

# INDUSTRIAL HEATING

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# Uniformity Surveys: Make Your Data an Investment in Profitability

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As the focus on quality processing has evolved, new innovations have come to the aid of thermal processors. There has been the advancement of oxygen probes, PLC and microprocessor controls, digital charts and even database management. However, one area that has not seen improvement in technology is the temperature uniformity survey (TUS). This periodic test determines the ability of the furnace to be able to process work for CQI-9, Nadcap and other quality-system requirements.

Meeting the requirements of AMS 2750 has become the bane of quality departments and the focus of auditors for decades. It is true that data loggers have replaced the tedious task of recording individual temperature readings over time. Data loggers, however, do not fit into the advanced world of Big Data that now dominates other industries to generate large amounts of information used to assess functionality of equipment. Real-time data collection of part dimensions, tool edge wear and even Rockwell hardness is quickly moving ahead, but the lowly temperature uniformity survey still lags far behind.

## Virtual Visual Survey

But now your collected data can enrich processing, determine when a furnace needs to receive focused attention to prevent TUS failures and even evaluate the performance of furnaces under consideration for purchase. The technology is called “Virtual Visual Survey,” or VVS for short. It takes the accumulated data often displayed in two dimensions and presents it in 3-D, as well as adds the variable of time to the evaluation (Fig. 1).

But before I describe the function and benefits of this new tool, it’s important to step back and consider the variables that affect the uniformity of a furnace or oven. This will provide the foundation of why VVS came into existence and how it is used as

a powerful tool to improve process quality, increase furnace performance and decrease costly downtime related to failed surveys. Even worse would be if product is processed in an out-of-calibration furnace.

The temperature uniformity of any given oven or furnace is a function of four major variables: door seals, uniformity of heating source, furnace insulation or refractory, and circulation. These four attributes combine to provide a temperature profile within a given work zone as defined by the manufacturer. Many times the degradation of one or more of these attributes causes a failed TUS, and the company is forced to reduce the usable size of the furnace or take it out of service for repair. A failed TUS forces your maintenance department to react to the failure. In most instances, the reaction will result in overtime labor expenses, and the obvious re-survey is mandated.

There is nothing more frustrating than having to accept a failed TUS as a cost of doing business, especially in an industry where your equipment is self-destructing 24 hours a day, 5 to 7 days a week.

When you consider the amount of data that is collected on each survey, it boggles the mind. A nine-point TUS that runs on VVS for a single setpoint can take 3 to 4 hours. When you tabulate the refresh rate on the nine T/Cs every 10 seconds over the time of the survey, there will be over 10,000 data points. Since there is no way for any one individual to comprehend this

**Fig. 1. Furnace survey setup in a vacuum furnace with VVS displayed**



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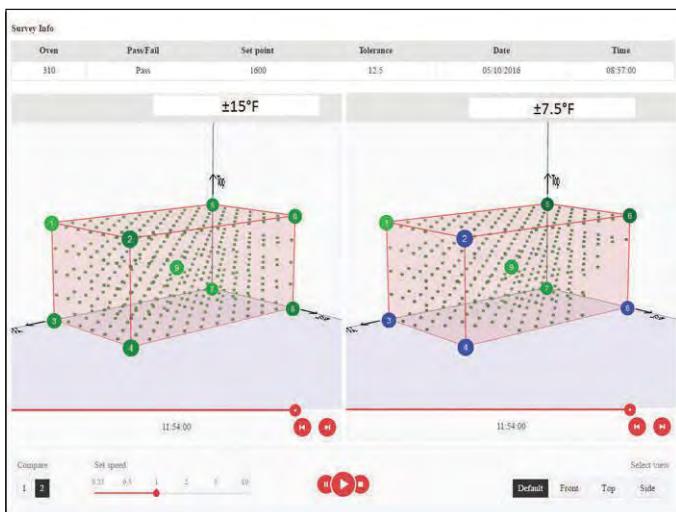
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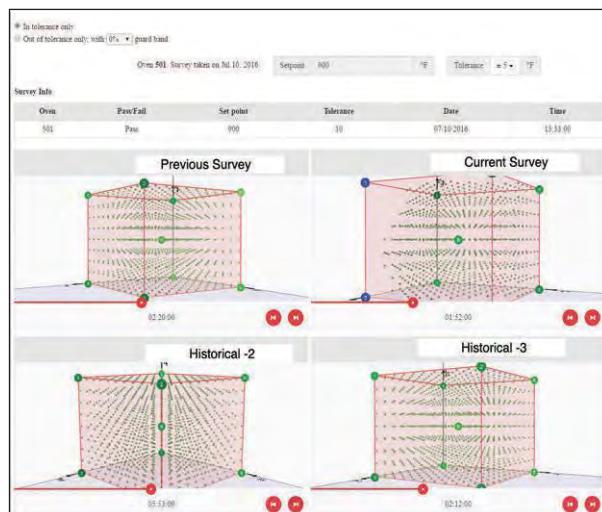


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**Fig. 2. Detailed view of furnace uniformity meeting AMS 2750E Class-3 requirements compared to a detailed view of the furnace at +/-7.5°F. Depicts where the furnace degradation is occurring and where a future TUS will fail.**



**Fig. 3. Detailed view of furnace uniformity trending over the past four surveys at the same temperature test point showing exactly where there are furnace issues.**

amount of data over time, it is conveniently plotted on a chart of time versus temperature for the period of the survey.

