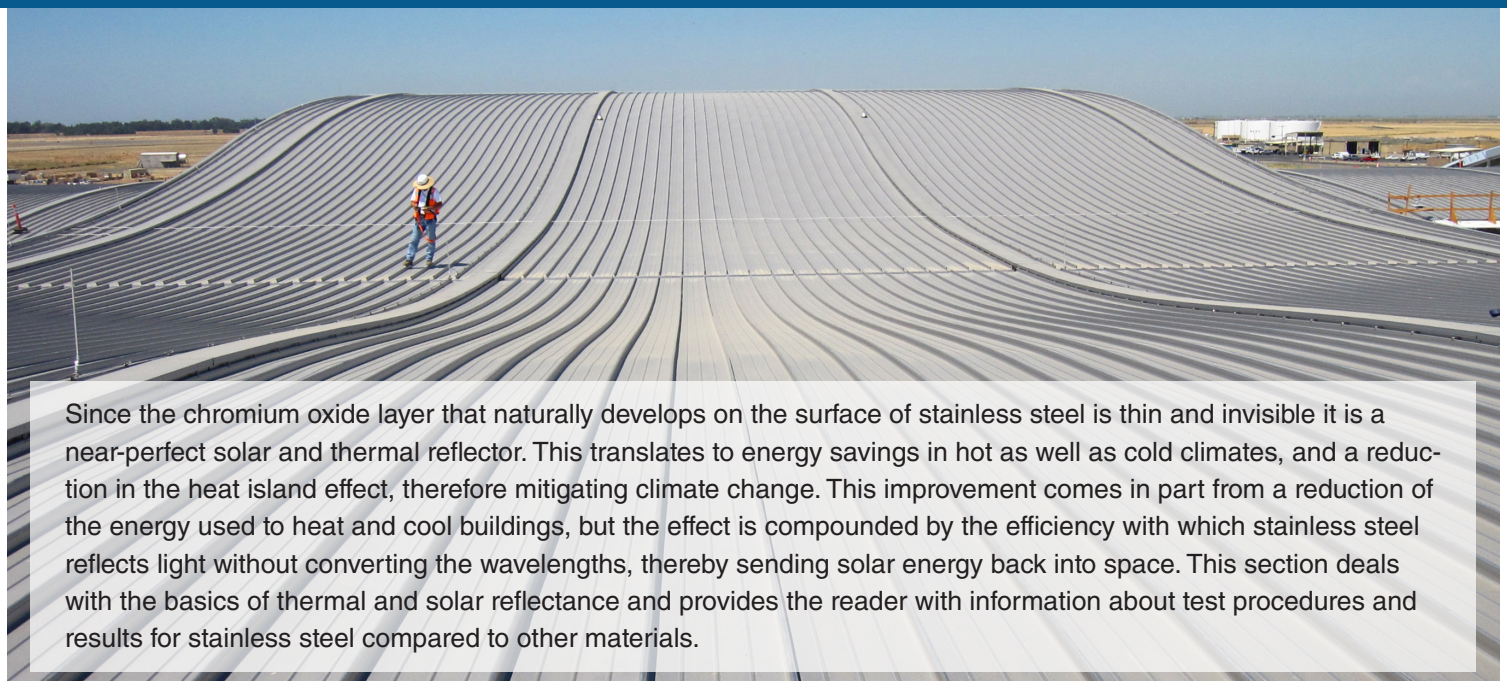
CMT
CONTRARIAN MICRO TEXTURES
by Rigidized® Metals Corporation

Save Energy

Thermal & Solar Reflectance of Stainless Steel



Since the chromium oxide layer that naturally develops on the surface of stainless steel is thin and invisible it is a near-perfect solar and thermal reflector. This translates to energy savings in hot as well as cold climates, and a reduction in the heat island effect, therefore mitigating climate change. This improvement comes in part from a reduction of the energy used to heat and cool buildings, but the effect is compounded by the efficiency with which stainless steel reflects light without converting the wavelengths, thereby sending solar energy back into space. This section deals with the basics of thermal and solar reflectance and provides the reader with information about test procedures and results for stainless steel compared to other materials.

Stainless steel, unlike every other outdoor metal people have day-to-day experience with, doesn't get burning hot in the sun. This is counter-intuitive. People are used to metals which oxidize and the oxide coatings have high absorption of solar energy (low solar reflectivity, or low SRI). Stainless doesn't behave like normal metals. While its passive film is technically an oxide, it is nonetheless very thin, transparent oxide that permits its surface to behave like true bare metal and reflects incoming electromagnetic energy, including sunlight. This property of stainless steel as it relates to buildings was first recognized on top of the Doha Airport roof during the installation of roof panels made from Contrarian Micro Textures' Invari-Matte® stainless steel. A company representative was able to place his hand comfortably on the metal surface on a sunny 118°F day. That phenomenon suggested there was a whole lot more to the story of stainless steel as a building material. As a result of that day, the company initiated research to better understand the thermal properties of stainless steel, and how they relate to energy efficiency, as well as the heat island effect of stainless-clad buildings. The findings explain how stainless steel building envelopes save energy and reduce urban atmospheric temperatures.

