High-Emissivity Coatings
Energy Efficiency Opportunities

1. Complete combustion with minimum excess air
2. Proper heat distribution
3. Operation at the optimum furnace temperature
4. Reducing heat losses from furnace openings
5. Maintaining correct amount of furnace draft
6. Optimum capacity utilization
7. Waste heat recovery from the flue gases
8. Minimize furnace skin losses
9. Use of ceramic coatings
10. Selecting the right refractories
Basic Properties

- Viscous Liquid
- High Density
- Water Based
- Non-Toxic
- Non-Explosive
- Non-Flammable
Coating’s Properties

- Chemical Stability
- Thermal Mechanical
- High Adhesion
- Long-life High Emissivity

HEC
Emissivity

Emissivity, $\varepsilon$

Temperature, °C

- High-Emissivity Coating
- Castable
- Fire Brick
- Ceramic Fibre
Energy Distribution

uncoated Refractory

$\varepsilon = 0.45$

40%

coated Refractory

$\varepsilon = 0.92$

87%

55%

8%
# Tubes surface coating

<table>
<thead>
<tr>
<th>Thermal conductivity</th>
<th>Tube surface temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>29 W/m*K</td>
<td>620°C</td>
</tr>
<tr>
<td>28 W/m*K</td>
<td>640°C</td>
</tr>
<tr>
<td>15 W/m*K</td>
<td>715°C</td>
</tr>
</tbody>
</table>

“white metal” coated with scale
Coating process

- Sandblasting
- Spraying
- Drying
Results

- Efficiency Increase
- Equalized Heat Distribution
- Protection from Bad Factors
- High Economic Performance
- Emission Reduction
Results

- **Efficiency increase**
  - Fuel Saving
  - Yield Increase
  - Thermal Efficiency Increase
  - Flue Gas Temperature Decrease
  - Tubes Surface Temperature Decrease
CTK-EURO is the official exclusive representative of SOLCOAT Ind. The staff of the company is fully trained and allowed to check the surface preparation and to apply the ceramic coatings.
State Certificates
Results

- Equalized Heat Distribution
  - Elimination of Hot/Cold Spots
  - Increase of Furnace Lifetime
  - Heat Loss Decrease
  - Coking Reduction
Thermography

Distillation unit furnace
Before coating

Distillation unit furnace
After coating
Equalized Heat Distribution

Heat Distribution without HEC

Heat Distribution with High-Emissivity Coating
Results

Tubes in Radiation Chamber

Before Coating

After Coating
Results

- Protection from Bad Factors
  - Protects Tubes from Corrosion
  - Prevents Scale Build-up on Surfaces
  - Hot Gas Erosion Resistant
  - Removes Acid Gases Influence
  - Extends Lifetime of Refractory
High Economic Performance

- Low Investments
- Easy Installation
- No Operating costs
- Short ROI cycle
- High Payback
- Long Lifetime
Applicable Industries

- Petrochemistry
  - Fire Heaters
  - Incinerators

- Metallurgy
  - Hot Stove Blast Furnace
  - Coke Oven
  - Anneal Furnace, Forges

- Power Generation
  - Boilers

- Recycling
  - Waste Incinerators
Case Study

Project Name: Deep Oil Refining Unit
Location: Refinery, Russia

Furnace Information
Furnace Type: Fire Heater
Fuel Type: Fuel Gas + Fuel Oil
Substrate: 20 year-old Concrete and new Process Tubes (08X18-H10T)
Operating Temp: 750 - 770°C
Background: Furnace temperature is controlled by furnace exit temperature. Customer looked for overall thermal improvements in the unit.

Application Information
Hi-E Coating was applied on the process tubes and the hard refractory sidewalls. The application took place in November, 2011.
Deep Oil Refining Unit KT-1/1

Furnace F-102 during the unit reconstruction
Deep Oil Refining Unit KT-1/1

Furnace F-102
Deep Oil Refining Unit KT-1/1

- **Bridge Wall Temperature**: ~ 760°C to 790°C
- **Flue Gas Temperature**: ~ 600°C to 630°C

~ 600°C to 630°C

~ 460°C
## Case Study

### Bridge Wall Temperature

<table>
<thead>
<tr>
<th></th>
<th>Average for 2011</th>
<th>Average for 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flue gas temperature</td>
<td>615</td>
<td>499.4</td>
</tr>
<tr>
<td>Bridge wall temperature</td>
<td>776</td>
<td>674</td>
</tr>
</tbody>
</table>

