CENOSTAR CORPORATION

Ceramic Microspheres as Thermal Fillers in Roofing and Coating Systems

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How do hollow ceramic microspheres add thermal qualities to coatings? As it turn's out, it's all in the way you approach the situation.

It took General Industries Corporation of Colorado Springs, 7 years to develop their "Perfect" roof system. They were not working alone.

Rohm and Haas, the resin manufacturer, worked closely in developing the resins required to accomplish this task.

3M's participation determined which ceramic particles were most efficient for insulation of buildings and reflection of solar radiant heat. These ceramics were a spin-off from the NASA Space Shuttle Program for dissipation of heat upon atmospheric re-entry. Hollow ceramic micro-spheres proved to have a tremendous ability to reflect, dissipate and act as nonconductors of heat or cold.

The requirements of ceramics used for buildings differ from those of a space shuttle. On buildings, the task is to reflect radiant heat, reduce heat build-up and transfer through walls, ceilings and roofs. The space shuttle is concerned with reflecting and dissipating heat from friction. Since it is not practical to put tiles on buildings, coatings incorporating the same hollow microspheres are used. Different methods with the same end result.

Most coatings use organic materials that are broken down by nature - extreme temperatures, chemicals, ultra violet light, ozone decay, wind, rain, snow, hail, sand abrasion. The coatings harden, crack, peal, decay, turn chalky and decompose. Successful thermal coatings overcome these problems. The three basic components are RESINS, the "glue", FILLERS, the "body", and PIGMENTS, the "coloring".

COATINGS	Interior Plaster	Exterior Plaster	Interior Wood	Exterior Wood	Interior Metal
Matt Emulsion	√	√			
Acrylic Eggshell	√		√		√
Vinyl Silk	√				
Wood Primer			√	√	
Metal Primer					√
Undercoat	√	√	√	√	√
Gloss	√		√		
Eggshell Finish	√		√		√
Stabilizing solution		√			
Masonry Paint		√			
Epoxy Floor Paint	√				
Wood Stains/Dyes			√	√	
Varnish					

RESINS:

A. They remain elastic and move with minor changes in the building, covering cracks and preventing new cracks from appearing.

B. They cover the entire surface with a seamless membrane preventing water or air penetration. When applied at an appropriate thickness, the roof coating will stand up to ponding of water.

C. They are resistant to nature's breakdown process. Laboratory accelerated weathering tests indicate that after long exposure, some coatings actually get tougher and maintain elasticity.

D. When some coatings are impacted, they will draw back to their original shape. When a hailstone hits, it will cause dents, but the coating will spring back.

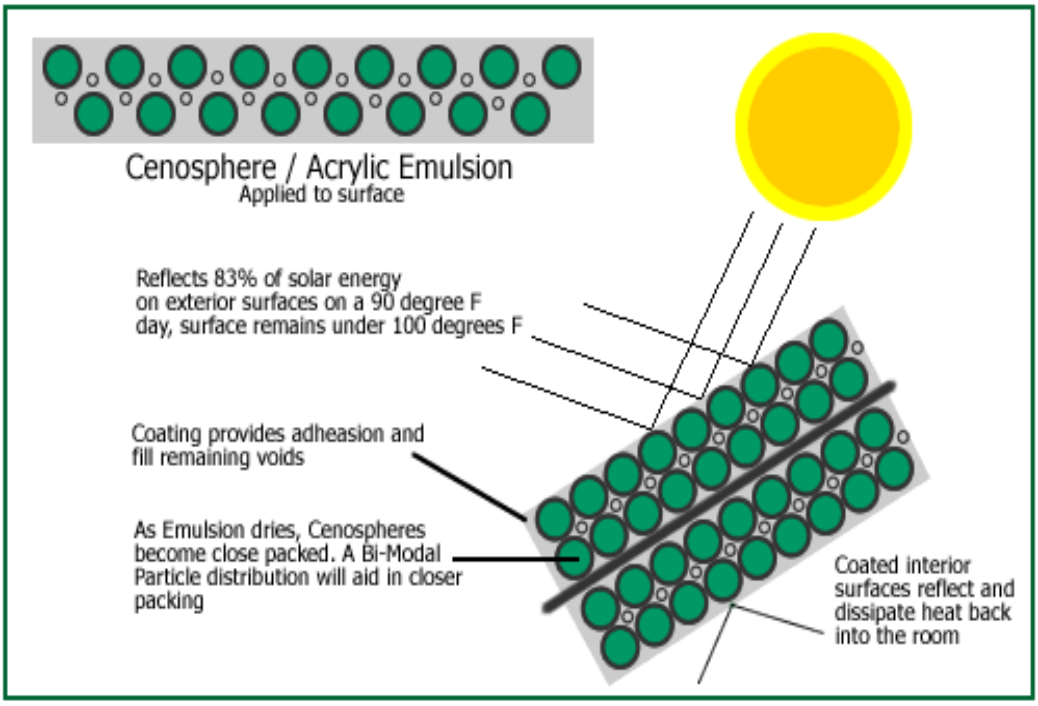
E. Resins are made of complex polymers that have the ability to hold large amounts of particles and still have adhesion. Large amounts of hollow ceramic microspheres are essential – 50% by volume is a good benchmark. However, they want to float to the surface. They need to be held in suspension by the polymers. Some manufacturers of thermal coatings claim to have similar ceramic

