Delta T & Protective Products

CCC 100 Ceramic Insulation Tests

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Objective:

The objective of these tests is twofold.

The first objective is to provide valued customers with a set of test methodologies so they can duplicate and verify our products insulating abilities.

The second objective is to answer questions of how to quantify performance of Ceramic Insulation. There is a lot of controversy and confusion in the building industry with the use of R-values or 'equivalent R-values' for products which have entirely different systems of inhibiting heat transfer. According to current standards, R-values are most reliably stated for conventional bulk insulation materials. Calculating the performance of our CCC100 radiant barrier is more complex. The tests and procedures to evaluate bulk insulators are not applicable to radiant barriers.

Background:

We insulate our houses to keep the heat in during the winter and out during the summer. In our modern world we insulate and control heat energy not only for our homes but in such diverse applications as the NASA space shuttle reentry heat problems, industrial tank protection, food production vessels, shipping containers and numerous other applications.

What we are doing by insulating is controlling Heat which is energy. Scientists and Physicists from Albert Einstein to Isacc Newton have defined principles relating to heat energy. Engineers are specialists in the highly technical Thermodynamics section of Engineering. So one doesn't just throw a few batts of R40 around the nose of the NASA space shuttle and hope to stop it from burning up. The engineer or applicator of the insulator should understand some very important principles of Heat energy.

The first important principle is to realize that Heat Energy is a composition of many other forms of energy. Heat energy from our Sun has a high content of UV (ultraviolet light). InfraRed is another form of light energy that is present in many sources of heat energy. Electromagnetic standing waves are present in many heat sources. So if you insulate you may block one form of energy and others will come waltzing through. So we feel the warmth or heat but it contains many other forms of energy. That is why we use "sun block lotion" at the beach. It doesn't cool us down but it does block out the UV component of the Suns Heat energy.

The second important fact is to understand the Second Law of Thermodynamics. This Law states in its simple form: "heat energy can only move from a higher to a lower temperature" Interested in First Law try this. An example of the second law of Thermodynamics is opening the door of your residence on a cold winter day; one might hear "close the door you are letting the cold in". In actual fact you are letting the Heat out as it is rushing out to the colder outside temperature.

The third important principal to understand is how Heat Energy moves. Energy will always be moving trying to establish and ideal Thermal equilibrium state. In our case Heat Energy always will see a cooler place to move to. These three methods of Heat Energy moving are convection, conduction, and radiation. In engineering, energy transfer by heat between objects is classified as either heat conduction, also called diffusion, of two objects in contact, by convection, which is the mixing of hot and cold fluid regions (air is considered a fluid), and by thermal radiation, the transmission of electromagnetic radiation described by black body theory. ***Delta T Coatings work only on radiant heat*** and are not too effective with conduction or convection Heat Energy. Radiated heat not only comes from our mighty sun with all its various components such as IR and UV. Radiated heat can be as simple as the heat coming from a wood stove; the metal is radiating the Heat Energy.

What we attempt, when we insulate is to put a barrier up to stop Heat energy from doing its travels. If our barrier can attain a temperature difference from one side to the other of 0° or Delta T=0°, the Heat Energy will not move as it has reached equilibrium. CCC100 Ceramic insulation works on radiant heat energy by reflecting it away or absorbing it to form a Radiant Barrier. Conventional insulation puts up a big fat wall of material so the Heat Energy gets trapped in the many air pockets and can't move.

As we present our test results on CCC100 Ceramic Insulation we will be referring often to very technical principles of Thermodynamics to demonstrate the insulating properties of Ceramic Insulation. We will keep the discussion as simple as possible so that a normal technical person can understand the insulating ability of CCC100. This can be difficult at times as CCC100 works best as a radiant barrier and this discussion can be complex.

Methodology

Four metal boxes were constructed. A thermocouple was placed inside each box. Each Box had the same inside volume. One of the boxes was larger to accommodate the application of 4" of Styrofoam to simulate conventional insulation. We placed a heat source into each box and measured the inside and outside temperatures.

