APTECH Update

Volume IV, Issue 1

June 2008

Affordable Technology to Reduce Emissions Effectively

APTECH CST LLC

Clean Stack Technologies

Introduction

APTECH CST is pleased to present timely information of interest to owners and operators of utility and industrial equipment concerned with emissions. With increasing regulations there will be an increasing demand for a cost-effective method for NO_X, SO_X, mercury, and chlorides emissions removal along with slag prevention. APTECH CST methods or proprietary techniques will greatly benefit units of any size but may be particularly attractive for small and medium size coal units where other technologies are cost prohibitive. We currently have two patents granted and one pending.

APTECH CST technologies will benefit those operators concerned about emissions, coal switching, etc, but do not want to spend valuable resources for scrubbers, SCR, etc. Wood, waste, and oil fired units have a similar need.

When compared to other available technologies, APTECH CST is far ahead in what can be delivered at an affordable price.

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Forensic Engineering News

Stove Flash Fire

On April 16, 2004, at approximately 5 p.m., two young boys were preparing to heat some vegetables on the stove top burner in the kitchen of their modular home located at a dairy farm south of Phoenix. Their parents were both away working; their father is a veterinarian on the farm and their mother is a nurse.

Both boys were standing in front of the stove. The stove was fired

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Petrochemical Service News

First RBI Study of Toyota Facility

In March 2008 APTECH completed the first ever RBI study of a car manufacturing facility. After providing an RBI training course at the Toyota manufacturing facility in Cambridge, Canada, APTECH

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Power Generation News

APTECH Breaks New Ground in Cycling

APTECH recently completed a two-phase project to assist a large utility company in addressing the future need to off-on cycle four large gas-fired units on a daily basis. The Phase 1 objectives were to:

- Quantify the adverse impacts of future daily cycling on future maintenance costs and forced outages.

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What We Expect to Achieve

We have summarized below what we can achieve with our technologies. Additional tests are planned to verify reductions of mercury, SO_3, and chlorides.

- Reduction of SO_2 >70%
- Reduction of NO_X >70% without the use of catalyst (SNCR)
- Reduction of SO_3 close to 100%
- Reduction of HCl close to 100%
- Reduction of Mercury. Not tested yet but >60% is possible with an ESP and close to 100% with a baghouse and will be tested soon
- No waste water produced
- Less than 0.4% parasitic power required (compared to > 2% for scrubber and SCR)

reductions in emissions (75% SO_2, 74% NO_X) can be increased even more

- CO_2 reduced by the difference in parasitic power
- Energy to the grid increased by the difference in parasitic power
- About 1/8th operating and maintenance cost
- Capital cost about 1/10th cost of scrubber and SCR on a medium sized unit
- Prevent or greatly reduce slagging in upper furnace and convective section which will reduce outages and increase availability and reliability
- Increase flexibility of using different coals

Test Results Completed and Planned

Initial testing for SO_2 and NO_X emissions has been completed at a coal-fired pilot plant at Southern Research Institute (SRI), an independent research facility which is DOE approved. The results were excellent!

The first few pages from the SRI report with Executive Summary are provided along with a sample of the data. Note SRI also says that the reductions in emissions (75% SO_2, 74% NO_X) can be increased even more.

APTECH CST expects to determine the extent of SO_3 removal. It is expected most, if not all the SO_3 will be eliminated. The client, who helped pay for these tests, was not interested in studying SO_3 control. Tests run on 1.4% sulfur coal also showed very good results with 62% SO_2 and 53% NO_X reduction.