benefits, but use solid ceramic spheres instead of hollow ones in an attempt to keep the particles in suspension. The solid particles do not have the same insulative benefit as the hollow microspheres.

F. The combination of resins and hollow ceramic microspheres also provides UV protection.

G. The proper roofing system has a very special property in its "Variable Permeability". When conditions are wet, the polymers swell up, becoming completely watertight. When conditions are dry the pores open up and trapped moisture escapes. This is of great importance. Moisture will work up through the substrata and become trapped under waterproof material. When this moisture heats up, it turns to vapor, causing blistering and destroying adhesion, or freezes, leading to roof failure.

FILLERS: Most coatings use inexpensive fillers to keep the cost down. Fillers like China Clay and calcium carbonate are common, organic products that, because they are developed by nature, are quite readily broken down by nature. Ceramic microspheres are close to indestructible by the conditions faced by buildings.



A. Successful coatings incorporate a minimum of 50% by volume of hollow ceramic microspheres.

B. The hollow microspheres enable coatings to reflect about 83% of the Solar Light. (They reflect about 85% of the infrared or “Hot” end of the light spectrum). Most radiant heat transfer is stopped before it becomes a problem.

C. Ceramic microspheres are a very good insulator; they reduce heat transfer by conduction. These microspheres are hollow and vacuumed inside - the best insulator.

D. With ceramics, think in terms of DISSIPATION. Other types of insulation just slow down the transfer of heat. Ceramics can dissipate heat, transferring it back into the atmosphere. The heat never gets into or out of the building to become a problem. The same is true for air conditioning. A cube of ceramic material can be heated to over 1100 C or cooled to near absolute zero and be safely picked up with bare fingers only seconds later, while the cube is still glowing red-hot or frozen in the center. Ceramics make the heat or cold dissipate from the surface.

E. Because of the ceramic microspheres, coatings are more resistant to dirt accumulation than other coatings, since it will wash off easily.

F. The ceramic microspheres are fireproof. As a result, coatings that use them have a high degree of fire resistance.

PIGMENT: Some coatings make use of titanium dioxide and aluminum - trihydrate as white pigments as well as hollow ceramic microspheres. These are stable substances that are resistant to natural breakdown. They add to reflectivity, long life and fire resistance. Coatings using these ingredients could be rated Fire Resistance Class A.

In short, this combination builds a strong coating system. The ingredients combined form coatings that are:

A. Environmentally safe - water based coatings are free of toxic materials. Tests show there are no harmful effects from their application.

B. Resistant to fading – Tests show that these systems had less fading than any other coatings.

C. Long life - applications more than 15 years old are still holding up with no signs of cracking, hardening or peeling. Roofs are still watertight even where they have been exposed to long-term water ponding.

D. These ceramic coating systems are resistant to chemicals. Tests show the finished products remain unharmed by very harsh chemicals, including battery acid and salt-water solutions.

E. Combined with thickeners, fungicides and other additives, ceramic coating systems present the user with affordable protection.

There are some additional points and properties that are significant in creating a successful thermal coating:

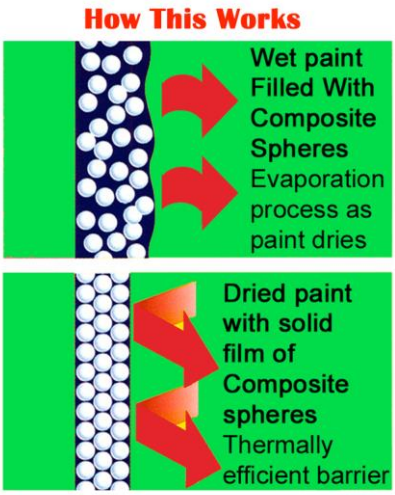
A. When the coating dries, it will tend to bring the ceramic microspheres closer together. This is critical. This creates the 'Arm in Arm' barrier to temperature transfer. The combination of a closely packed, high percentage of ceramic microspheres and the proper resins creates the reflection, insulative, and dissipative properties of the coatings.

