It is produced in the form of a 10% solution in xylene. It has been adopted at all petroleum refineries.

Mak-4 (Bulgaria) is a copper—ammonia complex (carbonate) including an organic component. When fed to an oil desalting line, it quickly reacts with the aggressive agents present in the oil, forming alkali-metal salts and compounds which are stable at the rectification temperatures; these accumulate in the still residues. In addition, MAK-4 has antioxidant and detergent properties, and also prevents the formation of scale. It is used at the Burgas Petroleum Refinery.

It is fed in together with the caustic soda: MAK-4 inhibitor in the form of a 5-10% aqueous solution is fed to the oil desalting line at C = 8-10 mg/liter relative to the feedstock. At 7 m from its injection point, a 10% solution of alkali is injected at 20-40 mg/liter. In refining high-sulfur oil it is recommended that 2-4 mg/liter of film-forming inhibitor should be added to the slime lines.

Economic Effect

Experience of the use of corrosion inhibitors in COMECON countries shows that, according to their applications, an economic saving of 20,000-100,000 rubles is obtained per ton of inhibitor.

COLLECTIVE EXPERT ASSESSMENT OF PROMISING DIRECTIONS IN THE THEORY OF CORROSION AND PROTECTION OF METALS, AND COOPERATION BETWEEN MEMBER-COUNTRIES OF COMECON IN ITS DEVELOPMENT

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UDC 620.193.01

A questionnaire has been addressed to 54 specialists from Bulgaria, Hungary, East Germany, Poland, the USSR, and Czechoslovakia on the present level and directions of development of the theory of corrosion and on the cooperation between the member-countries of COMECON in this field. By analyzing the replies, the authors elucidate and comment on the prevailing opinions on these questions.

In recent years, increasing use has been made of questionnaires addressed to experts in order to predict the development of science and technology. This method was included in the recommendations for forecasting in the COMECON group [1], and has been used, in particular, to assess the various courses for increasing the reliability of steel structures in hydrogenating media [2].

The aim of any questionnaire addressed to experts is to elucidate the spectrum of opinions, particularly the predominant opinions, and sometimes to find their "averaged" pattern. Of course, in scientific matters the predominance of some particular opinion does not guarantee that it is correct. Moreover, an inquiry made among specialists in a given field reflects, as it were, the "view from inside." It would also be very interesting to have a "view from outside," i.e., to find the opinions of specialists working in related fields of science and technology. To elucidate this it is necessary to overcome a whole series of organizational and technical difficulties. These circumstances reduce the value of questionnaires, but by no means render them worthless, because a statistically reliable knowledge of the prevailing opinions, irrespective of attitudes to them, is very important for solving a number of problems of science and scientific organization.

In our work, performed within the framework of the scientific—technical collaboration on Theme I, "Development of a Theory of Corrosion and Protection of Metals," in the COMECON

L. Ya. Karpov Scientific-Research Physicochemical Institute. Translated from Zashchita Metallov, Vol. 16, No. 3, pp. 237-249, May-June, 1980. Original article submitted October 31, 1979.

TABLE 1. Data on Experts

Characteristics		Range	Average
Age of expert in years		31–73	45
Length of service working on corrosion and protection of metals, years		3–49	17
Length of service working on theory of corrosion and protection of metals, years	for those with experience in this field	2–49	15
	for all the experts	–	12
Coeff. of competency of expert*		0,40–0,93	0,71

*Calculated as a figure between 0.0 and 1.0 by the method in [1].

program on "Development of Measures to Protect Metals from Corrosion," we have used a questionnaire addressed to experts in order to assess the present state, fruitfulness, and development prospects of the theory of corrosion and protection of metals (TCPM) and the prospective aims and forms of cooperation by the member-countries of COMECON in this field.* We also had in view the acquisition of experience in sending international questionnaires to corrosion experts for the purpose of subsequent wider use of this method in scientific and technical collaboration on this problem.

