In concentrated and dilute solutions of caustic soda and sodium chloride the corrosion resistance of the aluminide–boride coatings is fairly high for $\sim 1000$ h.

CONCLUSIONS

1. Boronizing of aluminized steel is expedient in the case in which the aluminum content of the coating does not exceed the concentration in Fe$_3$Al. Boronizing should be conducted at temperatures of 1000° and higher.

2. Alloying of FeB and Fe$_2$B with aluminum reduces the microhardness and increases the ductility of the coating.

LITERATURE CITED


COMPOSITION, STRUCTURE, AND CORROSION RESISTANCE IN DILUTE SULFUR OF A MULTICOMPONENT COATING IN STEEL St3

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Multicomponent diffusion saturation from active paste compositions has come into wider use in recent years [1-5]. The technique of producing protective coatings is greatly simplified in this process, which substantially increases the corrosion resistance of various materials. The use of active pastes is promising, e.g., for improving the corrosion resistance of steel inlet and outlet fittings for railroad tank cars transporting sulfur-containing melts. We investigated the structure, composition, and corrosion resistance of steel St3 after surface saturation with aluminum, chromium, and nickel.

The steels were coated in pastes based on Al–Cr, Al–Ni, and Al–Cr–Ni of the following composition: 70% Al + 10% NaF (activator) + 20% Cr or Ni or 20% (Cr + Ni). Lowering the chromium or nickel content of the paste leads to formation of very thin layers of chemical compounds not detectable by x-ray analysis and thus coatings with a lower corrosion resistance. A 5% solution of BF-6 blue in acetone was used as a binder. The samples were coated with the energy-liberating paste [1] and a flame was applied until the paste ignited (burning time 20-30 sec). With a constant thickness of the layer of applied paste ($\sim 0.6$ $\mu$m) we obtained multilayer coatings with a thickness characteristic of each composition (100-130 $\mu$m).

The structure and properties of the surface layers were investigated by x-ray and metallographic analysis. The x-ray analysis was conducted with the URS-60 apparatus with use of K$_\alpha$-Cr-radiation, using microsections and powders, and the metallographic analysis with the MIM-8 microscope. The microsections were etched in a reagent consisting of 20 g FeCl$_3$, 30 ml HNO$_3$, and 10 ml H$_2$O. The surface microhardness was measured with the PMT-3 apparatus under a load of 1 N.

The corrosion tests were made at 130° in an apparatus consisting of a thermostat filled with oil, with porcelain beakers immersed in it. The samples were suspended in the beakers on Nichrome wires. The samples were examined after each 8-10 h; total testing time was 90 h. The corrosion rate was determined from the change in weight of the samples.

The x-ray analysis showed [6, 7] that saturation of steel St3 from a paste based on aluminum and nickel leads to formation of a three-layer diffusion coating consisting of a
thin layer of Fe_5Si_3 on the surface, followed by coarse-grained texturized Ni_3Al and then a layer of cubic Fe_3Al. The coarse grains of Ni_3Al are evidently due to recrystallization processes resulting from the slower elimination of heat from the inner layers of the coating. The formation of Fe_5Si_3 on the surface is evidently due to the presence of quartz in the energy-liberating paste. With increasing concentrations of nickel in the active paste, no Fe_3Al is observed in the coating, which can probably be explained by the slower diffusion of aluminum into the steel under the influence of nickel [5]. The results of the microstructural analysis confirm the fact that the coating is multilayered, the thickness reaching 140-160 µm. The microhardness varies from H 400 to H 150 from the surface of the base metal.

When steel St3 is saturated from a paste based on aluminum and chromium a thin layer of FeO(Cr_2O_3, Al_2O_3) is formed on the surface, followed by a coarse-grained layer of texturized α phase (Al_{13}Cr_{4}Si_{4}) and then Fe_3Al. With increasing amounts of chromium in the active paste (>20%) no Fe_3Al is observed. The formation of oxide on the surface of the steel is evidently due to the presence in the saturating paste of aluminum and chromium oxides. The coarse grains of the α phase, like those of Ni_3Al, can be explained by recrystallization processes in the coating that is formed. The average thickness of the coating is 120-140 µm. The microhardness varies from H 500 to H 150 from the surface to the base metal.

The use of paste based on aluminum, nickel, and chromium leads to the formation of a diffusion coating consisting of FeO(Cr_2O_3, Al_2O_3) on the surface, a coarse-grained layer of texturized Al_{13}Cr_{4}Si_{4}, and a very thin layer of Fe_3Al. The total thickness of the coating is 100-120 µm. The microhardness varies from H 450 to H 140 through the thickness of the coating.

The corrosion rate was \(1.584 \times 10^{-5}\) kg/(m²-h) for steel St3 with no coating, \(3.345 \times 10^{-5}\) kg/(m²-h) for the steel with a coating based on aluminum and chromium, \(1.02 \times 10^{-5}\) kg/(m²-h) for the steel with a coating based on aluminum and nickel, and \(0.901 \times 10^{-5}\) kg/(m²-h) with a coating based on aluminum, nickel, and chromium. Thus, in molten sulfur the corrosion resistance is higher for steel St3 with coatings than without a coating. The corrosion resistance is highest after saturation from pastes based on Al-Ni and Al-Ni-Cr — 11-13 times higher than that of uncoated St3.

The shape of the corrosion curves (Fig. 1) indicates the complex character of the corrosion failure of the coating. Corrosion failure of the surface layer is observed in the