

Temperature monitoring system consists of ceramic sensors, measuring gauge and software to convert dimension to temperature.

Simple, Cost-Effective Documentation of Furnace Performance

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The question on many heat treaters minds is, “Why would I want more documentation on my furnaces? Recent revisions of AMS 2750D and CQI-9 have already increased documentation requirements on my furnaces, causing production interruptions and costing additional money. Who can afford these additional burdens?”

In most cases, the increased regulations in AMS 2750D and CQI-9 were driven by the purchaser of the parts. With a business climate that can generate a product-liability lawsuit quicker than a rapid quench, your customers are trying to protect themselves. This addresses the importance of protecting your company.

Most heat-treating facilities run the required temperature uniformity surveys (TUS) and thermocouple calibrations. Once the formal TUS is complete, other than the information generated from the control thermocouples, it is hard to know what is happening throughout the product load between formal surveys. If you passed your last survey but fail the next one, how do you know if something changed two days after the good survey or two days before the failed survey?

It is true that you can run a temperature data logger with an array of thermocouples attached through the furnace to get a complete picture of the furnace performance, but that process encompasses production interruption, an expenditure of precious manpower and significant sup-

port expense for the data logger.

So far we have defined the need for a cost-effective, user-friendly device to monitor the day-to-day repeatability of the performance of the furnace.

Metals Industry Demands

Based on all the questions raised above, and more than 100 years of experience in developing and manufacturing simple, cost-effective temperature monitoring and reporting devices for the ceramic industry, The Orton Ceramic Foundation initiated a development project to provide such a product for the metals industry.

The demands of the metals industry are quite different from those of the ceramic industry. The detection device had to be able to withstand rapid heat-up schedules, rapid quench, a wide variety of furnace atmospheres (air, nitrogen, hydrogen) and no atmosphere (vacuum), and do all this without giving off contaminants to the products being treated. No small challenge for an engineered ceramic product. Following a great deal of consultation and experimentation, Orton developed a line of products,

“TempTabs,” that can be used to benchmark and monitor furnace performance in most heat-treating applications.

How does the device work, and how is it made and controlled? The device depends on a constant-slope curve of shrinkage versus temperature. When the device is exposed to more temperature and for longer periods of time at peak temperature, the amount of shrinkage increases. The devices are made from exact blends of select ceramic materials prepared in an environment where the processing variables are tightly controlled. The ceramic material is selected based on its predictable shrinkage. The device is affected more by temperature than time, but holding at or near the peak temperature will have an impact on the final dimension.

Once the TempTab is out of the furnace, it is measured with a micrometer in millimeters to the nearest two decimal places. The dimension is entered into an Excel workbook that automatically looks up the relative temperature inside the furnace based on the time selected at peak temperature. Information is available with each batch to convert the final dimension

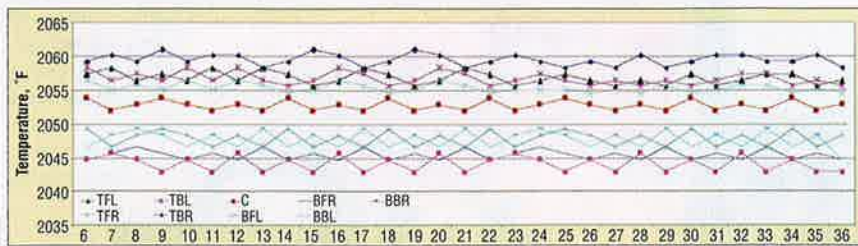


Fig. 1. Software allows process temperature tracking at a glance.