The questionnaire included 15 questions (and a number of supplementary questions) covering various aspects of the TCPM, and also some questions aimed at obtaining the necessary minimum information from the experts. Some of the 15 basic questions required an answer in "quantitative" form (involving assessment on a ten-point scale); others required an answer in "qualitative" form, e.g., on the most important results of work on the TCPM. In the case of a "quantitative" estimate of four or more similar objects of inquiry, as well as calculating the average we also ranked the estimates.

In view of the organizational difficulties, the questionnaire was circulated in one round only – i.e., without informing the participants of the answers by the other experts (this is often done in order to improve the concordance of the answers, etc.); this eliminated both positive and negative effects of mutual influence between opinions. Anonymity of the questionnaire ensured frankness in the answers.

In the opinion of the present authors, the main shortcoming of the questionnaire, appearing in the correlation of the results, was a somewhat unfortunate phrasing of the questions requiring answers in qualitative form: The degree of particularization in the answers was not specified, and therefore varied over a very wide range. As examples of the answers to the question on the achievements of the TCPM, we can give the following (in decreasing degree of particularity): "The polarization resistance method"; "electrochemical methods"; "methods of investigating corrosion." As a result, in processing the questionnaire we were forced to define the achievements and prospects of research in very general form. It would seem that to any question of this type it would be necessary to give a sample answer of a sufficient degree of particularity.

Our treatment of the questionnaire cannot be regarded as exhaustive. For example, we did not completely analyze the dependence of the answers on the experts' own research fields. However, in the authors' opinion, the material below reflects the main results of the survey.

Characteristics of Group of Experts. Fifty-four experts (from Bulgaria, Hungary, East Germany, Poland, the USSR, and Czechoslovakia) took part in the survey; 70% of them† have the degrees of Candidate or Doctor of Science. About 54% of the experts work at institutes

*Here and below we have in mind the COMECON member-countries which take an active part in collaboration on the TCPM, viz., Bulgaria, Hungary, East Germany, Poland, the USSR, and Czechoslovakia.

†Here and below, the percentages and scale estimates are usually rounded off. There may thus be slight discrepancies in their balances.

TABLE 2. Distribution of Experts among Lines of Research (% of total number)

Corrosion under stress and hydrogen embrittlement	26
Methods of corrosion investigation, tests and monitoring of corrosion	18,5
Corrosion-resistant metallic materials	18,5
Passivity and its breakdown	16,6
Corrosion inhibitors	11
General aspects of solution of metals	9,3
Electrochemical protection	7,4
Active solution of metals	5,5
Intercrystallite corrosion	5,5
Corrosion in power production	5,5
Acid corrosion	3,7
Various other aspects	24*

*One expert in each of 13 different lines summarized in this column.

(mostly research establishments) in various branches of the national economy (and in inter-branch foundations); about 24% work in academic scientific-research institutes; 18% work in teaching institutions; and 5% work in industry. Table 1 lists data on their ages and some other characteristics. We also invited the participation of specialists working on applied aspects of protection from corrosion; the proportion of such specialists was about 20%. Almost two-thirds of the experts (62%) work in one (albeit often very broad) part of the field of corrosion and protection of metals; the rest are pursuing researches simultaneously in two or more parts. In this connection, in assessing the distribution of the experts among lines of research (Table 2), we counted each one as many times as he or she indicated different lines of research in the questionnaire.

Principal Results, Level, and Practical Importance of Work. To the question of the principal achievements of the TCPM in the last 5-10 years,* the experts were asked to give two answers — one for the whole world, and one for the COMECON countries alone.

In the broadest outline, the distributions of the answers† almost coincided: In both cases about 60% of them refer to some particular theoretical work, and about 20-30% to development and adoption of devices and methods.