We will be working with the Second Law of Thermodynamics to demonstrate the Heat Energy movement in the metal boxes. As we heat the inside of the box up with the Heat Lamp, there will be a larger and larger temperature difference between the inside of the box and the outside. This DT will cause the Heat energy inside to leave the box and head for the cooler ambient air.

One of the boxes we will not insulate, so the Heat Energy has the easiest path possible thru the metal via conduction. This is the reason we used metal boxes. If we had used wood we would have had to concern ourselves with the dynamics of the wood as impedance to the heat flow. For these tests we want the heat to flow out of the box.

The next box is insulated on the inside with 20 mils DFT CC100 Ceramic Insulation to observe the insulating properties of CCC100 to convection and conduction heat energy inside of the Metal Box.

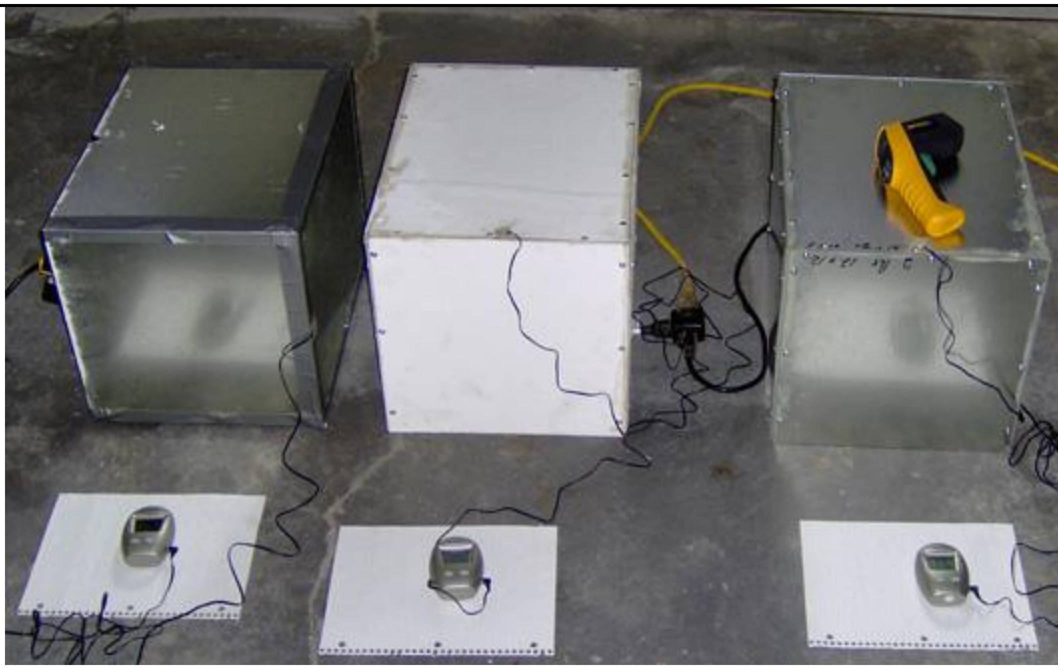
The next box is insulated on the outside with 20 mils DFT CC100 Ceramic Insulation to observe the forming of a Radiant Barrier to the Radiant Heat coming off the metal on the outside of the box

The Big Box is insulated to R20 building standards and we will be using the Delta T method to study its method of impeding the Heat Energy Flow.

Each box was heated inside with a 100 Watt Halogen Lamp for three hours. Temperature measurements were taken with our instrumentation, on the inside of the box and the outside of the box every 15 minutes. Delta T was calculated and charts were plotted for the three hour period.

In addition we used a 175 Watt Infrared lamp to further stress test the two boxes that were coated with CCC100 Radiant Heat Barrier Protection. This we recorded and charted.

