Fusion Bonded Coatings for Coker Service

A Cornerstone Valve Whitepaper



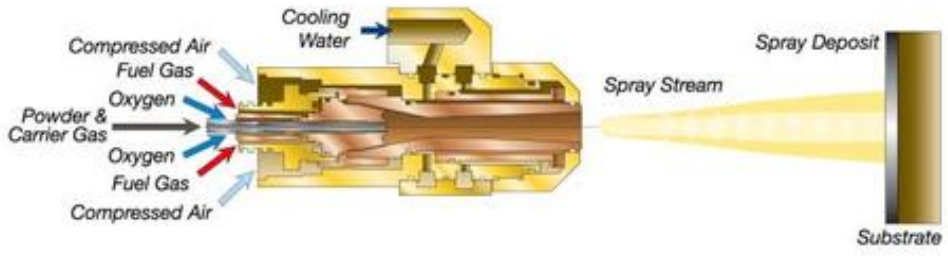
About the Author

Cornerstone Valve's Vice President of Engineering Brian Caprera has been a vital part of Cornerstone's leadership since May 2011 and has over 26 years of experience in the valve industry. Beginning his mechanical training as a military air crewman, he has since flourished as an accomplished inventor and has been awarded multiple patents for valve designs.

Brian is in charge of day-to-day engineering operations, and Cornerstone's cutting-edge product development endeavors. His unique background and knowledge of work-flow systems has significantly influenced Cornerstone's innovative engineering process.

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HVOF type spray coatings are commonly used to inhibit wear and galling for sliding components (ball and seat) of metal seated ball valves. This is a mature and effective technology that is economical in both time and cost but it does have some limitations in service application.



DCL Engineering Group - 2004

HVOF spray coatings don't impart much heat to the substrate (base metal). This allows a valve trim component to be machined to finish dimension, then coated without appreciable dimensional distortion of the part. HVOF coatings adhere to the substrate by mechanical bond strength with a typical maximum of 10,000 to 12,000psi. The mechanical bond and manner of coating application allows a wide range of coating/substrate combinations that wouldn't otherwise be compatible. HVOF type hard face coatings (and hard facings in general) also, by nature, have different coefficients of thermal expansion than the part they are coating. If the valve service conditions impart a large or rapid temperature change, this can create stress at the discreet boundary between the coating and substrate sufficient to break the bond, causing immediate catastrophic coating failure by delamination. Catastrophic HVOF failure may be immediate, or sometimes may occur over a period of time.



Cornerstone Valve - 2014

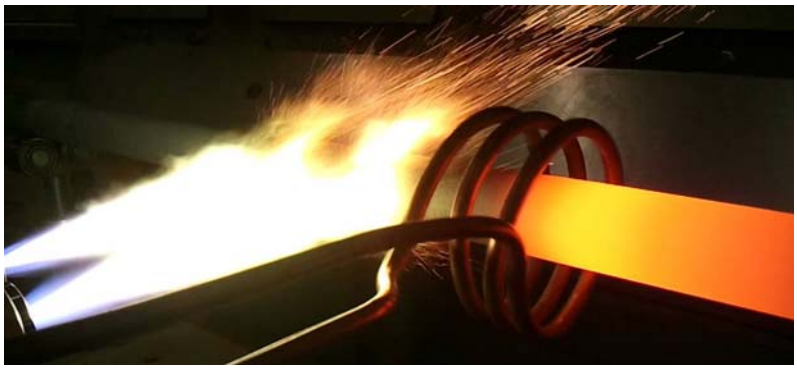
Variables that contribute to time dependent HVOF coating failure in valve Coker service are fatigue from thermal cyclic stress loading (typically the substrate expands more than the coating), mechanical cyclic stress loading (breakaway/sliding friction, pressure seat loading, and scraping action of coke deposits) and stress corrosion. These variables all contribute to crack propagation over time, usually at the boundary between coating and substrate.



F.W. Gartner Thermal Spraying - 2015

In practice, the upper temperature limitation for HVOF coatings in Coker valve service is approximately 750F. Above that operating temperature a metallurgical bond of either a weld deposit (weld overlay) or fusion bonded HVOF coating can be used to protect against catastrophic coating failure. Weld deposit/overlay is often not practical for valve ball coating. There are other options such as laser cladding but there are limitations for materials and bond strength that make it impractical for fused coatings in valve Coker service. A fusion bonded coating system gives functionally reliable thickness, density and bond strength.

It's difficult to be more accurate when defining a maximum service temperature for HVOF Coker valve service due to the variables of temperature, degree of thermal shock, adhesiveness of the media, changes in process conditions and conducted heat from placement of the valve in the piping system. Experience reveals differences in bond strength from one HVOF coating vendor to another, and even batch to batch from the same vendor. Ultimately, there is no better information source for a coating systems success than the end users experience. Barring direct input from the end user that would indicate HVOF spray coating is acceptable at higher temperature for their application; Cornerstone valve recommends metallurgical bonded coatings for Coker service where operating temperatures exceed 750F.



Eutalloy® RW - 2014

The "Spray and Fuse" method is a thermal spray process where the material is first sprayed, and then subsequently fused to the substrate to provide a dense, metallurgical bond coating with bond strengths approaching 50,000 psi. There are practical considerations for the spray and fuse method; not all coating/substrate chemical compositions are suited to spray and fuse, and the part features and manufacturing process need to accommodate the high application temperature. There are also commercial considerations of cost and the effect on project time.

With consideration for the above discussion Cornerstone Valve recommends fusion bonded coatings for Coker Valve service in excess of 750F operating temperature.