Among the answers indicating theoretical work, in both cases the first (25-30% of the answers) and second (20-27%) places were taken, respectively, by achievements: 1) in the field of kinetics and mechanisms of solution of metals, with especially frequent mention of work on the role of the interaction of the metal with the components of the medium in the process of solution and the stages of this process, and 2) in the field of passivity and its breakdown. The subsequent distributions of answers differed between research in the world as a whole and in the COMECON countries. For the world as a whole the third place is taken by work on the theory of corrosion under stress (22% of the answers), with special mention of the ideas of the mechanics of fracture. Then follows the achievements of the theory of corrosion of alloys (about 7% of the answers). For the COMECON countries the third place (17%) is taken by research on corrosion of alloys, and the fourth (8%) by work on inhibitors, especially on the relations between structure, protective properties, and mechanism of action of inhibitors.

*Judging by the answers, many of the experts in fact covered a period of up to 15-20 years.
†Many experts gave several (up to 4-6) answers to this and similar questions. Therefore, below in similar cases we give the percentage of replies of a certain type in the whole number.

Clearly, thesedifferences in the distributions of the answers reflect a relative lag in work on the theory of corrosion under stress in the COMECON countries, and success in investigations of alloys and corrosion inhibition.

In two other questions to the experts we asked them to indicate the most important results of work on TCPM as a whole, but from the viewpoint of possible practical applications at present or in the near future. In this case, the general distributions of the answers for research in the world as a whole and in the COMECON countries were roughly the same. The first place was taken by theoretical work proper (about 50% of the replies); the second and third places were actually divided (19 and 17%) between development of methods of protection from corrosion and methods of investigation, testing, and monitoring. As particular examples of methods of protection, in a number of cases the replies mentioned anodic (in particular, pulsed) and inhibitor protection, surface alloying by ion implantation, etc. As examples of the important devices and methods, the answers gave the method of polarization resistance for remote control of corrosion in industrial conditions, electrochemical methods of accelerated corrosion testing, potentiostats with automatic compensation of the ohmic potential difference, etc.

The fourth place (13-14% of the answers) was taken by development of corrosion-resistant metallic materials. Together with general answers to this question (of the type "new alloys"), there were a number of particular answers mentioning economically alloyed stainless steels, amorphous alloys, high-purity chrome–molybdenum ferrite steels (superferrites), etc.

The experts were also asked questions on the most important achievements in recent years for the TCPM in the fields of other scientific and technical disciplines, including those in the special field of methods. The answers to the former question were very varied and can hardly be generalized. Concerning achievements in the field of methods and devices, the experts were almost unanimous in indicating new physical methods of investigation of surfaces — x-ray spectral microanalysis, Auger spectroscopy, ESCA (x-ray photoelectron spectroscopy), etc.

In the concluding questions in this group, the experts were asked to give a comparative quantitative assessment, on a ten-point scale, of the present levels of development of the TCPM in the capitalist and COMECON countries, on the one hand, and the influence of theoretical work on the creation and development of technical methods of corrosion protection, on the other.

The distribution (Fig. 1) and mean scale point (about 5) of the estimates in the answers to the first question on the TCPM as a whole show that the average level of development of corrosion theory is regarded as practically the same in the COMECON and developed capitalist countries.

Analysis of the answers to this question in application to the fields of work of the experts indicates that researches on corrosion under stress and hydrogen embrittlement, and also methodological work, are lagging in the COMECON countries, while research on the general laws of solution of metals is leading, and work on corrosion-resistant metallic materials, passivity, and its breakdown is at about the same level. These conclusions largely agree with the above data from analysis of the answers to the question on the fields of TCPM in which the most important results have appeared in recent years.

