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Digital Insights Deliver Tangible Results in Cooling Water Systems & Tangible Life Safety Features in Recovery Boiler Systems

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Abstract:

1. *Cooling water systems were subjected to immense stress in spite of being a critical asset in a facility. The need to provide critical insights to deliver tangible results became imminent. The critical part was monitoring and testing of parameters in a cooling system. Ackumen™, a state-of-the-art technology designed to bridge this gap in the industry, was utilized to monitor, analyze and deliver insights on critical parameters in the cooling water system. Actionable insights generated by Ackumen™ and the Insights Lab resulted in reduction of corrosion in the system in line with international standards. Using Ackumen resulted in improved asset preservation, efficiency, health and safety and budget tracking.*

2. *Recovery boiler systems are subjected to a potential risk of explosion when there is a water tube leak which upon reaching molten smelt creates high temperature and pressure conditions. The critical aspect is to find these leaks in time to avoid accidents, injury and potential loss of life, and high costs related to emergency shutdown procedures (ESP). Recovery Boiler Advisor (RBA) is a digital tool born out of this necessity to avoid such accidents, ESPs and to protect the mill's reputation. Recovery Boiler Advisor is a state-of-the-art software which uses existing instrumentation as per BLRBAC. RBA not only detects leaks in early stages, it also provides valuable information on the boiler emissions and other monitoring aspects. Its efficiency has an exemplary track record in real-world applications. It's a complete package to help operators run to operate a recovery boiler with peace of mind along with substantial savings in avoiding costly emergency shutdowns, production loss, extended damage costs and manpower.*

Key words : Insights, Reduction in Corrosion, Asset Preservation, Improved Efficiency, Health & Safety, Budget Tracking, RBA, BLRBAC (Black Liquor Recovery Boiler Advisory Committee), Early Detection, Health & Safety, Peace of mind with substantial savings.

1. Ackumen Cooling Management:

Introduction

In today's economy, nearly every discussion about the business goals of a particular enterprise will touch on water in some manner. Businesses that consume water for utilities purposes, particularly in the commercial and institutional sectors, may be more concerned about water than ever before. Several factors are contributing to this increased attention to water, including corporate sustainability expectations, regulatory restrictions due to drought or conservation efforts, cost of fresh water and disposal, or efficiency initiatives to reuse water and reduce waste. Whatever the reason or combination of reasons, the result is increased attention to water use patterns and pressure to identify opportunities to use less water. At the same time, digital technologies have become pervasive in our world, and the cost has correspondingly decreased to such a point that it is now feasible to monitor many of the key parameters associated with water. Corrosion is one such metric that also has significant impact on operation, efficiency, and longevity of water systems and system components.

Without monitoring and automation enabled by modern digital transformation, monitoring of hydronic systems was reactionary at best. Oftentimes the impacts on system operation and asset protection were not visible until equipment was shut down for inspection. Impacts of corrosion, which can lead to inefficiency in heat transfer and reduced asset life, had real and considerable financial impact. When reacting to past conditions, owners were unable to take corrective action until after the damage had been inflicted.

Material and Methods:

In this paper, a case study is presented in utilizing digital technologies, coupled with human interaction, to provide actionable insights that lead to tangible results. This was achieved in two parts. Leveraging Ackumen™ Cooling Management, a state-of-the-art technology for managing cooling water systems, with automated controls and advanced sensors to provide data is the first part. An Ackumen Cooling Management is paired with the Insights Lab, a team of experts monitoring systems 24/7/365 with engineers trained as experts in reading results, identifying root causes, and providing actionable insights. This combination leads to simple, transparent, and efficient cooling water system management.

This case study was the result of an Ackumen Cooling Management (ACM) system installed at an industrial manufacturing facility that uses cooling water for production of their products and operates 24 hours a day, 7 days a week. Prior to installing Ackumen, an outdated control system was in place to provide basic information with manual intervention every shift for both testing and system control. The facility management was interested in upgrading their feed and control system with our state-of-the-art platform and wanted us to prove our value.

