Gmail **Norbert Senf <norbert.senf@gmail.com>**

Interesting setup for reading thermocouples on a bake oven

2 messages

alex_stovemaster@yahoo.ca <alex_stovemaster@yahoo.ca> Wed, Jul 13, 2016 at 9:08 AM
To: "Norbert Senf norbert.senf@gmail.com [MHAtech]" <MHAtech@yahoogroups.com>, Norbert Senf <norbert.senf@gmail.com>

Hi, Norbert.
I was in a conversa on with a fellow with a bake oven at home and he has shared his setup on reading the thermocouples. Seems interes ng. I thought that info may be useful or give some ideas for other. Here is the stu below.

Best,
Alex

By the way, I have a fun method for displaying thermocouple information (four channels but readily expandable) in an analog fashion. It involves using about $100 worth of readily available circuitry and open source code to feed large analog panel meters, can easily be driven by a battery for an entire day, and can even send data to a log and webserver. I'm happy to share more details if you're interested. There's a photo below of what they look like on my oven, the lower gauge is reading the saturated floor temp (500F) and the upper gauge (590F) cycles between three thermocouples in my vault/walls every few seconds. I've also set them up with a button and indicator lights for others.

Here is some further info on my gauge arrangement and a video of one on my workbench performing a "calibra on" of it hi ng each 200 degree mark: https://dl.dropboxusercontent.com/u/1484602/Videos/IMG_6530.mov

Major Parts:
TC4 Shield Kit: http://www.mlgp-llc.com/arduino/public/arduino-pcb.html
Arduino: http://amzn.to/29DgdHv
Either a suitable power supply for hardwired installation or a small USB battery pack lasts about a day
Analog Panel Gauge(s) (I personally love the Simpson 0-10A DC gauges for their design)
Couple of appropriate resistors and minimal hookup wire.

Alternatively, one could utilize the TC4 as a standalone, integrated board already hosting an Atmel chip instead of the shield and Arduino, but I'm not real clear on which outputs they expose and it may limit versatility for purposes other than roasting coffee.

The TC4 is a four channel thermocouple interface that was created and built by a bunch of coffee roaster geeks (said with the utmost respect) who wanted to better measure their process. It happens to be incredibly well suited, not to mention economic, for the purposes of measuring the relatively high temperatures of wood fired ovens as well.

Overall the system is quite straightforward, one places up to four thermocouples of choice in their position during the oven build. Type K thermocouples seem to be pretty standard, but the TC4 can interface with others as well I believe. I personally prefer to use them for measuring thermal mass saturation so typically place one between the hearth insulation and the bottom of the floor bricks. Generally, having one or more at the peak apex of the oven dome or vault as well as near the shoulders is helpful as well. If the oven mass is particularly high with thick walls, it would be nice to have a thermocouple somewhere in the middle of the wall section as well for reference.

While I have attempted displaying the information on large digital displays, it just seem really out of place on a wood fired oven and frankly isn't as "glancible" as an analog meter can be. The sky really is the limit as the Atmel processor in an Arduino is more than capable of providing the TC4's temperature information in any number of ways. My preference is definitely the large old Simpson rectangular panel meters with any 0-10, 0-100 or 0-1000 range displayed. They can be found on eBay relatively economically and are just beautiful instruments. If someone was motivated, they could even replace the actual panel behind the needle in these gauges but I can't imagine being able to improve on their build quality and design.

The key to actually displaying temperature information from the thermocouples is in scaling their value to fit on the panel meter accordingly. Electrically, this means modifying the analog panel meter to display the small 0-5v DC voltage range which is all the Arduino is able to supply. I have found that by removing the shunt resistor on a 0-10A DC gauge and adding a couple inline resistors with the Arduino output that a nearly perfect scale can be replicated as seen by the video above. Then I just take the temperature provided by the TC4 (the code provided by the creators did all the hard work for me) and "map" it to the 0-5v scale with 255 points of resolution. There is a function in the Arduino's language for this purpose: map(t1, 0, 1000, 0, 255). In simple terms, that function says take the value from a variable called t1 and converts that variable's value within a 0-1000 scale to its appropriate position in a 0-255 one. It's really pretty neat, and mathematically very straight forward. The Arduino hardware handles converting that 0-255 scale to the actual 0-5v dc output that is sent to the panel meter. In case you're curious about the math, dividing that 1000 degree scale into 255 points means we're theoretically capable of displaying a five degree change in temperature, presumably overkill given the nature of the beast!