Concerning the degree of practical utilization of work on the TCPM, the prevailing opinion is that in the COMECON countries it is lower than in the developed capitalist countries (Fig. 2; mean scale points, about 4.5 and 6.5, respectively). In developing methods to eliminate this lag, we must note that it exists only in certain fields of protection of metals, and it may have very varied causes. For example, we can say that in the field of measures against corrosion under stress it would be advantageous to accelerate the development of the necessary theoretical base in the COMECON countries, whereas in other fields we should try to realize either our existing research preeminence (general theory of solution of metals) or the theoretical potential which is at least as good as in the capitalist countries (research on corrosion-resistant alloys, etc.).

Factors and Prospects in the Development of the TCPM. In assessing the comparative roles of the five factors enumerated in the questionnaire (Table 3), the experts gave most value to new devices and methods and goal-directed experimental investigations. The results of ranking almost coincide with the mean scale points. The third place is taken by new

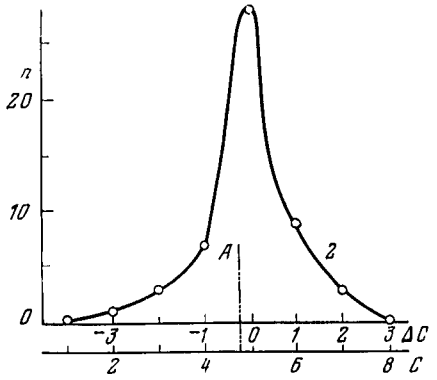

Fig. 1

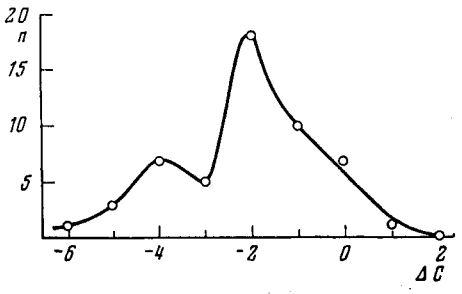

Fig. 2

Fig. 1. Distribution of estimates of relative level of work on the theory of corrosion and protection of metals as a whole in the COMECON countries in comparison with the capitalist countries. Here n is the number of experts giving a given estimate C on a ten-point scale (bottom scale of abscissas). We proposed the level "5" for equal levels in both groups of countries, and "10" and "0" for the cases in which the work in the COMECON countries is very far ahead and very far behind. Here ΔC is the difference of the estimates (top scale of abscissas); plus denotes lead, and minus denotes lag. The line A is the average scale point.

Fig. 2. Distribution of difference of estimates of influence of work on TCPM as a whole on creation and development of methods of corrosion protection in the COMECON countries and in the developed capitalist countries (ΔC: same as Fig. 1). The estimates were given on a ten-point scale for each group of countries separately.

ideas; the last places, with much lower scale points and ranks, are taken by theoretical calculations and effects observed by chance.

Nearly all the experts (47 out of 54) gave an affirmative response to the question of whether there are circumstances which are holding back the necessary development of TCPM. Allowing for such an answer, in the questionnaire we gave for comparative assessment six probable "retarding" factors. On processing the data (Table 4) we found that the highest importance is clearly assigned to unavailability of experimental equipment already being produced. A lesser role is assigned to an inadequate level of development of present experimental techniques, shortage of funds, qualified staff, and talented people working in the field of the TCPM. The last place is taken by inadequate utilization of computers.

Some experts mentioned other factors which, in their opinion, are holding back the development of the TCPM: enthusiasm for "isolated" experimental lines not linked with the general theoretical pattern; isolation of the TCPM from fundamental science which is far ahead of it in development; insufficient possibilities of making investigations on the TCPM according to programs supported by State organizations; and present complex experimental techniques which are too advanced for corrosion scientists and are too easily available.

This last answer is clearly in conflict with the above-mentioned opinion that unavailability of commercial experimental equipment (the latest physical equipment was evidently referred to here) is the most important factor holding back the development of the TCPM. In this connection we feel we should make certain observations.

The optimum supply of equipment to a laboratory cannot be determined on the principle of "the more, the merrier." For any laboratory there is a certain level of equipment provision beyond which further supply does not repay its cost. These factors must be carefully considered. The chief ones are as follows.

