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Fig. 5.60  SEM micrograph and variation in elemental composition across the cross-section of the NiCr duplex coating with Al$_2$O$_3$ top coat on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.61  Composition image and X-ray mappings along the cross-section of the T91 steel subjected to Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.62  Composition image and X-ray mappings along the cross-section of the HVOF sprayed NiCr coating on T91 steel subjected to Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.63  Composition image and X-ray mappings along the cross-section of the heat treated NiCr coating on T91 steel subjected to Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.64  Composition image and X-ray mappings along the cross-section of the sealed NiCr coating on T91 steel subjected to Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.65  Composition image and X-ray mappings along the cross-section of the NiCr duplex coating with Cr$_2$O$_3$ top coat on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.66  Composition image and X-ray mappings along the cross-section of the NiCr duplex coating with Al$_2$O$_3$ top coat on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.67  Macrographs of the Cr$_3$C$_2$-NiCr coated T91 steel samples subjected to hot corrosion in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles: (a) as-deposited Cr$_3$C$_2$-NiCr coating; (b) heat treated Cr$_3$C$_2$-NiCr coating; (c) sealed Cr$_3$C$_2$-NiCr coating; (d) Cr$_3$C$_2$-NiCr coating with Cr$_2$O$_3$ top coat and (e) Cr$_3$C$_2$-NiCr coating with Al$_2$O$_3$ top coat.
Fig. 5.68  Weight gain/area vs. number of cycles plot for the bare and Cr$_3$C$_2$-NiCr coated T91 steel subjected to molten salt environment (Na$_2$SO$_4$-60%V$_2$O$_5$) at 750 °C for 50 cycles.

Fig. 5.69  (Weight gain/area)$^2$ vs. number of cycles plot for the bare and Cr$_3$C$_2$-NiCr coated T91 steel subjected to molten salt environment (Na$_2$SO$_4$-60%V$_2$O$_5$) at 750 °C for 50 cycles.

Fig. 5.70  XRD pattern for HVOF spray Cr$_3$C$_2$-NiCr coated T91 boiler steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.71  XRD pattern for the heat treated Cr$_3$C$_2$-NiCr coating on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.72  XRD pattern for the sealed Cr$_3$C$_2$-NiCr coating on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.73  XRD pattern for the Cr$_3$C$_2$-NiCr coating with Cr$_2$O$_3$ top coat on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.74  XRD pattern for the Cr$_3$C$_2$-NiCr coating with Al$_2$O$_3$ top coat on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.75  FE-SEM/EDS analysis of the Cr$_3$C$_2$-NiCr coated T91 boiler steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles: (a) as-deposited Cr$_3$C$_2$-NiCr coating; (b) heat treated Cr$_3$C$_2$-NiCr coating and (c) sealed Cr$_3$C$_2$-NiCr coating.

Fig. 5.76  FE-SEM/EDS analysis of the Cr$_3$C$_2$-NiCr coated T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles: (a) Cr$_3$C$_2$-NiCr coating with Cr$_2$O$_3$ top coat and (b) Cr$_3$C$_2$-NiCr coating with Al$_2$O$_3$ top coat.
Fig. 5.77  SEM micrograph and variation in elemental composition across the cross-section of the HVOF sprayed Cr$_3$C$_2$-NiCr coating on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.78  SEM micrograph and variation in elemental composition across the cross-section of the heat treated Cr$_3$C$_2$-NiCr coating on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.79  SEM micrograph and variation in elemental composition across the cross-section of the sealed Cr$_3$C$_2$-NiCr coating on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.80  SEM micrograph and variation in elemental composition across the cross-section for the Cr$_3$C$_2$-NiCr coating with Cr$_2$O$_3$ top coat on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.81  SEM micrograph and variation in elemental composition across the cross-section for the Cr$_3$C$_2$-NiCr coating with Al$_2$O$_3$ top coat on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.82  Composition image and X-ray mappings along the cross-section of the HVOF sprayed Cr$_3$C$_2$-NiCr coating on T91 steel subjected to Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.83  Composition image and X-ray mappings along the cross-section of the heat treated Cr$_3$C$_2$-NiCr coating on T91 steel subjected to Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.

