Technical Briefing:

Microwave Metal Melting Temperature Control

Maximizing the cycle time and temperature control accuracy in a microwave melting process has been improved by implementing a dual zone controller with power ramping and PID control at set soak temperatures.

Background

At Hadron we are constantly developing new process controls for microwave (MW) metal melting and casting technology. The most recent development in control interface combines Ramp-Step-Soak programmability along with PID (Proportional, Integral, & Differential) control theory. Both of these concepts are applied in Hadron's exclusive dual mode microwave temperature controller. See Figure 1

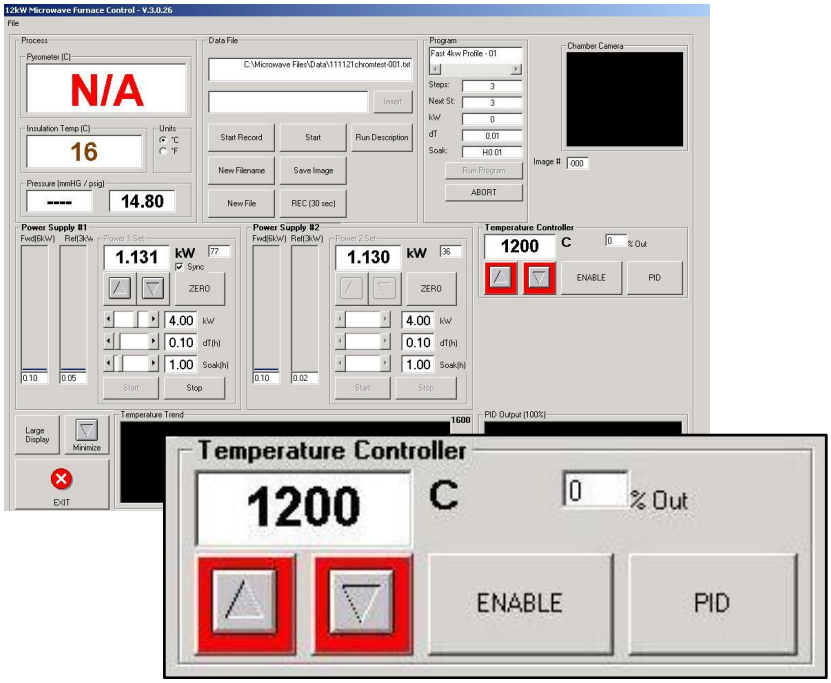


Figure 1 – Dual Mode Temperature Controller

Concept

At lower temperatures, typically < 600C, the forward power output from a magnetron into the furnace applicator is typically ramped up to reduce reflected power until the load can absorb most of the forward power. As the temperature of the charge approaches a desired soak point, the forward power is regulated. Using a typical PID controller in this case is not desirable due to inconsistent absorption at lower temperatures. The principle of Hadron's dual zone controller is represented graphically below in Figure 2.

