INTRODUCTION

This book has been written as a contribution to changing the attitude of mind when considering problems in industrial water systems. The need for such a change has been brought about by changes in prevailing economic conditions.

Industrial systems using water for heating or cooling purposes frequently encounter problems which are associated with the quality of water used. In former times, when both labour and materials were cheap, it was a relatively simple matter to discard a system that had encountered problems and build a new one designed in the light of the experience gained from an old system: in this way it was hoped to avoid the difficulties previously experienced.

If discarding the system was not considered necessary, some form of chemical treatment and monitoring might be introduced. If this was not entirely satisfactory then, with cheap labour available, it was, again, a relatively simple matter to arrange for periodic manual cleaning of the system to make good the deficiencies of the treatment. In fact some operators used to boast of the quantity of deposit removed during such manual cleaning operations. As though it was a matter of pride, instead of a reflection on the manner in which the system had been controlled and operated.

But under present day ecomomic conditions such a leisurely approach is no longer feasible. In the design and operation of industrial water systems it is important to know in advance what problems are likely to be encountered, and to be able to give a forecast in quantitative terms.

For one type of system, the steaming boiler, the problem is not too difficult. For example, a boiler feed water contains *X* mg/1 of hardness salts: since all the water entering the boiler is evaporated as steam, all the hardness salts must remain behind to form scale. Therefore *X* mg of scale will be formed for each litre of water evaporated. Expressing the problem in quantitative terms is therefore a matter of simple arithmetic. For this reason steaming boilers have been excluded from the discussions in this book.

But for systems involving heat-exchangers (whether for heating or cooling) a more complex situation exists, depending on the chemical reactions taking place in the water at various temperatures. The study in this book has been restricted to heat exchange systems where there is no loss of water by evaporation, or other means, unless specifically mentioned in special cases. It is also assumed that there is no change in the chemical characteristics of the water by accidental ingress of contaminants, or by the loss of dissolved gases by venting to atmosphere, unless addition of chemicals or loss of gases are specifically mentioned in special cases. Changes in the chemical characteristics of the water are limited to those induced by a change of temperature.

The problems most likely to be encountered in the types of systems outlined above are fouling and corrosion. Fouling is caused by:

Deposition of calcium carbonate.
Deposition of calcium sulphate.
Deposition of calcium phosphate.

These are studied by physical-chemistry methods.

It is appreciated that some fouling may occur by the formation of organic slimes, which may act as binders for the inorganic deposits mentioned above. But organic slimes have been excluded from the discussion as their formation is not amenable to physical-chemistry methods.

The metals of construction most likely to be used in industrial water systems are mild steel and copper: their rates of corrosion have therefore been included in the discussion. Other metals may be used from time to time, but mild steel and copper are regarded as basic: other (often more expensive) metals are introduced when justified on technical and economic grounds by the operating conditions existing in an individual system.

Manufacturers of special alloys are sometimes able to indicate how the rate of corrosion of their materials compare with mild steel or copper under given operating conditions. Thus, a knowledge of the probable rate of corrosion of the basic metals can be of assistance in selecting special alloys.

The purpose of the data offered in this book is to enable quantitative forecasts to be made of the fouling or corrosion likely to be encountered in an industrial water system, while the project is still at the design stage. A decision can then be made on the type of water treatment to be adopted, commensurated with the purpose for which the system is to be used, and its life expectancy.

A discussion on the various types of water treatment that might be considered is beyond the terms of reference of this book. It is a diagnostic tool utilising the basic physical-chemistry of water supplies. Water treatment methods may change from time to time, but the basic physical-chemistry remains unchanged.

However, a forecast of probable operating problems may be used to influence the choice of a water supply, if several alternatives are available on any given site.

In the case of a small project, or one handling a low grade product, a forecast of problems as outlined in this book may suffice. But for a large project, or one handling a sophisticated and expensive product, a trial run on a scale model may be undertaken before final design details are settled. In such a case an initial forecast of the problems will enable the trial run to focus on the most critical conditions likely to be encountered.

In addition, to work at the design stage of a project, the methods described in this book may be used to assist operators in investigating problems on an existing system. As this often involves working with portable testing equipment, the data are presented in the form of tables to facilitate site work.