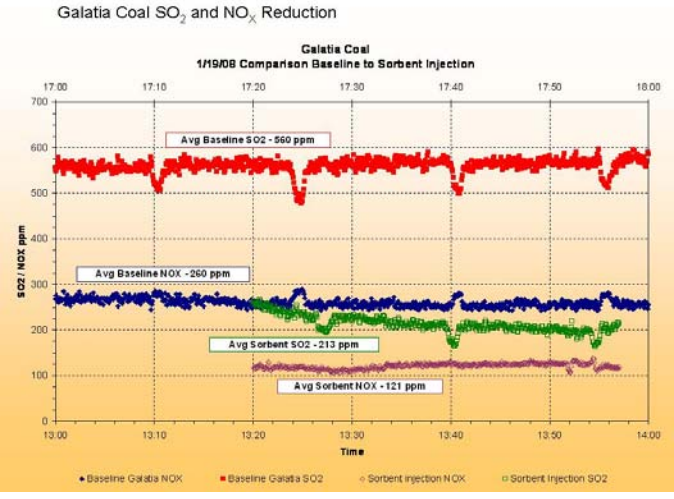
Prior CFD modeling by APTECH CST has shown Furnace Gas Exit Temperatures can be lowered below the Ash Fusion temperatures of all commercial coals which will reduce slag formation. Currently APTECH CST is designing a slag mitigation system for a small power plant.

Current Projects

Two projects are already in progress. The first project is for a wood burning power plant. The goal is to eliminate frequent outages required to remove slag. The second project is to install our emissions technologies on a coal unit. One of the goals is to replace a scrubber and eliminate the ponds and discharge of any waste water into the adjacent river. The technology will also allow our client to meet emission requirements for SO_2, SO_3, NO_X, chloride, and mercury. Our technology will also prevent any slagging that may occur with coal switching.

Costs

The capital cost of APTECH CST's technology is in the order of 1/10th the cost of installing a wet scrubber and SCR.



Affordable Technology to Reduce Emissions Effectively—Continued from Page 2

The O&M costs of our technology are also a small fraction of those for the conventional technologies, and the outage time required for installation is much less.

Most of the parasitic power needed to operate a scrubber and SCR, which can be in excess of 2.5%, will be eliminated. This is equivalent to reducing CO_2 emissions by about 100,000 tons/year on a 500 MW unit.

Because of the low estimated capital and operating costs of our technologies, future emissions trading may be of interest to some operators.

APTECH CST's technology can also be used to reduce mercury emissions, again at a small fraction of the cost of conventional technologies.

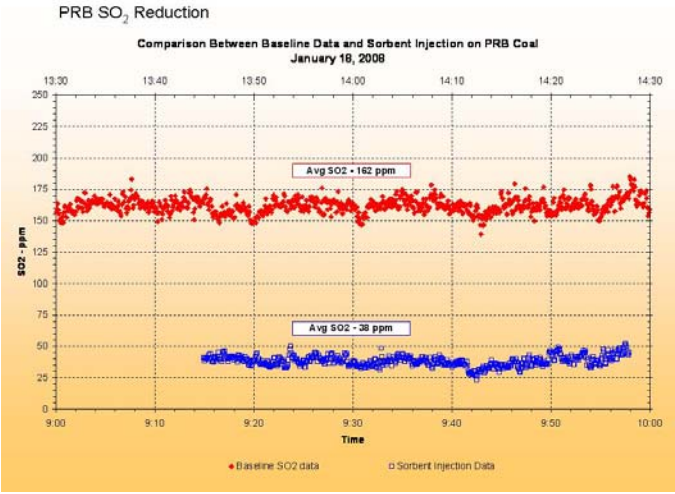
Summary

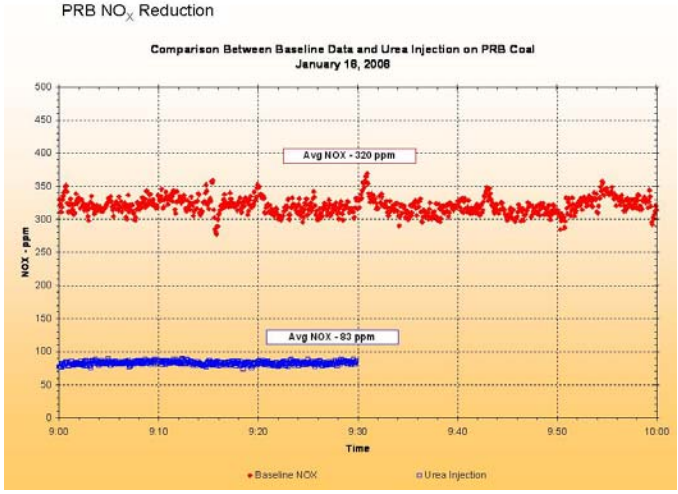
APTECH CST has successfully demonstrated a low cost technology to reduce SO_2, SO_3, NO_X, mercury, chlorides, and prevent slagging. Reducing the parasitic power will also improve heat rate and reduce CO_2. With the same amount of money, these technologies can reduce about 9 times the emissions. This should be especially attractive for coal units 300 MW or less that will find it hard to economically justify the installations of scrubbers and SCR systems.

