Chapter 7
Hydrogen iodide

7.1. Background

7.1.1 Basic chemical information

144. Hydrogen iodide (HI) is a water-soluble, colourless pungent gas. It is 4.4-times denser than air. Anhydrous hydrogen iodide produces aqueous hydroiodic acid when dissolved in water, which is a strong acid that is corrosive and reacts violently with bases.

Conversion factors at 25°C and 101 kPa:

1 ppm = 5.231 mg/m^3; 1 mg/m^3 = 0.1912 ppm

7.1.2 Sources

145. Releases of hydrogen iodide to air are not estimated by the National Atmospheric Emission Inventory and reporting is only required by the Environment Agency where the release is more than one tonne per annum or as a specific permit condition. The main source of hydrogen iodide in the United Kingdom is coal-fired power stations. Although the releases are not quantified, a small amount of hydrogen iodide is also likely to be released from chemical processes, domestic coal burning, clinical waste incineration and from disinfectants. Historically, iodine was also released from burning seaweed to produce fertiliser. Hydrogen iodide may also form in the atmosphere through the reaction of sea salt with acids such as nitric acid.

7.1.3 Ambient levels

146. No atmospheric measurements of hydrogen iodide in the United Kingdom have been identified. Concentrations of particle-bound iodide measured at Chilton (Oxfordshire), Styrupp (Nottinghamshire) and Warymires (Cumbria) between 1996 and 2001 range from 0.8×10^{-6}-2.0×10^{-6} mg/m^3.

147. The average global total iodine/iodide concentration has been reported by the United States Agency for Toxic Substances and Disease Registry (ATSDR, 2004) to range between 1×10^{-5}-2×10^{-5} mg/m^3 with

concentrations of between 2 x 10^{-6}-1.4 x 10^{-5} mg/m^3 being measured over land and higher levels found over the oceans.

148. On the basis of differences in their emission rates, mass concentrations of hydrogen iodide in the United Kingdom might be expected to be less than 2% of those of hydrogen chloride. Hydrogen iodide released to the atmosphere is likely to be rapidly deposited because of its high solubility in water.

7.2. Health effects

149. The Panel was unable to find any animal or human studies that specifically investigated the toxicology of hydrogen iodide. There is an extensive literature on the effects of iodine and iodide salts, largely in relation to dietary intake.

7.2.1 Animal studies

150. There is no information about the effects of acute exposure to hydrogen iodide in animals. No animal studies have been published that provide useful evidence on the health effects of ambient exposures in humans.

7.2.2 Effects in humans

151. Hydrogen iodide is a sensory and respiratory (breathing) irritant. Being highly soluble in water, the gas, following inhalation, is readily deposited in the nose and upper respiratory tract. At raised concentrations and at high breathing rates it may penetrate deeper into the lower respiratory tract and the lungs. A report in the Hazardous Substances Database indicates that exposure to about 35 ppm caused irritation of the throat after short exposure (Braker *et al.*, 1980). More severe exposures have been reported to lead to pulmonary and laryngeal oedema (build up of fluid in the lungs and walls of the voice box).

152. The irritant effect of hydrogen halides arises from the fact that they behave as strong acids in aqueous media, i.e. they dissociate forming high concentrations of hydrogen ions. Although hydroiodic acid is the thermodynamically strongest acid – i.e. the most highly dissociated when dissolved in water – hydroiodic acid, hydrobromic acid and hydrochloric acid all behave as very strong acids, and for equal molar concentrations they are expected to behave very similarly in their capacity to release hydrogen ions and cause irritation to the respiratory system.

153. Accidental exposures to high concentrations of hydrogen chloride in the workplace can lead to a form of irritant-induced asthma, reactive airways dysfunction syndrome (RADS, see Appendix 2). It seems plausible that high levels of exposure to hydrogen iodide would have similar effects. However, the exposures to hydrogen chloride involved in the development of RADS are thought to be far higher than ambient exposures to hydrogen halides.

154. Limited experience from volunteer experiments suggests that exposures to 3 ppm (10.50 mg/m^3) of hydrogen bromide are associated with irritation of the nose and throat in some individuals, with a no effects level of 2 ppm (7.00 mg/m^3) (see hydrogen bromide assessment). The no effects level in experiments with hydrogen chloride appears to be about 1 ppm (5.23 mg/m^3) (see hydrogen chloride assessment). The Health and Safety Executive cite lowest observed effects levels (LOELs) for irritation arising from exposure of animals to hydrogen bromide or hydrogen chloride as 5 and 10 ppm (17.50 mg/m^3 and 14.90 mg/m^3), respectively, although the experimental data are sparse (HSE, 2002).

155. In the absence of specific information about hydrogen iodide, a committee of the United States Environmental Protection Agency (USEPA, 2003) has recommended an acute exposure guideline level for hydrogen iodide that is the same as that for hydrogen bromide. A guideline of 1 ppm (5.23 mg/m^3) is recommended for averaging times of between 10 minutes and 8 hours to prevent nose irritation in humans.

156. In addition to short-term irritant effects, long-term exposure to hydrogen iodide may be associated with systemic effects. The Panel is not aware of any studies in humans or animals on the long-term consequences of hydrogen iodide inhalation. The International Agency for Research on Cancer (IARC) has evaluated the carcinogenicity of mists of strong inorganic acids (IARC, 1992). However, hydrogen iodide was not included in this evaluation and the overall evaluation is not relevant for the concentrations considered here.

157. It should be noted that the effects of inhaled iodine or iodide on iodine metabolism overall are unknown, but there is no reason to assume that this will not be absorbed and will thus probably contribute to the general body burden. Iodine is an essential element used in the synthesis of thyroid hormones. An excess intake of iodine, however, may adversely affect thyroid function. The potential effects of long-term exposure to hydrogen iodide will be discussed in an addendum to this report.

7.3. Justification for the air quality guideline

158. There are two adverse effects of potential concern: (i) the effects of iodine on the respiratory tract and the eyes due to its irritant acidic properties; and (ii) the longer term adsorption of iodine from the inhalation of hydrogen iodide.

159. In the absence of specific information about the effects of hydrogen iodide on humans, the Panel has recommended a short, 1-hour, guideline value based on its similar physico-chemical properties to the other hydrogen halides. A longer-term guideline value to protect against the chronic effects of iodine exposure will be recommended in an addendum to this report.

160. The information available on the irritant effects of hydrogen chloride or hydrogen bromide at low concentrations in humans is also sparse. Although, some data exist, as described in the relevant chapters of this report, there are insufficient data on which to base a firm opinion on the irritant effects of low exposure to these gases in the general population.

161. Based on comparison with the other hydrogen halides, the Panel considered that a concentration of 1 ppm (5.23 mg/m^3) should be regarded as a no observable adverse effect level (NOAEL) for irritant or potentially inflammatory effects on the lower respiratory tract and outer eye. To reflect the uncertainty in the derivation of the NOAEL and to take into account the presence of potentially susceptible individuals in the general population, the panel considered the application of a safety factor of 10 would be adequate for exposure in the ambient air. Therefore the Panel concluded that 0.1 ppm averaged over 1 hour would be an appropriate guideline value for hydrogen iodide that allowed for its irritant effects on the outer eye and lower respiratory tract

162. The Panel considered that by analogy with other hydrogen halides there were no grounds for regarding hydrogen iodide as a human carcinogen.

7.4. Recommendation

163. **The Panel recommends that a concentration of hydrogen iodide gas or mass equivalent aerosol not exceeding 0.1 ppm (0.52 mg/m^3) over a 1-hour averaging period should protect against irritant and inflammatory effects on the skin, eye and breathing airways.**

References

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