Case Study 1:
Customer Evaluations of Celsius Midi

Introduction

Measuring temperature in the food industry is critical to maintaining food quality and safety. Our customers manufacture products and package it in various combinations of plastic, foil and cardboard. Celsius offers a temperature measuring solution that can measure the temperature of the product through plastic films and cardboard, displaying the temperature of the product inside, without any damage to the product itself. The solution is particularly useful where the temperature distribution may not be homogenous (hot and cold spots) and it can even compensate for foil trays.

The fundamental principles used by Celsius are described in the seminal publications by Dr.Land which provides a practical method for determining the temperature of objects at lowered temperatures by means of microwave radiometry.

In recent months, the Celsius Midi temperature measuring system has been evaluated by several customers in real food production environments on a variety of food products and freezing / chilling systems.

In this case study, the evaluation extended to a total of 21 SKU's sampled from different chilling/freezing locations and tested with Celsius. The SKUs were also measured using a calibrated temperature probe and the results compared to the instrument. Products included pies in aluminium half pie dishes that were sampled from different lanes in the manufacturing plant.

The data relating to frozen products is presented hereafter;

Due to the innovative nature of this solution, the customer also sought to get an understanding of the levels of attenuation certain packaging types may introduce. For example, different plastics can attenuate the microwave signals by different amounts so a product specific correction needs to be applied. Similarly, aluminium foil does not allow microwaves to pass through the packaging and a partially enclosed package such as pie in a tray will have some signal attenuation.

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[1] Land, D.V.L, 2005. The Properties of Microwave Cavities for Radiometric Temperature Measurements. *Journal of Microwave Power & Electromagnetic Energy*, Vol. 40, No.2 pp.119-128.

[2] Land, D.V.L. 2001. An Efficient, Accurate and Robust Radiometer Configuration for Microwave Temperature Measurement for Industrial and Medical Applications *Journal of Microwave Power & Electromagnetic Energy* Vol. 36, No. 3, pp. 139-154

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Measurements and Analysis

Multiple products were tested from two Frozen Spirals (FSC) and from one Frozen Rack (FR). In this document, seven products are analysed and referred to as SKUs J, K,L,M,N,P,U. Figure 1 shows the data relating to Spiral Freezer 1 (four SKUs under test) and shows the probe temperature, Celsius temperature, difference without offset, difference with offset. The Celsius tracks the probe measurements with a distinct and quantifiable offset for each SKU, (K, 2.7°C), (L, 4.4°C), (M,2°C), (U, 2.5°C). Once the offset is applied it draws the data back to give good correlation between probe and Celsius as seen in the figure.

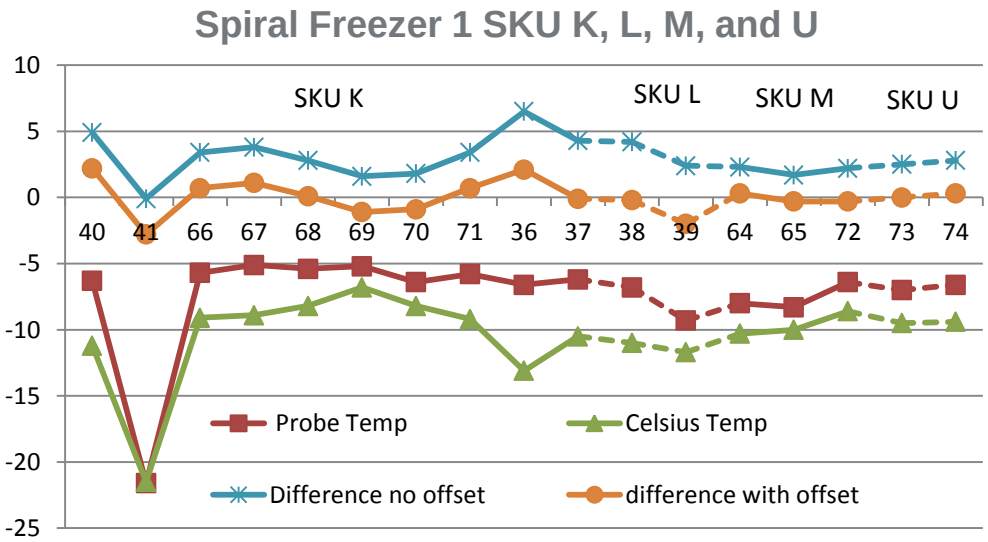

Figure 1: Plot for Spiral Freezer 1 showing correlation between Celsius and probe for 4 separate SKU's.

Figure 2 shows the data relating to Spiral Freezer 2 where two 2 SKU's are measured K and M. In this case, the offsets are calculated as (K, 2.3°C), (M, 1.3°C). There is however a single point where the probe temperature is colder than the Celsius and this is unexplained and could be an outlier.

