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PAPER 7

# APPROACHES TO CORROSION AWARENESS

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## 1. INTRODUCTION

Living in New Zealand, we perhaps feel out of the mainstream of world science and technology. In the corrosion scene, though, we are most definitely not. We have an infant petrochemical industry and an aluminium smelter, with plants built in areas with very high levels of sea-salt fallout by world standards, so bringing all the atmosphere corrosion possibilities as well as the corrosion within the actual process plant. We have a major tourist centre, with reliability of services and structures needed if world-wise tourists are to leave satisfied, built in a geothermal zone where corrosion is rampant. We have built our major population centres in all the appropriate places to enhance atmospheric corrosion: Christchurch in a valley where the pollution doesn't blow away, and Auckland, Wellington and Dunedin (to a lesser extent) where sea-salt is regularly blown in by prevailing strong winds. We rely on the agriculture and horticulture industries to earn our overseas funds, yet these industries are possibly capable of saving a considerable part of the costs by avoiding corrosion.

This paper considers ways that New Zealand can tap into overseas sources of information in our corrosion work, and some strategies we might adopt in future. We have to tread a fine line; it is important not to waste the small allocation of the nation's resources given for corrosion investigation by repeating overseas discoveries and "reinventing the wheel;" but it is also important that the corrosion problems that are of special importance to New Zealand are counteracted by methods suitable for New Zealand, rather than imported simply because an "overseas expert" said we should.

## 2. CORROSION IN AGRICULTURE

The example used of corrosion in agriculture is a good one to follow through in a little more detail. It brings out many of the worst problems involved in reduction of corrosion problems because:

(a) There were 71505 farms in New Zealand at 30.6.80, and it will be impossible for corrosion advisers to make a personal inspection of every farm.

(b) There are a lot of ingrained attitudes in the agriculture sector, along the lines of "Fertiliser storage sheds always corrode, so there's no point in my trying to stop it." Farmers have been suggested to take much more notice of their "intimates" than of expert advisers (Phillips, 1982).

(c) There are positive tax advantages in having buildings and equipment corrode away, since maintenance tends to be tax deductible and initial capital expense (which is likely to he higher for better corrosion protection) is generally not.

(d) New chemicals are continually introduced for improvement of productivity, whether to kill pests, or fertilise, or provide better storage properties for produce, with the farmer often not made fully aware of any positive or negative side effects on materials degradation before he puts the chemical into service.

Yet overseas studies have shown that:

(a) In the UK in 1980, the cost of corrosion in these industries alone was greater than NZ$10^9$.

(b) In the USA in 1975, the direct cost of corrosion to the agriculture sector was about 2.3% of its total input costs, and 58% of this was calculated to be avoidable using known methods.

(c) In Sweden in 1968, 50% of the cost of corrosion in agriculture was calculated to be avoidable.

It is at this point that we must sit back and take stock. Corrosion is obviously a big problem in agriculture in these overseas countries, and so it is probably an important cost in New Zealand, too. But (especially in the UK) farming is a much more intensive industry in these countries, with a lot of housing of animals and a lot of chemicals used as feed additives and preservatives, which isn't as common in New Zealand. Yet again, glass house culture is similar in both the UK and New Zealand, and the UK doesn't have problems with kiwifruit support fence durability which New Zealand might yet face. There is every reason, then, to expect on balance that corrosion is a big problem in both buildings and equipment in the farm-based industries in New Zealand. BRANZ and DSIR Chemistry Division set up a joint project to look at this subject in late 1982.

This sets the scene to examine several avenues of acquisition of corrosion awareness:

What produced the awareness that such a problem existed overseas?
How was the extent of the overseas problem elaborated?
How was the extension to New Zealand conditions undertaken?