Equipment



Three Metal boxes were constructed. Each metal box had the same dimensions of 12"x16"x16" so that the volume of each box was the same.

Each metal box had a thermocouples installed inside the box to measure the inside temperature in degrees Centigrade. The meter used was a ACU-TEMP accurate to +- 0.50C.

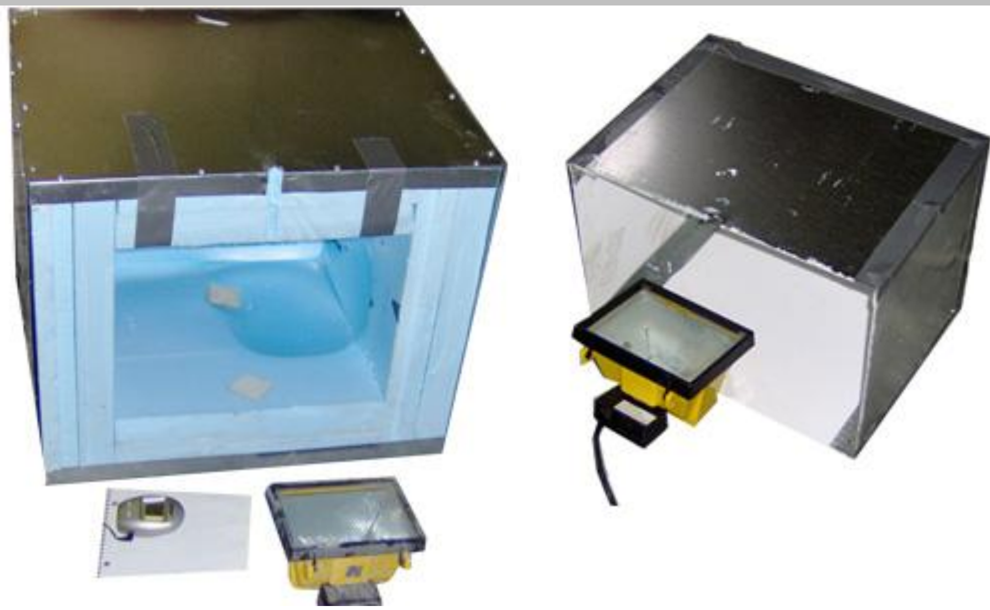
The box on the right in the upper Photo was un-insulated.

The box in the middle was coated on the outside with 20 mils DTF CCC100 Ceramic Insulation.

the Box on the Left was coated on the inside with 20 mils DTF of CCC100 Ceramic Insulation.

A quality Fluke 561 IR Thermometer, shown in the photo above was used to measure the outside surface temperature of the boxes. The Fluke 561 has a EMS setting (emisstivity) to accurately measure

temperatures on shiny surfaces. The Fluke 561 EMS setting was set to medium.