1. Getting the best out of the latest equipment, correct formulation and solution of experimental problems with its aid, and accurate interpretation of the results all require high specialized qualifications which corrosion scientists usually do not possess. Hence, it is necessary either to adjust the staff establishment at the same time as the stock of

TABLE 3. Assessment of Roles of Factors Stimulating the Development of the Theory of Corrosion and Protection of Metals

Factor	Mean scale point	Sum of ranks
Creation of new devices and research methods	7,0*	79
Goal-directed experimental investigations	7,0	91
New ideas	6,1	113
Theoretical calculations (approaches of the type used in theoretical physics)	4,0	170
Effect discovered by chance	3,7	168

*For the given case, taken as an example, with the aim of elucidating the degree of concordance between the opinions of the experts we used the method in [1] to calculate the coefficient of variation of the estimates $V_j = \sqrt{D_j}/M_j$ (where D_j is the dispersion of the estimates of a given factor and M_j is the average scale point of its estimates), which proved to be equal to 0.3.

equipment, or to expend a large number of man-hours on acquiring new specialized experience and knowledge in a related field of science.

2. The development of productive theories (on which the cost effectiveness of equipment for fundamental research ultimately depends) cannot be accelerated merely by accelerating or increasing the accuracy of experiments, or even by obtaining fundamentally new results. At present the flow of new experimental facts is outstripping the process of theoretical reappraisal of the fund of known facts to which they are being added (without which correct development of the theory is impossible). The further the limiting stage of the process moves from experimental to theoretical work (in the true sense of the word), the less are the returns from experimental work.

3. If the theoretical stages of the work lag behind, expansion of the equipment base alone will have the result that instead of crucial, theoretically well-founded experiments which explain the accumulated facts, experimental technique is used for a kind of "wide-area bombing," which, instead of putting the experimental data in order, leads to a chaotic multiplication and makes theoretical work even harder.

4. This is aggravated by a number of psychological factors associated with the apparent advantages obtained by an experimenter who is the first to apply new methods and devices in his field, and with the involuntary spread of authority and prestige from these methods, not understood by all, to the work done with them. Hence the haste generated by the urge not to lag behind others in acquiring these devices and using them in some way or other. Hence also the exaggerated value ascribed to the results, which are sometimes even made into fetishes, leading to erroneous interpretations and to their artificial separation from a wide circle of long-known matters with which they compose a unified whole.

All this means that in the present state of the relation between experimental and purely theoretical fundamental research, excessive unbalanced investment of resources in the latest experimental apparatus may not only prove unproductive (like any expansion of stages of production which are not the limiting ones), but may even lead to retardation of the productive development of the TCPM.

Of course, it is necessary to broaden the utilization of the latest physical methods in research on corrosion systems and processes. However, this must be done rationally, i.e., in strict proportion to the actual need, paying due attention to the proportionate development of all related investigations so as to get the maximum final returns for the resources invested, and starting by increasing the efficiency of utilization of the existing equipment.

The above opinion of the "self-isolation" of TCPM is valid in at least two respects. For example, in corrosion terminology there has arisen a clear and very undesirable departure from the general scientific system of terms and concepts of physical chemistry. How-

TABLE 4. Assessment of Factors Holding Back the Development of the Theory of Corrosion and Protection of Metals

Factor	Mean scale point	Sum of ranks
Unavailability of commercial instruments and apparatus for experimental investigations	6,0	83
Inadequate level of development of present experimental technique	4,7	114
Insufficient funds from state, enterprises, etc.	4,6	122
Shortage of qualified research staff	4,6	122
Shortage of talented people working in a given field	4,3	128
Insufficient utilization of already available computer methods	3,6	140

ever, the greatest danger lies rather in the fact that instead of appropriate development of particular solutions of general scientific problems specially for corrosion, ready-made results from other branches of science are often mechanically and perfunctorily transferred to the TCPM, both in the field of theory and in that of methods of investigation. As a result, we lose the necessary fundamental link between the TCPM and physical chemistry.