Product and Batch	Time	Date	Run	TFL	TFR	TBL	TBR	C	BFL	BFR	BBL	BBR
TempTab 800RFA-1	240+ Min.	8/1/2010	7	2,057.4	2,058.6	2,058.3	2,059.2	2,053.8	2,049.2	2,044.7	2,046.6	2,044.7
TempTab 800RFA-1	240+ Min.	8/2/2010	8	2,059.3	2,056.0	2,056.5	2,050.1	2,052.0	2,046.6	2,045.9	2,048.3	2,045.8
TempTab 800RFA-1	240+ Min.	8/3/2010	9	2,056.5	2,056.9	2,057.4	2,059.2	2,052.0	2,048.3	2,048.3	2,049.2	2,044.7
TempTab 800RFA-1	240+ Min.	8/4/2010	10	2,057.4	2,055.0	2,055.5	2,051.0	2,053.9	2,049.2	2,045.9	2,048.3	2,042.9
TempTab 800RFA-1	240+ Min.	8/5/2010	11	2,058.5	2,056.0	2,056.3	2,050.1	2,052.0	2,046.6	2,046.9	2,048.3	2,042.9
TempTab 800RFA-1	240+ Min.	8/7/2010	12	2,056.5	2,056.5	2,056.5	2,050.1	2,052.0	2,048.3	2,044.7	2,046.6	2,045.8
TempTab 800RFA-1	240+ Min.	8/8/2010	13	2,058.3	2,056.8	2,056.5	2,058.3	2,052.0	2,046.6	2,046.5	2,049.2	2,042.9
TempTab 800RFA-1	240+ Min.	8/9/2010	14	2,057.4	2,054.4	2,055.6	2,052.0	2,053.9	2,049.2	2,044.7	2,046.6	2,044.7
TempTab 800RFA-1	240+ Min.	8/10/2010	15	2,056.6	2,056.0	2,056.5	2,051.0	2,052.0	2,046.6	2,046.0	2,048.3	2,042.9
TempTab 800RFA-1	240+ Min.	8/11/2010	16	2,056.5	2,056.5	2,056.3	2,050.1	2,052.0	2,048.3	2,044.7	2,046.6	2,045.8
TempTab 800RFA-1	240+ Min.	8/12/2010	17	2,058.3	2,056.9	2,057.4	2,058.3	2,052.0	2,046.6	2,046.5	2,049.2	2,042.9
TempTab 800RFA-1	240+ Min.	8/13/2010	18	2,057.4	2,054.4	2,055.6	2,059.2	2,053.9	2,049.2	2,044.7	2,046.6	2,044.7
TempTab 800RFA-1	240+ Min.	8/14/2010	19	2,056.5	2,056.0	2,056.5	2,051.0	2,052.0	2,048.3	2,045.9	2,048.3	2,042.9
TempTab 800RFA-1	240+ Min.	8/15/2010	20	2,056.5	2,056.5	2,056.3	2,050.1	2,052.0	2,048.3	2,044.7	2,046.6	2,045.8
TempTab 800RFA-1	240+ Min.	8/16/2010	21	2,059.3	2,056.6	2,057.4	2,058.3	2,052.0	2,046.6	2,046.5	2,049.2	2,042.9
TempTab 800RFA-1	240+ Min.	8/17/2010	22	2,057.4	2,054.4	2,055.6	2,059.2	2,053.9	2,049.2	2,044.7	2,046.6	2,044.7
TempTab 800RFA-1	240+ Min.	8/18/2010	23	2,056.6	2,055.0	2,055.5	2,050.1	2,052.0	2,046.6	2,045.9	2,048.3	2,046.0
TempTab 800RFA-1	240+ Min.	8/19/2010	24	2,058.5	2,055.0	2,057.4	2,059.2	2,052.0	2,048.3	2,046.6	2,049.2	2,044.7
TempTab 800RFA-1	240+ Min.	8/20/2010	25	2,057.4	2,056.0	2,056.5	2,053.9	2,053.9	2,049.2	2,046.6	2,048.3	2,042.9
TempTab 800RFA-1	240+ Min.	8/21/2010	26	2,056.5	2,054.4	2,055.6	2,059.2	2,053.9	2,048.3	2,044.7	2,046.6	2,044.7
TempTab 800RFA-1	240+ Min.	8/22/2010	27	2,056.6	2,056.0	2,056.5	2,053.9	2,052.0	2,046.6	2,046.6	2,048.3	2,042.9
TempTab 800RFA-1	240+ Min.	8/23/2010	28	2,056.5	2,054.4	2,055.6	2,059.2	2,053.9	2,048.3	2,044.7	2,046.6	2,045.8
TempTab 800RFA-1	240+ Min.	8/24/2010	29	2,056.6	2,056.0	2,056.5	2,053.9	2,052.0	2,046.6	2,046.0	2,048.3	2,042.9
TempTab 800RFA-1	240+ Min.	8/25/2010	30	2,057.4	2,054.4	2,055.6	2,059.2	2,053.9	2,049.2	2,044.7	2,046.6	2,044.7
TempTab 800RFA-1	240+ Min.	8/26/2010	31	2,056.6	2,055.0	2,056.5	2,050.1	2,052.0	2,046.6	2,046.6	2,048.3	2,042.9
TempTab 800RFA-1	240+ Min.	8/27/2010	32	2,056.5	2,056.0	2,057.4	2,050.1	2,052.0	2,048.3	2,044.7	2,046.6	2,045.8
TempTab 800RFA-1	240+ Min.	8/28/2010	33	2,057.4	2,056.0	2,057.4	2,059.2	2,052.0	2,046.6	2,046.5	2,049.2	2,042.9
TempTab 800RFA-1	240+ Min.	8/29/2010	34	2,057.4	2,054.4	2,055.6	2,059.2	2,053.9	2,049.2	2,044.7	2,046.6	2,044.7
TempTab 800RFA-1	240+ Min.	8/30/2010	35	2,056.6	2,056.0	2,056.5	2,050.1	2,052.0	2,046.6	2,046.6	2,048.3	2,042.9
TempTab 800RFA-1	240+ Min.	8/31/2010	36	2,056.5	2,054.4	2,056.0	2,058.3	2,052.0	2,048.3	2,044.7	2,044.7	2,042.9

