

WORK OF THE METAL-CORROSION SECTION OF THE INTERINSTITUTE
CONFERENCE ON ELECTROCHEMISTRY

S. G. Vedenkin

Translated from *Zashchita Metallov*, Vol. 1, No. 5,
pp. 601-603, September-October, 1965

The interinstitute scientific conference on electrochemistry was held on May 31-June 2, 1965 at the Novocherkasskii Polytechnic Institute. About 250 reports were given in the five sections of this conference: metal corrosion, electrolytic metallurgy, hydroelectro metallurgy, chemical current sources, and electrochemistry without metal recovery.

More than half of the reports of the corrosion section were devoted to a study of corrosion inhibitors which is an important problem being developed at chemistry departments of many institutes of higher learning.

Of considerable interest were the works in this area by I. P. Anoshchenko (Novocherkasskii Polytechnic Institute) which were reported at the conference. The author, seeking means to intensify pickling, studied in detail the kinetics of the corrosion of iron in mixtures of HCl, H_2SO_4 and HNO_3 at temperatures of 20-80° and the effect of a number of inhibitors on the corrosion rate.

It was elicited that thiourea, ammonium sulfate, potassium thiocyanate sulfanilamide, and a number of their combinations lowers to a certain degree the corrosion rate of iron not only in the acids taken separately, but also in their mixtures. Acriflavine and ethodin in the presence of potassium bromide, urotropin, aluminum sulfate, stannous chloride, or their combinations nicely protect iron in 3 and 6 N solutions of hydrochloric and sulfuric acids. Acriflavine is more effective in HCl and ethodin in H_2SO_4 .

Numerous studies on corrosion inhibitors have been carried out at the Moscow Pedagogical Institute under the direction of S. A. Balezin. A study of the inhibiting action of various additions in the circulating solutions of mineral acids to remove scale in boilers established (V. I. Rodionova and E. S. Bulavina) that the addition to a 4% solution of HCl of 30-50 g/liter of the inhibitors PB-5, I-1A, BA-6, and katapin K, the corrosion rate of carbon steel decreases at a temperature of 40-50°C from 30-50 to 5-9 g/m²h. At 100° only katapin K protects effectively. The supplementary addition of urotropin (0.5%) increases the protective action of the indicated addition.

A study of the corrosion rate of alloy steels (ÉI-432, ÉI-448, SKhL-4) in 5-30% solutions of HCl at temperatures of 25-80° showed that under static conditions all the aforementioned inhibitors slowed down the corrosion rate, but katapin K is the most effective inhibitor. At a flow rate of 0.5-2.5 m/sec the effectiveness of the inhibitors decreases and the corrosion rate of steel ÉI-448 increases.

N. G. Klyuchnikov et al. (MGPI) revealed that primary and secondary alcohol in hydrochloric acid have a greater inhibiting effect than tertiary alcohols. With an increase of molecular weight of secondary alcohols, the effectiveness of inhibition increases.

An investigation of the corrosion and electrochemical behavior of steels (when flushing boilers) in solutions of citric acid in the presence of inhibitors (more than 400 substances were studied) showed that the best protective action is rendered by mercaptobenzothiazol (Captax), ortho-dimethyldiphenyl-urea, dibenzylsulfoxide, and the sodium salts or anthranilic acid. Mixtures of inhibitors Captax with katapin or with the inhibitor I-1-A are more effective. Their protective effect amounts to 99.8%.

Certain mixtures (0.1% katapin K + 0.03% Captax or 0.1% I-1-A + 0.03% Captax) give good results also in stationary solutions of ammonium monocitrate when it is used for prestarting flushing of thermal power equipment. Mixtures of inhibitors 0.1% OP-10 with 0.015-0.03% Captax and 0.1% VNIINP-58 with 0.015-0.03% Captax are more effective in circulating solutions.

The report of I. A. Mamedov concerning the work which he performed together with D. M. Abramov and N. M. Ageev under the supervision of V. F. Negreev cited data on the causes for intense corrosion of steel equipment in oil and gas wells. In industrial tests both the water-soluble (I-1-V) and the hydrocarbon-soluble (IKSG-1) inhibitors proved to be effective in the wells.

D. R. Sapronov and S. Ya. Pasechnik (Voronezh Technological Institute) elicited that foaming agents (a waste product from the production of divinyl by catalytic decomposition of ethanol at synthetic rubber plants) is a quite effective inhibitor for 23% solution of calcium chloride. Their addition lowers the corrosion rate from 14.4 mg/m²h to 0.4 mg/m²h.

Z. A. Iofa and V. V. Batrakov (MGU) studied the adsorption of surface-active substances on iron and their effect on the kinetics of electrochemical reactions. It was shown that in sulfuric acid solutions inhibitors of the cation type are weakly adsorbed and ineffective owing to the positive charge of the surface. Anions of certain organic sulfo acids are adsorbed nicely on iron, but they create a negative adsorption potential which according to the laws of electrochemical kinetics stimulates corrosion. A number of anions known as corrosion stimulators promote the adsorption of organic bases, forming with them ion pairs. In this case the stimulating effect of the anions disappears and a strong inhibitory action of the organic cations appears.

Yu. V. Fedorov et al. (Metallurgical Institute, Dneprodzerzhinsk) reported that mixtures of tribenzyl amine with β -naphthalene-sulfonic acid, indole with ammonium rhodanyl and tribenzyl amine and indole with potassium bromide appreciably lower acid corrosion of steels. It was shown that the inhibitor KKhK (coke by-product concentrated) is effective in sulfuric (0.5-8.0 N), nitric (0.5-2.0 N), and hydrochloric (0.5-6.0 N) acids.