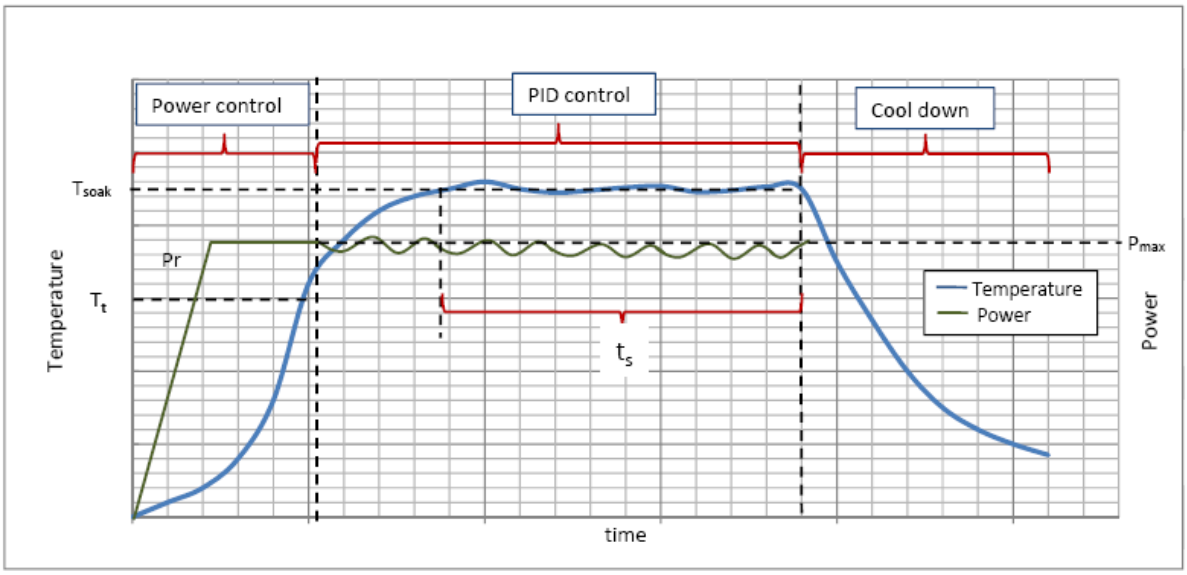
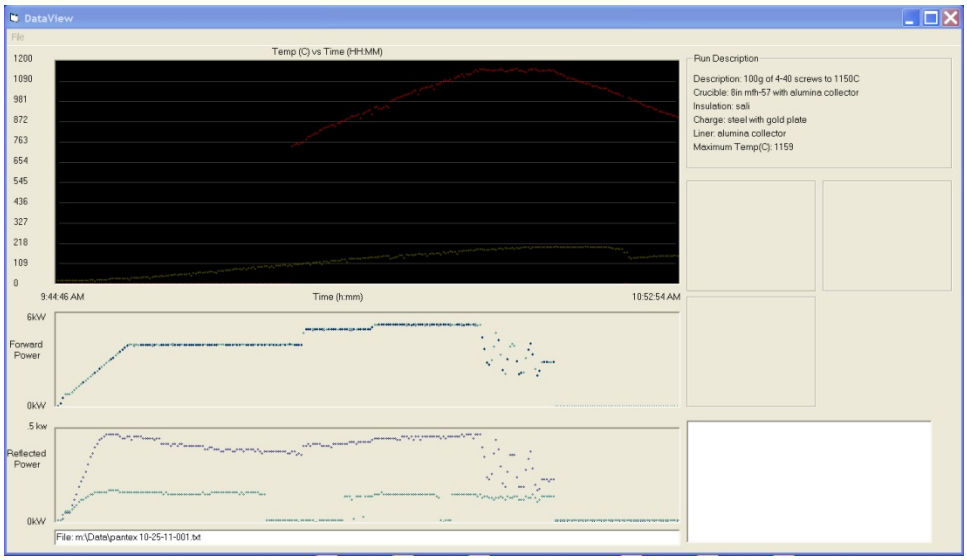


Figure 2 – Dual Mode Control Theory

This qualitative profile consists of 5 control variables including the following:

- P_r = Microwave Power Ramp Rate (kW/min)
- P_{max} = The maximum allowed forward power for initial heating (kW)
- T_t = Temperature Threshold (deg C or F)
- T_{soak} = Temperature Set point (deg C or F)
- T_s = Soak Period (min)

When this profile is initiated, the controller begins by ramping the power with at the rate P_r. After the total forward power reaches the maximum power, P_{max}, the controller maintains this power until the temperature passes the threshold temperature, T_t. Once this occurs, the controller switches to PID control and regulates the power to control the desired soak temperature, T_{soak}. After the soak time (t_s) has expired, the controller turns off forward power for cool down. Figure 3 below is an actual run to 1160 C using the Hadron dual zone controller.



Application

The dual zone controller had been developed for existing touch screen HMI systems and can be implemented with minimal hardware modifications. The dual zone controller can also be customized to specific processes requiring temperature profiling including step, ramping, and temperature soaking. Benefits include tighter soak temperature variation and reduced cycle times by programming profiles that match up to specific stack configurations.

Please contact us for quotes and further information

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