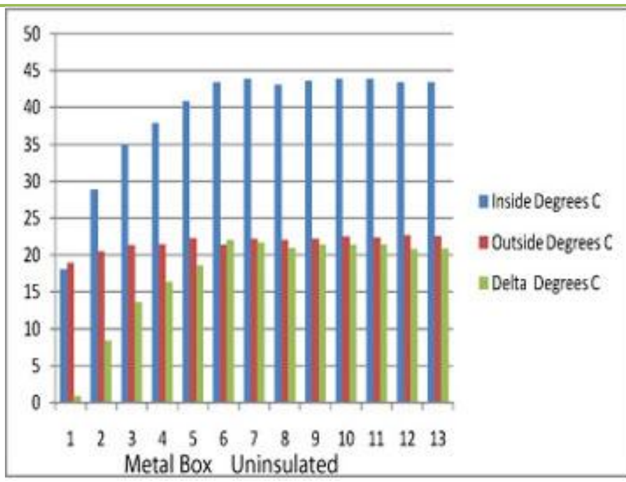


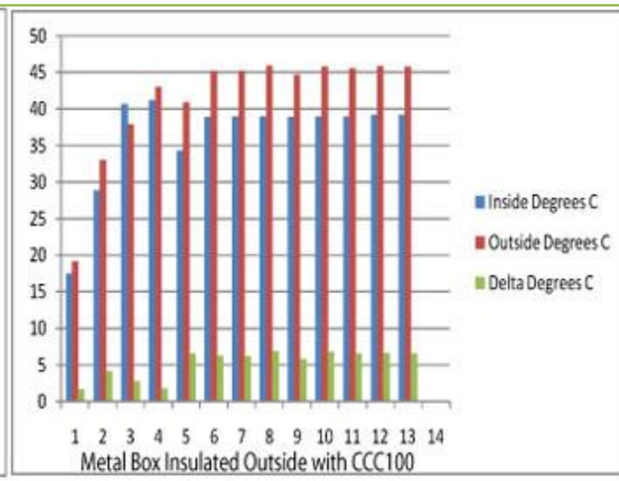
A fourth metal box was constructed with dimensions of 24"x24"x20" and lined with 4" of Styrofoam insulation to give it a R20 building code rating. It was significantly larger than the other metal boxes but has the same volume inside for air. A thermocouple was placed inside the box to measure the inside temperature of the box the same as the other three boxes.

The heat sources used were a Halogen 100 Watt work Lamp and a 175 Watt InfraRed Lamp. These heat lamps were placed alternately into each of the four boxes.

Conclusions

Uninsulated Box compared to Box insulated Outside with CC100





Observations:

A 100 Watt Halogen Lamp was used with these tests.

A large Delta T is observed meaning that the Heat Energy is moving out of the box.

The Heat energy is moving from the inside (hotter) to the outside (colder).

Observations:

A small Delta T is observed meaning that the Heat Energy is not moving out of the box as quickly as the uninsulated box on the left. It is approximately 80% slower than the box uninsulated.

The charts are virtually reversed with the box outside temperature slightly higher than the inside of the box. The Heat energy is moving from the outside (hotter) to the inside (colder).

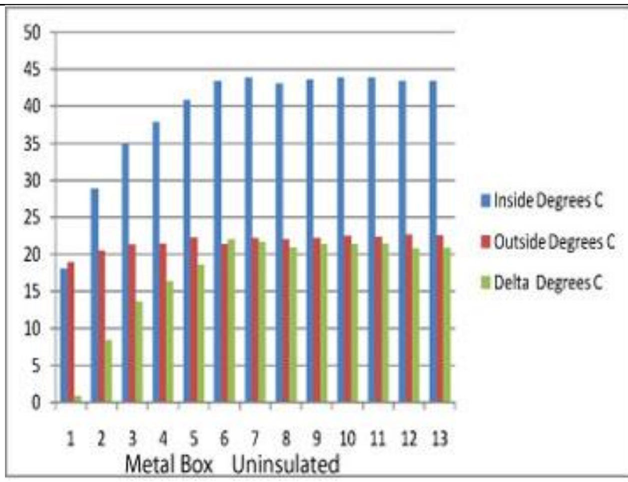
Conclusions:

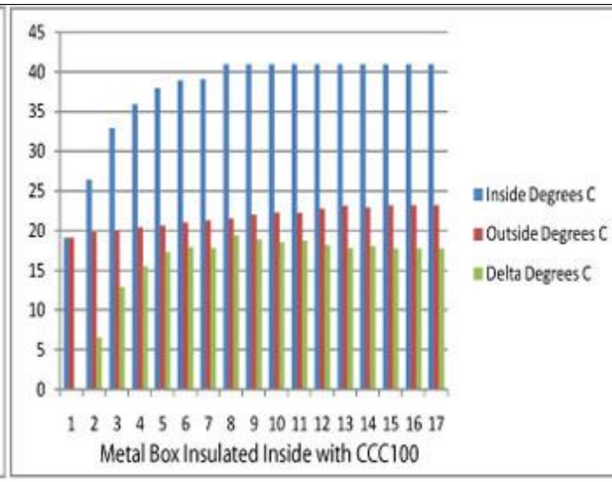
The outside of the box is metal and heat coming off the metal is radiant heat. The CCC100 coating on the outside metal can work with radiant heat.

