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# Conclusions

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A crusade is ongoing against element 17 in the periodic table, i.e. chlorine, one of the most abundant on earth. It is blamed, amongst other things, to be responsible for the depletion of the ozone layer, bioaccumulation of chlorinated compounds such as DDT or PCBs in animals and for the formation of dioxins in urban waste incineration.

Due to socio-economic implications the issue has gone too early beyond the borders of the scientific community, before facts have been proven and evaluated. As a result, it has been treated in inappropriate and emotional ways even affecting scientific ethics in some cases.

Therefore, the International Union of Pure and Applied Chemistry (IUPAC), conscious of its responsibilities in this area, has decided to publish this White Book with the collaboration of outstanding worldwide renowned scientific specialists from North-America, Europe and Japan in order to inform the public and the decision makers as well as the scientific community in an objective, open and unbiased way on the up-to-date scientific knowledge.

In doing so IUPAC is following its philosophy to make independent judgements on important issues that are touchy or sensitive to the general public, governments and industry. IUPAC is not acting as a judge, but would like to evaluate critically the various factors for and against a particular issue.

The occurrence of chlorine in nature and also in living organisms, either as inorganic compounds or as numerous and very diversified natural 'organo-chlorines' does not make any doubt any more (T. GRAEDEL and W.C. KEENE, G.W. GRIBBLE).

The availability of the raw material, salt, the development of convenient production technologies and the chemical properties of chlorine have generated a blooming tree of applications in such different fields as the pulp and paper industry (K. SOLOMON), the disinfection of water (H. GALAL-GORCHEV) but mainly in organic synthesis leading to a host of useful products like, for example, polymers, pharmaceuticals, pesticides, dyes and pigments (J. FAUVARQUE).

It is quite clear that chemists have not always been aware beforehand of all the possible consequences of having manufactured new molecules, be they chlorinated or not. Chemicals emitted voluntarily or inadvertently in the environment are distributed there according to a complex set of physico-chemical properties (J. MIYAMOTO, K. BALLSCHMITER).

Volatile compounds such as aliphatic chlorinated and chlorofluorinated hydrocarbons find their way to the 'atmospheric compartments'. Long-lived members of this family are even able to reach the stratosphere where they have been shown to produce detrimental effects to the global environment (M. MOLINA).

The substitution of these so-called CFCs by new shorter-lived molecules has probably been the best example of a sound scientific approach to solve environmental problems. A host of scientific studies has shown that short-lived chlorinated aliphatic compounds make only minor or even insignificant contributions to environmental problems such as stratospheric ozone depletion, global warming, 'photochemical smog', 'acid rain' or chloride levels in precipitations (H.W. SIDEBOTTOM and J.A. FRANKLIN).

Are organo-chlorines harmless or harmful? The question seems as irrelevant as asking if natural compounds are harmless and anthropogenic ones toxic. Ecotoxicity

(K. BALLSCHMITER) and toxicity (A. HANBERG) as any other 'chemical' property of any compound depends on the structure of its molecule; chlorinated or otherwise halogenated compounds do not escape this rule. Therefore, an undifferentiated ban of whole classes of chemical compounds has to be qualified as unscientific.

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Even in apparently 'homogeneous' families such as the dioxins, toxicity varies considerably with the position and the number of substituents (Ch. RAPPE). There is thus no scientific foundation to the amalgamation of all chlorinated compounds as a group showing special toxic and ecotoxic properties, no more than one should consider organo-oxygens or organo-nitrogens as a whole as harmful because highly toxic warfare agents, such as sarin or tabun, contain these atoms in their molecules.

This obviously does not mean that organo-chlorine waste, as any other sort of waste, has not to be managed. The problem has been tackled and technical solutions have been developed to reduce byproducts formation by improving the production processes, to destroy and/or vaporize the remaining production wastes (R. PAPP). This has now to be generalized in the most economic and environmentally friendly ways. In some cases, post-use recycling is being developed and starts to be generalized as for the recycling of PVC for which 'second life' applications have been found (G. MENGES).

In conclusion, I would like to add a few words formulated by the Nobel laureat Prof. Lord George Porter earlier on. 'There is no way that humans can foresee all the consequences of their actions,...The only sure foundation for security in this technological world is to have a science base which is continually asking whatever questions seem interesting and is always there to advise and to act when the need emerges.'

It is the responsibility of the scientific community to develop this science base, of the media to help them to inform the public in an understandable and unbiased way, of the public authority to take the relevant decisions on the bases of sound science and not on emotional reactions and of industry to act responsibly, endorsing product stewardship and responsible care. This is true for chlorine and its chemistry as well as it is for all human activities.