## 3. INTERNATIONAL MEETINGS

The concept that a study of the impact of corrosion in the agricultural sector in New Zealand was an urgent need was contained in my report as New Zealand delegate from the International Corrosion Council meeting in 1981. The Council is comprised of two delegates from each of 40 countries, and meets triennally to discuss means of mutual assistance in corrosion research and promotion of corrosion awareness. At the International Congress on Metallic Corrosion held at the same time as the 1981 Council meeting in Mainz, a paper on corrosion in UK agriculture was presented by a group from the University of Manchester Institute of Science and Technology (UMIST) (Fowler et al, 1981). The Agriculture

Research Council had sponsored this investigation, and severe costs were found to be accruing due to corrosion problems. When I reported back to the ACA New Zealand Branch (who nominate the two New Zealand delegates) I therefore made this a major discussion point, in view of the importance of agriculture to the New Zealand economy. The early indications of this problem area thus came because New Zealand had someone at the conference who could follow up by discussion with the overseas workers on how they had devised their study.

The International Congresses are the biggest truly international corrosion conferences; the last three have been held in, respectively, Sydney in 1975, Rio de Janeiro in 1978, and Mainz in 1981, and each has drawn a high fraction of the presented papers from corrosion workers from outside the host country. Other important conferences are held annually in North America by the National Association of Corrosion Science and Technology and in UK by the Institution of Corrosion Science and Technology. Groups such as these, and the American Society for Testing and Materials and the European Corrosion Federation, also organise "special interest" meetings at irregular intervals on aspects of corrosion. Though most of these meetings eventually have published proceedings, such publications rarely capture all of the discussion or the special nuances that can be gathered by personal attendance. It is in New Zealand's interest that opportunities become available for attendance at them – and then critically important that those able to attend ensure that there is good distribution of the information that they collect.

On the Australasian scene, ACA organises an Annual Conference, with the venue moving around the branches. This tends to be a large regional meeting; in 1982 in Tasmania it attracted only 6 delegates from outside Australia among the 170 who attended. Nonetheless, it provides a forum for discussion of ideas. In 1983 it will be held in Sydney; in 1984, in Rotorua.

## 4. CORROSION JOURNALS AND TEXTBOOKS

New Zealand is fairly well served by its libraries in keeping up subscriptions to corrosion journals. Table 1 shows libraries listed in 1981 as holding current subscriptions to three major corrosion journals. Some libraries, especially the first four in Table 1, have built up good collections of corrosion-oriented textbooks. It is pointless to try to list here the range of books and journals available; there are comprehensive lists of journals, books, conference proceedings and films which were available in 1977 in the Corrosion Prevention Directory (Department of Industry, 1978). The ACA Corrosion collection is housed in the library of Auckland Industrial Development Division of DSIR, and enquiries there may locate otherwise unavailable material, especially for proceedings of corrosion conferences. ACA members receive each month a Current Awareness Bulletin listing recently published material.

When it is necessary to locate information on a specific example, however, it is not sufficient simply to know that books and journals are available. It is necessary to know preceisely where to look, and under these conditions computer-searchable data banks come into their own. The subject of retrieval of corrosion information was excellently reviewed in 1981 (Mattson, 1981), and it is not worthwhile to repeat that information here. There are now the necessary telecommunication links for New Zealand libraries to search data bases world wide, which means that the average New Zealand corrosion worker has the same access to information published anywhere as workers in any other country.

The first step in the search for information on potential corrosion problems in agriculture was therefore a computer search (using the "profile" shown in Table 2) of the Engineering Index file using the DIALOG Information Retrieval Service in California. This took about 60 minutes "on-line" and turned up 151 references; it is reasonable to assume that these are virtually *all* the references in the corrosion in agriculture field noted in this abstracting base from 1969 to late 1982. A manual search would take many hours to perform this task: a preliminary search of the Agricultural Engineering Index had uncovered only a handful of papers after half a day's search. In contrast, for the computer search, the total computer and telephone link charges were less than $160, and needed about 3 man-hours in total to plan and later analyse, so that this is a very cost-effective and fast means of searching for information. There is considerable skill in writing the profile; the one in Table 2 is very general, and collected some peripheral references, but it is possible to screen out unwanted subjects (and hence reduce the cost even further) by appropriate tricks in the profile writing. There is an obvious corollary here, also, that if a researcher is to have the value of his work maximised he should aim to publish it in a location which will be noted on the computer-held reference banks, since it is quite possible that within a few years computer searches for relevant references will have outmoded the traditional manual library search.

