

SEMINAR ON THE THEORY AND METHODS OF STUDYING AND PREVENTING METAL CORROSION FOR WORKERS IN THE CORROSION LABORATORIES OF THE CHEMICAL INDUSTRY

V. M. Novakovskii

The main purpose of this Seminar, which took place from May 15 to 19, 1967, in the L. Ya. Karpov Physicochemical Institute, was to improve the organization of anticorrosion research in the chemical industry and to increase the scientific level and significance of this.

It was emphasized in the seminar that the usual figures of corrosion losses, estimated as 10 to 12% of all metal produced by the metallurgical industry, became far more appreciable if referred to the final metal products, machines, and equipment, and compared not with the total volume of production but with its annual increment. The percentage of equipment and means of production lost as a result of corrosion is quite comparable with, and sometimes even exceeds, the percentage increase of these required to maintain the country's planned growth of industrial production (6 to 7% per year). Hence any reduction in corrosion losses relative to their existing level is almost equivalent, in a hidden form, to the same relative increase in the annual percentage increment of the volume of production or the productivity of labor in the corresponding fields of national economy.

Hence combating the corrosion of construction metal, although only a "hidden" asset, nevertheless constitutes an important reserve of industrial expansion, labor economy, and technical progress as a whole, no less than a direct improvement to industrial technology. Hence anticorrosion research should not be considered as secondary and subsidiary to new technological developments, but on an equal basis with these. In large-scale operations involving improvements to design and the creation of new technologies, corrosion experts should take part from the very beginning, not only because the choice of material and protection methods requires time, but also because the correct solution of these questions may require certain changes in the technology in question.

As regards smaller technological developments, the question as to whether corrosion experts should take part in these can only be solved after obtaining at least preliminary data regarding the prospects of such developments and after comparing their expected economic effect with that of solving equally costly purely corrosion problems in existing production.

All this makes it an important matter for individual corrosion laboratories to make an exact calculation (at present nonexistent) of the total volume and structure of corrosion losses in the corresponding branches of industry. Only such a systematic calculation will make it possible to discover and prevent vast losses resulting from a failure to observe the appropriate norms for the protection, erection, and use of equipment and structures. Such a calculation will make it possible to determine the net cost and effectiveness of various protective measures correctly and to give an economic basis for the optimum employment of existing and new materials and methods of protection among the various branches of industry, thus securing data the absence of which at the present time is a severe handicap to efficient planning in the production of the corresponding materials and structures. Finally, only such a systematic calculation can give a clear picture of the most important trends which theoretical and applied corrosion research should follow.

The solution of the problem presented is impossible without the extensive participation of workers in the central industrial laboratories; thus an important part of the planning in leading departmental corrosion laboratories should be the methodical management of anticorrosion research in the industrial laboratories, the technical assistance required by these, the coordination of their planning, the discussion and correlation of the results obtained, and the spreading of experience by the publication of information, technical handbooks, etc.

Translated from *Zashchita Metallov*, Vol. 3, No. 5, pp. 654-656, September-October, 1967.

At the same time we require an improvement to the standard and fundamental scientific level of the research carried out by the laboratories of various institutes.

The main bulk of full-scale tests should be handed over to the industrial laboratories. For typical routine laboratory tests we should create technical or laboratory groups working by well-developed methods and producing data in accordance with an assigned program. The leading scientific workers in the corrosion laboratories of the scientific-research institutes should concentrate their main attention on the general management of anticorrosion research in their own fields and on the account of finer, generalized research on special questions arising from the systematic analysis of the state of the corrosion problem in the particular branch of industry and from the correlation of the results of factory experiments or observations.

Such research should be conducted with due allowance for all modern theoretical and methodical achievements in corrosion science, using the whole existing arsenal of ways and means of protection, taking full account of the fact that specific industrial conditions may pinpoint phenomena and circumstances which could not be observed or predicted under conditions of purely academic research.

On the general basis of the foregoing principles, a number of review lectures were presented to the participants of the seminar; these were devoted to the modern state of certain theoretical problems and methods of studying corrosion processes, and also to achievements in the development of new corrosion-resistant alloys and ways and means of anticorrosion protection.

A comprehensive lecture by Ya. M. Kolotyrkin (L. Ya. Karpov Physicochemical Institute) contained a general historical sketch of the theory of corrosion processes and also the modern tendencies toward their further development. It was shown how, as a result of the build-up of data and the development of neighboring branches of electrochemistry, the classical theory of corrosion microcells had gradually revealed itself as a special case of the more general theory of cooperative occurring electrochemical processes, and how it had become much clearer that corrosion was not a matter of one direct process but the multistage occurrence of many corrosion reactions with the direct participation of solvent molecules and other components of the solution, especially anions.

A curious paradox is the fact that it is precisely on the background of vast advances in electrochemical theory that scientists have recently discovered the existence of certain special mechanisms of corrosion reactions as a result of which the rate of corrosion of a metal in an electrolyte sometimes ceases to depend on the potential, and which may therefore be classified as chemical reactions.

