Heat Treat 2017: Proceedings of the
29th ASM Heat Treating Society Conference
October 24–26, 2017, Columbus, Ohio, USA
https://doi.org/10.31399/asm.cp.ht2017p0284

Software Solutions for Streamlining Furnace Compliance

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Abstract

This paper summarizes how technology used in every day applications is also being applied to advance innovation in pyrometry services and ensure compliance with AMS 2750 and CQI-9. The author also covers how innovation could continue to develop in the future, keeping furnace compliance aligned with the ever-increasing technology advancements of the aerospace and automotive industry

Introduction

Technology around us is expanding quickly, furnace compliance standards continue to develop and are increasingly complex, what innovative tools are heat treaters using to tackle furnace compliance?

This paper presents how every day technology is being used for innovative solutions for furnace compliance technology. The use of hand-held technology, cloud technology, software as a service (SaaS), Quick Response Code (QR Code), and developments for Application Programming Interfaces (API) are all being used to drive innovation for furnace compliance and will be discussed in the following paragraphs. Also covered are innovations of in-house solutions, third-party vendor solutions, and advancements in instrument technology for data loggers and thermocouples.

The possibilities in technology developments are exciting and, when applied, will chauffeur the industry into the forefront with better service to customers, reduced NCR's, more time for value-added analytics, and alignment to the high innovation expectations of the aerospace and automotive industry.

Yesterday's Furnace Compliance Process

Most industry specialists when discussing processes for furnace compliance would describe a scene with a technician, either in-house or external, standing next to a furnace with a clipboard in one hand and a meter in the other. The technician is writing down several as-found & as-left temperatures, diligently calculating and interpolating correction factors for sensors and field test instruments at several different test points and adjusting. Later that day, the technician inputs all the data points into an Excel report, checks and verifies calculations, turns to pdf and then emails the report to the Quality Assurance manager (QAM) for sign-off. If it's a technician from an external lab, the report is reviewed by the lab QAM who checks and verifies calculations, edits may or may not be made, and then a new PDF is sent to the customer for the heat treater's Quality Manager to sign-off. The QAM relies on the technicians to know and carry out 100+ pages of Nadcap and/or CQI-9 compliance standards, stay updated with the standards, be highly familiar with the customer's furnaces and instrumentation, ensure scheduling for on-going tests is done efficiently and accurately, and to avoid accidental human error. These technicians, the tests they conduct, and the data in those tests is relied upon by the heat treater to ensure a smooth audit process and more importantly, repeatable product quality.

Fortunately, there are many well-qualified technicians out there, nonetheless, innovations are happening that can streamline furnace compliance processes, reduce human error, and ease audit processes.

Everyday Technology Available Today

Innovations in the industry today are a result of acceleration in technology advancements that are used in everyday life and applied to industrial processes. Developments in computing power, cloud technology, mobility and mobile apps, particularly in the last 10 years have significantly opened possibilities to rethink how furnace compliance can be done.

Table 1 on the next page highlights familiar everyday technology and how it is being applied to advancements in heat treat processes today. The most prevalent include hand-held devices in conjunction with the use of cloud technology and software-as-a service (SaaS). Cloud computing has allowed the computing power of a hand-held device to increase exponentially. Data can seamlessly move to and from a mobile phone or tablet into the internet-based "cloud" where complex processing can be run and data storage is unlimited. The convenience and mobility of hand-held devices married with high computing power has inspired more applications to be developed for commercial and industrial use. These software applications can now be maintained with a software service provider, no longer requiring the user to maintain and update bulky software programs. The software service provider sends updates automatically to the users. Within the heat treat industry, for example, technicians can use software applications on hand-held devices to collect furnace compliance data on-site, streamline calculations and pass/fail results, and improve approval and reporting processes.