Fig. 5.84  Composition image and X-ray mappings along the cross-section of the sealed Cr$_3$C$_2$-NiCr coating on T91 steel subjected to Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750 °C for 50 cycles.
Fig. 5.85 Composition image and X-ray mappings along the cross-section for the $\text{Cr}_3\text{C}_2$-NiCr coating with $\text{Cr}_2\text{O}_3$ top coat on T91 steel subjected to $\text{Na}_2\text{SO}_4-60\%\text{V}_2\text{O}_5$ environment at 750 °C for 50 cycles.

Fig. 5.86 Composition image and X-ray mappings along the cross-section for the $\text{Cr}_3\text{C}_2$-NiCr coating with $\text{Al}_2\text{O}_3$ top coat on T91 steel subjected to $\text{Na}_2\text{SO}_4-60\%\text{V}_2\text{O}_5$ environment at 750 °C for 50 cycles.

Fig. 5.87 Macrographs of the T91 steel samples subjected to hot corrosion in $\text{Na}_2\text{SO}_4-60\%\text{V}_2\text{O}_5$ environment at 900 °C for 50 cycles: (a) bare T91 steel; (b) as-deposited NiCr coating; (c) heat treated NiCr coating; (d) sealed NiCr coating; (e) NiCr coating with $\text{Cr}_2\text{O}_3$ top coat and (f) NiCr coating with $\text{Al}_2\text{O}_3$ top coat.

Fig. 5.88 Weight gain/area vs. number of cycles plot for the bare and NiCr coated T91 steel subjected to molten salt environment ($\text{Na}_2\text{SO}_4-60\%\text{V}_2\text{O}_5$) at 900 °C for 50 cycles.

Fig. 5.89 $(\text{Weight gain/area})^2$ vs. number of cycles plot for the bare and NiCr coated T91 steel subjected to molten salt environment ($\text{Na}_2\text{SO}_4-60\%\text{V}_2\text{O}_5$) at 900 °C for 50 cycles.

Fig. 5.90 XRD pattern for bare T91 boiler steel subjected to the cyclic oxidation in $\text{Na}_2\text{SO}_4-60\%\text{V}_2\text{O}_5$ environment at 900 °C.

Fig. 5.91 XRD pattern for HVOF spray NiCr coated T91 boiler steel subjected to the cyclic oxidation in $\text{Na}_2\text{SO}_4-60\%\text{V}_2\text{O}_5$ environment at 900 °C for 50 cycles.

Fig. 5.92 XRD pattern for the heat treated NiCr coating on T91 steel subjected to the cyclic oxidation in $\text{Na}_2\text{SO}_4-60\%\text{V}_2\text{O}_5$ environment at 900 °C for 50 cycles.

Fig. 5.93 XRD pattern for the sealed NiCr coating on T91 steel subjected to the cyclic oxidation in $\text{Na}_2\text{SO}_4-60\%\text{V}_2\text{O}_5$ environment at 900 °C for 50 cycles.
Fig. 5.94  XRD pattern for the NiCr coating with Cr₂O₃ top coat on T91 steel subjected to the cyclic oxidation in Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles.

Fig. 5.95  XRD pattern for the NiCr coating with Al₂O₃ top coat on T91 steel subjected to the cyclic oxidation in Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles.

Fig. 5.96  FE-SEM/EDS analysis of the bare and coated T91 steel subjected to the cyclic oxidation in Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles: (a) bare T91 steel; (b) as-deposited NiCr coating and (c) heat treated NiCr coating.

Fig. 5.97  FE-SEM/EDS analysis of the NiCr coated T91 steel subjected to the cyclic oxidation in Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles: (a) sealed NiCr coating; (b) NiCr coating with Cr₂O₃ top coat and (c) NiCr coating with Al₂O₃ top coat.

Fig. 5.98  SEM micrograph and variation in elemental composition across the cross-section of T91 steel subjected to the cyclic oxidation in Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles.