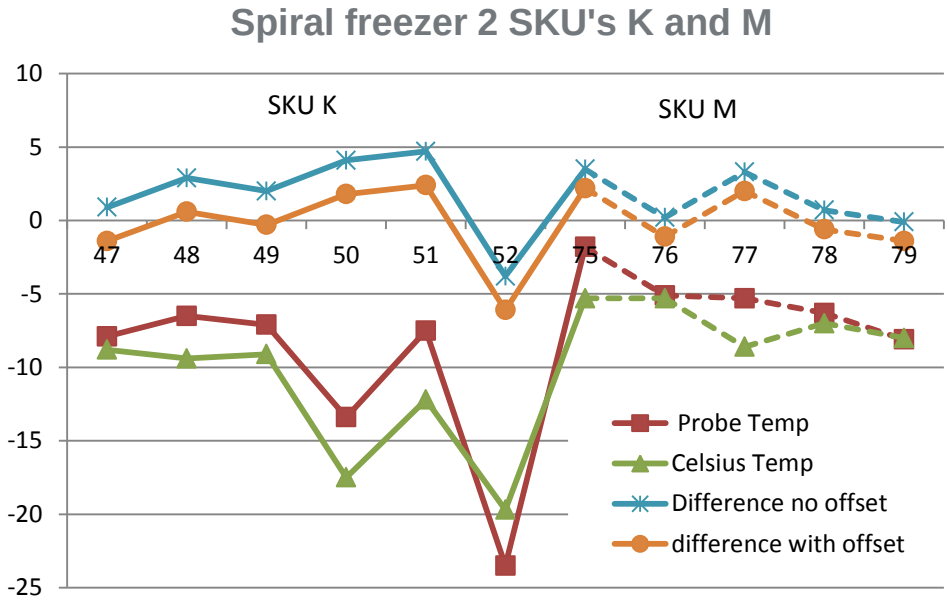

Figure 2: Comparison for Spiral Freezer 2, Celsius and probe

Using different freezing methods did not change the level of agreement between probe and Celsius as shown in figure 3 for Rack freezing. In all cases the Celsius and probe tracked one another with the SKU specific offset being available to gain accurate agreement. Throughout applying the offset calculated from the total dataset for a SKU allowed good agreement between probe and Celsius data.

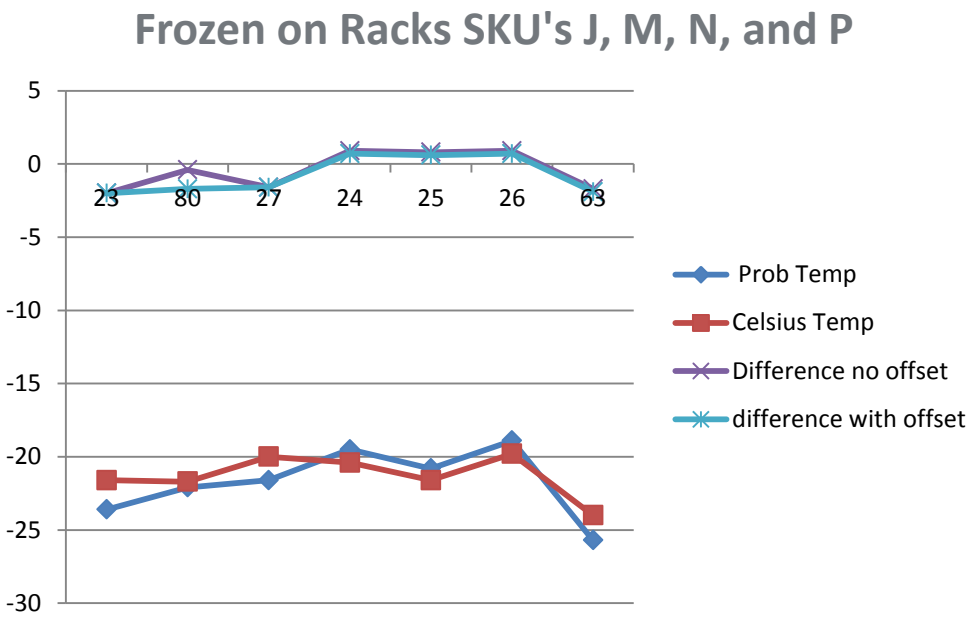

Figure 1: Frozen products taken from racks

Conclusions

The Celsius system has been compared with traditional probe measurements by a customer in a working environment. It was conducted by operators with minimal training and was not conducted under highly controlled “laboratory conditions”. A variety of SKU’s were tested, sampled from different freezing locations and tested with the Celsius and a traditional probe.

The Celsius and probe measurements track one another. As suspected an offset is required to improve correlation between the probe and Celsius, this is a function of both the packaging used (aluminium reflectivity, plastic attenuation) and the product particularly when operating in the “frozen” regime. It is a simple process to calculate the offset required and enter this into the instrument software which results in more accurate correlation.

The benefits of the Celsius in being non-destructive, simple to use and fast were amply demonstrated by the customer conducting the trial not requiring the assistance of Cerulean beyond initial set up.