Stable Temperature Sensing Achieved with Energy Harvesting

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Introduction

Restaurants and retail operations need to monitor foodstuffs to reduce risk of spoilage. These operations typically use battery driven temperature data loggers in cold chain transit and/or tethered temperature probes with handheld devices indoors. The units are unwieldy resulting in higher operational costs to monitor foodstuffs.

Currently, we are developing a energy harvesting, battery-less, passive temperature sensor (PTS) card. The sensor draws power from the energy field of a 13.56MHz high frequency radio frequency emitter. This temperature sensor can be placed in refrigeration units either in-transit or embedded in-situ at a retail food operation.

Purpose

This preliminary study was to determine the stability of the passive temperature sensor against a highly sensitive, commercially available monitor. The purpose was to assess the ability of a passive temperature sensor to:

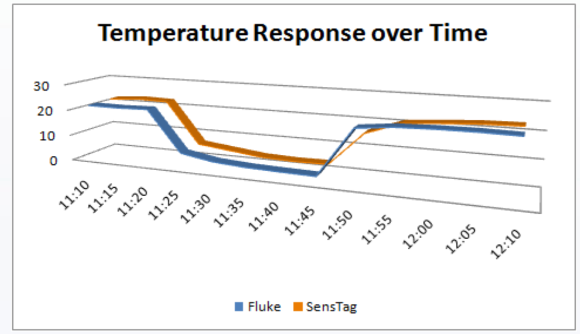
1. Provide stable and consistent temperature readings using only harvested energy.
2. Correctly indicate temperature within 1 ° C within 5 minute intervals.

Experimental Overview & Procedures

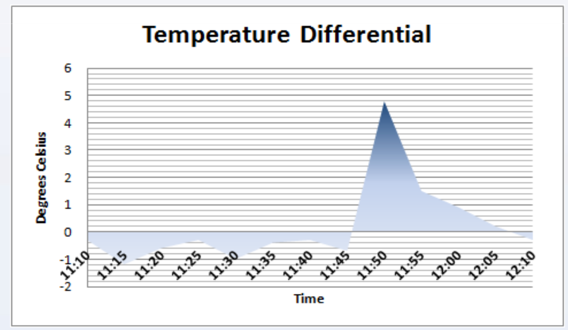
The reliability of the energy harvesting PTS temperature sensor was compared to a control device, the Fluke 54II Thermometer as tested in four different locations in a commercially available domestic refrigerator. The test was repeated 4 times. As the PTS card is encased in plastic, it was not expected to be as sensitive as the Fluke device. Both sensors were monitored in free air every five minutes, then placed on the glass shelf in the refrigerator. The thermometer end of the Fluke device was affixed so that it was not in contact with the glass. Data points were taken manually first from the Fluke device, then the passive tag using a digital clock for time interval.

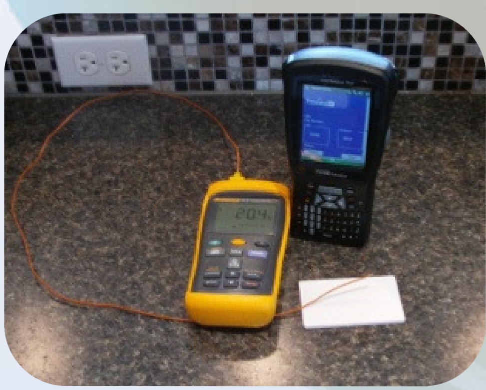
Results

The PTS temperature sensor card closely followed the Fluke control device during the cool down period. Not surprisingly, the Fluke device was far more sensitive and displayed changes to temperature swings within seconds. When both devices were removed from the refrigerator, the Fluke device immediately warmed up with the PTS lagging as expected.



The lag time of PTS card was 0.3 ° C of the Fluke device and within expected parameters of 1 ° C as it cooled down in the refrigerator. At the a peak temperature difference of 6.5 ° C, the PTS card required 5 minutes outside the refrigerator to stabilize to within 1.5 ° C of the control device.





Apparatus

1. Psion Teklogix Workabout Pro3 with AV-X 13.56 MHz RFID HF Reader running Proxima RF temperature software.
2. Fluke 54II Thermometer with external sensor probe.
3. Proxima RF passive temperature sensor (PTS) card (roughly the size of a credit card)

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Conclusions

Analysis of the preliminary data indicate that:

1. The PTS card performed as a stable and consistent temperature measurement device using only harvested energy
2. The PTS card had a longer than expected lag time vs. the highly sensitive control device when removed from the refrigerator.
3. Based on results of this study, the plastic enclosure temperature transfer characteristics could be investigated.
4. The PTS card may be released for further investigation in cold chain and food safety applications.