Fig. 5.99  SEM micrograph and variation in elemental composition across the cross-section of the HVOF sprayed NiCr coating on T91 steel subjected to the cyclic oxidation in Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles.

Fig. 5.100  SEM micrograph and variation in elemental composition across the cross-section of the heat treated NiCr coating on T91 steel subjected to the cyclic oxidation in Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles.

Fig. 5.101  SEM micrograph and variation in elemental composition across the cross-section of the sealed NiCr coating on T91 steel subjected to the cyclic oxidation in Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles.

Fig. 5.102  SEM micrograph and variation in elemental composition across the cross-section for the NiCr coating with Cr₂O₃ top coat on T91 steel subjected to the cyclic oxidation in Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles.
Fig. 5.103  SEM micrograph and variation in elemental composition across the cross-section for the NiCr coating with Al₂O₃ top coat on T91 steel subjected to the cyclic oxidation in Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles.

Fig. 5.104  Composition image and X-ray mappings along the cross-section of the bare T91 steel subjected to Na₂SO₄-60%V₂O₅ environment at 900 °C for 21 cycles.

Fig. 5.105  Composition image and X-ray mappings along the cross-section of the HVOF sprayed NiCr coating on T91 steel subjected to Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles.

Fig. 5.106  Composition image and X-ray mappings along the cross-section of the heat treated NiCr coating on T91 steel subjected to Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles.

Fig. 5.107  Composition image and X-ray mappings along the cross-section for the sealed NiCr coating on T91 steel subjected to Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles.

Fig. 5.108  Composition image and X-ray mappings along the cross-section for the NiCr coating with Cr₂O₃ top coat on T91 steel subjected to Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles.

Fig. 5.109  Composition image and X-ray mappings along the cross-section for the NiCr coating with Al₂O₃ top coat on T91 steel subjected to Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles.

Fig. 5.110  Macrographs of the Cr₃C₂-NiCr coated T91 steel samples subjected to hot corrosion in Na₂SO₄-60%V₂O₅ environment at 900 °C for 50 cycles: (a) as-deposited Cr₃C₂-NiCr coating; (b) heat treated Cr₃C₂-NiCr coating; (c) sealed Cr₃C₂-NiCr coating; (d) Cr₃C₂-NiCr coating with Cr₂O₃ top coat and (e) Cr₃C₂-NiCr coating with Al₂O₃ top coat.

Fig. 5.111  Weight gain/area vs. number of cycles plot for the bare and Cr₃C₂-NiCr coated T91 steel subjected to molten salt environment (Na₂SO₄-60%V₂O₅) at 900 °C for 50 cycles.
Fig. 5.112  (Weight gain/area)$^2$ vs. number of cycles plot for the bare and Cr$_3$C$_2$-NiCr coated T91 steel subjected to molten salt environment (Na$_2$SO$_4$-60%V$_2$O$_5$) at 900 °C for 50 cycles.

Fig. 5.113  XRD pattern for HVOF spray Cr$_3$C$_2$-NiCr coated T91 boiler steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C for 50 cycles.

Fig. 5.114  XRD pattern for the heat treated Cr$_3$C$_2$-NiCr coating on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C for 50 cycles.

Fig. 5.115  XRD pattern for the sealed Cr$_3$C$_2$-NiCr coating on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C for 50 cycles.

Fig. 5.116  XRD pattern for the Cr$_3$C$_2$-NiCr coating with Cr$_2$O$_3$ top coat on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C for 50 cycles.

Fig. 5.117  XRD pattern for the Cr$_3$C$_2$-NiCr coating with Al$_2$O$_3$ top coat on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C for 50 cycles.

Fig. 5.118  FE-SEM/EDS analysis of the bare and Cr$_3$C$_2$-NiCr coated T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C for 50 cycles: (a) as-deposited Cr$_3$C$_2$-NiCr coating; (b) heat treated Cr$_3$C$_2$-NiCr coating and (c) sealed Cr$_3$C$_2$-NiCr coating.

