GENERAL DISCUSSION

MR. E. H. DIX, JR.[1] (*abstracted*).—Mr. Dix, in the general discussion of the several papers, remarked upon the emphasis placed upon tension tests, in the discussions of the session, as a means of evaluating corrosion and pointed out that this method had been recommended by Mr. Blough as far back as 1925.[2] Except in special cases, weight changes are poor criteria of corrosion in aluminum alloys; changes in tensile strength and elongation proving more sensitive to the effects of corrosion. Mr. Dix, in particular, stressed the value of changes in elongation in detecting the first occurrence of corrosion and inquired whether Messrs. Crampton and Mitchell had included elongations in their measurements.

The part played by electrochemical corrosion, as against chemical or solution corrosion, was another point on which Mr. Dix commented. He explained that, by means of a simple test made in his laboratories, R. B. Mears and R. H. Brown had demonstrated that over 90 per cent of the corrosion of commercially pure aluminum in a chloride solution was electrochemical.

MR. R. F. PASSANO[3] (*abstracted*).—Mr. Passano stressed particularly the difficulty of interpreting corrosion test results on widely different materials by reason of the fact that corrosion processes seldom continue at a constant rate, nor do the extent and direction of change in rate with time remain the same for all materials. This point was demonstrated graphically by slides. He suggested that interpretation of test results from this angle would be facilitated by increasing the number of periods of inspection, and recommended a minimum of three inspections in connection with tests made under natural circumstances. In this connection he pointed out that an increase in thickness might not increase the life of all materials in the same proportion.

Mr. Passano also discussed area of test specimens, and presented exposure data obtained from large and small specimens of the same materials under the same conditions. These data showed that the amount of corrosion, and the variation from specimen to specimen depended on the area of the individual specimens, the deviation being greater with the larger specimens. He was of the opinion, therefore, that data should be reported in the units in which the measurements were made per test specimen.

In discussing reproducibility of test results, Mr. Passano stressed the fact that there could be no compromise on reproducibility. He thought altercations on the subject arose from employing the word in too many senses. He reserved it for agreement between successive tests. An inspection method should produce data which do not differ significantly from trial to trial when applied to homogeneous materials. The deviation of individual pieces from the average of a homogeneous lot was not the essential point in determining reproducibility.

He went on to say that tests are made

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[2] E. Blough, "Evaluation of Corrosion Tests," *Proceedings*, Am. Soc. Testing Mats., Vol. 25, Part II, p. 156 (1925).

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with an idea of prediction, and if successive applications of a method do not show it capable of giving the same essential results time after time, no prediction is possible, and the test method needs revision. Mr. Passano thought this point more important than mechanical detail. Adherence to the detail of the method of test which might contain incomplete specifications on some essential point could not possibly raise the quality of test results.

With particular reference to the suggestion by Borgmann and Mears that "regardless of how the tests are to be employed, it is highly desirable that the various testing methods be standardized," Mr. Passano pointed out that a single type of test, particularly when graced with the designation "standard," might be applied to materials of widely different characteristics. It would be necessary to define the limitations of test methods if one would avoid improper application and unfortunate situations. As an example, he mentioned the salt-spray test which has found wide use on aluminum alloys. The test has also been used for zinc coatings on steel, and on stainless steels. He pointed out that the conditions necessary for reproducibility on aluminum alloys were probably not the same as the ones which should be followed on zinc coatings, and that these were different from the precautions which had to be taken with stainless steels.

He referred to the decision which had been reached at one time with regard to the relative merits of cadmium and zinc coatings when salt-spray test results were the only results available. The salt-spray test had shown that cadmium coatings were better than zinc coatings. Actual exposure tests made by various persons in this country and abroad have actually shown, however, that zinc coatings are superior to cadmium coatings. Such a situation as this could certainly be repeated with disastrous results *ad infinitum* if the recommendation of Borgmann and Mears were followed.

MR. R. L. DUFF[4] (*presented in written form*).—The corrosion problem in an oil refinery is always a paramount and most serious one due to the diversified corrosive factors involved. Temperatures range from — 150 to 1800 F. and pressures will vary from a vacuum to a pressure of 3500 lb. per sq. in. The consumer of metals, including alloys, is not and cannot be interested in all the details of their inception or making. All the claims made for special favored materials discovered and possibly patented by the various alloy manufacturers must be taken with a grain of salt. Some specific reliable method of selection of materials of construction is necessary.

For speedy elimination of materials for special service, the small size sample or laboratory testing has its merits. The results obtained from such a procedure can with the application of good common sense, be used to advantage as an indicator of what might be expected in service.

The usual procedure is to select some promising materials and to test them by these so-called indicator tests using small specimens installed in the corrosive medium under or as near to working conditions as possible, in so far as temperature, composition and strength of corrosive medium are concerned. If time permits an experimental unit may be constructed from materials that showed up well in the corrosion test.

Other important factors that must be considered in the selection of materials of construction are:

1. The cost per pound as compared to common steel.

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2. Ease of fabrication.
3. Machinability and weldability.
4. Thermal expansion.
5. Stability of the physical properites under operating conditions.

Large scale testing is frequently practiced in the testing of various kinds of condenser or heat exchanger tubes. These may be either in units of a bundle of tubes consisting of several hundred, or in lots of ten tubes or more, care being taken to use similar material for tube sheets, header boxes and baffle plates. Cracking coil tubes are at times tested in lots of five to twenty in actual service, noting the metal temperature, pressure and hours in service. Materials for tank roofs have been tested in actual service either as complete roofs or sections.

Quite frequently the economic thing to do is to recommend the construction of specific equipment out of common steel allowing enough thickness as a corrosion allowance.

Various alloy and special surface treated pump rods as well as valve trim, are put into actual service and such variables as corrosive medium, wear, velocity, temperature and time are noted.

There is no metal or alloy that could be considered as a "cure all" to meet all refinery corrosive conditions.