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Owner, **Espresso Vivace** and your host at **Schomer's Table@Lucidcafé**

On The Table #27

Brewing Water Temperature PID Control (Italy meets Omega)

Dear cyber reader, What is PID control? It is proportional, integral and derivative control programs combined in one unit, and it thinks. Think of it like computerized boiler control. Combined with an RTD (resistive temperature detector), mounted in the boiler of my LaMarzocco two-group with modified group heads, and we are there.

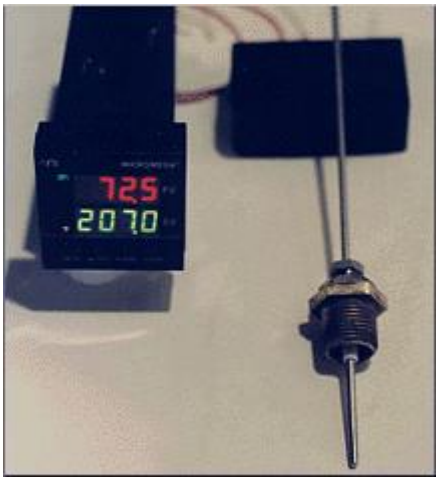


***Photo #1**—Omega Controller CN77544 connected to RTD (1000 ohm/385.2). RTD is mounted in 1/8" compression fitting with Teflon sleeve, welded into thermostat insert for LaMarzocco. (not pictured: solid-state relay Omega SSR240DC25)*

Espresso Vivace is pleased to announce that in collaboration with La Marzocco engineer John Blackwell and technician Roger Wittmann, we have developed technology that allows us to pass the temperature barrier in preparing caffe espresso. Using this technology our brewing water temperature does not vary more than 3/10th of a degree Fahrenheit during brewing. (Special thanks go to John Bicht of Versalab for help in finding and tuning the Omega controller).

Some background

In 1995 I created a modification to the LaMarzocco espresso machine that allowed me to stabilize the brewing water temperature to a two degree range of error rather than a six degree error. Immediately, I got a deep red brown crema, thicker and sweeter than anything I had yet tasted. Some shots were all the way there—i.e.; they tasted exactly like the fresh ground coffee smelled. A quote if you will, of the fragrance of the coffee, and the Holy Grail to every coffee lover everywhere—we just want it to taste as good as it smells. Some shots...not all shots were approaching this state of perfection.

I knew through experience that temperature variation was still affecting my coffee even with the new group head. As an aside it should be mentioned that this is in part a measurement story. The measurement technique that rocked my world was to place a J type thermo-couple in the surface of the packed coffee during the brewing of espresso to see exactly what temperature of water the coffee was being infused with. (Please see Brewing Water temperature measurement). My thermocouple showed that during a shot the temperature of the brewing water was changing about 1/2 of a degree with my new group head. However, that 1/2 of a degree range of error would wander up and down with the mechanical thermostat in the LaMarzocco. So it became a boiler control problem. My group head was outperforming the mechanical thermostat.

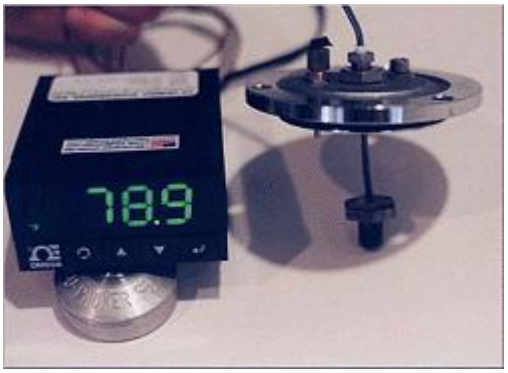
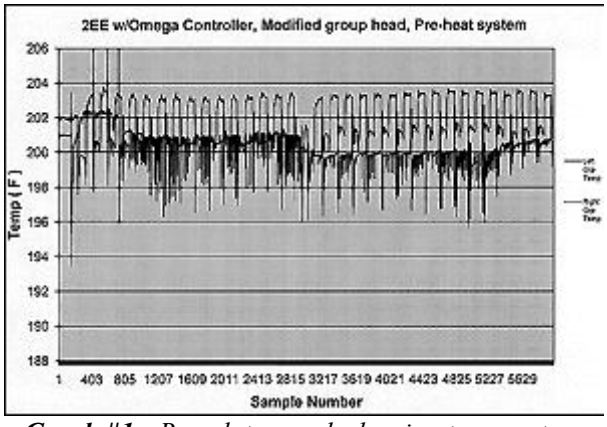


Photo #2*—Group head temperature monitor consists of an Omega DP18 meter connected to a thermo-couple welded into a LaMarzocco Banjo bolt. (Stainless steel tip removed from thermo-couple for high-speed reaction.) LaMarzocco group cap penetration requires 1/8" compression fitting.*

I brought it to the attention of several machine manufacturers that the stability of the brewing water temperature was no better then +/- 3 degrees F. on the best machines. Best, in my opinion, being machines featuring a dedicated boiler for coffee water, separate from the steam tank. Heat exchange machines, 90% of the machines out there, are as bad as +/- 15 degrees (a 30 degree range of error) on some of the most widely sold brands. My popularity in the machine world took a little plunge...