Fig. 5.119  FE-SEM/EDS analysis of the Cr$_3$C$_2$-NiCr coated T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C for 50 cycles: (a) Cr$_3$C$_2$-NiCr coating with Cr$_2$O$_3$ top coat and (b) Cr$_3$C$_2$-NiCr coating with Al$_2$O$_3$ top coat.

Fig. 5.120  SEM micrograph and variation in elemental composition across the cross-section of Cr$_3$C$_2$-NiCr coated T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C for 50 cycles.
Fig. 5.121  SEM micrograph and variation in elemental composition across the cross-section of the heat treated Cr$_3$C$_2$-NiCr coating on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C for 50 cycles.

Fig. 5.122  SEM micrograph and variation in elemental composition across the cross-section of the sealed Cr$_3$C$_2$-NiCr coating on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$–60%V$_2$O$_5$ environment at 900 °C for 50 cycles.

Fig. 5.123  SEM micrograph and variation in elemental composition across the cross-section for the Cr$_3$C$_2$-NiCr coating with Cr$_2$O$_3$ top coat on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C for 50 cycles.

Fig. 5.124  SEM micrograph and variation in elemental composition across the cross-section for the Cr$_3$C$_2$-NiCr coating with Al$_2$O$_3$ top coat on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C for 50 cycles.

Fig. 5.125  Composition image and X-ray mappings along the cross-section for the as-deposited Cr$_3$C$_2$-NiCr coating on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C.

Fig. 5.126  Composition image and X-ray mappings along the cross-section for the heat treated Cr$_3$C$_2$-NiCr coating on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C for 50 cycles.

Fig. 5.127  Composition image and X-ray mappings along the cross-section for the sealed Cr$_3$C$_2$-NiCr coating on T91 steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C for 50 cycles.

Fig. 5.128  Composition image and X-ray mappings along the cross-section for the Cr$_3$C$_2$-NiCr coating with Cr$_2$O$_3$ top coat on T91 steel subjected to Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 900 °C for 50 cycles.
Fig. 5.129 Composition image and X-ray mappings along the cross-section for the Cr$_3$C$_2$-NiCr coating with Al$_2$O$_3$ top coat on T91 steel subjected to Na$_2$SO$_4$–60%V$_2$O$_5$ environment at 900 °C for 50 cycles.

Fig. 5.130 Bar chart showing cumulative weight gain per unit area for NiCr and Cr$_3$C$_2$-NiCr coated T91 steel subjected to molten salt environment at 600 °C for 50 cycles.

Fig. 5.131 Bar chart showing cumulative weight gain per unit area for NiCr and Cr$_3$C$_2$-NiCr coated T91 steel subjected to molten salt environment at 750 °C for 50 cycles.

Fig. 5.132 SEM micrograph along the cross-section of HVOF spray NiCr coating on T91 boiler steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750°C for 50 cycles.

Fig. 5.133 SEM micrograph along the cross-section of HVOF spray Cr$_3$C$_2$-NiCr coating on T91 boiler steel subjected to the cyclic oxidation in Na$_2$SO$_4$-60%V$_2$O$_5$ environment at 750°C for 50 cycles.

Fig. 5.134 Schematic diagram showing probable hot corrosion mechanism for T91 boiler steel exposed to molten salt (Na$_2$SO$_4$-60%V$_2$O$_5$) at 900 °C.

Fig. 5.135 Bar chart showing cumulative weight gain per unit area for NiCr and Cr$_3$C$_2$-NiCr coated T91 steel subjected to molten salt environment at 900 °C for 50 cycles.

Fig. 5.136 Schematic diagram showing probable hot corrosion mechanism for HVOF sprayed NiCr/Cr$_3$C$_2$-NiCr coating on T91 boiler steel exposed to molten salt (Na$_2$SO$_4$-60%V$_2$O$_5$) at 900 °C for 50 cycles.