The 20 mil DTF coating forms an excellent radiant barrier to the heat Energy trying to move out of the box.

Firstly there is a very small Delta T therefore the heat energy isn't moving that much and in fact the heat is being pushed back into the box as the outside is (hotter) then the inside (colder).

Uninsulated Box compared to Box insulated Inside with CC100





Observations:

A 100 Watt Halogen Lamp was used with these tests.

A large Delta T is observed meaning that the Heat Energy is moving out of the box.

The Heat energy is moving from the inside (hotter) to the outside (colder).

Observations:

High Delta T means that Heat Energy is moving out of the box (hot) to (cooler) ambient.

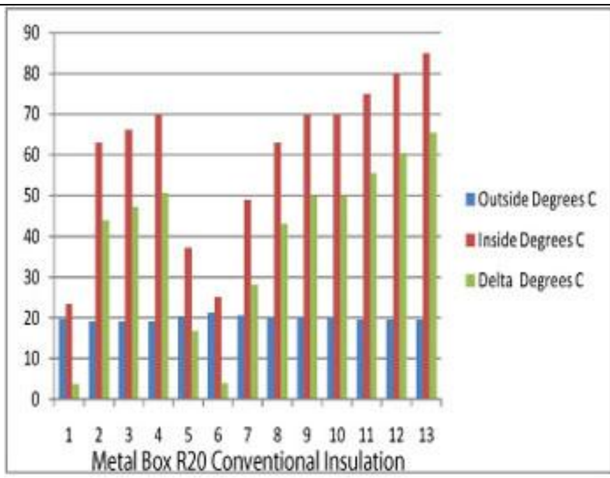
There seems to be a slightly smaller Delta T compared to the uninsulated box on the left.

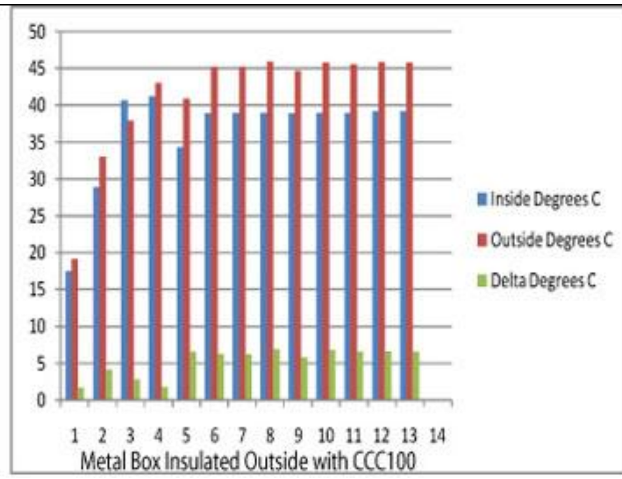
Conclusions:

No radiant barrier was possible because the heat inside the box was convection and conduction heat. CCC100 coating works only on radiant heat.

The slightly lower Delta T was the CCC100 working on the UV and IR components of the 100 Watt halogen Lamp. The only components it recognized as radiant heat.

Conventional Insulated Box compared to Box insulated Outside with CC100





Observations:

A 100 Watt Halogen Lamp was used with these tests.

The outside temperature of the box never changed.

The temperature inside the box just kept going up. In fact we left it on overnight and it got so hot inside the box that the Styrofoam melted in places.

During times 5 and 6 we turned off the lamp to see what happened to the outside and inside temperatures as the box cooled down.