Installation of ACM was performed and initially used to monitor current conditions with previous control methods for the first 30 days. This provided baseline data for the case study and customer trial. At this site, ACM monitored the following parameters, with data collection every minute:

- Conductivity
- pH
- Oxidation Reduction Potential
- Product concentration
- Product dose
- Temperature
- Mild steel corrosion rate and copper corrosion rate (Instantaneous measurements)

A month later, ACM took over control of chemical feed, and our Insights Lab provided their monitoring and analytical expertise to optimize operation. Comparing the data collected over the first 30 days with the next 45 days provides a clear picture of the gaps in system management with the previous control method and improvement in operation with ACM.

Results and Discussion

Proper feed and control of scale and corrosion inhibitor directly impacts both system efficiency due to heat transfer and asset life due to metal loss. Chemical feed rate can be determined by using several indices, software, proprietary calculations or other means and varies by chemical product and system parameters. Mild steel corrosion rates are usually compared to industry key performance metrics in mils per year (MPY). Most owners use 3 MPY as the maximum allowable corrosion rate.

Data from the comparison of the first 30 days with the 45-day trial shows a wide variance in both chemical feed and mild steel corrosion rate. Average mild steel corrosion rate over the first 30 days was slightly above 3 MPY. Once control was initiated by ACM at the beginning of the 45-day trial period, a sharp change in chemical control can be noticed within the first 48 hours through the use of our digital technologies, software, and Insights Lab expertise. During the corresponding 45 days, there was one slight upset that was quickly identified and remedied remotely by our team, without requiring the owner's employees' interjection. Corrosion rates were also considerably lower, with an average MPY of 0.3, resulting in a 90% reduction in corrosion rate and within the excellent result range of less than 1 MPY.

2. Recovery Boiler Advisor

Introduction

Tube leaks can cause destructive boiler explosions. Operators need good real-time bottom-line information. The Kraft Black Liquor Recovery Boiler is an essential and critical process unit in the wood pulping process. Its functions are three-fold: It recovers the sodium salts that are used in the pulping process; it consumes a significant waste product of the pulping process; and it generates high-pressure steam that is converted into electrical power. A pulp mill faces a quick shutdown or significant capacity reduction when a recovery boiler is unavailable.

The recovered sodium salts accumulate in a pool of molten material near the floor of the recovery boiler, together with the char bed, a large heap of burning organic material left over from the pulping process. The presence of this inevitable pool poses a significant safety hazard, as any water that gets in contact with the molten salt may lead to a violent explosion in the boiler. Over the history of the Kraft process, just in North America alone there have been over 50 documented recovery boiler explosions. Anyone near the boiler runs a serious risk of severe injury or death caused by escaping steam. In addition to these human casualties, significant economic losses are obvious. As part of the explosion avoidance plan, the recovery boiler can quickly be emptied out through a number of automatic drain valves. This draining procedure, commonly referred to as an ESP for Emergency Shutdown Procedure, must be initiated by the operator in the control room. An ESP is the better of two bad options, since an explosion can be avoided, but the boiler will be out of service for over a day and must be cleaned out at great expense. Further, the ESP causes great mechanical stress in the boiler, increasing maintenance costs and shortening its life expectancy.

The recovery boiler operator is normally very well aware of the danger; the instructions are to initiate an ESP whenever there is a potential contact of water with the smelt bed. On the other hand, the economic consequences of an unnecessary ESP are also significant. This poses the operator with a great dilemma; be too careful and initiate an unnecessary ESP or run the risk of not having prevented an explosion. For this reason, it is of great importance to give the operator the best possible insight when assessing any unusual operational situation. A well-informed operator is more likely to make the right decision in a tough and confusing situation.

Materials and Methods

The American Paper Institute, now part of the American Forest and Paper Association (AFPA), assembled a task force of recovery boiler experts to specify and create just such a system. Its focus was to help operators correctly identify boiler tube leak situations through a computerized rule-based system that has access to real-time boiler data. This task force described how large tube leaks could be identified from live operating data. Different scenarios were developed for leaks in different sections of the boiler, like furnace wall, generator bank, superheater bank, economizer section, or external leaks. The basis of the RBA had been created.

