product Marketing Manager -- Valves & Controls for Honeywell.

THE IMPROVEMENT OF MAGNETIC LEVEL INDICATORS FOR

DRUM LEVEL MEASUREMENT

BY **HAN DONG, CHIEF ENGINEER; JIANG CHONGMING, CHIEF ENGINEER; LI XUJUN, CHIEF ENGINEER**

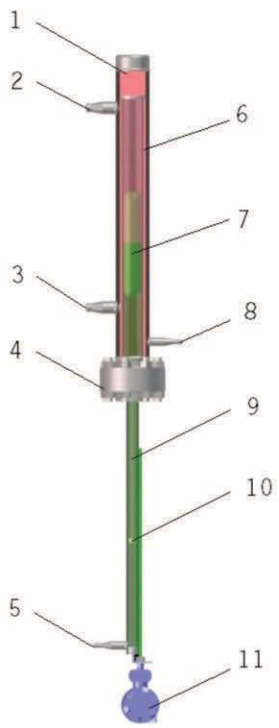


FIGURE 1 THE STRUCTURE OF MAGNETIC LEVEL INDICATOR FOR DRUM LEVEL MEASUREMENT
1. CONDENSATION CHAMBER
2. STEAM SAMPLING TUBE
3. WATER SAMPLING TUBE
4. CONNECTING FLANGE
5. DRAINAGE PIPING
6. STEAM HEATING CHAMBER
7. HIGH-PRESSURE FLOAT
8. DRAIN PIPE
9. CONNECTING ROD
10. MAGNETIC COMPONENT
11. MAGNETOSTRICTIVE SENSOR

A new type of magnetic level indicator for drum level with advanced architecture and technology (Figures 1 and 2) eliminates the effect of high temperature and high pressure, measuring accurately with stability, reliability, and low maintenance.

ADVANCED STRUCTURE TO MINIMIZE MEASUREMENT ERRORS

In this design, the steam sampling tube and the water sampling tube of the magnetic level indicator for drum level measurement are connected with the drum. The saturated steam in the drum flows into the steam heating chamber by the steam sampling tube. The steam heating chamber is connected with drum drop tube at the appropriate height by the drain pipe, so the condensation water from the saturated steam in the steam heating chamber flows in the drum drop tube.

When the unit is running, the temperature of the water in the drain pipe is lower than the temperature of the water in the drum drop tube. The density of the water in the drain pipe is greater than the density of the water in the drum drop tube. According to the principle of communicating vessels, if the connection point of the instrument drain pipe and drum drop tube is at an appropriate height, the water level of the instrument drain pipe is lower than the instrument, and the steam heating chamber is filled with saturated steam. The measuring water column in the instrument is surrounded with saturated steam in the steam heating chamber, which will prevent measuring water column from radiating heat outward.

At the same time, the condensation chamber will provide condensation saturated water into the measuring water column, replacing the measuring water column, improving the water quality, and further raising the temperature of the measuring water column. Since the temperature of the measuring water column is close to the temperature of the water in the drum, the level in the instrument is the same as the actual level in the drum. The

FIGURE 2 INSTALLATION DIAGRAM OF MAGNETIC LEVEL INDICATOR FOR DRUM LEVEL MEASUREMENT

FIGURE 3 MAGNETIC LEVEL INDICATOR

measurement is not affected by the environment as operating conditions change.

DESIGNING TO SOLVE THE PROBLEM OF HIGH TEMPERATURE DEMAGNETIZATION

The high-pressure float connected with magnetic component with connecting rod and the magnetostrictive sensor can measure the displacement of magnetic component. We can adopt the corresponding density compensation formula to calculate the measured value, in order to eliminate the error caused by the changing water density in the drum. At the same time, the water in the cylinder below the flange doesn't flow, so the temperature of the water reduces very fast through the heat dissipation, and the operating temperature of magnetic component and magnetostrictive sensor is near the ambient temperature (that is to say, no higher than 160). The structure optimizes the work conditions of the magnetic component and magnetostrictive sensor.

