TUTCO HEATING SOLUTIONS GROUP

TUTCONNECT

TUTCO FARNAM | TUTCO SUREHEAT | TUTCO CONDUCTIVE | JULY 2024

Electrification and Decarbonization

Buy Once. Cry Once.

A Cautionary Tale on Electrification

One of our distributors met with a company that manufactures outdoor living products. They were looking to convert the heat used in their production lines from natural gas to electric heat. In their process, air is warmed to enhance the application of coatings to various materials. The warming of the air and preheating of the material improves the adhesion of the coatings and speeds up drying and curing time. The company wanted to test the use of electric heat on one production line before converting all lines. This approach would allow for system refinement before making a complete changeover.

The company wanted a system that was movable, so we proposed a blower, heater, and controller combination, all plumbed together on a mobile skid that could be moved around easily and safely with a fork truck. This would be a plug-and-play solution where they could position the unit and simply push the start button. Using our heater and controller would have allowed them to achieve precise and repeatable temperatures. Instead of purchasing our complete system, they expressed the wish to design their own control system to use with our heater in an effort to save some money.

Even though they did not necessarily have the people or bandwidth to do it, they purchased only the heater and tried to create their own system. After one month, they needed to purchase the same heater again, and then a few weeks after that, they reached out to our distributor for help. After his visit, he shared photos of the process they had created. They were transitioning from a 4" blower exhaust to an 8" heater and then to a 3" tube, which delivered the heated air to the application. The connections between the blower, the heater, and the process air tube looked like someone had hobbled them together, beating sheet metal into shape and holding it in place with sheet metal screws. To make the unit portable, they mounted it on an old shipping pallet.

The first heater had already failed, and the second was beginning to break down. The airflow was cheating and not mixing into the heater correctly. The 4" of airflow was trying to shoot right down the center. In addition, the heat going from an 8" exhaust to a 3" tube was creating back pressure that the blower simply could not handle—and the blower was also having issues. Finally, they were not monitoring the thermocouples located at the exhaust of the heater as instructed. Instead, they were monitoring the temperature downstream. And, to make matters worse, they admitted that as they moved and set up the system, the operators were not even plugging in or using the thermocouples.

In the short term, the customer needed to order another heater so they would have a backup. They could not afford to have the line go down and production stop due to heater failure. Once again, we proposed our original solution with our controller on a skidded system, which they agreed to. Our turnaround time was 10-12 weeks, which is very reasonable for a custom system. In the meantime, they would need to have an operator stay by the existing setup and monitor the temperature to avoid failure.

Have you ever heard the saying "buy once, cry once?" If the customer had spent a little money upfront, instead of trying to go the cheap route and cobbling together their own solution, they would have avoided the need to continually replace equipment and the lost revenue due to downtime. Not to mention the need (and expense) to have an operator stand by the system to monitor it and make sure it did not overheat, while they waited for our solution to arrive.

TUTCO Farnam is a leader in electrification. If we have not already worked on an application like yours, we have done one very similar and can provide the expert guidance to help you make the jump to electric heat.

READ MORE ON ELECTRIFICATION

PID Temperature Controllers - What's that About?

by Ian Renwick

As the name implies, a temperature controller's purpose is to control a heating device so that a desired setpoint temperature (the temperature you want to achieve) is reached and maintained. A few examples of temperature controllers around your home are your central heating, refrigerator, freezer, oven, and water heater. These may be of the PID variety or could just be simple on-off controllers, otherwise known as thermostats.

For the purposes of this document, we'll use the example of a temperature controller being used to control heating something to a certain temperature. A PID controller is more advanced than an old-fashioned wall-mounted thermostat and performs more calculations when determining how to control a process.

In the name 'PID', 'P' stands for Proportional, 'I' stands for Integral, and 'D' stands for Derivative. Does that bring anyone back to calculus class? They are all calculated to determine how to adjust the temperature of a system in order for it to achieve the setpoint temperature and hold it there. Those variables and how they are adjusted are dependent upon the current temperature being measured, the setpoint temperature, and the current rate of change of the temperature. More on that later.

A temperature controller has a temperature sensor built into it or attached to it (to sense the temperature elsewhere, away from the actual controller), that senses the temperature of the surroundings or of the process/application being heated. In the controller interface, it also has a place for the desired setpoint temperature to be entered. The difference between these two numbers determines what the controller will do, as in, turn a heater on or off.

The proportional section of a temperature controller is the easiest to understand. If the current temperature is below the desired setpoint, it turns the heater on so things can get hotter. If the current temperature is above the desired setpoint, it turns the heater off. That's the behavior of an on-off controller when it just compares two numbers and turns things on or off. Pretty basic. That's how an old mechanical thermostat works. There's an issue with that type of control. As the temperature of the system approaches the setpoint temperature, the distance between the two (called the error) will decrease in size, meaning that the controller will call for less and less heat. The temperature of the system will approach the setpoint slower and slower, never really quite getting there. It will get there within a reasonable margin, but it'll take a while to get there.

The next two methods of control (Integral and Derivative) are used to help control the temperature better and bring things where they need to be more quickly, but they introduce other issues.