I speculated that the coffee was sensitive to errors of 1/2 a degree F., or less. That if we could operate an espresso machine that held a steady temperature during brewing we could preserve all the sweetness in the roasted coffee. That finally, we could preserve all the fragrance of the roasted coffee through the rigors of brewing to be enjoyed as a flavor/aroma experience. I am happy to say that I was right. I have tasted Heaven in a cup.

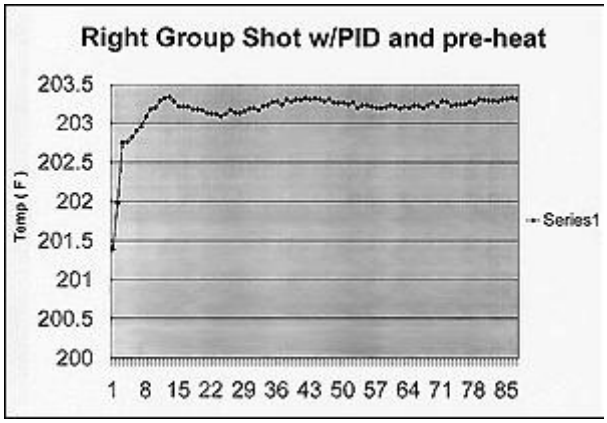


Graph #1*—Raw data graph showing temperature performance over thirty-two extractions. Each peak*

Datalogging- Biblical ramifications

We recorded the actual temperature of the water coming out of the group head of my machine in three stages. For this series of recordings we mounted a J type thermo-couple inside the banjo-bolt in the Marzocco group head. Essentially it is the last place that brewing water passes through before being dispersed over the bed of packed coffee in the porta-filter. The readings were recorded three per

represents a 25-second extraction, valleys in the graph result from the probe being exposed to the air during grinding and packing. The first fifteen peaks show the right group, the next seventeen peaks document the left group performance. The datalogger records three samples per second.
Click here for a larger version of the graph



***Graph #2**—Expanded view of one extraction showing the right group performance. The Left axis indicates degrees Fahrenheit. The datalogger records three samples per second.*
Click here for a larger version of the graph

second on a computer during brewing of ten to fifteen shots. A rhythm was established, draw a two-ounce double shot in 25 seconds, then turn off the pump bang out the grounds and pack a new shot, and brew it. Each complete measurement cycle was 50 seconds long. First we tested the mechanical thermostat and modified group head we have used since 1995 or so. The data shows a basic two-degree range of variation in the brewing water temperature, with most shots holding about 1/2 a degree error during the 25-second event.

Next on February 28th we hooked up an RTD in place of the mechanical thermostat, and connected it to the Omega PID controller. After a few measurements, the earth began to shake, quite a bit really. We all ran outside and considered our mortality and felt like ants in the face of the Earthquake. Then, right back to work. The data shows a 1/2 degree of basic error with most shots varying about 3/10ths of a degree F. during the 25 second event. But we had a difference between group heads. The right group was about 1/2 a degree F. hotter than the left.

The next day we had pre-heated the boiler water before it got to the boiler. We ran the copper water input tube through the Marzocco steam tank on the way to the coffee boiler. The brewing water entered the brewing tank at an average temperature of 190 degrees F.

I could not even sleep the night before I was so excited. When my boys, Taylor and Andre woke up it was clear they were sick...Pestilence. I scrambled to arrange care for them and flew to the lab. We datalogged right through lunch...Famine. And, the results are spectacular. The data suggests no difference between group head temperatures, with the total variation being +/- 15/100th's of a degree F., an error range of 3/10th a degree!

The Meaning of it All

After seven years of continuous whining and occasional bursts of actual

effort the temperature barrier fell. I just lost it. It was very emotional for me. I will never forget seeing the slight waves in the graph lines on the computer screen. A faintly undulating blue line of electrons, a timeless processional at once ancient and modern, mesmerizing like the surface of the Blackfoot River in the deep tailout below the riffle. Something eternal and hypnotically beautiful in stable streams of data flowing across the screen.

Next I made us espresso coffee on the tricked out rig, and Yeah Baby, we were there. Each shot sweet and so thick it can not get out of the porta-filter spout. Hints of anise, thundering caramel, toasty tones and a delicate fruit note from the Harrar. The espresso featured an aftertaste like a butterscotch bloom on the palate, with the mouth feel a more silky chiffon than anything I have ever experienced.

In my opinion, when machine manufacturers achieve this stability, this will be the beginning of espresso as a culinary art. Precision brewing that will allow the roaster and the lover of espresso to enjoy a repeatable flavor profile from their favorite blend. As Sergio Michael from Illy Caffe put it in the SCAA summit on espresso several years back, "each temperature gives you a different espresso." By holding the temperature constant we can preserve the coffees most fragile sugars and create thicker crema. This will add immensely to the popularity of espresso and give roasters the precision feedback they need to advance the art of roasting blending.

If you have any comments about my conclusions, please **please send me email** or contribute them to the ongoing discussions at **alt.coffee**.

Ciao for now!