Table 1. Heat Treat Applications of Common Everyday Technology

	What is it?	Developments	Heat treat process application
Hand-held devices	iPhone, iPad, Android, Smart Tablets	Computing power and availability of easily downloaded apps. Battery life expanded.	Furnace technicians can use software to collect data on-site and calculate complex compliance requirements in the palm of their hand.
Bluetooth Technology	Wireless technology for transmitting data over short distances	Readiness of the Internet of Things (IoT) technology with increasing range, speed, data broadcasting capacity.	Opens the possibility for furnace instruments and sensors to talk to each other.
Cloud Computing	Internet-based computing with shared computer processing. Allows processing power and storage to be unlimited.	Complex processing and data storage is no longer limited to the computing power of a device. Security encryption technology continues to strengthen.	On-site straight through processing of compliance assurance and reporting can be done through a hand-held. Data can be connected enterprise wide without expensive internal network solutions.
Internet of Things (IoT)	The interconnection of everyday objects or devices that can connect to the internet	Industrial IoT applications and middleware platforms to move data between physical and digital realms	Predictive analytics and furnace maintenance as instruments become interconnected
Software as a Service (SaaS)	Subscription based software that alleviates the requirement for software to be downloaded in a closed system and maintained by the user.	SaaS technology allows the software developer to maintain and push updates to the user.	Automated SATs, Calibrations, TUS, audit reporting, scheduling, furnace dashboard monitoring for sites or enterprises
Quick Response Codes (QR Code  s)	Originally designed for automotive industry to track vehicles and parts. Scanning provides the user access to lots of data and information.	Continuous development to improve storage capacity and functionality. Increasing popularity in everyday uses from industrial processing to consumer marketing.	Some manufacturers, of thermocouples, particularly in Europe, are using QR codes to share correction factors with the user reducing transcription errors.
Radio-frequency identification (RFID)	Device uses electromagnetic fields to automatically identify and track tags attached to objects.	RFID tags are being used to track products in a manufacturing process to animals and pets, clothing, and other possessions.	RFID tags can be used to store thermocouple correction factors which can then be accessed by software applications.
Application Programming Interface (APIs)	Allows one software product to talk to another. Removes barriers to access data allowing for sharing and thus quicker innovation.	APIs designed with "machine learning" allows the programs to update its processes with new knowledge in mind. Publicly available APIs using common design patterns and languages are fueling further innovation.	Data logger reporting software can connect to in-house or third party furnace calibration or monitoring programs.

Putting It All Together – Vision for the future

Imagine your furnace as a high functioning computer that self-calibrates, performs its own TUS and SAT tests. The furnace, test instruments and test sensors are interconnected to talk to each other so that real-time calibrations, SATs and TUS can be performed. Test data is streamed and organized into a dashboard viewed on a hand-held device or personal computer by the enterprise Quality Assurance Manager (QAM) across the globe. The dashboard shows a 3D image of furnace temperature and atmosphere, and reports real-time on instrument adjustments automatically made to keep the furnace in compliance. The self-calibrating furnace may seem far away, but consider several scenarios that are right around the corner:

Scenario 1: Quality Manager receives a notification on his phone or pc that one of the furnaces is at risk for non-compliance in the Tucson, AZ plant. He clicks on the notification and sees that Thermocouple XYZ is about to fail. With another click, he schedules a technician or maintenance person to survey the furnace and replace the thermocouple before it fails, avoiding non-compliance and the cost of a future scrap load.

Scenario 2: A pyrometry lab technician has been scheduled for calibrations for one of his long-time clients but has a personal emergency that takes him away. The technician manager quickly steps in and schedules another technician to do the job. All the furnace and instrument specifications, plus calibration processes and reporting processes, are automated in the software system making it easy for another technician to step in and keep the lab's commitment to customer service.

Scenario 3: Enterprise QAM wants to review furnace compliance history across the company's 10 North American plants. He opens his furnace compliance dashboard software on his pc or hand-held and sees most of the plants are meeting or exceeding expectations for consistent furnace compliance over the last several quarters, however two plants are struggling with multiple warnings. He prioritizes his time and travels to support the two struggling facilities.

Scenario 4: Commercial heat treater is attempting to gain the confidence of a potential new client. He sends a link with username/password to the prospective client allowing them to see the specifications and compliance history of the furnaces that would be running his/her product and their real-time compliance status. The comprehensive response and superior compliance results quickly wins the confidence of the new client.

Scenario 5: Aerospace plant is preparing for a Nadcap audit and wants to have confidence that all furnaces are compliant with AMS-2750E. The QAM opens the furnace compliance dashboard and instantly sees that all his/her furnaces are and have been compliant since their last Nadcap audit.

Scenario 6: A commercial heat treater processes several rear axle cross pins for a major auto maker, who later announces a recall of its vehicles due to "improper heat-treatment of the rear axle cross pin". The SCADA system validates that the correct heat treatment processes were carried out, but lawyers are demanding validation that the furnaces used were compliant with CQI-9 at the time of heat treatment. The heat treater's furnace compliance dashboard quickly and easily provides an unlimited historical real-time indication of all furnaces and their compliance to all required specs.

