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Saving Energy with Space Age
High Emissivity Ceramic Coatings

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Thorpe Corporation
Refractory, Engineering & Construction
Emissshield® High Emissivity Ceramic Coatings for Refractory and Metal Furnace Components

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EMISSHIELD® COATINGS

This aerospace materials science has been adapted for use in the industrial sector:

• Core emissivity agent technology was licensed from NASA.

• The Center of Adhesion and Sealant Sciences at Virginia Polytechnic Institute optimized the binder system for industrial applications.

NASA developed these high emissivity ceramic coatings to protect the X33 Orbiter from the heat and high surface velocity encountered during reentry.
Emisshield® ceramic coatings:
- For refractory, ceramic, and metal substrates
- Rated to 3500° F
- Non-toxic water based materials
- Become fully ceramic above 1500° F
- Excellent reliability and longevity
- Rapid payback

Technology:
- Unique binder system
- Patented emissivity agents
- Nanotechnology- small particle size
What is emissivity?

- Ability of a material to absorb and reemit radiant energy.
- A black body has an emissivity of 1.0. Theoretical concept. Non-existent.
- A perfect reflector has an emissivity of 0.0. Theoretical concept. Non-existent.
- All real materials fall between 0.0 and 1.0.
- Coatings can increase emissivity to 0.95.
The science of emissivity:

\[ Q = E_H \cdot \delta \cdot (T_H^4 - T_C^4) \]

- \( Q \) = Reradiated energy (BTU/hr-ft\(^2\))
- \( E_H \) = Emissivity of hotter surface
- \( \delta \) = Stefan-Boltzmann constant
- \( T_H \) = Temperature of hotter surface
- \( T_C \) = Temperature of cooler surface
$Q = E_{\text{COATING}} \cdot \delta \cdot (T^4_{\text{COATING}} - T^4_{\text{DEEP SPACE}})$

$T_C < 0^\circ F$

$T_H > 3000^\circ F$
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Oxyacetylene flame- over 6000° F theoretical temperature
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2300 rated refractory fiber board - melts at 3100° F

\[ Q = E_{\text{coating}} \cdot \delta \cdot (T_{\text{coating}}^4 - T_{\text{ambient}}^4) \]
HIGH EMISSIVITY COATINGS

Energy absorbed & reradiated

Radiation

Convection

Reflected Energy

No coating, E = 0.5

Heat loss
Absorbed & re-reradiated energy

Less Heat Loss

With coating, $E = 0.95$
Potential Benefits on Refractory:
- Fuel savings and/or production increases of 3 to 6%.
- More uniform heat distribution to the coil.
- Less heat loss and lower external casing temperatures. Improved personnel safety.

NOx Considerations:
- Realized fuel savings lowers fuel NOx.
- Lowering radiant box temperature has the potential to reduce thermal NOx.
- NOx reductions of 20% - 30% have been reported.
Process Considerations:

• Radiant box temperature and flue gas crossover temperature are reduced because more available heat is transferred to the coils.

• Preheat and/or steam production in the convection section will be reduced accordingly.
How much experience in fired heaters?

- Sept. 2003- Over modules and IFB in ethylene cracker at Eastman Chemical. Reported energy savings of $80,000 per year.

- July 2004- Over modules in F-W terrace wall NH$_3$ reformer at Terra Industries.

- June 2005- Over modules and IFB in ethylene cracker at Huntsman Chemical.
Continued:


- February 2006- Over modules in VCM cracking furnace at Formosa Plastics

- April 2006- Over modules and IFB in second ethylene cracker at Eastman Chemical.

- May 2006- Over modules and IFB in third ethylene cracker at Eastman Chemical.
New 24” x 24” Fiberlite burner blocks, coated with Emissshield ceramic coating.

New Z-Blok module lining surrounding the burner blocks is not coated.
Coating only the 24”X24” burner blocks produced a 30°F lower cold face temperature than the surrounding uncoated modules.
Huntsman Chemical- Installed June, 2005

- New refractory lining- IFB in lower walls, Z-Blok® modules in balance of radiant box.
- New radiant tubes.
- New low NOx burners.
- Cleaned convection section tubes.
- Tightened radiant box- Installed new HotSeal™ tube penetration seals.
- HiE coating installed on sidewalls only.

Documented performance as of October 2005

- 12% total fuel savings as qualified above.
- Estimated annual total savings- $1.47 MM
Huntsman Chemical
Ethylene cracking furnace
$Q = \text{Reradiated energy (BTU/hr. - ft}^2$}

$\delta = \text{Stefan-Boltzmann constant}$

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Shrinkage after 3 months operation.
End walls were not coated. More apparent shrinkage.
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Eastman- Installed April, 2006
  • Existing refractory lining- IFB in lower walls, Z-Blok modules in balance of radiant box.
  • Coating installed on endwalls and sidewalls.
  • New radiant tubes.
  • No other changes during shutdown.

Documented performance as of November 2006
  • 6% fuel savings.
  • 9% reduction in steam production.
  • Payback period- 10 months based on $6 /MBTU.