Environmental Health Criteria 21

CHLORINE AND HYDROGEN CHLORIDE

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World Health Organization

INTERNATIONAL PROGRAMME ON CHEMICAL SAFETY

ENVIRONMENTAL HEALTH CRITERIA 21

CHLORINE AND HYDROGEN CHLORIDE

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Published under the joint sponsorship of
the United Nations Environment Programme,
the International Labour Organisation,
and the World Health Organization

World Health Orgnization
Geneva, 1982

The International Programme on Chemical Safety (IPCS) is a joint venture of the United Nations Environment Programme, the International Labour Organisation, and the World Health Organization. The main objective of the IPCS is to carry out and disseminate evaluations of the effects of chemicals on human health and the quality of the environment. Supporting activities include the development of epidemiological, experimental laboratory, and risk-assessment methods that could produce internationally comparable results, and the development of manpower in the field of toxicology. Other activities carried out by the IPCS include the development of know-how for coping with chemical accidents, coordination of laboratory testing and epidemiological studies, and promotion of research on the mechanisms of the biological action of chemicals.

WHO Library Cataloguing in Publication Data

Chlorine and Hydrogen Chloride.
(Environmental health criteria ; 21)

ISBN 92 4 1540818
ISSN 0250-863X

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ENVIRONMENTAL HEALTH CRITERIA FOR CHLORINE AND HYDROGEN CHLORIDE

NOTE TO READERS OF THE CRITERIA DOCUMENTS

While every effort has been made to present information in the criteria documents as accurately as possible without unduly delaying their publication, mistakes might have occurred and are likely to occur in the future. In the interest of all users of the environmental health criteria documents, readers are kindly requested to communicate any errors found to the Division of Environmental Health, World Health Organization, Geneva, Switzerland, in order that they may be included in corrigenda which will appear in subsequent volumes.

In addition, experts in any particular field dealt with in the criteria documents are kindly requested to make available to the WHO Secretariat any important published information that may have inadvertently been omitted and which may change the evaluation of health risks from exposure to the environmental agent under examination, so that the information may be considered in the event of updating and re-evaluation of the conclusions contained in the criteria documents.

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[a] Also representing the Permanent Commission and International Association on Occupational Health

ENVIRONMENTAL HEALTH CRITERIA FOR CHLORINE AND HYDROGEN CHLORIDE

Further to the recommendations of the Stockholm United Nations Conference on the Human Environment in 1972, and in response to a number of World Health Assembly resolutions (WHA23.60, WHA24.47, WHA25.58, WHA26.68) and the recommendation of the Governing Council of the United Nations Environment Programme (UNEP/GC/10, 3 July 1973), a programme on the integrated assessment of the health effects of environmental pollution was initiated in 1973. The programme, known as the WHO Environmental Health Criteria Programme, has been implemented with the support of the Environment Fund of the United Nations Environment Programme. In 1980, the Environmental Health Criteria Programme was incorporated into the International Programme on Chemical Safety. The result of the Environmental Health Criteria Programme is a series of criteria documents.

A WHO Task Group on Environmental Health Criteria for Chlorine and Hydrogen Chloride met in Geneva from 22 to 26 February 1982. Dr M. Mercier, Manager, International Programme on Chemical Safety, opened the meeting on behalf of the Director-General. The Task Group reviewed and revised the second draft of the criteria document and made an evaluation of the health risks from exposure to chlorine and hydrogen chloride.

The first and second drafts of the criteria document were prepared by Dr R.R. Cook, Dr R.J. Kociba, and Dr R.R. Langer of Dow Chemical USA. The comments on which the second draft was based were received from the national focal points for the WHO Environmental Health Criteria Programme in Australia, Bulgaria, Canada, Czechoslovakia, Federal Republic of Germany, Finland, Greece, India, Italy, Japan, Norway, Poland, Thailand, the United Kingdom, the USA, and the USSR, and from the United Nations Environment Programme, the International Labour Organisation, the International Agency for Research on Cancer, the International

Union of Pure and Applied Chemistry, and the European Council of Chemical Manufacturers' Federations.

The collaboration of these national institutions, international organizations, and WHO collaborating centres is gratefully acknowledged. Without their assistance, this document would not have been completed. The Secretariat wishes, in particular, to thank Dr R.R. Cook for his help in the final scientific editing of the document.