**Graphs and Data:**
- **Flue gas temperature range:** 599-636°C
- **Bridge wall temperature range:** 650-700°C
- **Average values:**
  - Flue gas temperature: 615°C (2011), 499.4°C (2012)
Deep Oil Refining Unit KT-1/1

Efficiency (calculated on-line) about 60%

67-70%
High-Emissivity Coating Benefits:

• Bridge Wall Temperature and Flue Gas Temperature decrease of 100-120°C
• On-line calculated Efficiency increase up to 7%
• Specified fuel saving is 3-5%
• Reduced air emissions

Expected benefits (the unit will shutdown only in 2015)
• Decreased fouling of process tubes
• Extended Lifetime of Refractory
Project Name: Distillation Unit #6
Location: Refinery, Russia

Furnace Information
Furnace Type: H-1, H-2 two-slopped
Fuel Type: Fuel Gas + Fuel Oil

Application Information:
Hi-E Coating was applied on the process tubes and the hard refractory sidewalls. The application took place in November 2012.
Distillation Unit
## Distillation Unit

<table>
<thead>
<tr>
<th>Furnace</th>
<th>Flue gas temperature, C</th>
<th>Wall bridge temperature, C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before coating</td>
<td>After coating</td>
</tr>
<tr>
<td>H-1</td>
<td>509</td>
<td>407</td>
</tr>
<tr>
<td>H-2</td>
<td>503</td>
<td>456</td>
</tr>
</tbody>
</table>
Increase the furnace efficiency

<table>
<thead>
<tr>
<th>Item</th>
<th>Before coating</th>
<th>After coating</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>DU-6, H-1</td>
<td>60.4%</td>
<td>64.4%</td>
<td>4.0%</td>
</tr>
<tr>
<td>DU-6, H-2</td>
<td>59.6%</td>
<td>61.2%</td>
<td>1.6%</td>
</tr>
<tr>
<td>L-24/9, H-1</td>
<td>67.0%</td>
<td>73.4%</td>
<td>6.4%</td>
</tr>
<tr>
<td>L-24/9, H-2</td>
<td>70.5%</td>
<td>74.8%</td>
<td>4.3%</td>
</tr>
</tbody>
</table>
Specific fuel saving

- Before coating
- After coating
- Fuel saving,%

<table>
<thead>
<tr>
<th>Material</th>
<th>Before coating</th>
<th>After coating</th>
<th>Fuel saving,%</th>
</tr>
</thead>
<tbody>
<tr>
<td>KT-1-1</td>
<td>33.9</td>
<td>28.7</td>
<td>15.3</td>
</tr>
<tr>
<td>DU-6</td>
<td>28.3</td>
<td>27.0</td>
<td>4.6</td>
</tr>
<tr>
<td>L-24/9</td>
<td>420</td>
<td>395</td>
<td>6.0</td>
</tr>
<tr>
<td>KPA</td>
<td>12.6</td>
<td>10.8</td>
<td>14.3</td>
</tr>
</tbody>
</table>
## Economy via the fuel saving

<table>
<thead>
<tr>
<th>Unit</th>
<th>Feedstock flowrate, t/month</th>
<th>Real Fuel Saving, kg/tonnes</th>
<th>Saved Fuel, t/month</th>
<th>Evaluated Economy *, thousands Rubles per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>KT-1/1</td>
<td>324802</td>
<td>5,2</td>
<td>1689,0</td>
<td>9 862,6</td>
</tr>
<tr>
<td>KPA</td>
<td>81774,5</td>
<td>25</td>
<td>2044,4</td>
<td>11 937,9</td>
</tr>
<tr>
<td>DU-6</td>
<td>122400</td>
<td>1,3</td>
<td>159,1</td>
<td>929,2</td>
</tr>
<tr>
<td>L-24-9</td>
<td>6417</td>
<td>1,8</td>
<td>346,5</td>
<td>2023,5</td>
</tr>
</tbody>
</table>

