IMPACT OF NANOCOMPOSITE POLYMER FILM FORMULATION ON THE CORROSION RESISTANCE OF COLD-ROLLED STEEL SURFACES

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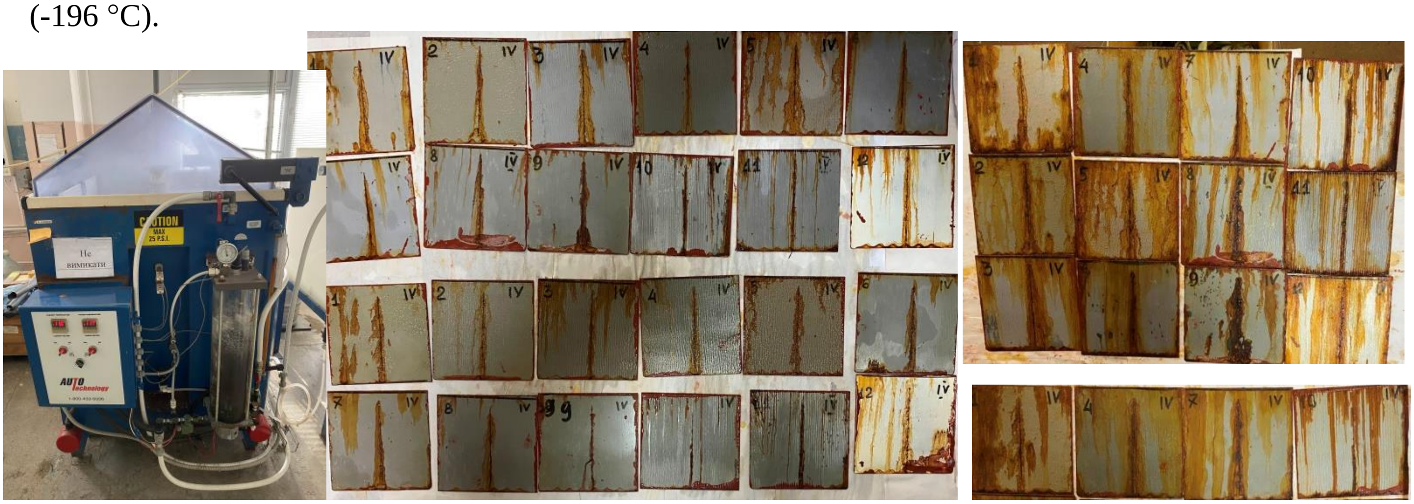
Introduction The search for sustainable anticorrosive coatings for metal surfaces capable of operating across a wide temperature range and in aggressive environments based on epoxy polymer materials remains a critical scientific challenge today. This study focuses on investigating coating stability by determining the impact of salt spray on the surface corrosion of cold-rolled steel coated with an epoxy-polymer nanocomposite film.

Experimental The composite is based on ED-20 epoxy resin cured with PEPA (polyethylenepolyamine) and PO-300 (polyamide resin). Highly dispersed oxides of silicon, aluminum, and titanium, as well as asbestos, basalt, tuff, and talc, were utilized as nanofillers, along with heat-resistant organic additives to enhance the mechanical strength of the composites. A salt spray atmosphere with a constant temperature of 35±1.7 °C was generated in an Auto Technology climatic chamber. The concentration of the sprayed NaCl solution was 5%, with the pH maintained within the range of 6.5–7.2. Standard 0.5 mm wide scribes were applied to the center of the 100×100×0.77 mm steel plates, reaching the metal substrate through the 30–50 μm thick polymer films. The panels, previously heat-treated at 25 °C and 100 °C, were exposed to the aggressive environment with inspections conducted after 48, 100, 200, 300, 500, 800, and 1000 hours, in accordance with DSTU ISO 9227:2015. Adhesion was evaluated using the cross-cut method (ISO 2409) both before and after the corrosion tests, as well as after exposure to liquid nitrogen (-196 °C).



Figs. Auto Technology climatic chamber (left). Visual inspection of the test panels (center) after 200 hours of exposure. Samples cured at 25 °C (Rows 1–2) versus post-cured at 100 °C (Rows 3–4). The test panels (right) after 1000 hours of exposure. Samples cured at 25 °C (Rows 1–3) versus post-cured at 100 °C (Rows 4).

Conclusions The corrosion resistance of the coating on cold-rolled steel depends on several factors, ranked in the following order of importance:

1. Optimal composition (synergy): The best results (1000 hours) are achieved through the synergy of the epoxy resin with active fillers (TiO_2, SiC, basalt) and complex curing agents (PEPA or PO-300).
2. Thermal conditions: For most epoxy systems, post-curing (heating up to 100 °C) is desirable to ensure the completion of polymerization processes.
3. Barrier effect: Fillers with plate-like (lamellar) or needle-like (acicular) structures provide superior protection against salt spray penetration compared to a thick layer of pure polymer.