

Application of Thermal Spray Techniques for Combatting High Temperature Corrosion in Waste-to-Energy Boilers

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In the United States, about 389 million tons of Municipal Solid Waste (MSW) are produced every year. The only proven alternative to landfilling for the treatment of post-recycled MSW is thermal treatment or waste to energy (WTE) of MSW for the production of energy and materials. MSW contains materials with high chlorine content ¹, such as chlorinated plastics, polyvinylchloride (PVC), etc. This in combination with the temperature level of superheater tubes, 300-550°C, and the high concentration of alkaline metals (Na, K, etc), heavy metals (Pb, Zn, etc), and sulfates during combustion causes severe high temperature corrosion (HTC)², which may lead to material wastage, tube leakages, unplanned shutdowns of the boiler, and shortened lifetime of the tube.⁵ Thus, searching effective methods to prevent HTC problem and extend the lifetime of superheat tubes is an urgent issue. An appropriate choice of the combination of thermal spray techniques and coating materials can effectively prevent HTC problem inside WTE plants. The aim of this project is to identify available thermal spray techniques and coating materials for combatting HTC in WTE boiler.

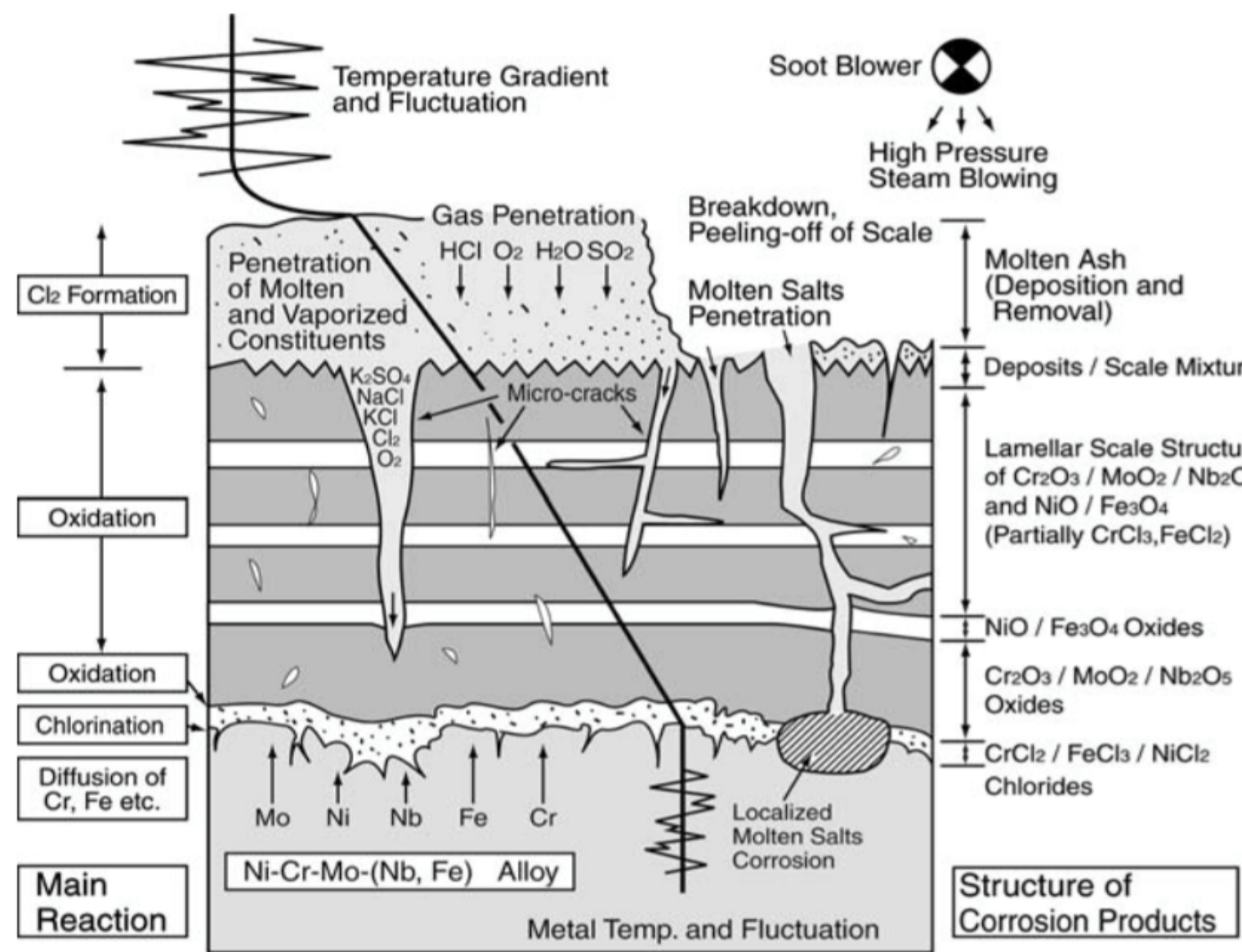


Figure 1 Sample Corrosion Mechanisms in Ni-Cr-Mo-(Nb, Fe) Alloy²

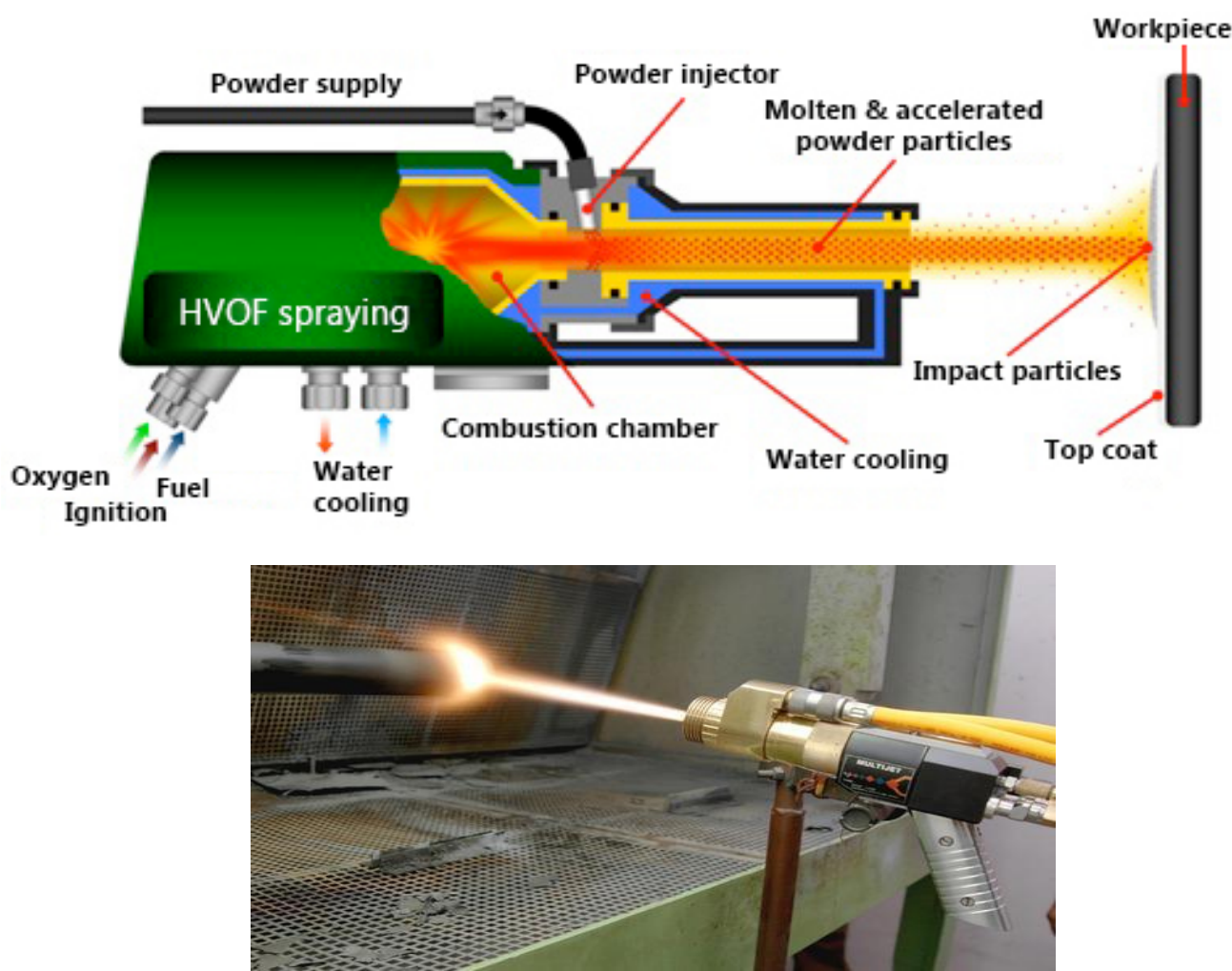


Figure 2 Mechanics of High Velocity Oxy-Fuel (HVOF) Spray^{7,8}

Available Thermal Spray Techniques⁵:

- Flame Spray
- Electric Arc Spray
- Plasma Spray
- High Velocity Oxy-Fuel(HVOF) Spray
- High Velocity Air-Fuel(HVAF) Spray
- Detonation Spray
- Warm Spray

It is applied in southern Europe in WTE plants.

It is widely used on sites because:

- It is easy to apply
- It has large spray area

It is widely used now because HVOF coatings give compact, low porosity, homogeneous, and hard structure with suitable thickness. HVOF coatings has been proven to have high erosion-corrosion resistance. HVOF with Carbide Jet Spray (CJS) produce higher velocity and lower temperature, HVOF with Diamond Jet (DJ) produce lower velocity and higher temperature.⁵

Selection of Coating Materials⁴:

- Amorphous Alloy (e.g. Fe-based)
- Ni-based Alloy
- Cermet
- Ceramics
- ...