*Assume that 1 ton of the Fuel oil (mazut) = 1,37 tons of standard fuel*

*Price of 1 ton of the Fuel oil (mazut) = 8 000 Rub.*
### Cases of coating

<table>
<thead>
<tr>
<th>Furnaces</th>
<th>Units</th>
<th>Date</th>
<th>Efficiency Increasing, %</th>
<th>Fuel Saving, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>F 601/1</td>
<td>KT-1/1, Deep Oil Refining Unit</td>
<td>Oct.-Nov. 2011</td>
<td>2.9</td>
<td>5.6</td>
</tr>
<tr>
<td>F 601/2</td>
<td></td>
<td></td>
<td>2.9</td>
<td>5.6</td>
</tr>
<tr>
<td>F-102</td>
<td></td>
<td></td>
<td>2.9</td>
<td>5.6</td>
</tr>
<tr>
<td>BH 311-314</td>
<td></td>
<td></td>
<td>2.6</td>
<td>6.6</td>
</tr>
<tr>
<td>BH 315</td>
<td>Aromatics Production Complex</td>
<td>Apr. 2012</td>
<td>5.1</td>
<td>6.6</td>
</tr>
<tr>
<td>BH 1031A</td>
<td></td>
<td></td>
<td>7.2</td>
<td>6.6</td>
</tr>
<tr>
<td>BH 1031B</td>
<td></td>
<td></td>
<td>4.1</td>
<td>6.6</td>
</tr>
<tr>
<td>F-1</td>
<td>DU-6, Crude oil Distillation Unit</td>
<td>Oct.-Nov. 2012</td>
<td>4.2</td>
<td>4.6</td>
</tr>
<tr>
<td>F-2</td>
<td></td>
<td></td>
<td>1.6</td>
<td>4.6</td>
</tr>
<tr>
<td>F-1</td>
<td>Diesel Hydrotreating Unit</td>
<td>Apr. 2013</td>
<td>6.5</td>
<td>4.6</td>
</tr>
<tr>
<td>F-2</td>
<td></td>
<td></td>
<td>4.5</td>
<td>4.6</td>
</tr>
</tbody>
</table>
### Cases of Coatings

<table>
<thead>
<tr>
<th>Type of Furnace</th>
<th>Coating</th>
<th>Efficiency Increasing*, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reforming Furnace (semi-continuous catalyst regeneration)</td>
<td>+</td>
<td>6.0 – 12.0</td>
</tr>
<tr>
<td>Reforming Furnace (continuous catalyst regeneration)</td>
<td>+</td>
<td>7.0 – 15.0</td>
</tr>
<tr>
<td>Delayed Cocking Unit Furnace</td>
<td>+</td>
<td>5.0 – 10.0</td>
</tr>
<tr>
<td>Atmospheric Distillation Furnace</td>
<td>+</td>
<td>3.0 – 7.0</td>
</tr>
<tr>
<td>Vacuum Distillation Furnace</td>
<td>+</td>
<td>3.0 – 7.0</td>
</tr>
<tr>
<td>Hydrotreating Unit Furnace</td>
<td>+</td>
<td>2.5 – 5.0</td>
</tr>
<tr>
<td>Other furnaces</td>
<td>+</td>
<td>Up to 15 %</td>
</tr>
<tr>
<td>Steam reforming Unit Furnace</td>
<td>+</td>
<td>2.5 – 7.0</td>
</tr>
<tr>
<td>Ethylene Pyrolysis Furnace</td>
<td>+</td>
<td>1.5 – 4.0</td>
</tr>
</tbody>
</table>

* According to HEC Producers Information
Ceramic coating condition after 2.5 years of operation
European Project in Bulgaria

Our first European project with application of High-Emissivity Coatings technology was implemented in LUKOIL Neftochim BURGAS (Bulgaria)
European Project in Bulgaria

Project Name: Heater P-1 Atmospheric Vacuum Distillation (AVD-1)
Location: LUKOIL Neftochim BURGAS, Bulgaria

Furnace Information
Furnace Type: Double-chamber Vertical Fire Heater 55,56 Gcal/h
(Foster Wheeler Iberia, 2009)
Fuel Type: Fuel Gas
Substrate: Concrete refractory and alloyed Process Tubes
Background: The project was completed on the basis of an open Tender in order to reduce of the fuel consumption
Payment for the work performed from the real resulting effect.

Application Information:
Hi-E Coating was applied on the process tubes and the hard refractory sidewalls. The application took place in February, 2014.
Some photos of process performance

Cleaned surfaces of process tubes and liners prepared for coating

Surfaces covered with High Emissivity Coatings
The results of the application

Specific fuel consumption, kg/ton

- 2014: 16.38 kg/ton
- March 2015: 15.01 kg/ton
- April 2015: 14.94 kg/ton
- May 2015: 14.77 kg/ton
- June 2015: 14.72 kg/ton
Savings in fuel consumption, %

- March 2015: 8.37%
- April 2015: 8.80%
- May 2015: 9.86%
- June 2015: 10.13%
Thank You!