Development of Coating Technologies for High Temperature Chlorine-Induced, Corrosion Mitigation in Biomass, Waste to Energy and other Process Plants

PUBLISHABLE SUMMARY

19977

Background

The overall aim of this project was to mitigate the effects of high temperature corrosion and erosion on critical power generation components exposed to the combustion products of biomass, waste and similar fuels through the development of suitable thermal spray coatings and sealants. The technology may also be applicable to other high temperature environments such as co-firing, petrochemical and process plants.

To address their aim, TWI carried out a technology gap review with the help of the industrial Sponsors to establish current working practice and experience relating to the use of coatings in biomass and waste to energy power plants. A number of coating systems were identified and prepared using high velocity oxy-fuel (HVOF) and twin wire arc spraying (TWAS) on lengths of superheater tube alloys for testing. To facilitate this, TWI designed and built a dedicated high temperature HCl test facility in which samples were subjected to 1000ppm HCl gas at temperatures between 430-530°C, for ~4000hours. Selected coatings were also evaluated in municipal solid waste (MSW) Waste to Energy (WTE) plants for ~2000 hours. Further laboratory trials were also conducted on a number of thermal spray coatings sealed with slurry based sealants.

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Objectives

The overall objectives of the project were:

- To identify current technology gaps and establish current working practice and experience related to the mitigation of corrosion in biomass and WTE plants.
- To identify a number of thermal spray coatings which mitigate high temperature chlorine induced corrosion, oxidation, erosion and slagging in biomass, WTE and other process plants.
- To provide information relating to industrialisation of thermal spray coating processes for biomass, WTE and other process plants.

Project Outcome

WP1 - one (final) report

WP2-4 (two progress and one final report)

The main outputs of the project were:

- Performance data and ranking of selected thermal spray coatings in laboratory simulated biomass and waste to energy environments and on-site testing at MSW WTE plants.
- Assessment of the behaviour of sealants applied to thermal spray coatings for biomass and WTE applications.
- Information on the industrialisation of thermal spray coatings for biomass and WTE boiler applications including spraying procedures, QA/QC requirements, relative costs of coating consumables and processes, equipment and consumable suppliers, coating contractors and health and safety recommendations.

Benefits

The main benefits of this project were:

- Development of cost effective, corrosion mitigation solutions for variety a of process plant applicable to new builds and existing power plant.
- Significant reduction in unscheduled maintenance and lost operating days.
- Potential ability to operate in more severe environment, at elevated temperature and with increased efficiency.

Participants

The Sponsor Group comprised:

- Energy Power Resources Ltd; (EPR)
- Kawasaki Heavy Industries Ltd; (KHI)
- Scottish & Southern Energy; (SSE)
- States of Jersey. (SoJ)

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Scope of Work

The project comprised four work packages, broadly categorised as:

- WP1: Technology Gap Review.
- WP2: Development of thermal spray coatings for high temperature, chlorine induced corrosion mitigation.
- WP3: High temperature corrosion testing and performance evaluation.
- WP4: Industrialisation of thermal spray coating processes for biomass and waste to energy power plant applications.

The project involved preparation of a number of thermal spray coating compositions including NiCr alloys and Fe based nanocrystalline and amorphous materials. Coatings were prepared on short lengths of 16Mo3 alloy boiler tube for testing purposes. The performance of the coatings was then assessed in three separate laboratory tests detailed below:

- 4150 hours of testing of 15 coated boiler tube samples and 9 benchmark alloys at 430°C in 1000ppm HCl (Test A).
- 1489 hours testing of 15 coated boiler tube samples and 9 benchmark alloys at 530°C in 1000ppm HCl (Test B).
- 2822 hours testing of boiler tubes coated with 11 different thermal spray coatings and three sealants at 530°C in 1000ppm HCl with ash (Test C).

In addition, two field trials were conducted on HVOF C-276 alloy and Ni625 alloy coatings in KHI and SOJs WTE plants. Both sets of samples were subjected to ~2000 hours exposure in MSW WTE plants.

Following completion of the laboratory and field tests, the samples were sectioned and examined using light and scanning electron microscopy. The coatings were ranked in terms of performance, based on the amount of degradation of the coating and also corrosion at the coating-substrate interface.

The relative costs to apply each coating type using either high velocity oxy-fuel (HVOF) or twin wire arc spray (TWAS) processes was also considered along with the steps required to industrialise the processes for application in biomass and WTE plants.

Based on this, recommendations were made on suitable coating compositions and processes for biomass and WTE power plant applications.

Price and Duration

The project had a duration of two and a half years and a budget of £200,000. It was funded by four Sponsors each making a contribution of £40,000; TWI also contributed £40,000 towards the project. The fee for additional companies buying-back into the project results is £40,000.

Further Information

For further information on Joint Industry Projects (JIP) and their operation please visit:

http://www.twi.co.uk/services/research-and-consultancy/joint-industry-projects/

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