BLRBAC collects data on all critical incidents and reports to its membership as part of the effort to share knowledge and improve boiler safety. Many boiler incidents involve water leaks. In the incident cited in the table below, Buckman's RBA, the Buckman RBA detected a leak and directed the operators to confirm it and conduct an orderly boiler shut-down for repairs. Undetected, the leak would have continued and grown, possibly leading to an emergency shutdown procedure (ESP). In the BLRBAC data, most water leaks are detected by operators' observation during their rounds. Some are first detected by leak detection systems, with RBA being the significant leader in frequency of leaks first detected.

ECONOMIZER	
Location:	North America
Unit	#1, RU, 1965, CE DE 0193 2-drum, front-slope hearth,1984 Tampella extended large econ
Unit Size	2.35 MM lb ds/day; 296,000 lb/hr steam at 900 psig 810ºF, 1000 psig design
Downtime hrs, leak/total:	26.6
ESP?	No
Leak/Incident Loc:	Extended econ-1/8" pin hole outside of first bend above bottom header, tube 21 row 9;
How discovered?	Lead detection indicated
Wash adjacent tube:	No
Root Cause:	Dissolved oxygen pitting
Leak detection:	Yes. Buckman Recovery Boiler Advisor Nea Jan 2014. Gave initial detection.
Bed cooling enhance	no
Sequence of events:	Day1: Leak detection indicated. Did walk down inspection. 20:00 Saw water in new economizer hopper. Began to burn the bed out 23:35 Fire out. Orderly shut down. Day2: Repairs complete. Hydro Ok. 20:30 Fire in unit.
Repair Procedure:	Tube cut off & plugged at top & bottom headers. Welds dye penetrant tested & unit hydro'd
Future Prevention:	Detailed UT inspection palnned for October 2014 annual outage to identify specific areas

From the Critical Incident report, there was a recording of the alarm the operators saw. The light blue line has crossed the critical red line, indicating an alarm. Other graphs detail the state of the feedwater and steam flow, the air and fan operations, the boiler steam drum level, and the drum pressure. In the lower right corner is the "mismatch correction" showing that while RBA always "learns" what is normal for the boiler, it must compensate for instrument drift and mismatch. When it can no longer compensate for those changes, an alarm may be indicated. Where the yellow and blue lines diverged in the correction screen, operators saw the beginning of the leak.

Operators saw another chart that shows a cross-section of the tube failure from the incident report. The failure was very small and no ordinary water balance or chemical balance system would have identified this leak. It saved the mill from performing a costly ESP, and they were able to manage an orderly-planned shutdown, made quick repairs and got back on-line without affecting production.

Results and Discussion

Using the large volume of available real-time information, like flows, pressures, temperatures, and analysers, but also the status of fans, pumps, valves and individual soot blowers, the capability of the RBA is not limited to leak detection. Over the years, mostly at the request of existing users, emission prediction and monitoring, boiler plugging prediction, black-out monitoring and other useful functionality was added. Special client requests can be considered.

Cost – Benefit Analysis

As with all safety-related investments, a cost-benefit analysis can only be made by using some statistical facts and methods. The BLRBAC industry group (Black Liquor Recovery Boiler Advisory Committee) has records that show that over the past 30 years, there has been one explosion for every one hundred operating years. This number has recently declined, to some extent because leak detection systems are being installed.

The benefits not only include the prevention of explosions, but also the prevention of unnecessary ESPs. Assuming the cost of an explosion to be $50 million and the cost of an unnecessary ESP $500,000 (risk is once every 5 years), the average annual risk is 1/100 x $50 million + 1/5 x $500,000, or $600,000 per year. Of course, these numbers are rough guides only because insurance reimbursements, lost production, etc. affect the annual risk. But it clearly illustrates the approach to demonstrating the benefits.

Many operators also derive a peace-of-mind from the presence of a Leak Detection System. This is of course a non-quantifiable, but undoubtedly important benefit.

Conclusion:

Ultimately, the integration of digital technology in these systems not only optimizes operations but also reinforces safety, paving the way for a more reliable and efficient industrial environment. In cooling water management, these insights translate into tangible results such as improved efficiency, reduced operational costs, and minimized downtime. In recovery boiler systems, the implementation of digital tools provides enhanced life safety features, real-time monitoring and predictive maintenance to prevent accidents and protect the well-being of personnel.