CORROSION INHIBITION
OF
WATER COOLING SYSTEM
IN INDUSTRY

A THESIS

Submitted by

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(M. Sc)

National Research Centre

For The Degree of

DOCTOR OF PHILOSOPHY

IN

PHYSICAL CHEMISTRY

TO

Faculty of Science

Ain Shams University

Cairo

1993

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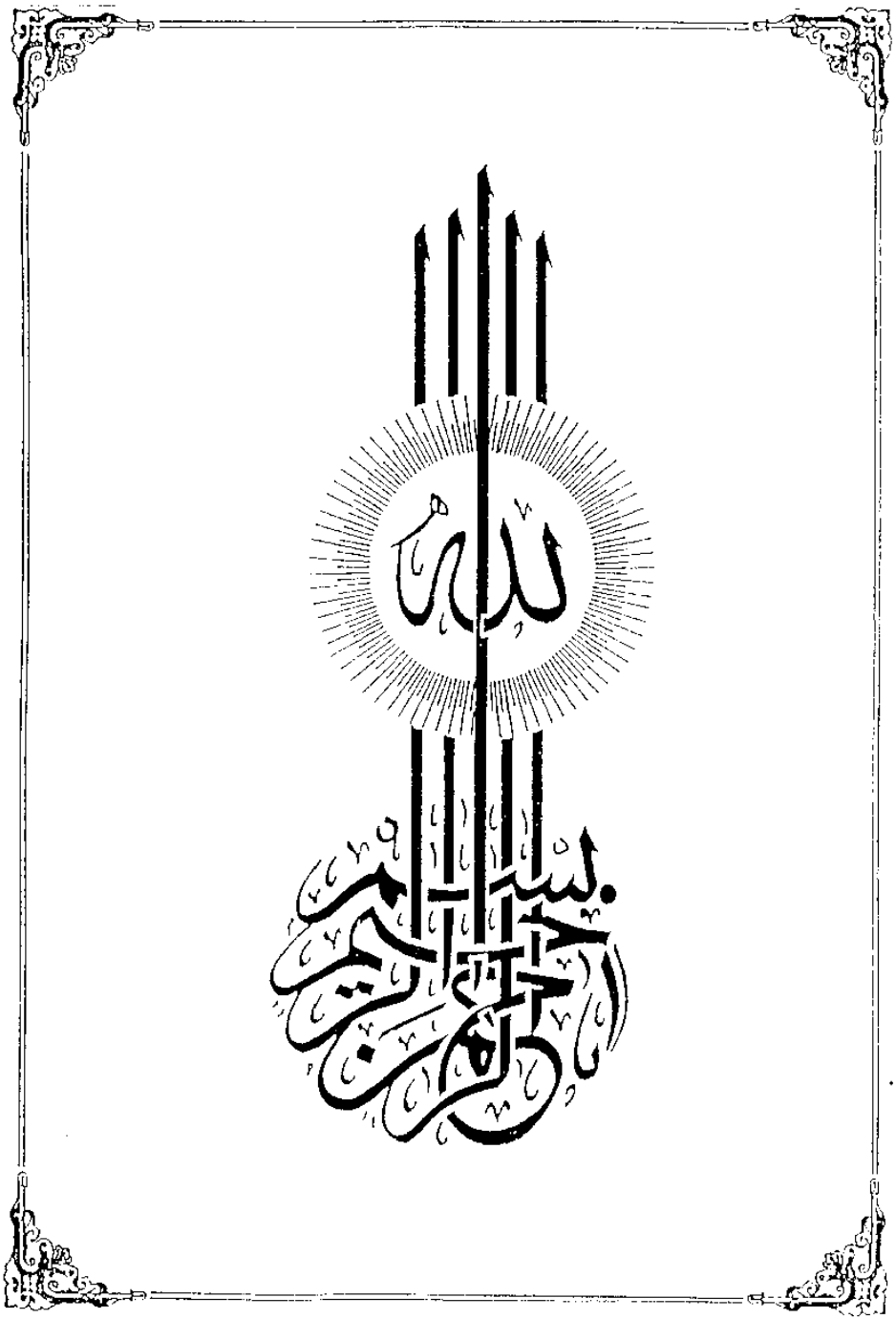

ACKNOWLEDGEMENT

The author wishes to express his deep gratitude to **Prof. Dr. S. S. Abd El Rehim**, Professor of Physical Chemistry, Ain Shams University for his interest in the work and for his encourgement.

