coker coaters llc

A SUBSIDIARY OF C³ INTERNATIONAL

Nano-Sized Surface Treatment Blocks Coking and Carbon-Fiber Growth

Breakthrough Technology May Be Coming to Your Plant Site Soon!

Coker Coaters LLC is bringing C3 International's award-winning nanotechnology (MIST) to petroleum processing. MIST is a patented thin-film surface treatment which has been shown to block coke formation in refinery heating tubes and eliminate metal sulfidation. Alpha and Beta Tests conducted at Oak Ridge National Laboratory and Fouling and Coking Technology (FACT) confirm that MIST creates a barrier, which separates hydrocarbon process flows from the steel tubes used in many refinery heating applications. Dr. G. Dickakian, of FACT, authored a paper detailing the results of FACT's Beta Tests, and will present this paper at the 2008 Coking.com conference in Galveston, TX.

To apply its chemical solution to coker heaters on-site, Coker Coaters is partnering with Decoking, Descaling Technology, Inc. (DDT), whose patented, advanced pigging process leads the industry in decoking fired heaters. This means the MIST thin-film can be applied to your existing equipment during a scheduled shutdown both quickly and economically, delivering greater run lengths, increased flows, lower BTU requirements, and fewer equipment shutdowns.

DDT's simple "clean-apply-heat" process is run by expert engineers who are experienced with a variety of refinery equipment and will safely and effectively treat your cokers.

DDT
DECOKING DESCALING TECHNOLOGY

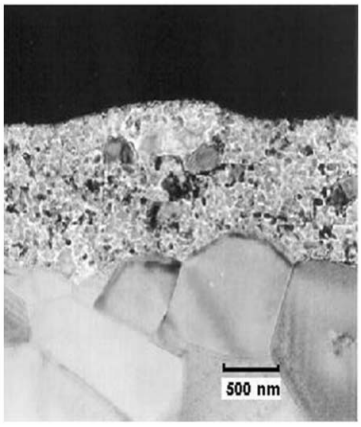
Key Features

- ✓ In Situ Application
- ✓ Increased Run Length
- ✓ Fewer Decokes
- ✓ Increase Flow Rates
- ✓ Lower Heater Duty
- ✓ Decreased Emissions
- ✓ Retards Pyrolytic Coking
- ✓ Prevents Catalytic Coking
- ✓ Prevents Metal Sulfidation

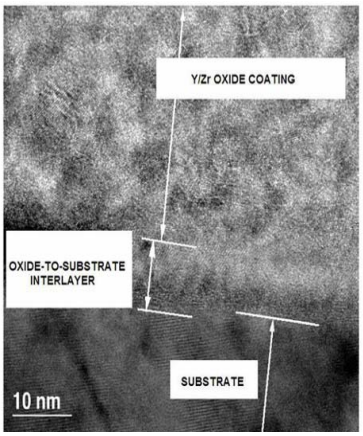
Inside MIST Technology

MIST technology is a low-temperature application process by which any one of 79 elements (or their combination) becomes infused several hundred angstroms deep into an inorganic substrate surface under atmospheric conditions.

The thermal treatment produces a 50 to 500 nanometers (nm) modified surface or thin film that is "anchored" or "rooted" at the molecular level into the treated substrate material, thus providing enhanced functional surface properties that can lead to better performance of the components in specific environments.



Chemical Vapor Deposition Coating



Coker Coaters MIST Technology

Electron microscopy images at left show a cross-sectional view of a standard chemical vapor deposition (CVD) coating versus Coker Coaters MIST Technology.

Compare the large and irregular crystal structure in the CVD coating to the extremely small and uniform nano-scale crystalline structure of the MIST coating.

This nanocrystalline structure gives MIST superior adhesion to the metal surface via an infusion interlayer, which creates a "surface alloy" like feature, not available from any other coating technology.

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Frequently Asked Questions

How long does it take to apply?
Extra polishing of the internal surfaces by the decoking company is required prior to coating. The total net time addition to a typical decoke is estimated at ~4 days.

What happens if the coating flakes off?
Testing by Fouling and Coking Technology (FACT) indicates that the coating will not flake off. The coating is nonvolatile and should be captured downstream in the drums. For a 1 micron thick coating in a 4" OD heater with roughly 4,000 ft of tubes, the total volume of the coating is roughly <1 cup.

Is dissimilar thermal expansion causing the coating to crack and fail an issue? Has the coefficient of thermal expansion (CTE) been measured for the coating? This is an issue with other coatings as well as cladding.
CTE mismatch is not an issue for the coating. First, the coating is very thin making it flexible to move with the substrate material during expansion and contraction. This coupled with the diffusion layer of the coating which anchors it into the substrate precludes MIST from having CTE mismatch issues. Also, the fact that the coating is chemically bonded to the substrate (rather than just mechanically) prevents CTE issues. Remember, MIST is both a surface modification and a surface coating. The exact CTE of a given coating depends on which coating is used but correlates to the CTE of the oxides formed.

What is the maximum temperature the coating has been tested?
A thermo-gravimetric analysis (TGA) up to 1,200°F was performed and found the MIST coating to be stable. Theoretically, most of the oxides we use are stable at temperatures above 2,000°C which is higher than the melting temperature of all the materials Coker Coaters will be treating.

Does the coating affect heat transfer in the heater? What is the thermal conductivity of the coating?
Thermal conductivities for the metal, coke, and coating are 54, 5, and 7 W/mK. Given that the coating is so thin (<1 micron) relative to the wall (8,000-10,000 microns), the heat resistance of the coating is insignificant to the thickness of the coke considering they are both insulators. The thickness of coke can exceed 1" or 25,400 microns.

What type of bond is achieved at the surface?
The data from Oak Ridge National Laboratory indicates that the bond is both physical and chemical which is what makes MIST technology so unique with its low processing temperature.

Is there any danger of embrittlement or crystalline phase changes during the application of the coating?
With the application temperature being low, ~830°F, it does not result in a chemical change to the metal. Crystalline changes in the metals typically found in delayed coking service, 9Cr and 347SS, are around 1,300°-1,500°F. In fact, the application temperature is well below typical operating conditions.

If and when the tube warps, what happens to the coating? Does it crack or does it bend with the tube?
Delayed coker heater tubes have been observed deflecting by as much as 4 ft between supports. Again, because MIST is so thin, the coating would simply move with the warped tube. In essence, the critical radius of the MIST coating would not be less than the critical radius of the item treated. If the tube mechanically cracks, then MIST would crack with it. If the tube warps, MIST would simply move with it.

For more information, contact Morgan Spears at morgan.spears@cokercoaters.com