CORROSION RESISTANCE OF LOW-COST ALLOY STEELS IN THE MANUFACTURE OF CELLULOSE TRIACETATE

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With the objective of economizing in acutely short nickel, the NIIKhTTs, together with the VNIIVproekt and the Kaunas artificial fibre plant, has made a study of the possibility of using new types of low-cost alloy steels in the manufacture of triacetate fibre.

The possibility of using low-cost alloy steels instead of 12Kh18N10T steel was judged on the basis of the corrosion resistance of the steels, with consideration of their ability to ensure the necessary degree of purity of the spinning solution. According to the experience of the Kaunas plant, the limiting allowable iron ion content in a spinning solution of cellulose triacetate (CTA) before the first filtration should not exceed 3 mg per kg of CTA.

The corrosion resistance of the steels was evaluated by the ten-point scale of All-Union State Standard 13819-68. In conformity with the requirements of chemical engineering, it is allowable to use metals in which the corrosion rate does not exceed 0.1 $g/(m^2 \cdot h)$ — a five-point resistance by All-Union State Standard 13819-68. The corrosion rate, K, was determined from the weight loss of specimens [ΔP, in $g/(m^2 \cdot h)$] and was calculated by the formula

$$K=\Delta P/S\tau, \tag{1}$$

where S is the sample area, in m^2; and τ is the duration of the tests, in h.

We investigated the corrosion resistance of unwelded specimens of stainless steels having a reduced nickel content, types 08Kh22N6T (6% Ni by wt.) and 08Kh18G8N2T (2% Ni by wt.), and the nickel-free chromium-manganese steels 07Kh13AG20 and 12Kh13G18D. The chemical compositions of the steels 08Kh22N6T and 08Kh18G8N2T corresponded to All-Union State Standard 5632-72; that of type 07Kh13AG20, to technical specification 14-1-1636-76; and that of type 12Kh13G18D steel to technical specification 14-1-1352-75. The studies were carried out in a dull spinning solution containing 18% CTA (NIIKhTTs, laboratory conditions), a 19.6-19.9% colored solution (Kaunas plant, production tests), and 20% bright solutions (laboratory tests). The spinning solutions in the Kaunas plant contained additions of an inhibitor (0.1% by wt. of benzotriazole, BTA), a modifier (0.4% by wt. polyethylene glycol, PEG), and sodium carbonate (0.05% by wt.); the colored solution additionally contained (1.8% by wt. carbon black and 0.5% by wt. of a dark blue dye). In the Kaunas plant tests were also conducted in the solvent $CH_2Cl_2 + C_2H_5OH$ (9:1) with no additives (under manufacturing conditions) and with additions of 0.1% by wt. BTA, 0.4% by wt. PEG, and up to 0.05% by wt. soda (in laboratory tests). The corrosion tests were carried out in conformity with the requirements of Technical Materials 26-01-68 [1]. The duration of the tests was from 500 to 1000 h. Test results are given in Table 1.

Additionally, we performed an analytical determination of iron content (in mg/100 g of solution) in the form of trivalent ions by the sulfosalicylic acid method [2, p. 594] after corrosion tests of the steels in the spinning solution; for these we calculated the rate of transition of iron into solution (K_{Fe}, $mg/m^2 \cdot h$). On the basis of the experimental values of K_{Fe}, for each type of steel we calculated the total iron content (ΔFe, in mg/liter) which had gone into solution as a result of corrosion of the equipment from its entire surface (S), with consideration of the velocity of the stream of solution (Q), by the formula

$$\Delta Fe = K_{Fe} S/Q \tag{2}$$

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Corrosion Rate, $K \times 10^5$, $g/(m^2 \cdot h)$ of Low-Cost Alloy Stainless Steels in a Spinning Solution of CTA and Solvent