The fact is a stainless steel roof has major advantages in both warm climates and cold. A stainless roof provides a degree of insulation value in and of itself, thereby enhancing the performance of insulating systems or even reducing the extent to which the building must be insulated. This allows the designer to make an informed decision to determine the optimal balance of construction versus operating costs.

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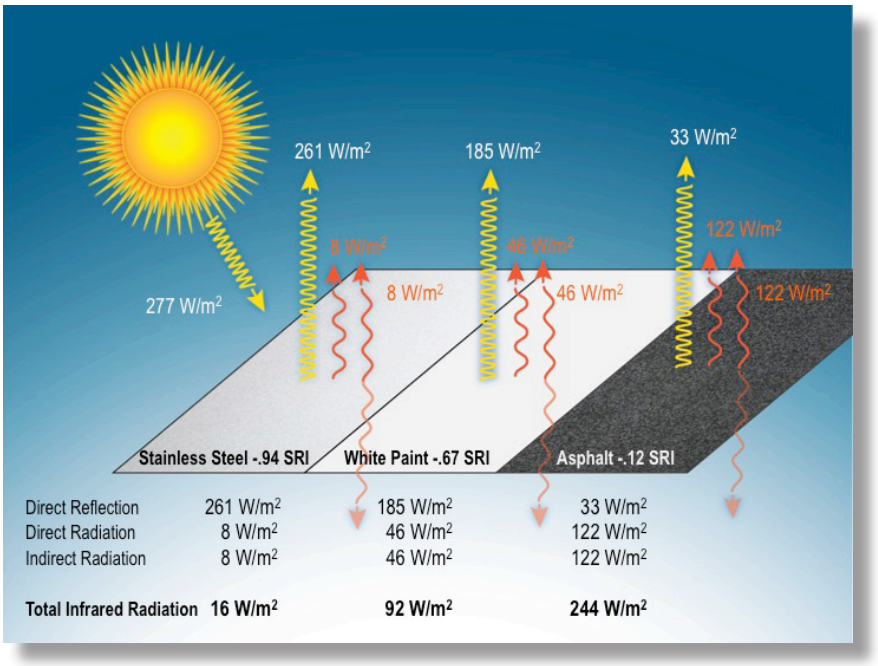
Several areas of investigation were conducted. Before digging into the details, it is first important to understand how stainless steel as a building material relates to solar energy, global warming, heat islands, cool roofs and SRI (solar reflectance index).



Let's look at the physics first. The sun's radiant energy is the uncontrollable given in the problem. The radiation has peak energy of roughly 1375 watts per square meter which strikes the earth's atmosphere. It doesn't all reach the earth's surface. It is diminished by absorption and reflection. The atmosphere, and principally clouds, reflects 25% back into space. The atmosphere absorbs another 23%. This absorption is selective with ozone strongly absorbing ultra-violet wavelengths, and carbon dioxide and water strongly absorbing infrared wavelengths. This leaves just 52% to hit the earth's surface. Of this amount 90% is absorbed and 10% is reflected back to space. The amount of energy per unit area hitting the earth's surface is called irradiance, and for the US the monthly average is 4-6 kWh/day/ square meter or about 200 watts/m^2.

When solar energy is reflected the wavelengths do not change, so the radiation which is reflected goes right through the atmosphere to space since it consists of wavelengths that are less affected by atmospheric absorption. The absorbed energy heats the earth's surface. The re-radiation of this heat is at infrared wavelengths. When it radiates from the earth toward space it is almost entirely absorbed by the greenhouse gasses, water and carbon dioxide. To the extent the concentration of these gasses increases, the earth's heat has a harder time escaping and the surface temperature must rise to compensate. This is global warming. This is the problem.

Stainless steel has a major advantage in that it is more efficient at reflecting solar energy than typical roofing materials. These include painted surfaces, rubber and plastic membranes and bare metals like aluminum, copper and zinc develop oxides or patinas that convert solar energy to infrared wavelengths.

In fact, stainless steel has the distinct advantage in that its surface does not degrade. Unlike other metals, including painted lines that oxidize, the only degradation of solar reflectance that can affect stainless steel (provided corrosion resistance is suitably matched to the environment) is the accumulation of dirt. Further, certain finishes of stainless steel are more dirt resistant than others, creating opportunity for minimal degradation of solar reflectance over an extended period of time. Clearly, the sustainability of surfaces matters.

Beyond the sustainability of the finish, characteristics of a given stainless steel surface weigh heavily in the solar reflectance equation. Particular attention is paid to Contrarian Micro Textures' InvariMatte® stainless steel finish which was designed for roofing and other building envelope applications. While the original objective in developing this product was to create a uniform low glare finish that would not produce unwanted environmental glare when used in large surface areas such as a roof, the energy investigation we have undertaken has shown distinct advantages of this finish relating to energy performance.

The team investigated the David Lawrence convention center in Pittsburgh, Pennsylvania, which has InvariMatte® stainless steel installed on its roof. Since its construction in 2002, the owner has enjoyed less than expected energy costs in order to heat and cool the building. Data collected from the convention center roof support the notion that the stainless steel roof is a contributor to the building's low operating costs.

Clearly, stainless steel has been an under-appreciated building material. While it does cost a bit more to install than conventional metals used in construction, it has tremendous value in terms of durability and low maintenance cost. We can now add energy savings and heat island mitigation as further justification for its use in building envelopes.

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