B. There must be enough ceramic microspheres in the mix. 50% or greater by volume is required. Without sufficient volume the spheres will not come Arm in Arm with each other to provide the desired effect in a resin coating.

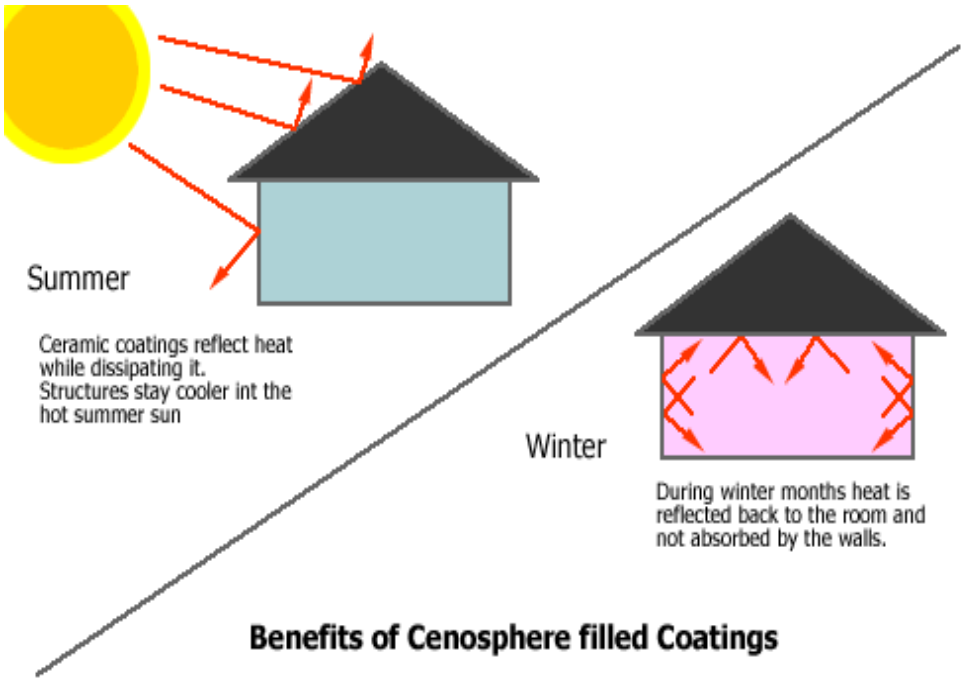
C. Particle size distribution is key. The distribution is important to create tight packing. A bi-modal distribution should be considered for optimal results.

D. The true density of the microspheres is important. They should be selected to enhance the resins ability to hold them in suspension.

If they are too light this will become more problematic and they will tend to float out.



Rooms painted with hollow ceramic microsphere systems (ceiling and walls) will feel warmer at the same temperature than before the application. This is the same phenomenon as a person being outside in the sun and feeling hotter than being in the shade even though the temperature is the same. Further, walls painted with these coatings will be more durable as the ceramic microspheres create a hardened surface.



Ceramic microsphere coating systems can improve the energy efficiency of any structure by painting interior walls (outside) and ceilings to keep heat in during the winter and cool in during summer.

Appendix A

All the materials that are used in the construction of your home or business absorb and transfer Heat. 80% - 95 % of this heat is transferred! Standard insulation works by slowing down the RATE of transfer of the heat that has been absorbed by the walls, and roof or your home. Heat ALWAYS flows from the warmer side to the cooler side of an object by one or more of the following ways:

Conduction - Conduction is the transfer of heat through a solid object. When one part of an object is heated, the molecules within it begin to move faster and more vigorously, when these molecules hit other molecules within the object they cause heat to be transferred through the entire object

Convection - Convection is the transfer of heat by the movement of a fluid or gas. Inside a wall cavity air removes heat from a warm interior wall, then circulates to the colder exterior wall where it is lost

Radiation - Any object will radiate heat to cooler objects around it by giving off "heat waves". This is a direct transfer of heat from one object to another, without heating the air in between. This is the same process in which the Earth receives heat from the Sun or a wood stove supplies heat to its surroundings.

The ceramic materials have unique energy saving properties that reflect heat while dissipating it. The hollow ceramic microsphere reflective quality affects the warming phenomenon called "Mean Radiant Temperature," where heat waves from a source such as direct sunlight cause a person to feel warmer, even though the actual air temperature is no different between a shady and sunny location. It is the molecular friction within the skin caused by the sun's radiant energy that makes the body feel warmer.

References:

3M
Rohm and Haas
General Industries Corporation
Thermo Shield
The Insuladd Company
CenoStar Corporation