An example is the wide use of ideas from the theory of adsorption, which was largely developed in application to processes of heterogeneous catalysis. No account is taken of the need to make serious corrections in the theory for the case of adsorption on a dissolving metal surface. On the other hand, many investigators [3-7] have shown that the use of the physical methods to study passivating layers requires considerable modifications — elimination of contact between the specimen and the air (from the moment of removal from the solution to insertion in the high-vacuum chamber of the apparatus), deep chilling to avoid changes in the films, use of nitrogen in ionic etching instead of the usual argon ions, etc. Theoretical consideration in obviously also needed on aspects associated with possible changes in the state of the metal surface when it is transferred from the electrolyte to a vacuum.

In indicating the most promising trends in the development of the TCPM, the experts gave clear preference to general theoretical aspects of corrosion and anodic solution of metals (columns A_1 and A_2 in Table 5). In the second and third places we find problems in developing corrosion-resistant metallic materials and methods and devices for corrosion research. About one answer in every 10 refers to corrosion under stress, including hydrogen embrittlement; then follows passivity.

Development of apparatus and methods is mentioned less often in the plan of prospects than in the above answers to the question on the most important results. Apparently some of the experts either think that the "methods boom" of the last few years will gradually decline, or regard methodological development as merely auxiliary in formulating the aims of research.

Promising Trends and Forms of Scientific and Technical Cooperation in the COMECON Association on the TCPM. As seen from Column B in Table 5, the experts' assessment of the promising trends in cooperation in the COMECON association are different from that of promising trends in general (columns A_1 and A_2). For cooperation, by far the most frequent topic in the answers is that of apparatus and method development. Almost a third of the answers of this type refer to problems of unification and standardization. General problems of solution of metals occupy the second place; all the other research trends together occur about as often as the first two. Evidently most of the experts, in considering the definitive features of international cooperation, think it most necessary and productive to collaborate in the development and unification of methods and devices and also of fundamental aspects of the kinetics and mechanism of solution of metals.

Not unimportant in the development of scientific and technical cooperation are personal attitudes of the experts (who in most cases work in the collaborating organizations in their various countries) to the various forms. In this connection, in the questionnaire we tried

TABLE 5. Promising Trends in the Theory of Corrosion and Protection of Metals (A_1: for the expert's own field; A_2: for other fields; B: for scientific–technical cooperation of the COMECON countries)

Direction	Percentage of total number of replies		
	A_1*	A_2†	B‡
General theoretical problems of corrosion and anodic solution of metals	24	26	15,6
Corrosion-resistant metallic materials	17	17,8	8,2
Methods and devices for corrosion research and testing	10,4	17,8	29,5
including unification and standardization	1	0	9
Corrosion under stress and hydrogen embrittlement	9,4	8,3	9
Passivity	8,5	7,1	8,2
Local corrosion	6,6	3,6	4,1
Corrosion inhibitors	4,7	6	7,4
Coatings	4,7	7,1	4,9
Electrochemical protection	3,8	0	3,3
Other questions	11,3	6	9

*106 answers.
†84 answers.
‡122 answers.

to assess, in relation to the TCPM, the real and potential effectiveness of the various forms of scientific and technical cooperation used or possible in the COMECON association. As seen from Table 6, among practical forms of cooperation, the most highly esteemed were the most traditional ones — participation in conferences and exchange of reprints of published work. The lowest assessment was given to secondment of specialists to organizations in other COMECON countries — obviously because this form of cooperation is very rarely realized. The assessments of other forms of cooperation were in intermediate positions.

