# Diffusion Coatings for Corrosion Resistant Components in Coal Gasification Systems

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## DISCLAIMER

## ABSTRACT

Advanced electric power generation systems use a coal gasifier to convert coal to a gas rich in fuels such as $H_2$ and CO. The gas stream contains impurities such as $H_2S$ and HCl, which attack metal components of the coal gas train, causing plant downtime and increasing the cost of power generation. Corrosion-resistant coatings would improve plant availability and decrease maintenance costs, thus allowing the environmentally superior integrated gasification combined cycle plants to be more competitive with standard power-generation technologies. A startup meeting was held at the National Energy Technology Center, Pittsburgh, PA site on July 28, 2003. SRI staff described the technical approach of the project.

## TABLE OF CONTENTS

## INTRODUCTION

In collaboration with U.S. Department of Energy and Conoco Phillips, SRI International recently embarked on a project to develop corrosion-resistant coatings for coal-fired power plant applications. The objective of this program is to develop corrosion resistant coatings for use in coal gas streams at high temperatures and pressures typical of advanced coal gasifiers. Development of low-cost corrosion-resistant components will minimize maintenance and replacement costs and increase plant availability, which will in turn result in an overall decrease in the cost of power generation from coal in the environmentally superior gasification process, and in less reliance on foreign oil.

The current program is collaborative effort between SRI International and Wabash Energy River Laboratory (WREL), a subsidiary of Conoco/Phillips. A significant aspect of the proposed program is to test the coatings both at SRI using simulated coal gas for determining the performance at various temperatures and in an actual coal gas stream at the WREL facility in Terre Haute, IN.

SRI's fluidized-bed reactor chemical vapor deposition (FBR-CVD) technology allows (1) both internal and external surfaces to be coated, (2) diffusion bonding to the substrate, (3) formation of a dense layer on the surface and increased corrosion protection of the substrate, and (4) requires a relatively low temperature (500° to 800°C) during the coating process and a short period of time (< 2h), resulting in minimal changes in mechanical and physical properties. A significant advantage of the FBR-CVD technology is the ability to deposit more than one element or their compounds simultaneously or sequentially on metal surfaces. This feature allows the composition to vary across the coating thickness, if necessary, to maximize the desired functional characteristics.

The scope of the proposed program is as follows: Initially, available information will be reviewed and several coating compositions will be selected that are suitable for service in the coal gasifier environment. Selected formulations will be coated on steel coupons using the FBR-CVD approach and screening tests will be performed under a range of conditions, including condensate exposure that may occur during a shutdown for plant maintenance. The screening tests will be performed both under simulated conditions and at the WREL gasifier. Upon completion of the test period, the specimens will be examined using a variety of techniques including optical and scanning electron microscopies, X-ray fluorescence, and X-ray diffraction to identify composition, phase,

and morphological changes. Based on the above findings, three superior coating formulations will be selected for detailed evaluation. These coatings will be applied to coupons of components such as tube sheets, or fasteners and subjected to performance tests at the WREL gasifier. Changes in mechanical, microstructural, chemical, and morphological changes will be determined. The test results will be evaluated and one or more reliable coatings will be selected for long-term testing, up to 2000 h in the WREL gasifier. Finally, the technical merits of the proposed concept will be assessed, preliminary economic cost estimates of the preferred schemes will be made, and technology transfer with potential manufacturers will be discussed.

**PROGRESS**

A startup meeting was held at the National Energy Technology Center, Pittsburgh, PA site on July 28, 2003. SRI staff described the technical approach of the project. We are negotiating with Conoco/Phillips which has acquired the Global Energy Corporation (GEC), the earlier operator of Wabash River Energy Laboratory (WREL) coal gasifier at Terra Haute, IN.

We have initiated a literature review of materials that are used in advanced coal gasifiers, the level of corrosion that has occurred, and the remediation measures that have been attempted. Based on the literature review, consultation with Conoco Phillips, SRI experience, corrosion resistance coatings for alloy steel components will be developed at SRI. The coated samples will be tested under simulated conditions in a bench-scale set up at SRI. In addition, the coated samples will be inserted in a test bed at the gasifier facility at WREL.