FINAL REPORT

February 27, 2009

THERMAL VALIDATION OF RENDERING COOKERS VIA REMOTE SENSING

Principal Investigators:

Annel K. Greene, Professor
Dept of Animal & Veterinary Sciences
250 Poole Agricultural Center
Clemson University
Clemson, SC 29634
Phone: 864-656-3123
Fax: 864-656-3131
E-mail: agreene@clemson.edu

Richard S. Figliola, Professor
Department of Mechanical Engineering
247 Fluor Daniel Engineering Innovation Building
Clemson University
Clemson, SC 29634
Phone: 864-656-5635
Fax: 864-656-4435
E-mail: richard.figliola@ces.clemson.edu

William C. Bridges, Jr., Professor
Department of Experimental Statistics
F148 Poole Agricultural Center
Clemson University
Clemson, SC 29634
Phone: 864-656-3012
Fax: 864-656-1309
E-mail: wbrdgs@clemson.edu

Date Submitted: April 15, 2006

Start Date: July 1, 2006

Project Summary:

Numerous methods of measuring the internal temperature of the rendering cooker have been investigated.

Objective(s):

1) to develop remote sensing methods of validating the thermal process that occurs within rendering materials in a cooker;
2) to validate that rendering cookers time and temperature parameters to ensure destruction of avian influenza

Project Overview:

In the destruction of microorganisms, thermal lethality is a measure of time, temperature and pressure. In order to determine the lethal dose applied to microorganisms within rendering cookers, it is necessary to know the temperature dose and time factors that occur within the cookers. It is imperative to know the exact temperature exposure within the cookers to satisfy governmental validation that will be necessary during disease outbreaks such as avian influenza.

Numerous methods of measuring the internal temperature of a Dupps Supercooker rendering cooker have been evaluated for 1) feasibily, 2) accuracy of readings, 3) ability to obtain data, 4) safety to workers, 5) safety to the cooker, and 6) safety to the finished product (no lost pieces in the finished product).

Studies have centered on methods of collecting and transmitting data via telemetry. After considerable study though, it has been determined that telemetry will not be possible to accomplish with current technology for the following reasons:

1) the electronics necessary to log and transmit the data are heat sensitive and thermal shielding will be difficult;
2) the telemetry unit would have to transmit signals through a thick metal housing. Installation of antennae would be necessary and installation attempts could possibly damage the cooker. GPS and telemetry would be estimates and not accurate measures of location;
3) the buoyancy of the sensor could affect the speed/path of the transmitter through the cooker. If too buoyant, the sensor would ride on the top of the material and be pushed under only intermittently. If too dense, the sensor could settle to the bottom of the cooker and not move forward. Additionally, a dense sensor would post problems for retrieval;
4) magnets would be necessary to catch the sensors as they exit the cooker to ensure electronics do not contaminate the product. Magnets would require magnetic shielding around the sensor to prevent data corruption. Shielding is possible but will add to the cost, size and weight of the unit.
5) prototypes of transmitting sensors have cost between $1500 to $3000 each. Since numerous sensors are needed, this cost is prohibitive.

Researchers have concluded that the telemetry method of obtaining this data is not possible due to constraints within the cooker.

Next, the use of thermal dataloggers was investigated for use within the cooker. The suggestion was to hang these sensors within the cooker and allow them to collect data over a period of several days. Both “iButton” sensors and Madgetech Temp1000S thermal dataloggers were tested in the laboratory for this project. These small sensors can be programmed to turn on at a desired time and record data. The researchers proposed hanging the sensors inside the cooker on the rotating shaft and upon weekend opening of the cooker, the sensors would be retrieved and data downloaded.