In assessing the potential effectiveness of various forms of cooperation, together with the written scale points we also used answers to the question on promising trends in cooperation on the TCPM in the future. On this aspect, for each stated trend in collaboration, the experts were asked to recommend the optimal forms for its realization from the list given here in Table 6. In most cases the experts simultaneously indicated two to six forms. The number of such proposals was summed and the proportion of proposals for each form then calculated (fourth column in Table 7).

Comparing Tables 6 and 7, we see that from the viewpoint of order, assessments of the potential effectiveness of forms of cooperation only partly agree with the assessments of the real effectiveness.

With all three methods of calculation, the first place is occupied by cooperation according to joint working plans (which occupied the fourth or fifth place in real effectiveness), and the last place by agreement on specialization of research in different countries. Clearly, activation of cooperation according to working plans may receive the most favorable attitude of the specialists.

For other forms of cooperation, the methods of calculation did not always give coincident results. However, we can conclude that from the viewpoint of potential value, conferences and acquaintance visits obtained high places (2-3). In the scale and rank assess-

TABLE 6. Assessment of Actual Effectiveness of Various Forms of Scientific and Technical Cooperation for the Theory of Corrosion and Protection of Metals in the COMECON Association

Form of collaboration	Brief name or designation	Mean scale point	Sum of ranks
Participation in conferences, symposia, seminars, etc., organized in COMECON channels	Conferences	4,7	100
Systematic exchange of reprints of published work	Exchange of reprints	3,7	111
Spending 1-2 weeks on trips to become acquainted with organizations in other countries in the COMECON group	Acquaintance visits	3,7	134
Participation in scientific coordination conferences (to consider annotation reports, coordinate plans, etc.)	SCC	3,6	137
Cooperation in joint working plans (with planned mutual visits 1-3 times per year, exchange of specimens for investigation by various methods, preparation of joint reports and publications, etc.)	Working plans	3,4	135
Participation in temporary multilateral working groups (or programs) to unify and and standardize devices and methods of corrosion research and testing	TWG	3,1	146
Long-term secondment to postgraduate work and collaborative research in organizations in other COMECON countries	Secondment	2,8	168
Creation of temporary international collectives of scientists and specialists to solve important individual problems	TICS	0*	–
Arrangements on specialization of investigations in countries according to predetermined plans	Arrangements on specialization	0*	–
Creation of permanent international laboratories for predetermined aspects of the theory of corrosion and protection of metals	International laboratories	0*	–

*These three forms of cooperation on the TCPM are not yet in use, so that they should receive zero assessments, and this was done by nearly all the experts. Nonzero assessments, erroneously made by some experts, were not taken into account in compiling the table.

ments, exchange of reprints moved from the second place (Table 6) to the eighth or ninth (Table 7). The high percentage of proposals for this type of cooperation (Table 7) is due to the fact that many experts indicated it among other forms, apparently, as an extra channel of exchange of information which is very useful for all cases. Scientific coordination conferences moved from the fourth or fifth place in Table 6 to the eighth in Table 7, indicating the relatively poor promise of this type of cooperation and the desirability of gradually dispensing with it. The place of secondment rose from the sixth to the fourth. Only slightly lower than these was assessed the creation of temporary international collectives of scientists. A certain skepticism concerning the creation of permanent international laboratories (about the seventh place) is probably due to the anticipated organizational difficulties, rather than the expected degree of productivity of the work of such laboratories. However, we notice that the mean scale point assessments corresponding to the first and last places in Table 7 do not differ so markedly, so that the attitudes of the experts to agreements on specialization can be regarded as very suspicious but hardly a complete repudiation.

TABLE 7. Assessment of Potential Effectiveness of Various Forms of Scientific and Technical Cooperation on the Theory of Corrosion and Protection of Metals

Form of collaboration	Mean scale point	Sum of ranks	Percentage of proposals
Working plans	7,3	115	20,7
Conferences	7,2	125	11,9
Acquaintance visits	6,8	133	14,2
Secondment	6,8	133	10,7
TICS	6,5	140	7,2
TWG	6,4	140	8,0
International laboratories	6,4	139	5,7
SCC	5,9	155	6,5
Exchange of reprints	5,9	158	10,3
Agreements on specialization	4,9	190	4,6

*Total number of proposals, 204.