Materials with high nickel (Ni), chromium (Cr), and molybdenum (Mo) contents have been proved to be a considerable choice to provide outstanding corrosion protection under high temperature.⁵

HVOF Coatings performed better than X20 or SAN25, but nickel-based alloy A263 performed best. However, due to its high price, coatings offer an attractive alternative for corrosion protection. Diam4006_DJ and SHS9172_CJS presented the best corrosion performance of the coatings due to their composition of Cr and Mo.⁵

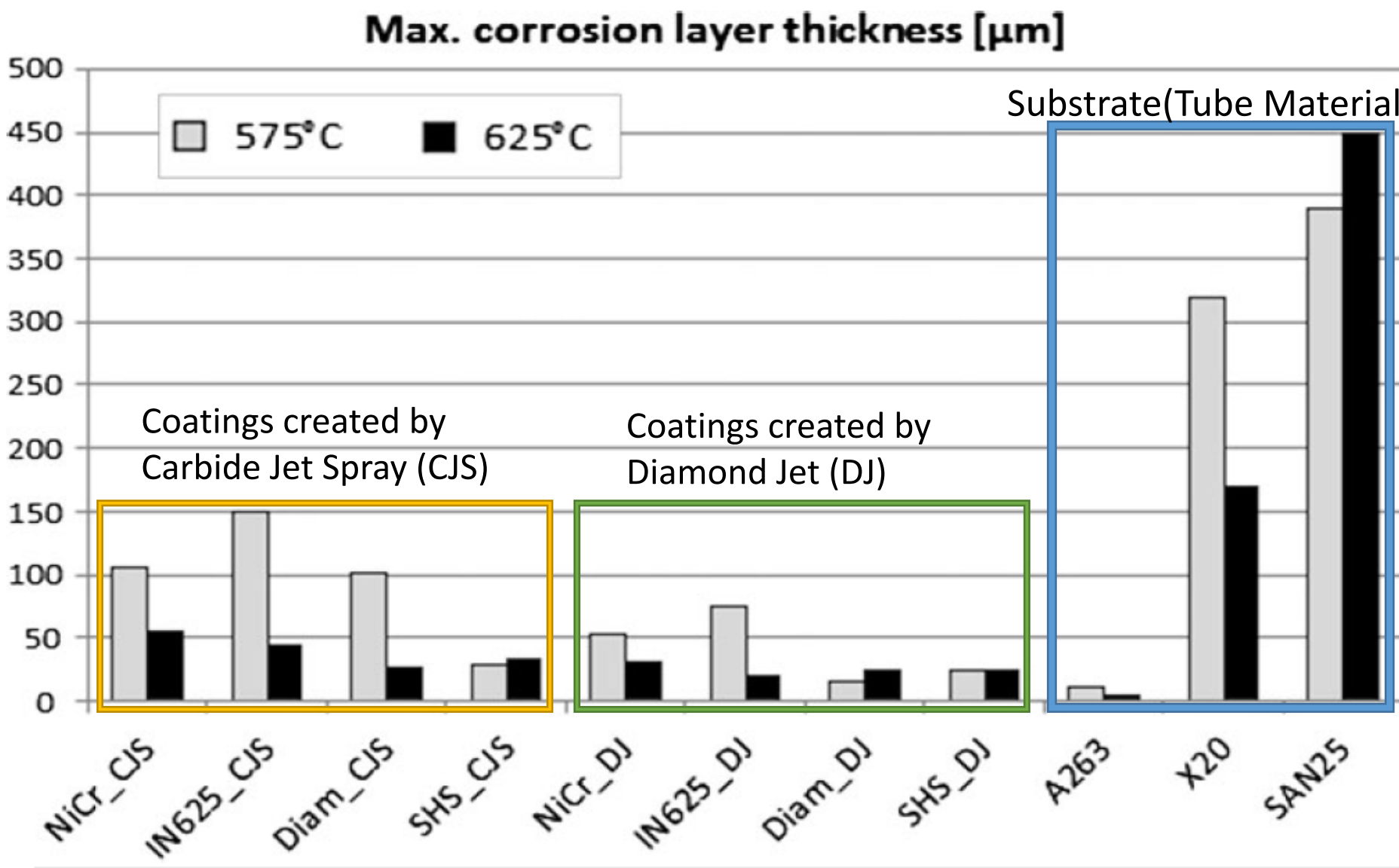


Figure 3 Maximum Thickness Values of the Oxide/Corrosion Layers Formed During the Test (in NaCl-KCl-Na₂SO₄ salt with controlled H₂O atmosphere at 575 and 625°C for 168 hours; coatings are made by HVOF).⁵

Other factors related to thermal spray techniques that can affect the quality of thermal spray coatings⁵:

- Applied techniques
- Raw material
- Gun
- Nozzle
- Fuels and fuel ratio
- Spray distance
- Powder feed rate

Further Study:

This project is going to select the most applicable thermal spray techniques for WTE boilers. Particular coating material and coating thickness will be determined. Economic feasibility will be analyzed.

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