ABOUT THE MAGNETIC LEVEL INDICATOR

Measuring the drum level by magnetostrictive principle can measure drum level accurately in all conditions and full scale range. It can be activated quickly and is almost maintenance-free. Its attributes include high measuring precision, strong anti-jamming, smoothing measurement curve, and stable and reliable performance. It works very well during unit startup, shutdown period, boiler drainage, and boiler maintenance, providing reliability and accurate measuring signals, but the DP-type level gauge cannot work in the same conditions.

The measuring error is reduced with advanced heating structure design and corresponding density compensation formula.

The operating temperature of the magnetic component and magnetostrictive sensor is low with advanced structural design, avoiding high temperature demagnetization and improving working conditions of electronic components.

Water quality is optimized automatically by itself. Good water quality ensures instrument operating stability and reliability. With no leakage, components can be replaced simply and almost maintenance-free while running.

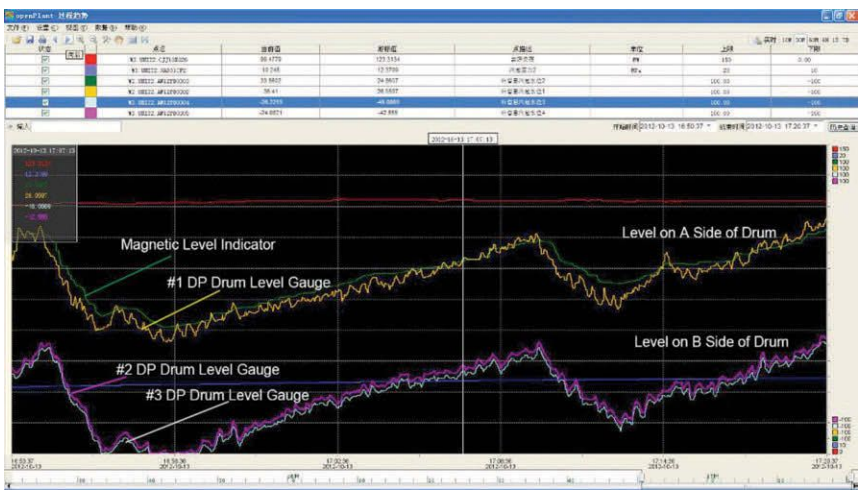


FIGURE 4 HISTORY CURVE OF MAGNETIC LEVEL INDICATOR AND DP DRUM LEVEL GAUGE

APPLICATION CASES

This magnetic level indicator for drum level measurement has been applied in some power plants.

On the A side of the drum, the yellow curve is the DP drum level gauge's curve; the green curve is magnetic level indicator's curve.

On the B side of the drum, the white curve is the DP drum level gauge's curve; the purple curve is another DP drum level gauge's curve.

The curve of the magnetic level indicator and the curve of the DP drum level gauge on the same side of the drum are almost coincident, and the curve of magnetic level indicator is smoother.

CONCLUSION

The research and application of magnetic level indicator for drum level measurement allows this magnetostrictive principle instrument to be used for high-temperature and high-pressure container level measurement. It provides another principle of instrument accuracy, stability, and reliability, with 4-20mA output signal. It perfects the configuration of drum level gages and improves the safety and reliability of drum level measurement and protection systems. TB

Cleaver Brooks®

How Logan Hospital took the pressure off rising fuel costs.

Completely integrated boiler solutions can generate results for you, too.
Logan Regional Hospital of Logan, Utah, reduced their gas consumption by 44% by pairing an ultra-efficient ClearFire®-V boiler with their existing Cleaver-Brooks boilers. Read about this case study and others at **cleaverbrooks.com/Logan** or call 1-800-250-5883 to locate your local rep.

Visit Booth #1523 at the AHR Show in Chicago