Software Solutions Available Today

The vision scenarios discussed in the previous section are not all available today, but the industry technology is beginning to move quickly given the advances that have already happened in the everyday technology discussed earlier in the paper. Table 2 highlights technology being used in the industry today.

The level of advancement for furnace compliance varies among heat treaters and pyrometry laboratories. Many heat treaters and labs still use hand written results, transcribed into an Excel-based tracking process, and then a digital document (PDF) reports are electronically distributed for approval and signature. Some heat treaters and labs have built in-house systems and software to improve tracking and storing of historical results. The challenge with this choice is the maintenance and available focus as compliance technology development is not likely to be the main priority or expertise for a heat treater. The benefit though to an in-house system is full control and customization ability.

Third-party software, comprehensive enough to cover the intricacies of furnace compliance, have not been available up until recently. There are two primary providers available; C3 Data's eCapture and Eurotherm's eCAT and EOS Advisor. These third-party providers offer SaaS alternatives for heat treaters and labs to streamline furnace compliance processes and reduce human error inherent in processes that are not automated. The benefit of third-party SaaS is the ability to participate in the continued enhancement and development of the software. Since software development is the primary focus of the providers, heat treaters and labs can focus on their core competencies and benefit from continued innovation provided through the software subscription. However, significant customization is not commercially feasible at this early stage of development and thus heat treaters and labs may need to be flexible in their approach and adapt new processes to gain the time and accuracy benefits of the software applications.

The developments listed in Table 2 "Technology Available Today" is likely to merge over time either directly or through partnerships to create a broad comprehensive solution for customers. 3D furnace compliance modeling will enhance the user experience and improve the furnace monitoring process. Data logger enhancements in reporting can be connected into furnace compliance software to easily generate consolidated audit and monitoring reports. Advancements in the reporting of thermocouple correction factors through QR codes can also be tied directly to SAT and TUS software reducing the risk of human transcription error and improving feedback on thermocouple lifespan and performance to the thermocouple manufacturers.

Table 2. Heat Treat technology available today

Technology Available Today	Description	Pros	Cons
In-house systems for better furnace compliance reporting and scheduling	Heat treaters and labs have built in-house systems for better tracking of furnace compliance results	Fully in-control of design development, thus fully customizable	Key man risk, limited time and attention, expensive to develop and maintain if not scaled.
Third-party software for furnace compliance reporting, testing, and scheduling	Two comprehensive systems for automated processing of calibrations, SATS, and TUS are offered (C3 Data's eCapture & Eurotherm's eCAT & EOS)	Comprehensive solutions, focused on continued, enhancements, subscription based software limited financial risk for sites and labs	Due diligence needed for heat treaters and labs on applicability, limited customization
3D furnace compliance modeling	Aggregation of data points for temperature & atmosphere visually allows QM analysis of likely compliance or failure	Visual aggregation of data provides useful management information for monitoring furnaces	Limited for use as a preventative maintenance tool, not required for compliance.
Thermocouple advancements	Advancements include; early stage wireless, less thermal drift, longer-life span, QR Codes and RFID tags.	Advancements in thermocouples reduce errors and ease processes for technicians.	Wireless technology does not yet withstand high temps, Nadcap & CQI-9 specs have not yet been approved for longer-lifer, QR codes and RFID tags have limited availability from OEMs
Data logger reporting software	OEMs have built Nadcap and CQI-9 & TUS reporting software	Helpful tool for users to take thousands of data points and more easily generate TUS reports	Relies heavily on user to have a deep understanding of specs, and thus potentially prone to NCRs. No direct integration with sensor correction factors. Not compatible with all data loggers.

Conclusion

Technological developments in the world around us have direct applicability to furnace compliance processes. Continued innovation will motivate the industry to question and rethink old processes. Products are already available to help ensure compliance, generate time efficiencies, improve results, and alleviate costly NCRs. Compliance standards for AMS2750 and CQI-9 are continuing to become more complex with ongoing aerospace and automotive developments. Innovation in the pyrometry industry will step-up to handle these complexities, while also improving efficiencies and reducing non-conformances. Furnace instruments will not only continue to develop to provide customers with more reliability and longer life, but will also provide technology for instruments to talk to each other providing automated data to the user or other software systems. This is an exciting time for the industry. We, at C3 Data encourage you to envision the possibilities and reach out for further discussions.