APTECH CST is confident this is the most cost-effective and best available technology for new or retrofit applications, and will be extremely useful, effective, and inexpensive compared to scrubbers and SCR systems, and mercury reduction. The time to install is short. The cost per quantity of emissions removed is extremely attractive. There is also the added benefit of not wasting power to run these expensive alternatives.

Contact Us

For more information about how we can apply these technologies to meet your needs, go to www.aptechcst.com or contact Terry Rettig at trettig@aptechcst.com (408-745-7000).





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APTECH Completes First RBI Study of Toyota Manufacturing Facility—Continued from Page 1

was asked by Toyota's head office in Kentucky to bid on providing RBI implementation services. Following the successful bid, Tim Malone spent 4 days at the Cambridge plant completing inspections and collecting data on the facility's piping systems. Tim then completed a risk assessment of the piping systems using RDMIP software and a business risk model. The results of the study will provide guidance to Toyota for their future refurbishment efforts at the facility. It is hoped that the project will eventually be extended to all six of the Toyota manufacturing facilities in North America.

Petrochemical Service News

APTECH Participates in Middle East Pipeline Conference

Phillip Nidd from the APTECH Houston office is one of the renowned industry speakers at the Africa / Middle East Oil and Gas Flow Assurance Summit 2008 in Cairo, Egypt. Some of the key topics for discussion include:

- Ensuring flow and production – Challenges met, Challenges remaining
- Production chemistry / engineering, flow assurance and operability issues
- Flow assurance problem analysis to screen the best technology solutions.
- High Temperature and High Pressure (HT/HP)
- Solving gas hydrate problems in subsea pipelines
- Pipelines, Technology, Laying and Operation (Onshore and Offshore)
- Integrity Management
- Shutdown and restart strategy options

Power Generation News

APTECH Opens New Florida Office

APTECH has hired Douglas Hilleman, starting a new office in Jupiter, Florida. Doug has 38 years experience in the Power Industry as an engineer/supervisor. Experience includes general boiler design including auxiliary equipment; power plant maintenance, boiler, and balance of plant; power plant operation; plant reliability improvements; process management and improvement.

APTECH Breaks New Ground in Cycling Services—Continued from Page 1

- Identify specific components that are most susceptible to cycling damage.
- Identify cycling countermeasures that can be employed to reduce cycling damage and maintain current levels of reliability.
- Estimate the benefits of each candidate cycling countermeasure based on detailed study of past cycling costs for individual components, and on stress analyses to determine the relative impact of the countermeasure in reducing these cycling costs.
- Estimate the costs of each candidate countermeasure using industry input on costs.
- Determine the benefit/cost ratios of each candidate countermeasure, and recommend those that should be implemented.

This project was managed by Paul Grimsrud, and conducted by Steve Lefton, Phil Besuner, Jim Yavelak, Dwight Agan, and Joe Lesiuk. Due to the very tight time schedule, 2.5 months total duration, all parties needed to work fast and efficiently. The draft final report was delivered on time, and the client was very pleased with the quality and comprehensiveness of the report.

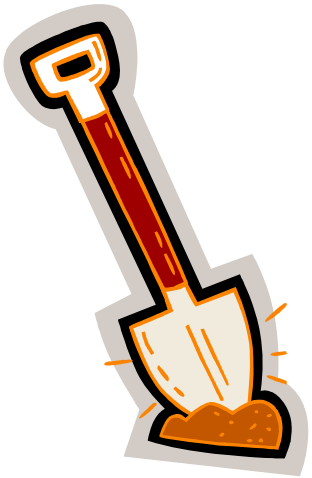
Phase 2 of APTECH's work was to develop detailed functional and conceptual specifications for use in a Request for Proposal the client sent to potential companies that will do detailed design and implementation of the countermeasures. The two countermeasures are briefly described below.

