# ENCLOSURE (B) 14

# STUDIES ON THE CORROSIVE PROPERTIES OF ALCOHOL FUELS

by

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SUMMARY

The traces of copper-ion and chlorine-ion in ethanol definitely possess corrosive properties and the corrosion seems to be accelerated by the co-operative reaction of copper-ion and chlorine-ion.

## I. INTRODUCTION

The aliphatic alcohols are much more corrosive to the metals commonly employed in automobile construction than normal hydrocarbon fuels and much trouble has occurred. The trouble most generally encountered was the corrosion of brass and aluminum in carburetors, due to the ready attack of the aluminium by alcohol.

## II. DETAILED DESCRIPTION

The ethanol, which attacked the aluminium metal violently, was distilled into two separate parts. The distillate (pure alcohol) did not attack the aluminium metal at all, but the residue part attacked the aluminium metal violently. When the residue part was analyzed by means of chemical and spectroscopic methods, NaCl, Fe, Pb, Mg, Ca, Br and gasoline, etc., were found to be present. Of these impurities, chlorine-ions and copper-ions were found by laboratory test to be the active components of the corrosive substance in ethanol.

The test conditions were as follows:

Test piece.....aluminium metal (1cm x 5cm)
Test temperature.....50°C
Tested time.....24 hrs.

The aluminium test piece was immersed in ethanol at a temperature of 50°C maintained by means of thermostat for 24 hrs. The appearance of the attacked test piece was of two types: one state consisted of pin-hole black spots on the surface of the test piece; the other, a gelatinous substance which covered the surface of the test piece. We found that former was caused by the copper-ion, the latter by the chlorine-ion.

Accordingly, it was possible to evaluate the corrosion visually.

The copper-ion or the chlorine-ion alone is not markedly corrosive when present in ethanol. For example, even when one of these classes of ion exists (0.02 mg per liter of ethanol), corrosion scarcely appears. When ethanol contains both ions, the corrosive action of ethanol becomes very noticeable.

It would be deduced from these experiments that the maximum allowable content of copper-ion is 0.02 mg, and chlorine-ion is 1 mg per liter of ethanol, when aluminium metal contacts both.

In the case of alloy of aluminum and copper, because it contains copper-metal, the alloy is attacked by ethanol containing the chlorine-ion only, but unattacked when copper-ion only exists.

## III. CONCLUSIONS

The maximum allowable content of copper-ion is 0.02 mg and chlorine-ion is one mg per liter of ethanol, if the corrosion of aluminium metal by ethanol is to be prevented.

This problem occurred when the chlorine-ion was mixed in ethanol that had been transported by a ship-tank which previously transported gasoline, and its bottom was filled with sea-water. The copper-ion in ethanol entered when the ethanol was distilled by copper column on a commercial scale. As the anti-corrosion dope of such ethanol, it is supposed that aliphatic amines may be suitable for the copper-ion, because these form the complex salt of copper and amines.

To prevent trouble from the chlorine-ion in transporting at sea, only clean drums, but not ship tanks, should be used.