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February 27, 1945.

## R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1801.

Corrosion-Resistant Coatings for Magnesium: A Survey.



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Origin and Object of Investigation:

On January 25, 1945, copies of C.D.M.L. Report No. 1783, entitled "Investigation of Corrosion Resistance of Lightened Mortar Base Plates and Bipod," were submitted to Col. J. L. McAvity, Director of Vehicles and Small Arms, of the Department of National Defence (Army), Ottawa. In the report it was mentioned that a survey was being made to determine the most satisfactory corrosion-resistant coatings for magnesium. Although the experimental work is far from complete, the preliminary investigation, consisting of correspondence, conferences, attendance at the "Surface Finishes" symposium of the Magnesium Association in Cleveland, etc., has been finished. The present report covers the information obtained in this preliminary investigation.



TYPES OF CORROSION-RESISTANT COATINGS:

Corrosion-resistant coatings for magnesium may be divided into three classifications:

1. Inorganic.
2. Organic.
3. Combinations of inorganic and organic.

Inorganic Coatings

Inorganic coatings (chromates, phosphates, manganates, fluorides, etc.) applied by ordinary chemical dipping methods have been investigated in a considerable number of laboratories. A few of them, such as the chrome pickle and the #7 treatment of the Dow Chemical Co., have proven to be useful on a large production scale.

Selenium coatings, in the past, have not been particularly successful. However, results obtained in these Laboratories (working in co-operation with an industrial firm which produces selenium as a by-product) are definitely encouraging. Probably earlier investigators did not pay sufficient attention to pre-treatment of the surface prior to the actual coating process. It is hoped that selenium coatings will prove to be as good as or better than other inorganic coatings for many purposes. Selenium should be an unusually good protective material in view of its low electrical conductivity and its inactivity when in contact with dilute acids and alkalies as well as neutral solutions. There are definite indications that selenium is poisonous to small organisms which cause fouling and corrosion, especially in the tropics.

Protective coatings can be produced in alkaline solution, using considerable pressure in an autoclave. These probably are superior to most of the ordinary chemical treatments used at present, especially for abrasion resistance.

Electrolytic coatings have been developed which show



(Types of Corrosion-Resistant Coatings, cont'd) -

a great deal of promise. Possibly the three outstanding processes are:

- (1) Waterman process, owned by the Turco Products, Inc.
- (2) Consolidated Vultee Aircraft process.
- (3) Caustic soda process, recommended by the American Magnesium Corporation.

The first two of these processes apparently are not available to the general public at present. The Turco people write:

"At the present time we have proceedings under way for proper protection in Canada. We have licensing agreements in this country whereby interested parties may undertake pilot scale installations of our process. The process cannot be demonstrated in a small way in the laboratory and only a pilot installation, involving some expense, will yield useful results. . . . As our laboratory equipment is now dismantled we are unable to turn out coated samples for testing."

This situation is unfortunate because, according to Dr. Waterman, his coating is equivalent to the Dow #7 coating plus a single coat of paint primer.

The Vultee people write:

"At the present time we are negotiating with a nationally known organization to handle the licensing and servicing of the process. Therefore, we are temporarily unable to furnish you full information relative to your request. . . . For your information, two patent applications are on file covering this process."

Tests are under way at present in these Laboratories with a view to evaluating the caustic soda process recommended by the American Magnesium Corporation.

#### Organic Coatings

A process for coating magnesium with rubber has been developed and is available at the present time. In conference with the owner of this process the following claims were brought



(Types of Corrosion-Resistant Coatings, cont'd) --

out:

1. A rubber coating of any thickness can be produced. It can be made as thin as a film of paint if desired.
2. The coating gives perfect corrosion protection to metal articles exposed to any climate.
3. The coating gives excellent resistance to abrasion.
4. The coating adheres unusually well to the metal.
5. Any one of over eighty colours can be used for the coating.
6. The coating material can be applied to aluminium and steel as readily and as satisfactorily as to magnesium.
7. Two spray coats of the material are recommended to give the desired corrosion- and abrasion-resisting properties.
8. The cost of the coating in production quantities is approximately the same as that of a good industrial paint. In smaller experimental batches the cost, naturally, is considerably higher.

The application of ordinary paint directly to the magnesium surface is not recommended.

Combination of Inorganic and Organic Coatings

In applying a paint coating to magnesium it is considered best practice to apply an inorganic coating first. Such treatments as chrome pickling and the #7 treatment of the Dow Chemical Co. have been used to a considerable extent. However, coatings produced electrolytically or by the pressure process are considered to be definitely superior to these.

Over the inorganic coating it is preferable to apply first a thin coat of specially formulated zinc chromate primer, then follow this with one or, preferably, two top coats which



(Types of Corrosion-Resistant Coatings, cont'd) -

have been formulated to meet the desired service conditions. For instance, a top coat recommended for indoor service should be used indoors only. It would be quite unsatisfactory if used out-of-doors. It has been found that a considerable number of Canadian paint firms are not in a position to furnish the special materials necessary for painting magnesium.

It should be emphasized that, although much has been accomplished, the final answer to the proper protection of magnesium has not been attained as yet. Another point to be considered is the fact that materials required for some of the better protective coatings are not available at the present time, due to wartime shortage. For these two reasons any recommendation made at the present time regarding the most satisfactory coatings for magnesium is entirely tentative and probably will require revision in the near future.

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Recommendations:

On the basis of the above information it is anticipated that:

- (1) Rubber coatings would be the most satisfactory with regard to corrosion and abrasion resistance and adhesion. Coloured rubber coatings would have considerable value from the point of view of appearance.
- (2) The best painting procedure would involve the application of
  - (a) An inorganic coating produced by an electrolytic or pressure method;
  - (b) A specially formulated zinc chromate primer; and
  - (c) Two top coats suitable for the required service conditions.

It is anticipated that much more information will be available



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(Recommendations, cont'd) -

at the conclusion of the experimental work which is now  
under way in these Laboratories.

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