

Basic Principles of Electrochlorination

The use of sea water as a feedstock for OSEC[®] systems for disinfection of potable water

Paper 3

Introduction

Sea water may be used as a feedstock for electrolytic chlorine generation for a variety of applications, in particular disinfection of power station cooling water.

Unfortunately, the presence of certain contaminants in seawater makes it unsuitable for generating hypochlorite for the disinfection of water intended for drinking. One of these natural constituents of seawater is bromide which can lead to the formation of the potentially harmful disinfection by product, bromate, at concentrations well above recommended levels. Other potential problems may arise from the presence of contaminants such as oil. Seawater is essentially prone to contamination by a range of

natural and man-made contaminants which cannot be easily controlled.

Bromate is classified as a possible human carcinogen by the International Association for Research on Cancer (Ref. 1).

The WHO 10⁻⁵ cancer risk is 25µg/l (Ref. 2).

A recent EPA risk assessment (Ref. 3).

In Support of Summary Information on the Integrated Risk Information System (IRIS) March 2001) gave "an upper bound cancer potency estimate for bromate ion (of) 0.70 per mg/kg-day. This potency estimate corresponds to a drinking water unit risk of 2×10^{-5} per µg/L, assuming a daily water consumption of 2 L/day for a 70-kg adult. Lifetime cancer risks of 10⁻⁴, 10⁻⁵, and 10⁻⁶ are associated with bromate concentrations of 5, 0.5, and 0.05 µg/L, respectively."

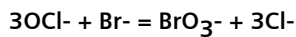
EC Directive 98/83/EC on the quality of water intended for human consumption requires a parametric value of 25 µg/l from 2003 until 2008 when the value falls to 10 µg/l. The parameter carries a note that "where possible, without compromising disinfection, member states should strive for a lower value".



Product Sheet

The prescribed level for bromate in the Regulations is 10 µg/l with effect from 2003.

Bromate is formed in electrolytically generated sodium hypochlorite as a result of the presence of bromide in the salt used to manufacture these products. The bromide is converted stoichiometrically to bromate as follows:



When using non marine derived salt the levels of bromate in the hypochlorite can easily be kept within recommended limits. Sea water, however, contains a typical concentration of 64.6 mg/l bromide.

If this level of bromide is stoichiometrically converted to bromate then we can calculate from the molecular masses that the electrolysed brine will contain

$$127.904 / 79.904 \times 64.6 = 103.4 \text{ mg/l of bromate.}$$

At a nominal chlorine dose of 1 mg/l we can calculate the bromate dose as follows:

For a hypochlorite containing 1800 mg/l chlorine

$$103.4 / 1800 \times 1000 = 57.4 \text{ µg/l BrO}_3^-$$

For a hypochlorite containing 900 mg/l chlorine

$$103.4 / 900 \times 1000 = 114.8 \text{ µg/l BrO}_3^-$$

Summary

It can readily be seen that these levels are considerably in excess of all recommended and prescribed levels for bromate. It is concluded that the presence of bromide makes seawater an unsuitable feedstock for electrochlorination where the product is to be used to disinfect potable water. In addition to this there is the general problem associated with the potential pollution of seawater and the impracticability of protecting the quality of the seawater used in the electrolyser.

References

1. (IARC) (VOL.: 73 (1999) (p. 481))
(<http://193.51.164.11/htdocs/monographs/Vol73/73-17.html>)
2. (Guidelines for drinking-water quality, 2nd ed. Vol. 2 Health criteria and other supporting information, 1996 (pp. 940-949))
(http://www.who.int/water_sanitation_health/GDWQ/Summary_tables/Tab2d.htm)
3. (EPA/635/R-01/002 TOXICOLOGICAL REVIEW OF BROMATE (CAS No. 15541-45-4))
(<http://www.epa.gov/iris/toxreviews/1002-tr.pdf>)

The requirements of the Directive are implemented in English law as The Water Supply (Water Quality) Regulations 2000 (<http://www.dwi.gov.uk/regs/si3184/3184.htm>).

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