Blowing Hot Air

Reflective Roof Coatings Improve A/C Efficiency

by Alexander Cua - Advanced Coating Systems

Best Western Inn (Above Main Lobby)

IHOP (Above Dining Area)

Introduction

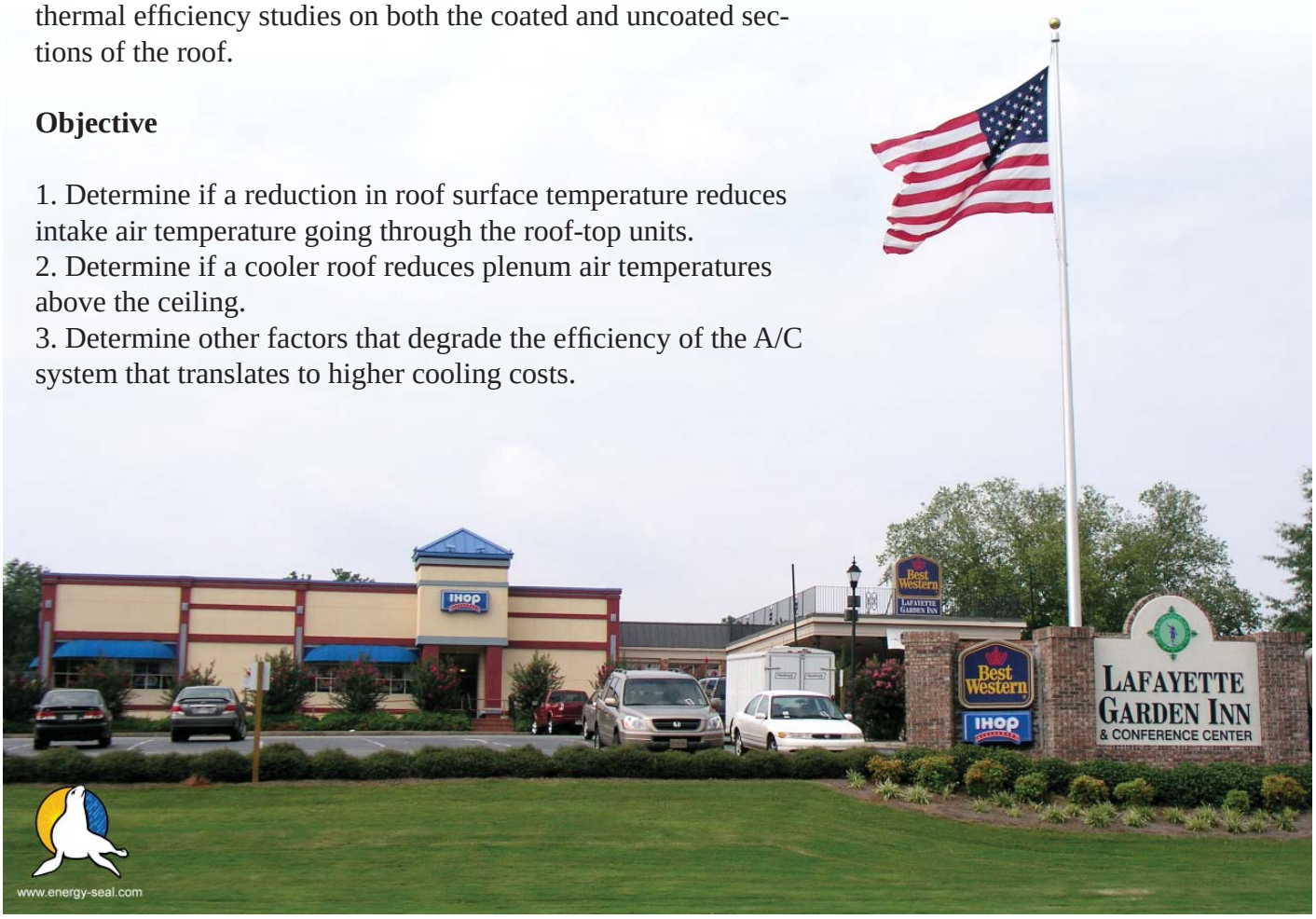
Located in La Grange, GA, this Best Western Inn had a black EPDM roof with leak problems. EPDM is an inexpensive black roofing material that resembles tire tubes. The system typically lasts 15 years.

A portion of the roof (above IHOP restaurant) was recently re-roofed with a similar EPDM membrane. Since the removal and disposal of EPDM is expensive, the owners sought other methods to solve the leak issues. Energy Seal elastomeric roof coatings are an excellent, environmentally friendly alternative to roof replacement.