Fig. 5.137 Schematic illustration of some of the main aspects of the development of cracks and oozing out of material from beneath during hot corrosion of the coated steel exposed to molten salt (Na$_2$SO$_4$-60%V$_2$O$_5$) at 900 °C.
Fig. 6.1 Macrographs of the T91 steel samples exposed to a platen superheater of the coal fired boiler for 1500 h: (a) bare T91 steel; (b) as-deposited NiCr coating; (c) heat treated NiCr coating; (d) sealed NiCr coating; (e) NiCr coating with Cr$_2$O$_3$ top coat and (f) NiCr coating with Al$_2$O$_3$ top coat.

Fig. 6.2 Bar chart showing cumulative weight gain per unit area for bare and NiCr coated T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.3 Bar chart indicating the thickness change in mils per year (mpy) by the bare and NiCr coated T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.4 BSE images for the bare and NiCr coated T91 steel after exposure to platen superheater zone of the coal fired boiler for 1500 h at 900 °C: (a) bare T91 steel; (b) as-deposited NiCr coating; (c) heat treated NiCr coating; (d) sealed NiCr coating; (e) NiCr coating with Cr$_2$O$_3$ top coat and (f) NiCr coating with Al$_2$O$_3$ top coat.

Fig. 6.5 XRD pattern for the T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.6 XRD pattern for the HVOF sprayed NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.7 XRD pattern for the heat treated NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.8 XRD pattern for the sealed NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.9 XRD pattern for the NiCr coating with Cr$_2$O$_3$ top coat on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.
Fig. 6.10  XRD pattern for the NiCr coating with Al₂O₃ top coat on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.11  FE-SEM/EDS analysis for the bare and NiCr coated T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C: (a) bare T91 steel; (b) as-deposited NiCr coating and (c) heat treated NiCr coating.

Fig. 6.12  FE-SEM/EDS analysis for the NiCr coated T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C: (a) sealed NiCr coating; (b) NiCr coating with Cr₂O₃ top coat and (c) NiCr coating with Al₂O₃ top coat.

Fig. 6.13  SEM micrograph and variation in elemental composition across the cross-section of the T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.14  SEM micrograph and variation in elemental composition across the cross-section of the HVOF sprayed NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.15  SEM micrograph and variation in elemental composition across the cross-section of the heat treated NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.16  SEM micrograph and variation in elemental composition across the cross-section of the sealed NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.17  SEM micrograph and variation in elemental composition across the cross-section of the NiCr coating with Cr₂O₃ top coat on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.18  SEM micrograph and variation in elemental composition across the cross-section of the NiCr coating with Al₂O₃ top coat on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.
Fig. 6.19  Composition image and X-ray mappings across the cross-section of the T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h.

Fig. 6.20  Composition image and X-ray mappings across the cross-section of the NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h.

Fig. 6.21  Composition image and X-ray mappings across the cross-section of the heat treated NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h.

Fig. 6.22  Composition image and X-ray mappings across the cross-section of the sealed NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h.

Fig. 6.23  Composition image and X-ray mappings across the cross-section for the NiCr coating with Cr$_2$O$_3$ top coat on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h.

Fig. 6.24  Composition image and X-ray mappings across the cross-section for the NiCr coating with Al$_2$O$_3$ top coat on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h.

Fig. 6.25  Macrographs of the Cr$_3$C$_2$-NiCr coated T91 steel samples exposed to a platen superheater of the coal fired boiler for 1500 h: (a) as-deposited Cr$_3$C$_2$-NiCr coating; (b) heat treated Cr$_3$C$_2$-NiCr coating; (c) sealed Cr$_3$C$_2$-NiCr coating; (d) Cr$_3$C$_2$-NiCr coating with Cr$_2$O$_3$ top coat and (e) Cr$_3$C$_2$-NiCr coating with Al$_2$O$_3$ top coat.

Fig. 6.26  Bar chart showing cumulative weight gain per unit area for bare and Cr$_3$C$_2$-NiCr coated T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.27  Bar chart indicating the thickness change in mils per year (mpy) by the bare and Cr$_3$C$_2$-NiCr coated T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.
Fig. 6.28  BSE images for the Cr$_3$C$_2$-NiCr coated T91 steel after exposure to platen superheater zone of the coal fired boiler for 1500 h at 900 °C: (a) as-deposited Cr$_3$C$_2$-NiCr coating; (b) heat treated Cr$_3$C$_2$-NiCr coating; (c) sealed Cr$_3$C$_2$-NiCr coating; (d) Cr$_3$C$_2$-NiCr coating with Cr$_2$O$_3$ top coat and (e) Cr$_3$C$_2$-NiCr coating with Al$_2$O$_3$ top coat.