Color printers have made it easier to see the stray high and

low points of the survey. The pyrometry technician can easily identify these locations, and the QA manager can then take a few moments to evaluate the TUS findings. By the time it gets



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2-1" Boards/Facing (Vendor 1)	502	616	704
2" Board/Facing/Uncoated (Vendor 2)	611	709	795
2" Board/Facing (Vendor 3)	441	520	594
2" Board/Facing Graphite (Vendor 4)	444	521	596
2" Board/Facing Carbon (Vendor 5)	410	493	586

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\*chart results provided by SOLAR MANUFACTURING



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to the maintenance department, the panic button has been pressed, and the decided-upon repairs may not solve the root cause of the failed survey.

The VVS computer program eliminates the guesswork and filters the data, arranges it in 3-D and allows you to watch the three-hour survey in a matter of 60-90 seconds. While this alone is a huge technological advancement in the thermal-processing industry (on the same level as automated heat treating), VVS does even more (Fig. 2).

The ability to compare data from various TUSs on a single screen allows the maintenance people, who are typically more tactile and visual in their work, to see trends in living color. Characteristics of a single furnace are identified: heating source gas, burner adjustments, broken or shorted elements, fan or motor degradation, door seal flaws, and even insulation failures. Once these characteristics are defined, a system to solve the inadequacies can be determined (Fig. 3).

VVS becomes the tool to reduce the frequency of reactive TUS remedies. It can also be a tool to provide the early warning of an impending TUS failure that will allow resources of material and labor to be efficiently implemented. Once a "proposed" remedy to the failure is applied, the follow-up survey will quickly identify if the remedy was effective.

The current TUS evaluation is a simple pass or fail, which clearly does not deliver the kind of information that is useful in today's technology-driven world.

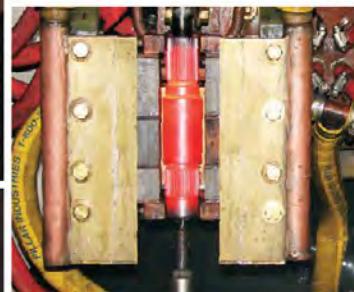
#### Benefits

When VVS is applied from the onset of new equipment, it can illustrate the systematic breakdown of the four cardinal systems that affect the uniformity of the furnace. This will allow companies to actually compare rebuilds of equipment over time to that of the original TUS as provided by the OEM. Furthermore, VVS can be used for comparison of new equipment as manufacturers vie for the best uniformity

as opposed to simply meeting a stated grade. This comparison is extracted from the TUS data by switching the filter from +/-25°F to +/-15°F or even +/-10°F. As the screen shows a diminishing work zone, the best uniformity can be displayed for all to see with their own eyes.

As a production tool, the most recent TUS for the setpoint of the cycle being considered can be displayed on the operator's desktop. If the load is not utilizing the complete furnace volume, it would be best to place the work in the tightest uniformity

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Fig. 4. Eric Reamer shown with vacuum furnace TUS and four-survey display

### VVS Cloud Explanation and No-Cost Usage for Four Months

The VVS software application runs in the cloud on secure servers and sends the interface to your browser or mobile device. As a result, the software is not loaded on your system. There are no plug-ins, apps or software that need to continually be updated. The system automatically updates spontaneously in the cloud. VVS is easy to access via a secure password and user name, just as you would access your bank account. No one else can access your data.

Just to demonstrate that VVS is the most technologically advanced survey tool now available in the thermal-processing universe, you can use it absolutely free for four months on one to three furnaces.



available as displayed using VVS.

For the quality department, the conjunction of VVS with the photo of a load can assist in root-cause analysis or help to explain size-change differentials within a given load.

Vacuum furnaces have a built-in temperature circulation system. While it is not a fan that assists the distribution of the temperature (i.e., reduces non-uniformity), it is furnace lining, element design and even element placement.

For far too long, vacuum furnaces have had trouble passing surveys because there is no atmosphere to actually circulate. The use of VVS, however, will contribute to advances in vacuum uniformity through objective analysis that can be applied to furnaces in individual companies as they seek to improve operations (Fig. 4). Thermal-processing companies will no longer be dependent on the furnace manufacturer for these advancements. Advances in hot-face reflectivity, or lack thereof, will be a consideration when choosing rebuild options.

### Conclusion

VVS is a tool for the future of materials processing. It takes the tens of thousands of data points per TUS, allows comparison of the hundreds of thousands of data points from previously performed TUSs and forms the basis of process improvement across entire companies or processing departments. Processing is the function of part design, metal quality, process design and control, which all combine in the crucible of the furnace and its inherent temperature uniformity. How well do you evaluate your temperature uniformity?

All things being equal, the uniformity can make or break the end result and, therefore, is critical to the cost of quality. Tracking the degradation of uniformity over time will be the new barometer of performance. Furnace uniformity, which is the basis of quality processing, has taken a huge leap forward. Virtual Visual Survey will protect your processing, your quality and your profitability. 🇺🇸

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