Integral

The Integral part of the control reacts to the difference between the actual and setpoint temperatures as well as the time that they're separated based on the past history of the system. You could say that this part of the control gets the system to temperature faster by looking at this error over time, but it introduces two new issues. One of the errors is overshoot, where the temperature goes beyond the setpoint temperature. The other error is hysteresis, which is a fancy word for bounce or wobble. It occurs when the temperature bounces up and down on either side of the setpoint temperature over time, which can take a while to settle down.

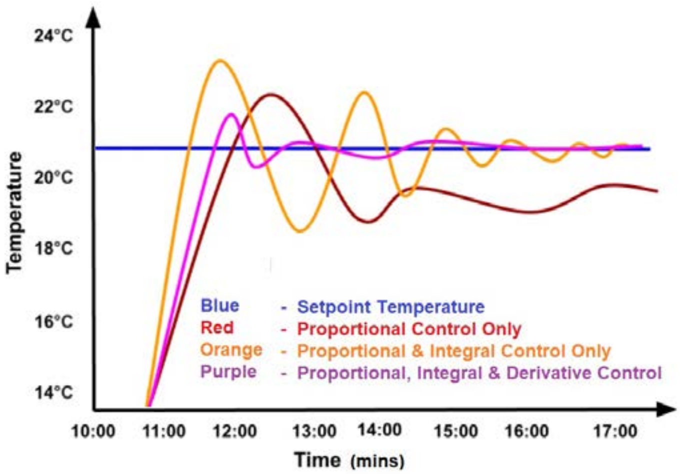
Derivative

The Derivative part reacts to the rate at which the other two parts of the control cause the temperature to change, regardless of how close or far away the actual temperature is from the setpoint. This can be restated as a reaction to the steepness of the temperature climb and making sure it doesn't get too out of hand. The derivation part of the control watches the rate of change of the error of the system. It does impede the rate of change of the process (slows it down), but with the other proportional and integral components of the control, it balances out nicely, thereby reducing the overshoot and hysteresis.

Continued on next page

Ask Ian continued

You can see in the image below how the addition of different control methods to a system improves performance.



The red line represents the simplest form of control, proportional control or on-off only. If you were to follow the red line long enough (beyond the edge of the chart) you can see how it might achieve the setpoint temperature. It's not very good. Add the integral component of the control and you get the orange line. It introduces quite a bit of overshoot and hysteresis, but it reaches the setpoint a lot faster, though at a cost. The best line is the purple line utilizing full proportional, integral, and derivative control. The time to the setpoint is the middle of the three, but the overshoot and hysteresis are greatly lessened.

All these settings have coefficients that need to be set inside the controller. They affect how impactful each component of the input has on the behavior of the system. How on earth do you adjust the settings to get the system to behave as best as possible? You can either be a PID controller expert, or you can simply put the controller into auto mode. It's sometimes called autotune mode. When in autotune mode, the controller will adjust the coefficients for each control input and determine how effective each of them are, adjusting as necessary. It will continue to adjust and tune the settings until it gets to optimum performance: quick ramp-up time, little overshoot, and little hysteresis (bouncing) around the setpoint temperature. This may take varying amounts of time for everything to autotune, depending on the setpoint temperature and the mass of what's being heated. Once complete and the coefficients are set, if there are no changes to the system, those numbers don't need to be touched again.

Something else to think about: The size and material composition of a mass being heated will determine how quickly it'll heat up. A PID controller takes this into account and 'watches' the temperature and the rate at which it rises, thereby determining the best way to control the temperature. 'Watching' in this case means that the controller uses those three methods of control and blends them together to provide the best output to the system. They're based on the current condition (proportional control), the past performance (integral control), and the predicted future performance based on the rate of change of the error in the system (derivative control). Once at the correct temperature, the controller will turn a heating device on and off in a fairly periodic fashion. Maybe the heater will be on 10% of the time (think of a quick blip of power, once per second, for example), or maybe the same heater would be on 90% of the time if it were heating a much larger mass, which would mean that a heater would be on for a much bigger fraction of a second.

Those differences in duty cycle (that's what it's called) are based on the same heater being used to heat two different masses or two masses of the same weight but of different materials (aluminum vs copper, for example). There's another factor that can have an effect too. In the case of a cartridge heater, it would be how well it fits into a hole in the mass it's heating, be it a tight fit or a loose, sloppy fit. For a band heater, it would be based on how tightly it's clamped in place. A loose fit would require the heater to work harder to achieve temperature, meaning it would be on longer, take longer to reach the setpoint temperature, and once there, would have a higher duty cycle than a heater that was tightened in place well.

What this all means is that a PID temperature controller can compensate for these unideal situations in a system, be it a loose hole fit or a loosely tightened band heater. The cost, though, is heater life. The controller will make a heater work harder and hotter to achieve the desired setpoint temperature, which, though great for the system, isn't too good when considering the longevity of a heater.