The work presented in this thesis was suggested to the author by **Prof. Dr. A. A. El Hosary**, Research Professor of Physical Chemistry, National Research Centre. It is the pleasant task of the author to acknowledge his guidance, help and criticism.

The author wishes also to thank Abu Zaable fertilizer Co. for all facilities, provided during the evaluation tests in the pilot cooling tower.

ABSTRACT

The problems of corrosion and inhibition of water cooling systems in industry has attracted the interest of several workers all over the world.

The present study consists of the following five chapters :

I. A literature survey is given on the corrosion of water cooling systems in chapter I. The survey includes some factors affecting both the corrosion and corrosion inhibition processes in the cooling systems, like, water composition, dissolved gases, water velocity and temperature.
The kinetics and mechanisms of the corrosion of iron, as the constituent of major important in all cooling systems in different industries, have been reviewed. This chapter includes also the types of corrosion inhibitors and a brief idea about the important and widely used inhibitors for cooling water systems.

II. The experimental techniques used in this study are given in Chapter II. Weight loss, galvanostatic and potentiostatic anodic polarization were performed with coupons and electrodes of commercial mild steel. Measurements were carried out in tap water which is simulating same water used in the majority of cooling systems. The following thirteen inorganic and organic inhibitors were investigated : Orthophosphate, tripolyphosphate, hexametaphosphate, 3 zinc salts, molybdate,

aluminate, benzotriazole, benzoate, 2 gluconate salts and glycerophosphate. All solutions are prepared from laboratory pure grade chemicals.

III. In chapter III, the thirteen single inhibitors were examined. On the basis of the results of weight loss and galvanostatic polarization, the inhibitors could be devided into four groups :

- **Highly effective** : molybdate and orthophosphate.
- **Moderately effective** : aluminate.
- **Weak inhibitors** : zinc salts, benzoate, BTA and glycerophosphate.
- **Accelerators** : polyphosphates and gluconates.

IV. In chapter IV, binary mixtures have been tested. From the different binary mixtures examined, only three molybdate - base binary mixtures gave good inhibition action. These binary mixtures are : molybdate-orthophosphate, molybdate-gluconate and molybdate-glycerophosphate.

V. On the basis of the results of chapter IV, three formulations have been prepared by adding some additives on the above mentioned most effective binary mixtures. These formulations have been evaluated in the laboratory in stagnant as well as in flowing solutions, at room temperature and at 40 °C. The effect of increasing the chloride content in the water has been also tested. The results showed a good inhibition action. Values of inhibition efficiency ranging from 80 - 100 % could

be obtained.

The effect of addition of antiscalant on the performance of the three formulations has been tested. The results indicate that, the addition of the scale retardant slightly decreases the corrosion inhibition.

The second part of this chapter includes the results of evaluation of the three formulations in a pilot cooling tower in Abu Zaable Fertilizer Co.

The corrosion rates were monitored by weight loss using coupons inserted in coupons holder and by electrochemical method using Corrater systems model RCS 9000. The corrosion rates could be reduced from 62.54 mpy in absence of the programs to 4.25, 8.02 and 5.19 mpy in the presence of the three programs. The corresponding inhibition efficiency amounts 93.2, 87.2 and 91.9%. Also the scale inhibition of the programs in the pilot were inspected by three different methods :

- Following the difference between inlet and outlet temperatures (ΔT) °C.
- Water analysis for the hardness and Ca^{++} ion before and after the condensers.
- Visual inspection for the heat transfer pipes to observe their features after every test period and photographed.

All the three methods supported each other and indicated that, there was no scale or preciptants inside the pipes.

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