A number of reports were devoted to a study of titanium corrosion. A. P. Brynza reported on works performed at the Dnepropetrovskii State University concerning the regularities and mechanism of titanium corrosion in acid media. Effective inhibitors were substances of anion and molecular types containing groups capable of being reduced (nitro derivatives of aniline, sulfonic acids of naphthalene, etc.).

The report of E. A. Yakovleva and V. V. Andreeva (Institute of Physical Chemistry, USSR Academy of Sciences) revealed that if ions of tetravalent titanium are introduced into solutions of H₂SO₄ and HCl, then it is possible to slow down or completely prevent the process of corrosion of titanium in them. Ions NO₃⁻ also severely inhibit this process. The mechanism of the inhibiting action of these additions was examined.

Numerous reports were devoted to a study of the mechanism and kinetics of the corrosion of various alloys in aggressive media. In the work "Investigation of Intercrystalline Corrosion of Stainless Steels in Nitric Acid by the Potentiostatic Method," I. K. Burtseva and A. I. Krasil'shchikov (GIAP) established that intercrystalline corrosion develops mainly at high positive potentials when the steel changes to a state of overpassivation. The dependence of the potential of overpassivation on temperature and concentration of the acid, composition of the steels, and heat treatment was determined.

A. I. Glukhova and V. V. Andreeva (Institute of Physical Chemistry, USSR Academy of Sciences) gave a report on the electrochemical and corrosion behavior of alloys of the niobium-titanium system in strongly corrosive electrolytes. It was established that alloys of this system have an exceptionally high resistance in oxidizing media. In solutions of KOH they are resistant (up to 20% concentration) at 40°; with an increase of temperature and concentration of the alkali, their resistance dropped.

I. K. Marshakov, V. P. Bogdanov, and V. I. Vigdorovich (Voronezh State University) in the report "Mechanism and Kinetics of Corrosion Destruction of Solid Solutions and Intermetallic Compounds" gave data on investigation in this area. The problems were solved on the basis of studying the corrosion of alloys Cu·Zn and Cu·Mg and compounds of magnesium with metals having markedly different electrochemical properties (Cu, Sn, Sb, Zn). It was found that partial exchange currents, corresponding to each of the alloy components, are set up between the intermetallic phase and the electrolyte. The surface layer of the intermetallic phase, as a consequence of the presence of a base component, acquires a defective unstable crystal lattice which can be destroyed upon the formation of a new phase. At alloy potential close to the potential of the base component, the new phase can occur as a result of electrochemical reduction of the ions of the noble component.

Several reports were given on the corrosion of aluminum alloys. V. P. Grigor'ev and V. V. Kuznetsov (Rostov State University) investigated the effect of various ketones on the acid corrosion of aluminum. Ketones inhibit the corrosion in HCl and H₂SO₄ only in the presence on the specimen surface of an oxide layer whose solution in the presence of cations is slowed down.

P. N. Smirnova et al. investigated the effects of certain technological factors on the corrosion resistance, electrochemical characteristics and structure of alloy AMG-6. They established the optimal conditions for aging of alloy V92 including stepwise conditions, one of which (60° for 24 h + 200° for 3 h) ensures good corrosion and high mechanical properties, and a second ensures the greatest resistance against corrosion under stress in the weld-metal zone. The same authors studied the corrosion effect of hydrolytic and synthetic alcohols on alloys of aluminum, copper, carbon and stainless steels, and other metals. Hydrolytic alcohol proved to be equivalent in corrosive activity to ethyl alcohol; the corrosive activity of synthetic alcohol was appreciably higher.

Ya. M. Kolotyarkin and G. G. Kossyi (Karpov Research Physicochemical Institute) reported on the anodic behavior of chromium in methanol solutions of hydrogen chloride containing various quantities of water. A number of regularities were established indicating the direct participation of water in processes of passivation and of the anions of the electrolyte in the dissolution of chromium in an active state.

In water-alcohol solutions it is more difficult to passivate chromium and it can be activated by chlorine ions with the production of depressions which is not observed in water solutions. When the water concentration is increased, passivation of chromium is facilitated and pitting is hampered.

Yu. P. Khranilov and V. S. Poroikova (Ivanovskii Chemical Technology Institute) studied corrosion resistance and the anodic behavior of magnesium-lithium and magnesium-aluminum-lithium alloys in concentrated solutions of sulfuric acid and in solutions of a number of salts of various concentrations. The corrosion behavior of alloys in these solutions were related by the authors to the phase composition and structure of the surface layers.

Data on the effect of heat treatment of zirconium on its corrosion resistance in hydrochloric acid were presented by L. N. Yagupol'skaya (E. O. Paton Institute of Electric Welding).

At elevated temperatures highly pure zirconium is tens of times more resistant in the acid than commercially pure zirconium; vacuum annealing at 600° increases this resistance even more. The mechanism of the effect of admixtures in zirconium and its heat treatment on corrosion in hydrochloric acid at high temperatures was studied.

The conference showed that in many peripheral institutions of higher learning serious scientific research is being carried out in the field of electrochemistry, including on the corrosion of metals which is of considerable practical interest. Many young scientists gave well substantiated reports at the conference.

The conference was well set up, for which we have to thank the chairman of the organization department of the conference Professor M. F. Skalozubov and secretary Docent I. P. Anoshchenko.