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INTERNATIONAL II, INC.

STEEL MANUFACTURING PLANT

Test Areas

1. Extreme Temperature application

First Set of Pictures taken at the testing site over a 2000F (1093C) oven with fire brick on the interior. We applied HPC on the exterior wall to reduce the heat lost. When the original temperature readings were taken directly on the exterior metal skin of the furnace, the temperature was 500F (260C). The team doing the testing had brought only one pail of HPC for all the testing spots. The steel manufacturing plant engineers wanted a larger test site after the team arrived which made the quantity of HPC too little, but we continued with the testing. As we sprayed the HPC over the surface, the exterior temperature on the surface of the HPC dropped to 160F (71C) and everyone was happy. I had my doubts that the 500 mils (12.5mm) applied would be enough thickness to insulate but also be enough to cover over the char that would happen when the HPC contained the surface heat and the resulting heat rise due to HPC not allowing the heat to escape from the surface. This heat under the HPC would increase and cause the organic resins in the coating to char which would be normal, but makes it look like the HPC has failed - only because it charred and is black. It is only the resins charring and not the ceramics. When the char happens the surface temperature on the exterior surface of the HPC will rise because of the increased heat on the metal surface that HPC is now insulating and by holding the additional heat on the surface of the metal, the heat is increasing dramatically. We applied 500 mils or 12.5mm and had to take the remaining HPC to do other test areas. I told the engineers that the 500 mils would char and become black because I thought the heat would increase behind the HPC on the metal surface and cause this to happen. I did not know how effective the HPC would be but we would check later. After the team left the steel manufacturing plant and over the next three weeks, the HPC did char and turn black. Due to our resin mix, the char will not fall off and must be scrapped off. Even when charred, it will continue to stay adhered to the surface. It is the resins that charred and not the ceramics that continue to work as scheduled. The engineers at the steel manufacturing plant told the team that the HPC had charred and that the surface temperature had increased which we knew it would. The engineers thought that maybe this was a total breakdown of the HPC and that it was failing. I had told them this would happen and this is not a failure, but they did not understand.

When the team came back to the steel manufacturing plant to check the charred HPC and take readings, the exterior of the HPC was reading at 315F (157C) on the surface. Before the HPC charred, it was reading 160F (71C) and therefore had an increase of 155F (86C) which seemed to show that HPC was failing and not holding the heat from the metal surface. The original surface temperature of the metal when we applied HPC was 500F (260C).Picture number 1 shows the reading on top of the exterior of the blackened HPC.

The second picture shows the metal surface after we scraped back some of the charred HPC to expose the metal surface and find the temperature behind the HPC to see how well HPC was insulating and holding the heat on the surface of the metal. The metal temperature under the HPC is now 838F (448C). This surprised the entire engineering staff because they now understood that even though the HPC has blackened from the increased heat and too little thickness, it was working very well and had increased the heat held on the metal surface from 500F (260C) to 838F (448C) or was holding the surface heat more efficiently by 68%. The BTU savings from lost without having HPC was in the millions of BTUs and the savings were huge and enough to pay for the coating within months of application. See the following picture where they scrapped the HPC off the surface to take the reading. Just enough HPC was removed to take a reading.

The next picture is when the HPC was removed more in the middle of the test area to capture a more accurate temperature reading that the HPC was holding on the surface of the metal. The metal was glowing red directly under the HPC and the temperature gauge could not read above 1000F (538C). This showed that the HPC was holding 100% more heat than when first applied on the surface of the metal. You can see the red glow at the top side of the scrapped area.

The BTU savings per day of operation is so large that the engineer team knew immediately that the savings offered by applying HPC would be dramatic and into the millions of dollars.
The give a quick summary of the BTU savings, the ASHRAE formula is used to show the BTU savings on all three readings below:
ASHRAE formula: (Org. Temp X Difference/24=tons of energy X 12,000 BTU per ton = BTU savings.

1. Readings:	**Surface of metal**	Surface of HPC	**BTU savings (Use formula above)/hr.**
	A. 500F(260C)	160F (71C)	85,000,000/hr.
	B. 838F(448C)	315F (157C)	219,137,000/hr.
	C. 1000F(538C)	315F (157C)	342,500,000/hr.