There are many uses for temperature controllers and other PID controllers in industrial applications that require the control to be precise. That's where the PID temperature controller comes in and is able to easily provide the control needed to get processes operating smoothly. PID controllers are not just limited to heating applications. They can also be used to control the cooling of a system. Additionally, if the property of a process that needs attention can be measured and adjusted, then it can be controlled. Think of pressure, humidity, flow rates, the concentration of compounds in an air stream, and many others. They can all be controlled well with a PID controller.

READ MORE ASK IANS

Feature Product

TUTCO's Line of Control Panels

Built for Precision, Safety, and Connectivity

- *NEMA 4 and 12 Painted Steel Enclosures*
- *Input voltages: 380/400VAC, 50-60Hz,*
- *3PH in 30A (24 FLA) or 60A (48 FLA)*
- *UL 508A, RoHS (CE Mark for International)*
- *Emergency Stop Button (E-stop)*
- *Eurotherm Temperature Controller*
- *LAN connection configured with iTools*
- *Expedited Delivery Options*

TUTCO's advanced line of control panels were designed to elevate the performance and safety of our heaters. Drawing from our deep expertise in heater technology, our engineers have crafted these state-of-the-art controllers with the latest in heater control and safety features. Perfect for industrial facilities and OEMs, these panels ensure reliable and consistent operation in various demanding environments.

TUTCO's control panels are equipped with power controllers, temperature controllers, and thermocouples, working together to maintain consistent output voltages to the heater. This continuous monitoring ensures that, no matter the fluctuations in your process or changes in airflow, the temperature remains consistent.

Easy Integration Across Applications

Our Control Panels are designed to be incredibly versatile and easy to implement. Whether you're dealing with different operating environments, installation requirements, or existing control equipment, we've thought of every detail. The panels come with user-friendly features like an illuminated start button, stop button, over-temp alarm button, and an e-stop button for straightforward local control.

Enhanced Connectivity with LAN

One of the standout features of our new control panels is the Ethernet port. This crucial addition makes it simple to integrate and communicate with other industrial components. The Ethernet connection allows the system to report and integrate remotely with popular LAN-operated solutions, making your overall system more efficient and connected.

User-Friendly Operation

At the core of our control panels is the Eurotherm Temperature Controller, known for its precision and reliability. It's designed to be easy to use, with quick start codes, automatic help text, custom messages, and auto-tuning. The LAN connection further boosts the controller's capabilities, enabling seamless communication and data retrieval from remote HMIs, data loggers, and even web pages.

A Commitment to Innovation and Reliability

TUTCO is dedicated to providing top-quality products, and our new control panels are a testament to that commitment. By harnessing cutting-edge technology, we offer robust, reliable, and efficient solutions for temperature control. Whether you're working in environmental remediation, industrial processes, or other demanding applications, TUTCO's new line of control panels will deliver the performance and peace of mind you need.

Custom Control Panels

If your application requires a custom control solution, TUTCO produces custom control panels that deliver safe, precise and reliable control for large multifaceted applications that require a more robust control solution. Watch this month's feature video to learn more about custom control panels.

READ ABOUT TUTCO CONTROL PANELS

The Hottest Thing Around – TUTCO MI Better Band Heaters

Some applications may not require us to think too far outside the box. They may simply need a customizable band heater that can reach very high temperatures. This is common in plastic and polymer applications where heat plays a critical role in manufacturing and processing, such as extrusion, injection molding, blow molding, and thermoforming. Other industries, including food service, packaging, rubber processing, chemical processing, and scientific equipment manufacturing, also require band heaters that can maintain elevated temperatures.

TUTCO MI Better Band Heaters are suitable for any application requiring temperatures up to 1400°F (760°C), the highest temperature option in our offering. These heaters are available with inside diameters from 3/4" to 30", widths of 3/4" to 6", watt densities up to 80W/IN^2, and voltages up to 480 Volts (AC or DC). Termination options include S.S. screw terminals or leads with various protections like fiberglass sleeving, S.S. braid, or S.S. armor, positioned as desired on the band heater. Ground studs or wires can be added as options. We offer weld-on strap end or loose strap clamping, with choices for spring clamping or Belleville washer assemblies. Additional options include dual voltage, 3-phase voltage, terminal boxes, metric sizes, and other custom requests. If you need it hot, let us take care of your needs.

If you have a demanding application and expect better performance from your band heater, look no further than TUTCO MI Better Band Heaters—the hottest thing around.

MORE THINKING OUTSIDE THE BOX

Feature Video

TUTCO Custom Control Panels

In this month's feature video, National Sales Manager, AJ Nidek provides an overview of TUTCO's custom control solutions.

TUTCO, an innovator in electric heating solutions, has launched its own line of control panels. When paired with our high-quality heaters, these control panels offer a complete, integrated system for a wide range of applications. Recognizing that standard solutions may not fit every need, TUTCO also offers custom control panels. These more robust solutions are designed by our engineers, who work closely with clients to understand their specific challenges and needs in order to produce controls that enhance performance, provide safety, and ensure precise and reliable heat delivery. Whether it's a specialized industrial process, a unique environmental condition, or a complex integration requirement, TUTCO's custom control panels provide the perfect fit. Learn more about our capabilities in this month's feature video.

WATCH THE VIDEO