Nitrogen Blanketing System

A nitrogen blanketing system will be designed to reduce the level of dissolved oxygen in the condensate fed to the existing condensers during cycling operations and to the boilers during boiler fill to reduce the dissolved oxygen to 200 to 400 ppb. The system will be designed to maintain the dissolved oxygen level in this range throughout the range of anticipated cycling conditions for the unit.

Drain System for Certain Parts of the Boiler and Main Steam Line

The drain system will provide positive condensate removal/warm-up through the heat recovery area drains, convection pass outlet header drains, primary superheat outlet header drains, and main steam line drains during startup and at or below 90 MW. During these periods, condensate and steam will be automatically extracted from these



systems, the fluid pressure and temperature reduced for injection into the condenser hot well, below the low water level at low loads, to provide heating and deaeration of the hot well condensate. These drain systems will be sized to effectively remove condensate from steam cooled enclosures including the primary superheater and facilitate a balanced temperature warm-up of the subject boiler areas. In addition, it will benefit the startup water chemistry by providing deaeration of the hot well condensate. The drain will flow (estimated to be 400,000 to 575,000 lb per hour) to the hot well and increase the boiler steam flow and resulting steam temperature balance in the boiler superheater, while providing cooling steam to protect the superheater.

Steve Lefton managed this ground breaking effort and was supported by Dwight Agan. The client used APTECH's specifications for solicitations to prospective bidders, and plans to install the countermeasures during the 2009 and 2010 overhaul outages at the four units.

Stove Flash Fire—Continued from Page 1

by natural gas supplied by the local utility's underground pipeline to the residence. There were four stove top burners and one oven burner, all lit by standing pilot flames. There was no electricity supply to the unit. At the very instant the older boy, 12 years old, turned on one of the stove top burners, a flash fire erupted and momentarily engulfed him and his younger brother, 4 years old. There was very little overpressure associated with the flash fire: the walls of the modular home shook but there was no structural damage. Even the fire damage was minimal: only some scorching of the walls, ceilings, and cabinets in the kitchen and the melting of some plastic flowers and curtains there. Unfortunately, the flash fire was large enough and hot enough that both boys were seriously burned. Their burns were so severe that they would be impaired for life and would require numerous surgical procedures for many years while they were in their growing stage.

In July of 2004, APTECH was retained by a plaintiff personal injury law firm in Phoenix to determine the cause of the flash fire at the stove. This law firm represented the two boys and their family and specializes in children burn cases. They have been successful over the years in winning cases and setting up trust funds for the future care of the victims they have represented.

Four years later, in March 2008, this case went to trial in Florence, Arizona, in Pinal County southeast of Phoenix and located near the famous Superstition Mountains and the Lost Dutchman gold mine. In the intervening 4 years, a very adversarial technical battle was waged between our law firm client and the manufacturer of the stove.

APTECH inspected and tested the stove on several occasions in 2005, 2006, and 2007. We also tested two identical exemplar stoves in our Sunnyvale, California lab. We quickly determined in 2005 through nondestructive testing of the incident stove that there was a small gas leak in the pilot gas train for the oven burner. This leak caused the stove to violate ANSI standards for maximum pilot gas flow when the oven is off. It would take 2 more years before the cause of this leak was determined.

In order to determine the source of the gas leak, we recommended a destructive evaluation protocol. The defendant, the stove manufacturer, stone-walled for 2 years on our recommendations, and tried to argue that the flash fire was not fueled by natural gas but rather by a bottle of isopropyl alcohol which was found at the fire scene. We and other experts for the plaintiff attorneys agreed that the actual flash fire had no characteristics of an alcohol fire, but instead was very consistent with a natural gas fire.