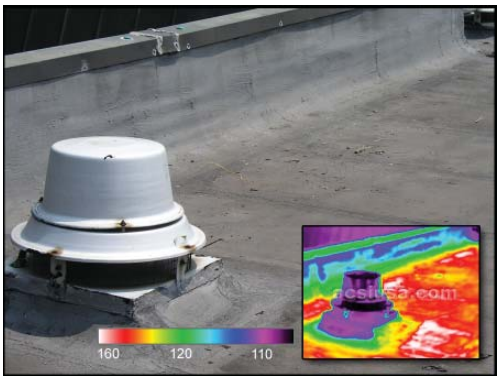
This scenario provided the perfect opportunity for us to conduct thermal efficiency studies on both the coated and uncoated sections of the roof.

Objective

1. Determine if a reduction in roof surface temperature reduces intake air temperature going through the roof-top units.
2. Determine if a cooler roof reduces plenum air temperatures above the ceiling.
3. Determine other factors that degrade the efficiency of the A/C system that translates to higher cooling costs.



The Rooftop



Infrared Thermography taken on July 26, 2005 at 2:00PM clearly shows extreme roof temperatures on a black, non-reflective roof system.

Rooftop Data before Coating Application

Time	Ground Ambient	Roof Ambient	Roof Surface	Rooftop A/C
11:00AM	89.2°F	99.7°F	149.0°F	94.6°F
12:00NN	94.3°F	102.9°F	170.0°F	97.9°F
1:00PM	94.8°F	106.2°F	172.0°F	103.1°F
2:00PM	97.5°F	106.5°F	176.5°F	104.9°F
3:00PM	95.9°F	113.5°F	165.0°F	103.9°F
4:00PM	96.6°F	110.3°F	168.0°F	101.7°F
5:00PM	95.5°F	103.5°F	151.0°F	99.0°F

*Measurements taken July 26, 2005

These initial readings were taken at the first heat wave of the season in La Grange, GA. We had a heat index of 105°F and at 2:00PM roof surface temperature reached a whopping 181°F on certain sections of the black EPDM roof. For this study, we took lowest reading from 6 test points all over the roof.

On average, a black, non-reflective roof raises the ambient air temperature on the roof about 10°F (10%). I was getting lower readings from thermocouples placed near the A/C units. Airflow had a cooling effect on the thermocouples (even with cones), thus lowering the measured temperature. Direct sunlight also skewed the readings so we had to keep the thermocouples in the shade for the duration of the test.

Rooftop Data after Coating Application

Time	Ground Ambient	Roof Ambient	Uncoated Surface	Coated Surface	BW A/C Coated	Ihop A/C Uncoated
11:00AM	88.9°F	96.8°F	149.0°F	91.0°F	97.9°F	102.9°F
12:00NN	92.5°F	98.5°F	159.0°F	93.2°F	98.3°F	103.2°F
1:00PM	92.9°F	99.3°F	163.0°F	94.2°F	98.6°F	103.9°F
2:00PM	93.2°F	99.8°F	168.2°F	**94.5°F**	98.5°F	104.2°F
3:00PM	93.0°F	99.9°F	165.0°F	94.4°F	98.5°F	104.1°F

*Measurements taken August 4, 2005

These readings were taken a few days after the roof was coated with Energy Seal reflective roof coatings. There was a significant reduction in roof surface temperatures! The uncoated area measured 168.2°F; the coated area was 94.5°F. It is a heat reduction of 73.7°F or 98%. Even air around the coated and uncoated A/C units had a temperature differential of almost 5°F.

Test Methods

Ambient Air Temperature

We used a Radio Shack ambient air thermometer and thermocouples. All units were given 1 hour to normalize before readings were taken. All readings were taken with the probes in the shade and placed in close proximity to the test area.

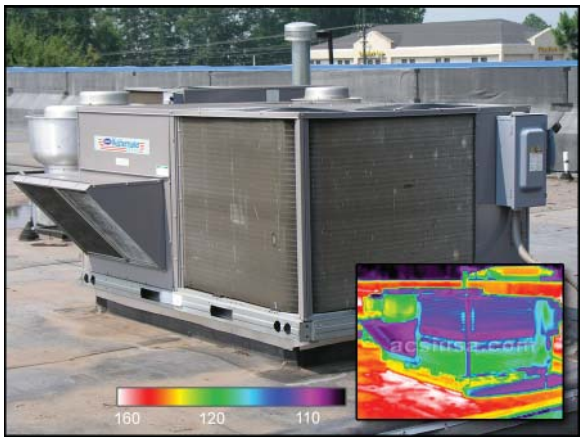
Roof Surface Temperature

We used a Raytek Raynger non-contact thermometer.