Change BTU into KW to find **COST SAVINGS** per hour / day/week/month/year. (1 BTU = .293 WATT)

A. 85,000,000 BTU/hr. X .293 Watt = 24,905,000 Watts divide 1000 = 24,905 KW/hr
In Kansas City (0.08cents/KW) or 24,905 X .08 **=$1992.40/hour**
$47,817/day---$1,434,528/ month --- $17,214,336/ year.

B. 219,137,000 BTU/hr X .293 Watt = 64,207,141 divide 1000 = 64,207 KW/hr
(0.08cents/ KW) or 64,207 X .08 = **$5136.57/ hour**
$123,278/day---$3,698,331/month---$44,379,976/year.

C. 342,500,000 BTU/hr X .293 Watt - 100,352,500 divide 1000 = 100,352 KW/hr
(0.08cents/KW) or 100,352 X .08 **= $8028.16 /hour**
$192,675.84/day---$5,780,275/month---$69,363,302

SUMMARY Savings per year:

A. $17,214,336
B. $44,379,976
C. $69,363.302

This is a steel manufacturer, so their energy consumption is enormous, therefore, the savings can be enormous.

HPC is being specified into the operation immediately. The fact that the HPC was applied too thin and it charred over the surface was completely understood after seeing the results of how effective HPC is at holding the surface heat on the metal and not allowing it to be lost to the atmosphere. The application to get the HPC up to 2" (50mm) or whatever it may take, is completely understood that this additional cost will be saved very quickly in the savings of BTUs because these lost BTUs will be kept inside the furnace to heat the metal and the input of heat and consumption of fuel to maintain the heat will be saved and reduced. Again, the cost of the HPC is very minor to the savings of BTUs and fuel consumption to operate the furnace.

LESSON LEARNED: When the HPC is charred on the surface means that the temperature we originally coated over has increased by as much as 100%. This means that now we do not have enough HPC to cover the surface and take on the

increased surface heat and cover over the char that will rise up through the coating. When we apply the correct thickness, the char cannot be seen and the HPC is performing it's job very well and outperforming any coating or any other insulation material known.
It has not failed. You have not applied enough coating thickness.

<u>UPDATE (July 2011):</u> We have found an additive to go into HPC that can reduce the charring through and up to the surface of the coating. When the charring reaches the top surface, the resin has lost its' ability to form a cast around the pipe and hold on. This is an excellent improvement.

2. Metal Jacket with 3" (7.5cm) of rock wool compared to 250mils or 6mm of HPC.

Finished temp on the HPC at around ¼" thickness. Temp on the jacket next to the bolt connector area. Fairly dramatic difference.

Second set of Pictures is the standard metal jacket over 3" (7.5cm) of slicia/rock wool. Second Picture is 250 mils (6mm) of HPC directly over pipe after removing jacket and silica.


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180.8
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3. Third set of photos:

Interesting photo of the rock wool insulation and the exterior jacket. The temps of both the rock wool and the jacket are basically the same. Clearly shows thermal equilibrium of the rock wool. The heat is transferring in equal amounts through the rock wool to the jacket. R rating = 0.

The heat has already loaded (fully) into the rock wool and is now passing the heat through at a constant rate. At this point, there is no R value or K value of heat resistance. After the material fully loads, the resistance falls to "0".

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"Charting the Course to a Greener Future"


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SCAN ε=0.95
111.5 °F
EMS
°C °F
Set
Laser
Mode


Raytek
ε=0.95
110.1
EMS
Set
Laser
Mode


Raytek
139.1
EMS
Set
Mode

4. Fourth set of pictures:

Steve applying HPC. Reading at around a 1/16" (62 mils or 1.6mm) thickness.
The 3" (7.5cm) of rock wool and metal jacket is 139F (59.4C).
The 62mils (1.6mm) of HPC is 102F (39C).
Difference of 37 F (20C) with only 62mils or 1.6mm).

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