This document is based primarily on original publications listed in the reference section.

Details of the WHO Environmental Health Criteria Programme, including definitions of some of the terms used in the documents, may be found in the general introduction to the Enivronmental Health Criteria Programme, published together with the environmental health criteria document on mercury *(Environmental Health Criteria I - Mercury,* Geneva, World Health Organization, 1976) and now available as a reprint.

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Partial financial support for the development of this criteria document was kindly provided by the Department of Health and Human Services through a contract from the National Institute of Environmental Health Sciences, Research Triangle Park, North Carolina, USA - an IPCS Lead Institution.

1. SUMMARY AND RECOMMENDATIONS FOR FURTHER STUDIES

1.1. Summary

1.1.1. Sampling and analytical methods

A variety of methods are available for collecting and concentrating airborne chlorine and hydrogen chloride, using either liquid or solid absorbents. Analysis is carried out using colorimetric and potentiometric methods. Various modifications of these techniques have resulted in the development of direct reading instruments. However, most of these monitoring methods are cumbersome and non-specific. The choice of analytical procedure depends on the atmosphere to be sampled, the analytical tools available, and the sensitivity and accuracy needed.

1.1.2. Sources and pathways of exposure

The major sources of exposure to chlorine and hydrogen chloride that are of significance for human health are found in industry. Both chlorine and hydrogen chloride are corrosive to most construction materials, as well as tissue, and closed process systems are used to contain the compounds. Exposure mainly occurs as a result of plant malfunction or through accidental releases.

Though gaseous chloride species have been detected in the atmosphere, specific identification has not been possible. Chlorides are natural constituents of fossil fuels, and organochlorides have been added to premium grades of gasoline, but this use has decreased in recent years.

While the main use of chlorine is in the production of chlorinated hydrocarbon solvents and intermediates for polyvinyl chloride and polyglycols, large quantities are also used in the bleaching of pulp and paper. Another application of chlorine is in

the disinfection of water.

Hydrogen chloride (HCl) is a by-product of hydrocarbon chlorination and dehydrochlorinations. Much of the hydrogen chloride produced is consumed by the chemical industry. Large quantities are also used in the pickling of steel. Acidification of oil wells with hydrogen chloride, to increase the flow, is rapidly increasing. Smaller amounts are used for adjusting the pH in the treatment of water.

Occupational exposure to both chlorine and hydrogen chloride has long been regulated by consensus guides and by governmental standards. Since both materials are gases at normal temperature and pressure, exposure of workers is usually limited to inhalation.

1.1.3. Experimental animal studies on the effects of chlorine

Under physiological conditions (pH 7.4, 37 °C), chlorine reacts with water to produce hypochlorous acid. There is evidence to suggest that chlorine and chlorides produce oxygen radicals. Elemental chlorine, hypochlorous acid, hydrogen chloride, and oxygen are all thought to contribute to the biological activity. Apparently, hypochlorous acid can penetrate the cell wall, disrupting its integrity and permeability, and by reacting with sulfhydryl (SH) groups in cysteine, can inhibit various enzymes. Since chlorine can be distributed throughout the entire respiratory tract, these effects follow a similar distribution.

From data selected to represent the overall single and repeated inhalation toxic effects of chlorine in animals (Table 1), it can be seen that a single exposure for 30-60 min to concentrations in the range of 368-2900 mg/m^3 (127-1000 ppm) caused death in various species of animals. A single exposure of several hours to a chlorine concentration of 29-87 mg/m^3 (10-30 ppm) induced definite adverse effects, including high mortality rates, in rodent species tested. Repeated exposure to chlorine concentrations of 2.9-26 mg/m^3 (1-9 ppm), for a period of several weeks to months, induced dose-related pulmonary and other adverse effects. A level of 2 mg/m^3 (0.7 ppm) was reported to be a "no-observed-adverse- effect" level, for rabbits and guinea-pigs, repeatedly exposed to chlorine through inhalation.

In studies designed to evaluate the effects of chlorine exposure on resistance to disease, repeated exposure to 261 mg/m^3 (90 ppm) for 3 h/day, during a 20-day period, had a greater effect on rats with spontaneous pulmonary disease (SPD) than on those that were specific pathogen-free(SPF). A higher mortality rate and a