From the references found it was possible to capitalise on overseas experience, especially in the fields of use of plastics to replace metals, and the corrosive effects of fertilisers. New Zealand has, until the recent commissioning of an ammonia-urea plant, used relatively little nitrogenous fertiliser, relying instead on nitrogen fixation by legumes whose growth is promoted by phosphate fertilisers. If these overseas reports are applicable to NZ, and there is little reason to expect they are not, then urea and other nitrogenous fertiliser is going to pose a lot of new corrosion problems to concrete and steel on farms.

## 5. DISSEMINATION OF INFORMATION

This subject has been placed under considerable focus by the International Corrosion Council in recent times, and a working group of the Council is presently assessing the ways that corrosion awareness is handled in different countries. At the Mainz Congress there was a considerable part of the programme devoted to Corrosion education and Corrosion awareness. Some of the major points to emerge were:

(a) Effective communication is all-important, and "information multipliers" such as University or training college lecturers and editorial staff of journals should be prime targets. If information is supplied in suitable form to these people, even if they do not use it directly themselves, they should be better attuned to ideas which might later be advanced in the corrosion field. In our present exercise on corrosion in agriculture, an important "information multiplier" group are Farm Advisory Officers.

(b) Protection against corrosion can be induced either by consumer demand or "big stick" push. An example of the latter is in using Standards Association committees to ensure that products reaching the market have a sensible degree of built-in corrosion prevention.

(c) A study by the Institution of Corrosion Science and Technology in the UK across a range of industries showed a big variation in availability and use of training facilities. The gas and electricity authorities in the UK seem to know far more about the corrosion problems likely to occur in the equip-

ment they have than do the manufacturers of it, and similarly farmers in the UK know more about corrosion than suppliers of their machinery and equipment.

(d) The sophistication of corrosion awareness varies between industries, and between countries within an industry. In Egypt and the USA, the costs of corrosion as a percentage of input cost in their oil refining industries are about equivalent (perhaps reflecting the multinational nature of this industry) but the Egyptian food canning industry loses proportionately eight times as much as the USA due to corrosion.

This latter point is a strong reason for a survey of farmers' awareness of corrosion problems and an assessment of the cost of corrosion in New Zealand's farm sector, to see how it compares with the very high figures quoted for the UK and the USA. It is hoped that a final outcome of the present BRANZ/DSIR joint project will be a demonstration of the need for such a survey. The strategy for disseminating information in this project is two-pronged; firstly as noted earlier, to provide as much backup information as possible to advisory service staffs, and secondly to provide a series of 1000-1200 word illustrated articles on aspects of corrosion in the farm sector for publication later in 1983, aimed at introducing the farmer to the concept that corrosion is not totally preventable, but that careful materials selection and sensible anti-corrosion practices can help him to achieve a better return on his capital investment. These approaches approximately parallel those used after the UK study. A booklet "Corrosion in agriculture" in the series "Guides to Practice in Corrosion Control" has been published by the UK Department of Industry (DOI), and some farm advisory service leaflets are planned.

## 6. SOME CORROSION ADVISORY SERVICES IN EUROPE

Mention was made in the previous paragraph of a DOI series of booklets in the corrosion field. The titles of these are listed in Table 3, and they form, in my view, the most valuable English-language tool available to the corrosion advisory worker now in print.

The UK Government, as a result of the Hoar Report in 1971 on the cost of corrosion to the UK economy, took an active role in promoting corrosion awareness and established the National Corrosion Service in South London and the Corrosion and Protection Centre attached to the University of Manchester Institute of Science and Technology (UMIST), in the early 1970's. These bodies are now largely self-financing, the NCS in providing advice to industry under contract and CAPCIS funding itself by attracting research contracts (and also performing some contract advice) from companies and government agencies both within UK and overseas. The Government's contribution to funding has therefore been markedly reduced (Elliott, 1982).