Type of steel	In CTA spinning solution			In $CH_2Cl_2 + C_2H_5OH$ solvent	
	Kaunas plant tests		NIIKhTTs tests	Kaunas plant tests	
	manufacturing conditions, 1000 h	laboratory, 1048 h	laboratory, 500 h	manufacturing conditions, 1000 h	laboratory, 1048 h
12Kh18N10T	24	23	10—20	0	52
08Kh22N6T (ÉP-53)	2—140	40	40	30	0—90
08Kh18G8N2T(KO-3)	90	—	900	0	—
07Kh13AG20 (ChS-46)	17	14	30—300	4	2
12Kh13G18D (DI-61)	28	20	200	30	30
St-3	—	—	2 00	—	—

As applicable to the manufacturing conditions of the Kaunas artificial fibre plant, the values of S and Q are 315 m^2 and 550-450 liters/h. The values of ΔFe obtained in mg/liter were recalculated to mg/kg of CTA and were compared with the limiting allowable norm for manufacturing in the Kaunas plant:

Type of steel	K_{Fe}, $mg/(m^2 \cdot h)$	ΔFe, mg/liter	ΔFe, mg/kg of CTA
12Kh18N10T	0.33	0.19	0.73—0.89
08Kh22N6T (ÉP-53)	0.66	0.38	1.46—1.78
07Kh13AG20 (ChS-46)	1.14	0.65	2.50—3.05
12Kh13G18D (DI-61)	1.95	1.11	4.27—5.10

It is apparent from the data given that the low-cost alloy steels have a high corrosion resistance in the spinning solution or solvent, comparable with the resistance of type 12Kh18N10T steel — the corrosion rate is not over 0.0002-0.009 $g/(m^2 \cdot h)$ in the spinning solution or 0.0009 $g/(m^2 \cdot h)$ in the solvent (1-3 point resistance by All-Union State Standard 13819-68). In corrosion resistance these steels may serve as replacements for 12Kh18N10T steel. It was found that the corrosion resistance of low-cost alloy steels depends on the additives which are used in manufacturing at the Kaunas plant (BTA inhibitor, soda, modifiers, and dyes). These additives help improve the corrosion resistance of steels 08Kh18G8N2T and 12Kh13G18D almost tenfold, but exert practically no effect on the corrosion rate of 12Kh18N10T steel. The corrosion rate of the steels is considerably reduced when their surfaces are additionally ground — from 0.0014 to 0.0002 $g/m^2 \cdot h)$ for type 08Kh22N6T steel.

After the corrosion tests, the amount of iron which has gone into solution is higher for the low-cost alloy steels than for type 12Kh18N10T steel. According to calculations, in the case of making equipment from type 08Kh22N6T steel, ΔFe is 1.4-1.78 mg/kg of CTA, which is within the limits of the allowable norm of the Kaunas plant (up to 3 mg/kg of CTA). For 07Kh13AG20, ΔFe may reach the upper limit (2.5 + 3.05 mg/kg of CTA), and for type 12Kh13G18D steel it considerably exceeds this norm (4.27 mg/kg of CTA).

Thus, in corrosion resistance and ability to ensure the required degree of purity of the spinning solution, type 08Kh22N6T steel may serve as a replacement for type 12Kh18N10T. To give a conclusion about the possibility of using 07Kh13AG20 steel or 08Kh18G8N2T steel in the manufacture of triacetate fibre, it is necessary to conduct additional corrosion tests, including studies of specimens with welded joints. Considering the effect of additive content on the corrosion resistance of stainless steels, it is necessary to carry out tests in spinning solutions of various compositions, containing the additives used in the manufacture of CTA fibre.

LITERATURE CITED

1. Technical Material 26-01-21-68. Directive Technical Material. Procedures for Corrosion Testing of Metallic Materials. Basic Requirements. Evaluation of Results. [in Russian], NIIKhIMMASh, Moscow (1968).
2. F. M. Shemyakin, A. N. Karpov, and A. N. Brusentsov, Analytical Chemistry [in Russian], Vysshaya Shkola, Moscow (1965).