Figure 1. Thermal dataloggers: a) iButton on left and b) Madgetech Temp1000S on right

However, it was determined that 295-300°F was the fail point for these dataloggers. Since the dataloggers cost up to $600 per unit and more importantly, the failure or explosion of a batter could cause a hazard within the rendering cooker, it was suggested that maximum temperature be ascertained via use of a product known as TempilStiks. TempilStiks are fusible melting point standards which melt and change physical characteristics at a particular temperature. The product has been tested and melts within 1°F of labeled melting temperature. In our laboratory experiments, we have used the 275°F, 300°F, 325°F, 338°F and the 350°F and all have performed as the manufacturer states. We proposed to put these temperature markers within sealed tubes within the rendering cooker. These will be left in the cooker for a week. The highest temperature reached would melt the markers. Upon retrieving these from the cooker, we would know our highest temperature. This is crucial to knowing if we can use the iButtons or Madgetech datalogger within the cooker. Since rendering temperatures are very near the maximum operating temperature for electronic sensors and since batteries have a maximum operating temperature before they explode, it is imperative to know the maximum temperature within the cooker.

At the last ACREC Research Committee meeting, it was suggested that researchers purchase an infrared temperature gun and measure the bolts on the headsheet of an operating rendering cooker. Temperatures were measured on all exposed bolts on both the entrance and exit ends of the cooker. Temperatures were read in a clockwise manner from the top bolt.

Table 1. Temperatures (°F) of bolts on entrance end of rendering cooker (read clockwise from the top)

	Rep 1	Rep 2
Bolt 1	207	208
Bolt 2	205	203
Bolt 3	198	197
Bolt 4	203	198
Bolt 5	209	209
Bolt 6	209	209
Bolt 7	204	206
Bolt 8	208	209
Bolt 9	211	208
Bolt 10	211	204
Bolt 11	211	206
Bolt 12	213	210
Bolt 13	208	206
Bolt 14	205	206
Bolt 15	207	202
Bolt 16	201	206
Bolt 17	210	208
Bolt 18	204	207
Bolt 19	206	206
Bolt 20	203	208
Bolt 21	209	204
Bolt 22	205	204

Table 2. Temperatures (°F) of bolts on headsheet (exit end) of rendering cooker (read clockwise from the top)

	Rep 1	Rep 2
Bolt 1	220	222
Bolt 2	230	225
Bolt 3	240	230
Bolt 4	259	260
Bolt 5	256	255
Bolt 6	250	247
Bolt 7	252	248
Bolt 8	248	252
Bolt 9	252	247
Bolt 10	255	253
Bolt 11	265	264
Bolt 12	276	275
Bolt 13	270	268
Bolt 14	252	250
Bolt 15	266	260
Bolt 16	265	258
Bolt 17	279	261
Bolt 18	277	261
Bolt 19	273	257
Bolt 20	278	263
Bolt 21	271	270
Bolt 22	270	268
Bolt 23	266	255
Bolt 24	258	268
Bolt 25	248	254
Bolt 26	237	240
Bolt 27	248	230
Bolt 28	249	230
Bolt 29	230	228
Bolt 30	232	235
Bolt 31	238	240

The temperature at the center shaft on the entrance end of the cooker was 190°F and the temperature at the center shaft on the exit end was 266°F. For the majority of the measurement points, temperature was above 230°F.

In the project on destruction of avian influenza in rendered animal co-products, it was determined that temperatures at or above 110°C(230°F) for 15 seconds or longer destroyed avian influenza. Therefore, since mapping the interior of the rendering cooker seems unfeasible with current technology, we suggest mimicking the standard FDA approved procedures utilized in the food and dairy industry for including a time factor into thermal processing; we propose to measure exit temperature and subsequent temperature of material flowing out of the cooker for a minimum of 15 seconds. If the material remains 230°F or higher through this “holding period,” then the industry will have irrefutable evidence that rendered animal co-products have been processed sufficiently to destroy avian influenza.

Impacts and Significance:
In the event of a large-scale outbreak of high pathogenic avian influenza, it will be crucial to the renderers to prove that rendering processing is sufficient to destroy avian influenza.