6 Preservation of agrochemicals

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6.1 Introduction

Agrochemical products have been used widely for many years to increase the yield and improve the quality of food and fibre crops all over the world. The agrochemical industry has become a major business producing products with a total world sales value estimated in 1993 at about US$25 billion, and it plays an important part in the economies of most countries. The agrochemical business represents a significant opportunity for surfactants and other essential formulation additives and adjuvants in spray applications. Although the agrochemical industry has reached maturity in North America, Western Europe and Japan, there is still considerable scope for new more environmentally friendly formulations. Developing areas, especially the Asia-Pacific region, will show increasing need for agrochemical products.

Changes in the population of the world and increasing urbanisation and industrialisation of communities are placing a great demand on the efficient use of available land for agriculture. For example, the United Nations have forecasted that if present trends continue, the population of the world will increase from about 5 billion now to about 10 billion by the year 2040, and the fastest rate of growth will be in the less developed areas, particularly the Asia-Pacific region.¹ There will, therefore, be an increasing need for agrochemical products as an important input in the management of food and fibre crops to improve their yield and quality.

The ability to protect growing crops from weeds, pests and diseases has been known since ancient times in the Old World of the Middle East, Asia and China. However, the greatest improvements in crop protection efficiency and productivity in terms of crop yield and quality have occurred mainly in the West and within the last century. Simple emulsifiable oils and soaps have been used as agricultural sprays for many years. The modern era of weed control can be said to have started in the 1940s with the development of the phenoxy acid herbicides such as 2,4-D acid. Since the Second World War, particularly in the 1960s, 1970s and 1980s, many new synthetic pesticides have been introduced to combat a very wide range of weeds, pests and diseases. A great deal of research and development has been carried out by all the major agrochemical companies to produce
formulations which can be applied easily to crops and which will optimise the activity of the pesticide.\textsuperscript{2}

Although the last few decades have seen remarkable development in new agrochemical active ingredients and formulations, most companies are now reviewing their product strategies and government regulatory authorities are introducing controls and legislation which are leading to the introduction of safer and more environmentally friendly active ingredients and formulations. There is also a need to reduce the total amount of active ingredients applied per hectare. The increasingly high cost of the development of new products is causing the industry to consolidate by mergers of companies or joint ventures between companies.

The wide variety of agrochemical formulations which is available requires a range of different formulation additives to produce safe and usable products. Two of the most important formulation additives are surface active agents, or surfactants, and preservatives. Surfactants have been obtained from natural products by extraction or modification for thousands of years. Many examples of surfactants are well known, like soaps for cleaning, greases and tallow for waterproofing and glue, egg white and natural gums as dispersing and emulsifying agents.

Synthetic surfactants, which have been specially synthesised in order to obtain surface active effects, represent a relatively modern development which may be said to have evolved from the ‘sulphonated oils’ of the last century. The period between the two World Wars was a very active phase in the development of sulphated and sulphonated anionic surfactants with long hydrocarbon chains.

Since the Second World War, the development of surfactants entered a more specialised phase with the introduction of amphipathic molecules for specific applications. Non-ionic surfactants became available in which the hydrophilic part of the molecule was based on condensed chains of ethylene oxide. A wide range of surfactant properties can be achieved by varying the ethylene oxide chain length. This development has led to a better understanding of the colloid and surface chemistry principles involved in the fundamental functional properties of wetting, dispersing, emulsification and solubilisation in the formulation of pesticides. As a result of all this work, it is now possible for surfactant suppliers to prepare ‘tailor-made’ surfactants to suit particular functions.\textsuperscript{3–5}

For nearly all formulations the most important formulation additive is the surfactant in terms of preparation and production. The surfactant often determines the maximum concentration of the formulation that can be achieved, the particle or droplet size, long term stability and sometimes even the biological activity of the formulation.

Preservatives are also an important additive to formulations to prevent biodegradation during preparation and storage, particularly where the formulations are aqueous based and contain carbohydrates, or where the