Finally, in the Spring of 2007, joint destructive testing of the stove was conducted with both plaintiff and defendant experts present. The gas leak was found to come from a pinhole corrosion leak in the 3/16-inch aluminum tubing that supplied natural gas to the oven pilot. This particular tubing ran along the top of the stove, under the stove top burners. The tubing was unshielded from contamination by cooking activity on the stove top. Metallurgists from both sides agreed the pitting corrosion in the small, thin-wall aluminum tubing was chloride corrosion. It is well known that aluminum is susceptible to corrosion from salt water environments, and most food products cooked on the stovetop have significant salt and moisture content.

The jury award was the largest ever awarded

Following the discovery of chloride corrosion on the oven pilot gas line in the subject stove, we examined nine exemplar stoves. We found the same pitting corrosion, at the same location, in all nine exemplars. One exemplar had through-wall corrosion very similar to that in the subject stove. We took the position that this was clearly a design and manufacturing defect.

Stove Flash Fire—Continued from Page 1

We also found another design defect in the oven pilot gas delivery train, related to the method used to control the rate of gas flow. An orifice technique was used by the manufacturer, and we determined the orifice was located in the wrong position. Had it been in the correct position, the flash fire would not have occurred even with the pinhole leak path present.

Late in 2007, the defendant still refused to settle so, as mentioned above, the case went to trial in early 2008. The plaintiff's position was that the stove had been leaking unburned natural gas through the corrosion pinhole in the oven pilot gas tubing for hours and even days. This fugitive gas accumulated in and around the stove which was tightly confined in the small kitchen of the modular home. When the boys turned on the stove top burner, it ignited the accumulated unburned natural gas which resulted in the flash fire.

The defendant's position was multifaceted. They first argued that the flash fire could not have been caused by the leaking natural gas because the leak was too small. They also argued that therefore the flash fire must have been caused by the alcohol, which they claimed was splashed around the kitchen by the boys (contrary to sworn statements by the boys and their parents, and contrary to all fire scene evidence that indicated it was impossible for alcohol to be the cause).

Fact witness and expert witness testimony was heard by the jury for several weeks. The jury then adjourned for deliberation. They returned to the court room in 2 days with the following verdict: the flash fire was indeed due to the leaking natural gas, resulting from design and manufacturing defects which were the responsibility of the stove manufacturer; an award of $43 million was recommended for the pain and suffering of the family and the future lifetime care for the two boys.

APTECH personnel who worked on this case included Kimble Clark, Richard Schreiber, Robert Gialdini, Paul Buehler, Robert Hedgecock, and Philip Lindsay. The jury award was the largest ever awarded in the Superior court of the State of Arizona, County of Pinal.

Petrochemical Service News

APTECH Offers New Design Services

APTECH Offers New Design Services

The APTECH Houston office now provides design and operational support services in the pipeline, gas, LNG/LPG, refinery and petrochemical industries. These services include:

- Plant Equipment and Facility Design
- Design Reviews
- Design Verification
- Fitness for Service Evaluations
- To conduct design evaluations, APTECH has the in-house capabilities to use a range of software design tools. These include the following:
- CODEWARE COMPRESS® ASME SECTION VIII DIV 1 & DIV 2 ANALYSES and HEAT EX-CHANGER MODULE(S)
- PRG NOZZLE Pro
- COADE: CAESAR II®
- COADE: CADWorx Plant Professional®
- PVElite with CodeCalc
- ANSYS

Petrochemical Service News

APTECH Welcomes the Following New Employees

APTECH would like to welcome the following new employees to the Houston office:

Steve Cooper – Mechanical Engineer and Manager of Operations

Walter Wincheck – Senior Inspector (API 510, 570)

Petrochemical Service News

APTECH Assists with the Raising of a Sub-Sea Pipeline

APTECH engineers Bill Witte and Steve Cooper spent 5 days in the Gulf of Mexico onboard a salvage vessel to document the raising of a sub-sea pipeline involved in a litigation project. Following the successful retrieval of the pipeline, APTECH is now responsible for the testing and inspection of the pipeline section.

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