SEA WATER CHLORINATION: CREATION OF MUTAGENIC BYPRODUCTS

B. Kurelec, S. Britvić, M. Rijavec, B. Sieben, N. Bihari, W. E. G. Müller and R. K. Zahn
Center for Marine Research Zagreb, and Rovinj, Ruđer Bošković Institute Zagreb and Institut für Physiologische Chemie, Mainz

Recently it came to light how water chlorination generates carcinogens and mutagens. In addition to the formation of a small number of the mutagenic low molecular weight halogenated methanes (haloforms) there is also a potential to produce high molecular weight mutagenic substances. Some of these have been identified as derivatives from natural organic material dissolved in a sea water. Coastal regions differ with regard to the quantity and quality of dissolved organic molecules due to the depth or due to the extent of environmental contamination. Consequently, the antibiofouling chlorination of the rather huge amounts of sea water used in cooling systems may result in large amount of mutagens, depending on the quality of the input water. These facts make it environmentaly more desirable to locate power stations at the positions low in organics. We have chlorinated experimentally sea water sample collected from the surface and the bottom (30m) of a "clen" area and of the "mixing zone " with wastes of cannery. All samples were treated with 1 mg/l of chlorine (as hypochlorite). After 1 h samples (25 l each) were extracted with hexane. The extract was divided into two portions, the hexane evaporated, and the first residue taken up in 1 ml of dimethyl sulphoxyde to be used in Ames microsomal test with the TA 100 strain. The second residue was dissolved in a minimal amount of acetone, plotted on thin layer (particle acetylated cellulose) chromatographic plates and developed with acetone-methanol-water (4-4-1). Automatic screening was at 365 nm activation light and recorded in 400 nm emittedlight with a Shimadzu Dual-Wavelength TLC Scanner CS 910.

Results of mutagenicity testing are given in Table 1. Unchlorinated samples from both locations were not mutagenic. Upon chlorination all samples gave direct mutagens. TLC of hexane extracts of chlorinated surface water does not show fluorescent material. However bottom water shows green fluorecsent material with a retention time of 3.57 and a blue fluorescent spot of 4.33. "Mixing zone" sample give a small quantity of unseparated material.

Bottom water in a relatively shallow sea is known to contain much more organic material than is present in the water column (Stephens, 1972). This is the reason why more mutagens are formed upon chlorination. The "Mixing zone" sample is haevily polluted with cannery wastes. Sporadically these waters contain mutagenic material (Kurelec

Table 1. Mutagenicity of different chlorinated seawater samples

Sample	liter equivalents per plate	TA 100 revertants -S9	TA 100 revertants +S9
"Clean" site, surface	0.5	180, 187	166, 153
	1	205, 211	168, 175
	2	242, 258	173, 185
"Clean" site, bottom (30 m)	0.5	230, 251	176, 189
	1	305, 291	208, 226
	2	Toxic	248, 261
"Mixing zone"	0.5	181, 175	142, 156
	1	222, 242	181, 188
	2	Toxic	Toxic
Controls		139, 152, 145	140, 161, 146
1 ug B(a)P oxyde		1280, 1324	
5 ug B(a)P			450, 476

et al, 1979). Payne and Rahimtula (1981) described that chlorinated polluted waters represents strong sources for environmental mutagens.

From these preliminary results it is reasonable to conclude that by careful choise of the location for the cooling water inlets the creation of mutagenic substances in the marine environment can be diminished.

Literature:

Kurelec, B, Z Matijašević, M Rijavec, M Alačević, S Britvić, WEG Müller and RK Zahn, 1979, Induction of benzo(a)pyrene monooxygenase in fish and the Salmonella test as a tool for detecting mutagenic-carcinogenic xenobiotics in the aquatic environment. Bull.Environm. Contam.Toxicol. 21, 799-807.

Payne, JF and A Rahimtula, 1981, Water chlorination as a source of aquatic environmental mutagens. In: Toxycology of halogenated hydrcarbons: Health effects. Eds.: MAQ Khan and RH Stanton, Pergamon Press, New York, 1981, pp. 209-221.

Stephens, GC, 1972, Amino acid accumulation and assimilation in marine organisms. In: Nitrogen metabolism and the environment. Eds.: JW Campbell and L Goldstein, Academic Press, New York, 1972, pp. 155-184.