The lecturer gave special attention to the development of the theory of passivity, from the coarsely-mechanical concepts of the classical "film" theory to the electrochemical principles of the "adsorption" theory, which, as is now known, remain largely valid even for a strict consideration of the behavior of oxide films over a few angstroms thick. The theoretical bases of the most important methods of anticorrosion protection were also considered.

The lecture by V. M. Novakovskii (L. Ya. Karpov Physicochemical Institute) was devoted to the theoretical foundations and certain practical questions of the use of modern electrochemical methods of studying corrosion processes, including the measurement of the so-called stationary potentials of corrosion, various forms of polarization and pulse measurements under potentiostatic and galvanostatic conditions, the study of capacity and electrode impedance, and so forth. It was also emphasized that there was little value in electrochemical measurements, even of the most modern and "modish" types, in corrosion systems unless these were accompanied by a fair understanding of the question required to be answered and of the best combination of methods and measurements providing the answer required.

V. A. Makarov (L. Ya. Karpov Physicochemical Institute) considered the method of anodically protecting metals from corrosion; he dealt with the calculation, modeling, and engineering formulation of a protection system on the basis of initial industrial trials with stainless steel apparatus in weakly-oxidizing acid media.

A series of lectures was devoted to the development and use of new corrosion-resistant alloys in chemical machine and apparatus building.

A. A. Babakov (Central Scientific-Research Institute of Ferrous Metallurgy) gave a detailed review of work on creating various classes of special chemically resistant alloys, giving particular attention to economically alloyed steels of the ferritic-austenitic class, and also to high-alloy chromium-nickel-molybdenum steels. Work on special nickel-molybdenum-base alloys was also treated. Of special interest to the

audience was an analysis of the possibilities associated with the introduction of various alloying elements, especially manganese, silicon, and nitrogen, and also ways of improving the technological properties of high-alloy steels, illustrated, in particular, by the example of the progressive movement from É1629 steel to the É1943 type, further development of which is continuing at the present time.

It was especially emphasized in the lecture that even now a whole series of types of alloy steels has been developed for the chemical industry, and that in selecting a construction material for specific conditions one must take careful note of the potentialities and cost of each of these, always selecting the cheapest and most abundant materials capable of ensuring the required reliability.

I. I. Kornilov (Baikov Institute of Metallurgy) gave the modern position and the prospects of the development and industrial manufacture of new titanium alloys, briefly presenting the results of fundamental research carried out in the Institute of Metallurgy in the theory of titanium alloying. Special attention was given to the need for increasing the part of the chemical industry in the use of titanium and titanium alloys, which in many cases gives a very considerable economic effect. The exclusive properties of titanium-tantalum alloys, hardly inferior to those of pure tantalum in corrosion resistance, were discussed.

Yu. M. Vinogradov (Scientific-Research Institute of Chemical Engineering) gave a detailed treatment of experience in the development and industrial acceptance of chemical apparatus made from new corrosion-resistant alloys, and described the difficulties of a constructional, technological, and organizational character which had to be met, and also the technological deficiencies still besetting some new alloys.

Two lectures were devoted to the properties and application of corrosion inhibitors.

E. N. Chankova (Experimental Station of the Dnepropetrovsk Metallurgical Institute) systematized the Station's results on acid-pickling inhibitors developed in the Soviet Union and elsewhere, both in the laboratory and especially under industrial or semi-industrial conditions. Emphasizing the specific nature of the action of certain inhibitors, the lecturer noted that the Station not only tested any newly-developed inhibitors but could also give more detailed information regarding specific materials at its present disposal.

V. P. Persiantseva (Institute of Physical Chemistry of the Academy of Sciences of the USSR) gave a lecture on industrially-adopted and newly-developed atmospheric-corrosion inhibitors, including the volatile type. Treating the mechanism underlying the action of the inhibitors and its relation to their chemical constitution, Persiantseva gave a number of practical recommendations on their use and demonstrated its effectiveness in the storage of certain metal products.

Unfortunately, these two lectures left no doubt that, although the chemical industry produces many substances with good inhibiting properties, it hardly uses them at all itself for combating the corrosion of structures and communication systems, while corrosion experts working in the chemical industry show a sad lack of interest in the development and acceptance of such methods of protection as have found wide application in many other countries.

The seminar also received a contribution from L. V. Nitsberg (State Institute of Paints and Lacquers) on new forms of paint and lacquer coatings containing reducing and passivating pigments.

During the seminar the participants were given the opportunity of acquainting themselves with the equipment, methods, and arrangement of research in the Corrosion Laboratories of the L. Ya. Karpov Institute, the Institute of Physical Chemistry of the Academy of Sciences of the USSR, the State Institute of the Nitrogen Industry, and a number of other Institutes, and also with the work of the Anticorrosion Establishment of the Shchelkovsk Chemical Combine.

In answers to a questionnaire the participants of the seminar unanimously agreed that it had been very useful to them and proposed the annual holding of such conferences for workers in industry and allied institutes.