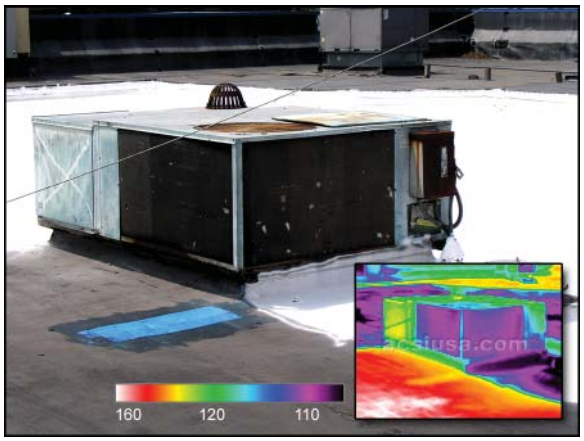
Thermal Imaging

We used an IR-Insight Infrared Camera. An invaluable tool that allowed us to view the heat gain on the A/C units more accurately than any thermometer could provide.

Rooftop A/C



IHOP Roof (Uncoated Area) Infrared Thermography taken on July 26, 2005 at 2:00PM clearly shows higher temperatures near the roof due to superheated air on the roof surface.



Best Western Inn Roof (Partially Coated) Infrared Thermography taken on August 4, 2005 at 2:00PM. The evaporator coils on this unit are running cooler and more efficiently since the surrounding air temperature has been lowered by Energy Seal reflective roof coatings.

"The uncoated area measured 168.2°F; the coated area was 94.5°F. A heat reduction of 73.7°F or 98%."

Best Western Inn Roof (Readings taken near A/C above.)

The Plenum

The plenum is the space between a false ceiling and the actual ceiling that serves as a distribution area for heating or cooling systems. For unducted air returns, this is also called the return plenum and a significant amount of cooling energy is lost here.

So much attention has been placed on achieving optimum R-values and SEER ratings that almost no emphasis was given to efficiency lost during distribution. The heat load on the roof raises plenum temperatures significantly and this directly affects the cooling efficiency of the system since cool air is being reheated as it enter the plenum and then re-cooled.

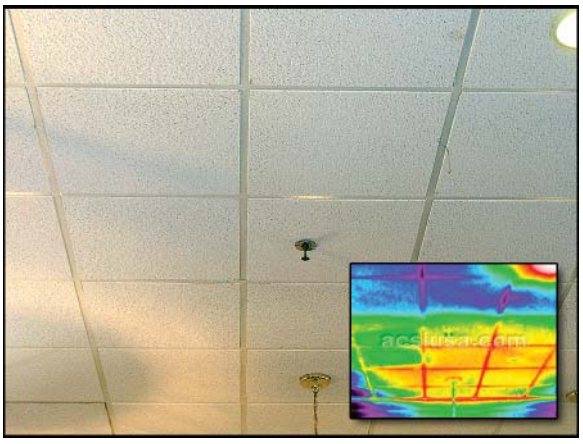
"A temperature reduction of 11.5°F at the plenum translates to a 34.8% decrease in cooling load."

IHOP (Below Uncoated Roof)

Best Western Inn (Below Coated Roof)

The temperature inside this plenum went down from 93°F to 81.5°F or a reduction of 11.5°F. The supply temperature was 60°F and this translates to a 34.8% decrease in cooling load. As of this writing, the test area was limited to 1/3 of the entire roof surface. **The temperature differential would have been greater if the entire roof was coated with Energy Seal reflective roof coatings.**

Ceiling Grid



Heat transfer from the plenum to the room was clearly evident in this IR thermograph. The ceiling grids become “heat sinks” and represent 8.3% of the surface area of the ceiling if taken collectively.

Conclusion

The performance of A/C system can be severely degraded by heat gain coming from the roof. An A/C system works by removing heat from the room and dissipating it outdoors. Any heat gain around the supply ducts, return plenum, ceiling and roof-top units contribute to this degradation. In this case study, the heat gain on the A/C system probably reduced the cooling efficiency by as much as 40%.

The owners of this building not only saved re-roofing dollars by extending the service life of this roof, they also will save money in the long run by enhancing the performance of their A/C system.

As an Energy Star-labeled product, Energy Seal reflective roof coatings reflects up to 90% of the heat from the sun and significantly reduced the heat load on this roof.

“In this case study, the heat load from the roof may have reduced the cooling efficiency by as much as 40%.”

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