Conclusions:

Conventional insulation works completely different then Ceramic insulation. It works and works excellent as seen from the chart keeping the Heat Energy in the box. It works by trapping the heat energy in the many air pockets of the mass bulk material. Thus we couldn't get a outside measurement on the metal because all the heat energy was in the mass of Styrofoam .When the heat source (lamp) is turned off the heat energy will move according to the Second Law of Thermodynamics from (hot) to (cold). And this does cause some problems with condensation etc.

Observations:

A radiant barrier is formed and the heat energy is not moving.

No comparisons can be made with the graph on the left for conventional insulation.

There is better regulation of the temperature inside the box. The temperature inside the box doesn't get as high as the conventional insulated box.

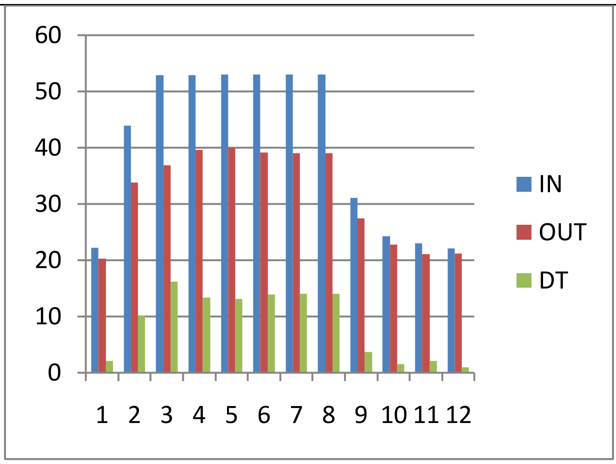
Conclusions:

The CCC100 Ceramic Insulation forms a Radiant Barrier to Heat energy and works in a completely different way than conventional bulk insulation. Also it was proven that CCC100 only works on radiant heat.

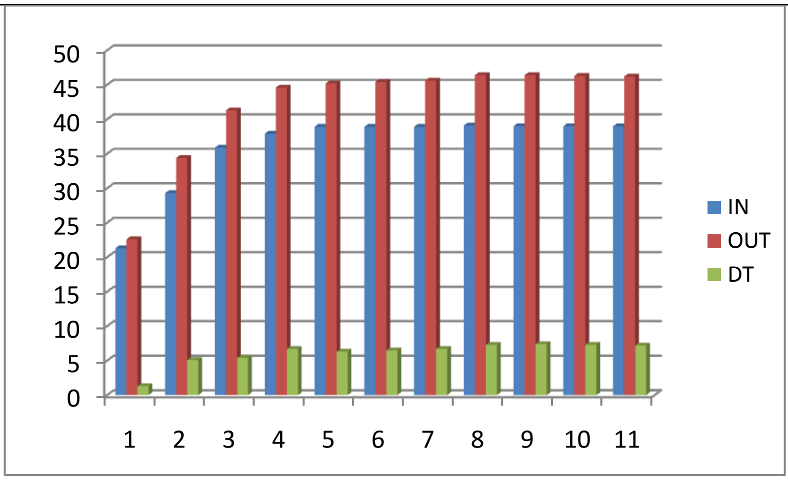
So there is no way that an engineer could give Ceramic Insulation an equivalent R-value.

Advantages and disadvantages of the two insulating methods can be discussed, but comparing them by a R-value is not possible.

Box insulated Outside with CC100 Stress Tested with 175 Watt IR Heat Lamp



175 Watt Infrared Lamp



100 Watt Halogen Lamp

Observations:

The inside of the box reached a higher temperature because of the higher wattage lamp. Approx 50^0 vs 45^0 with the 100 Watt Lamp

A radiant heat barrier was formed because of the low Delta T. Approx 12^0 vs 6^0 average with the 100 Watt Lamp.

Conclusions:

CCC100 will form a radiant barrier at higher temperatures.

Further applications of the coating giving a higher DFT will enable an applicator to achieve the lowest Delta T and the best Radiant Barrier possible.