Fig. 6.29  XRD pattern for the HVOF sprayed Cr$_3$C$_2$-NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.30  XRD pattern for the heat treated Cr$_3$C$_2$-NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.31  XRD pattern for the sealed Cr$_3$C$_2$-NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.32  XRD pattern for the Cr$_3$C$_2$-NiCr coating with Cr$_2$O$_3$ top coat on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.33  XRD pattern for the Cr$_3$C$_2$-NiCr coating with Al$_2$O$_3$ top coat on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.34  FE-SEM/EDS analysis for the Cr$_3$C$_2$-NiCr coated T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C: (a) as-deposited Cr$_3$C$_2$-NiCr coating; (b) heat treated Cr$_3$C$_2$-NiCr coating and (c) sealed Cr$_3$C$_2$-NiCr coating.

Fig. 6.35  FE-SEM/EDS analysis for the Cr$_3$C$_2$-NiCr coated T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C: (a) Cr$_3$C$_2$-NiCr coating with Cr$_2$O$_3$ top coat and (b) Cr$_3$C$_2$-NiCr coating with Al$_2$O$_3$ top coat.

Fig. 6.36  SEM micrograph and variation in elemental composition across the cross-section of the HVOF sprayed Cr$_3$C$_2$-NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.
Fig. 6.37  SEM micrograph and variation in elemental composition across the cross-section of the heat treated Cr$_3$C$_2$-NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.38  SEM micrograph and variation in elemental composition across the cross-section of the sealed Cr$_3$C$_2$-NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.39  SEM micrograph and variation in elemental composition across the cross-section of the Cr$_3$C$_2$-NiCr coating with Cr$_2$O$_3$ top coat on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.40  SEM micrograph and variation in elemental composition across the cross-section of the Cr$_3$C$_2$-NiCr coating with Al$_2$O$_3$ top coat on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.41  Composition image and X-ray mappings across the cross-section of the Cr$_3$C$_2$-NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h.

Fig. 6.42  Composition image and X-ray mappings across the cross-section of the heat treated Cr$_3$C$_2$-NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h.

Fig. 6.43  Composition image and X-ray mappings across the cross-section of the sealed Cr$_3$C$_2$-NiCr coating on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h.

Fig. 6.44  Composition image and X-ray mappings across the cross-section for the Cr$_3$C$_2$-NiCr coating with Cr$_2$O$_3$ top coat on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h.
Fig. 6.45  Composition image and X-ray mappings across the cross-section for the Cr$_3$C$_2$-NiCr coating with Al$_2$O$_3$ top coat on T91 steel exposed to a platen superheater of the coal fired boiler for 1500 h.

Fig. 6.46  Schematic diagram showing probable erosion-corrosion mode for the bare T91boiler steel subjected to actual boiler environment at 900°C for 1500 hours.

Fig. 6.47  Bar chart indicating the thickness change in mils per year (mpy) by the bare and coated steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.

Fig. 6.48  Schematic diagram illustrating the high temperature oxidation mode for the HVOF sprayed Ni-20Cr coating on T91 boiler steel exposed to boiler environment at 900 °C.

Fig. 6.49  Schematic diagram showing probable erosion-corrosion mode for the HVOF sprayed Cr$_3$C$_2$-NiCr coating on T91 boiler steel subjected to actual boiler environment at 900°C for 1500 hours.

Fig. 7.1  Bar chart showing cumulative weight gain per unit area for bare and coated T91 steel subjected to molten salt environment at 600, 750 and 900 °C for 50 cycles.

Fig. 7.2  Bar chart indicating the thickness change in mils per year (mpy) by the bare and coated steel exposed to a platen superheater of the coal fired boiler for 1500 h at 900 °C.