The well-known skepticism of experts on this last topic, apparently due to insufficient acquaintance with the essence of such agreements and the danger of limiting the freedom of scientific creativeness, is apparently only partly justified. If such agreements involve the creation of a rational system of large specialized research centers in the countries, then this form of cooperation, which will ensure the necessary concentration of scientific forces (in particular, interested specialists from the countries) and technical means for the solution of crucial scientific problems, could be very effective. Unfortunately, the creation of such centers would at present meet with considerable organizational difficulties.

It is also important that the scale point assessments in Table 7 are clearly higher than in Table 6. This, unfortunately, reflects the inadequate utilization of the existing possibilities for cooperation, but, on the other hand, shows that they have possibilities in reserve. Allowing for a certain degree of arbitrariness, from the assessments we can infer that the average degree of utilization of the various forms of cooperation exceeds the 60% level only in the cases of conferences, exchange of reprints, and scientific coordination conferences, while for the other forms it hardly reaches 40-50%.

The authors sincerely thank all the specialists who took part in the survey, and also their colleagues from leading organizations of the countries collaborating in its organization: the Institute of Physical Chemistry of the Bulgarian Academy of Sciences; the Research Institute of the Heavy Chemical Industry, Hungary; the Central Institute of Solid-State Physics and Investigation of Materials of the Academy of Sciences of the German Democratic Republic; the Institute of Physical Chemistry of the Polish Academy of Sciences; and the G. V. Akimov State Institute for Protection of Materials, Czechoslovakia.

CONCLUSIONS

1. An international survey has been made by sending a questionnaire to 54 specialists of member-countries of the Council for Mutual Economic Aid (COMECON) — Bulgaria, Hungary, East Germany, Poland, the USSR, and Czechoslovakia — asking about the present problems of creating and developing a theory of corrosion and protection of metals (TCPM) and about scientific and technical cooperation in this field along the channels of COMECON.

2. According to the averaged assessments, the level of work on the TCPM in the COMECON countries is about the same as in the developed capitalist countries. The degree of practical utilization of work on the TCPM is on the whole recognized as very substantial, but in the COMECON countries it is thought to be lower than in the capitalist countries.

3. In recent years, important results have been obtained in all the main fields of the TCPM. However, the greater part of the answers mention the results of research on the kinetics and mechanism of solution and passivation of metals (these trends are also assessed as the most urgent for further research). For research in the world as a whole, the next place is taken by the results of work on corrosion under stress; for the COMECON countries, it is taken by work on corrosion of alloys.

4. Among the most important results for TCPM obtained in the development of other branches of science and technology, new physical methods of investigation of surfaces were mentioned almost unanimously — x-ray microspectral analysis, ESCA, Auger electron spectroscopy, etc.

5. For the development of the TCPM, the creation of new apparatus and methods and the pursuit of goal-directed experimental work were acknowledged as most important. Among the factors holding back the development of the TCPM, the first place is given to unavailability of the presently produced experimental equipment. The authors comment on this point.

6. All the main trends in the TCPM are proposed for further scientific and technical cooperation between the COMECON countries. However, preference is given to development of apparatus and methods, including unification and standardization of methods of corrosion research and testing.

7. Judging by the assessments, the possibilities of all the forms of scientific and technical cooperation on the TCPM are not yet being used to the full. In terms of actual effectiveness, the highest valuation is given to participation in conferences, symposia, etc., organized along COMECON channels, and also to systematic exchange of reprints of published work. From the viewpoint of potential effectiveness, favorable appraisal was given to all the proposed forms, but the first place was taken by cooperation on joint working plans, and the last place by agreements on specialization of research.

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