Fig. 2. Temperature data is displayed by location and can be copied into existing SPC software.

to a temperature for several different hold times (temperatures available for 10-, 30-, 60-, 120- and 240-minute hold times). The software allows you to monitor up to nine different locations inside the furnace for up to 360 runs (Fig. 1). The temperature data is automatically displayed by the software in both table and graphical format for easy interpretation. The data can also be copied into other Excel spreadsheets and SPC (Statistical Process Control)

programs to be incorporated into existing quality programs.

How are TempTabs Being Used?

Companies are using them as an early warning device and to document that their processes are under control. They first establish a benchmark of their thermal process by running several TempTab disks through their furnace. After they have established a benchmark, including

upper and lower control limits, they continue to run disks on a regular schedule. The disks are placed in the same location every load alongside the parts in the furnace. Once the disks come out of the furnace they are measured and the dimensions are entered into an accompanying Excel workbook. Each dimension is automatically converted into a process temperature by the software. The process temperatures are graphed and displayed in table form (Fig. 2). At a glance, the furnace operator, the quality manager or the general manager can see if the process is under control. The disks document if the thermal process is, or is not, within the control limits established.

**Case Study #1
High Value Heat Treating**

A heat-treating facility serving the aerospace industry historically ran nine thermocouples in every load of their batch furnace. They did this to document the furnace's performance. The labor cost to set up the thermocouple array and the recurring cost of replacing the certified thermocouples made the method of documenting expensive and time consuming. After doing a correlation study, they replaced the thermocouples with TempTab disks. Now, they place disks inside every load so they have the information they need at a much lower cost (Fig. 3). If they see any change in dimensions, they run the thermocouple array to see how their temperature profile has changed.



Fig. 3. TempTabs go through continuous furnaces without interrupting production.



Fig. 4. TempTab wired in place during daily monitoring.

Case Study #2
**Developing Backup Facilities/
Preparing for Increased Demand**

A company specializing in powder-metal sintering wanted to make sure they had a duplicate facility to sinter one of their products currently only being done in a single facility. Initially, they duplicated all the settings in the new location (temperature settings and belt speed) and found that the resultant parts were different than those from of the original site. They had been running TempTabs daily in their production process (Fig. 4). Since they had developed a benchmark of the disk dimensions yielding good parts, they were able to adjust the new facility settings so their process could be duplicated in the second facility.

Once the TempTab information was duplicated, their process was duplicated, and they were able to produce product in the new facility consistent with the old facility.

Case Study #3
**Furnace Documentation When You
Need It**

A captive heat treater ran TempTabs alongside the thermocouples in one of its required nine-point uniformity surveys with a data logger. After the formal survey, they continued to run disks in each load, monitoring the dimensions. The heat-treating facility wanted to document the thermal treatment of the product in every load. If something does change inside their furnace before the next re-

quired survey, the TempTabs will act as an early warning system alerting them that a formal survey may be necessary. The TempTabs help minimize the risk of recalling product treated in a furnace that has subsequently failed a survey. **IH**

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