Similar government initiatives led to establishment of corrosion centres in other countries. While the UK might be argued in population terms to be massively larger than New Zealand and so not a suitable model, Denmark, with a population of around 5.1 million, is much closer to New Zealand's size yet has a dedicated corrosion centre unlike anything in New Zealand. Korrosionscentralen was founded in 1964 and by 1975 it had a staff of 28, and generated about 65% of its income from consulting and laboratory work, including research contracts. The remainder came from central government funds,

some of it for specific research contracts (Arup 1976). This corrosion centre serves the whole Danish economy, and provides corrosion failure investigation services, consultation on selection of materials and methods of their protection, and training and teaching in corrosion fields, among other services. It provides, in short, a focus and a coordination for corrosion awareness activities in Denmark in a way which we do not see in New Zealand at present, despite the efforts of ACA, DSIR, and other bodies. Is Denmark a model for New Zealand to follow?

## REFERENCES


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## TABLE 1

**Availability of some major corrosion journals in New Zealand Libraries (based on National Library Finding List, 1981).**

| | Materials Performance | British Corrosion Journal | Corrosion Science |
|---|---|---|---|
| A.I.D.D. | ✓ | ✓ | ✓ |
| Engineering School Auckland University | ✓ | ✓ | ✓ |
| Engineering School Canterbury University | ✓ | ✓ | ✓ |
| Chemistry Division, DSIR, Wellington | ✓ | ✓ | ✓ |
| Dockyard, Auckland | ✓ | | |
| MWD, Wellington | ✓ | ✓ | |
| BRANZ, Wellington | ✓ | | |
| N.Z. Post Office, Wellington | ✓ | | |
| DSIR Soil Bureau, Wellington | ✓ | | |
| C.I.D.D. | | ✓ | |

Note: Not all these libraries have unbroken holdings reaching back to Volume 1.

## TABLE 2

### Computer Literature Search Profile : Corrosion/Agriculture

| | | Entries Found | Print-outs |
|---|---|---|---|
| 1. CORRO? | : | 23506 | |
| 2. FENC? | : | 300 | |
| 3. SILO? | : | 1000 | |
| 4. GREENHOUS? | : | 649 | |
| 1 AND (2 OR 3 OR 4) | : | 19 | 19 |
| 5. INSECTIC? | : | 717 | |
| 6. PESTIC? | : | 1216 | |
| 7. HERBIC? | : | 473 | |
| 8. FERTILI? | : | 1713 | |
| 9. MANUF? | : | 49966 | |
| 1 AND 8 NOT 9 | : | 36 | 36 |
| 1 AND (5 OR 6 OR 7) NOT 9 | : | 15 | 15 |
| 10. AGRICULTUR? | : | 7700 | |
| 11. TRACTOR? | : | 1339 | |
| 12. ORCHARD? | : | 194 | |
| 13. DAIR? | : | 633 | |
| 1 AND (10 OR 11 OR 12 OR 13) | : | 49 | 49 |
| 14. SEWAGE? | : | 7625 | |
| 15. WATER? | : | 93833 | |
| 16. IRRIGAT? | : | 2860 | |
| 17. FARM? | : | 2900 | |
| 1 AND (14 OR 15 OR 16) AND 17 | : | 11 | 11 |
| 1 AND 17 | : | 32 | 21 (11 caught, previous line) TOTAL 151 |

## TABLE 3

**Titles in Corrosion Awareness Series**
**Published by UK Department of Industry**

CONTROLLING CORROSION

1. Methods.
2. Advisory services.
3. Economics.
4. Standards and specifications.
5. Case studies on corrosion.
6. Monitoring.

GUIDES TO PRACTICE IN CORROSION CONTROL

1. Souces of corrosion information.
2. Corrosion of metals by wood.
3. Packaging for handling and transport of coated goods in the construction industry.
4. Stress corrosion.
5. The handling and storage of coated and wrapped steel pipes.
6. Temporary protection.
7. The corrosion of steel, and its monitoring, in concrete.
8. Corrosion factors in pumps and valves.
9. Cathodic protection.
10. Corrosion control for buried pipelines.
11. Avoidance of corrosion during chemical cleaning of plant.
12. Paint for the protection of structural steelwork.
13. Surface preparation for painting.
14. Bimetallic corrosion.
15. Corrosion in agriculture.