While one could certainly have 4 separate panel gauges representing each of the four thermocouples, I find it relatively unnecessary given the temperatures aren't exactly changing quickly ;) Instead, one gauge can cycle between each thermocouple every few seconds. It would be trivial to light an indicator next to a label or even use a push button to select a specific channel if necessary; most operators know their oven well enough to negate such a need. I've chosen to place two gauges stacked with the lower one dedicated to displaying the hearth temperature and the upper one cycling between the remaining three channels. Visually, the 0-10 scale of the gauges I've chosen is highly legible because their big spade needle is so easy to read even from a distance. If the needle is pointing at the 6 one quickly recognizes the temperature to be 600 degrees F.

Nearly all of the code I used to program the system came from the coffee roasting examples which the hardware was designed around and is open source. My trivial modifications were mostly to facilitate the mapping of the temperature to the analog output. One could very easily add a $5 esp8266 wifi interface and write a little web server so the temperature data could be checked from a smartphone or displayed on a computer screen in tandem with the analog displays. I have on a couple of occasions out of curiosity charted a data log of a full temperature cycle over a couple days which the Arduino facilitates through a native serial port; unfortunately, I can't seem to find any of them now.

I'm happy to answer any further questions you may have as well as share what little code I've written/modified, it's kind of hard to tell just how down and dirty to get into the details when discussing such an arcane topic ;)

Thanks again for sharing your experience with higher thermal mass performance and your concerns about exceeding existing designs.

edgar

On Tue, Jul 12, 2016 at 8:34 PM, Alex Chernov <alex_stovemaster@yahoo.ca> wrote:

> Hello, Edgar.
> We built several 4x6ft (net) commercial bread ovens and there are some also that were built from my design. All work very well with our standard mass solution: 9" for walls and vault and 10 to 10.5" in the floor and lots of insulation. Reports are that one can easily bake 10 batches of bread from a single firing with very gradual temperature drop (then one can bake still more with lower temps, breads like pan rye etc). One can also bake two days after firing if doors are closed and oven is not touched in this time.
>
> For sure, there can be too much mass. Higher mass would require accordingly prolonged firing period to saturate entire mass with heat, which is absolutely necessary for proper backing. Length of the baking period would then depend on heat transfer and heat capacity of the bricks used with potential for heat transfer from the deep mass being too slow for sufficiently fast backing. I would also suspect the mass being able to hold heat for long period of time, but to hold temperatures at lower level as it is difficult to keep such huge mass super-charged. I do not think it is going to work.
> I am also not sure why one would like to get super mass. To extend baking? Why, when 10 batches take at least 5hrs considering prep and loading/unloading. How much longer one would like to keep baking/working? It will be time to move on to a larger oven to increase production, not to higher mass.
>
> The readout setup is interesting. I would appreciate detailed info if you have it ready and do not mind sharing.
>
> Thanks,
>
> Alex Chernov
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From: Edgar Pankey <build@flkj.us>
To: alex_stovemaster@yahoo.ca
Sent: Thursday, July 7, 2016 12:32 PM
Subject: High Mass WFO

Mr. Chernov, I see from your website that you have built at least a couple of high mass wood fired ovens. I am interested in the performance of those ovens as I am assisting a friend in designing a similar one. He and I have built three wood fired ovens together already (we're both bakers and farmers) and are really wondering if there is such a thing as too much thermal mass (thicker than 9").

It appears you used a relatively similar approach to integrating large thermal mass on both the gargantuan Humble Bread oven as well as Mr. Navazesh's smaller backyard oven. Given you have likely heard reports on their operating characteristics from both owners I'm very curious how they compare assuming similar construction/insulation but with such different volume. What do you think would happen to their performance if those ovens had another layer of bricks or even double the thickness (besides the obvious heat up times and wood required)?

We are huge proponents of insulation being the primary key to a successful oven as it appears are you. Have both ovens met your expectations as to their heat retention?

I very much appreciate that I am asking questions which you may have already written about somewhere so feel free to point me at such articles if they exist rather than wasting your time with me directly.

By the way, I have a fun method for displaying thermocouple information (four channels but readily expandable) in an analog fashion. It involves using about $100 worth of readily available circuitry and open source code to feed large analog panel meters, can easily be driven by a battery for an entire day, and can even send data to a log and webserver. I'm happy to share more details if you're interested. There's a photo below of what they look like on my oven, the lower gauge is reading the saturated floor temp (500F) and the upper gauge (590F) cycles between three thermocouples in my vault/walls every few seconds. I've also set them up with a button and indicator lights for others.

Again, thank you for your time.
edgar

Norbert Senf <norbert.senf@gmail.com> Wed, Jul 13, 2016 at 9:24 AM
To: Alex Chernov <alex_stovemaster@yahoo.ca>
Cc: "Norbert Senf norbert.senf@gmail.com [MHAtech]" <MHAtech@yahoogroups.com>

Cool!.....Thanks.....Norbert
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