Cenospheres used in Advanced Coatings

In 1994, NASA patented Protective Coating for Ceramic Materials (PCC). This material was developed for the next generation of Space Vehicles; the X-33 and the X-34. Wessex Incorporated obtained an exclusive license for the material and has gone on to develop PCC into Emisshield™; unique coatings for the ceramic/refractory, metal, textile and various other markets where heat is concerned.

In order to understand how Emisshield™ can have such a benefit for many different applications, it is important to understand the concept of emissivity.

Emissivity is defined as a substrate's ability to absorb energy (heat in most cases) and reradiate that energy to a cooler substrate. All substrates have an emissivity value that can range from 0.0 (lowest) to 1.0 (highest). If a substrate has an emissivity of 1.0, it is known as a black body. A black body is defined as a substrate that absorbs all energy regardless of the direction or wavelength of that energy. Not only will a black body absorb all energy, it is also a perfect radiator of that same energy. To date, no such "perfect" black body exists. Instead, substrates that have fairly high emissivity values are known as grey bodies or near perfect to a black body. This means that the ratio of energy absorbed is not exactly the same amount of energy that is reradiated, but it is close. The smaller this ratio, the closer to black body a substrate is.

The NASA scientists that developed PCC determined the emissivity of the coating to be between 0.8 and 0.9; a grey body. Many substrates can have high emissivity values at ambient or lower temperatures. But as the temperature increases, the emissivity of these non-grey body substrates can decrease rapidly. PCC was developed to be able to withstand the extreme conditions of re-entry which included going from -250°F to 5000°F in a matter of seconds. Therefore, the emissivity agents in Emisshield™ allow the coating to maintain its grey body

capabilities at temperatures over 3000°F. In other words, Emisshield™ will continue to absorb and reradiate at the same ratio, even at high temperatures.

An equation can be used to determine the amount of energy that will be absorbed and radiated from the substrates surface:

Q = EwÉ–(Ts4-Tsur4)

Where:

Q is measured in units of Btu/hour-ft2
Ew = emissivity of substrate
É– = Stefan-Boltzman Constant
Ts = surface temperature
Tsur = surrounding temperatures

As shown by this equation, emissivity is also a function of temperature. In keeping constant with its grey body characteristics, the more energy that is absorbed by Emisshield™, the more energy it will reradiate. High emissivity coatings will allow more heat to be absorbed and dispersed at high temperatures while some of the low emissivity Emisshield™ Coatings will be as effective at lower temperatures.

When discussing emissivity, its value is usually reported with just a number of 0.0 to 1.0. However, to truly understand what the value represents, it is important to understand wavelengths. All energy (heat) has a measured wavelength that corresponds to a point on the electromagnetic spectrum.

The Electromagnetic Spectrum
Wavelength (μm) (not to scale)

Humans can see visible light that ranges from red (longer wavelength of 0.7 μm) to blue (shorter wavelength of 0.4 μm). When white light is reflected through a prism to show all visible colors and temperatures are taken of each color, red measures

hotter than blue. It was Friedrick William Herschel that discovered the infrared part of the electromagnetic spectrum. While measuring the temperatures of the visible spectrum, he moved his thermometer further past the red light and saw that the temperature rose still. Moving to the left of the electromagnetic spectrum, the wavelengths become shorter and hotter in temperature. It is in these infrared (below the red) wavelengths that Emisshield™ Coatings re-radiate energy.

When a substrate is coated with a high emissivity coating and is subjected to high temperatures, over 2000°F, the coating will absorb that energy at its wavelength and reradiate that same energy at different wavelengths. This is possible because of the emissive properties. A non-grey body does not have the ability to emit energy at a different wavelength than it was absorbed. This is what prevents most substrates from behaving as grey bodies for a wide range of temperatures. Instead, these non-grey bodies will lose their emissive capabilities as the temperature they are subjected to changes.

The value of emissivity assigned to each substrate therefore relates directly to the black body concept. If a substrate has an emissivity of 0.6, it is able to reradiate only 60% of the energy that a black body would be able to reradiate. Since black bodies have an emissivity of 1.0, it will reradiate 100% of the energy it absorbs. Emisshield™ Coatings have an emissivity of between 0.8 and 0.9. This means that Emisshield™ will reradiate 80% to 90% of the energy that a black body would reradiate.

This can be a huge benefit to many different applications. For example in batch furnaces or kilns; if the refractory in such applications is highly emissive, the load can be brought up to temperature quicker. This can reduce fuel costs and increase production. Catalytic converters in automobiles can also benefit from high emissivity Emisshield™ coatings by decreasing time to light up and therefore reducing harmful emissions. There are many more applications in which Emisshield™ Coatings can be of a benefit. To learn more about Emisshield™ and its effects on your application please contact us today.