Committee Secretary
Select Committee on Australia's Food Processing Sector
PO Box 6100
Parliament House
Canberra ACT 2600
Australia

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The committee should be aware of a boron problem from reverse osmosis (RO) desalinated water used for drinking water when RO desalinated water is not mixed (shandied) with reservoir water. Desalination plants will provide a large part of potable water volume in a drought if they are only turned on in the drought. A low output on a constant basis is safer. Water at Kurnell & Wonthaggi is, and will, be used to replace reservoir water unshandied. Borax is an accumulative poison. There are other derivatives of Boron, Boranes, that are lethal to all humans at very low dosages (5 parts per billion). The use of borax for nappy rash killed many infants in the late 1890-early 1900s. It is still used as a pecticide.

The latest Dow Chemical films can get the boron count to average at about 0.47 mg/L, (Veolia Gold Coast & Kurnell plant). What this means is that the second pass in the desalination process used to remove boron is able to get a count of about 0.3 mg/L when the films are new but over 12 months of use the count goes over 0.7 mg/L. So the boron which mainly exists (90% in seawater) as boric acid or B(OH)3 or H3BO3 is still in the potable water and if it is not mixed with reservoir water of low boron content will exceed 0.5 mg/L for much of its output life.

The WHO set the allowable boron count at 0.5 mg/L under their 2003 guideline. In 2011 it will change to 2.4 mg/L. There has been no published toxicology to justify this change and the make up of WHO committees suggests influence from the desalination industry.

As you can see from using the ADW Guideline standard formula 0.5 mg/L is still not low enough for drinking by infants or prenant women.

Mixing for the latest films in existing desalination plants would need to be 1 desal: 2 fresh water for safe infant consumption using the ADW Guideline formula.

Regards,

Geoff Croker BE Civil

http://www.um.es/aim/files/Download/238.pdf

Preconcentration and determination of boron in milk, infant formula, and honey samples by solid phase extraction-electrothermal atomic absorption spectrometry

I López-García, P. Viñas, R. Romero-Romero, M. Hernández-Córdoba Department of Analytical Chemistry, Faculty of Chemistry, University of Murcia, University of Murcia, Spain

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1. Introduction

Boron is present in human milk within a well-defined range (10–100 μg L−1), although higher levels have been found in infant formulas (120 μg L−1) and whole cow milk (280 μg L−1) [1].

Infant formula has up to 0.12 mg/L

National Water Quality Management Strategy

AUSTRALIAN DRINKING

WATER GUIDELINES

2004

Endorsed by NHMRC 10 – 11 April 2003

GUIDELINE

Considering that boron may be an essential trace element for humans and based on an acceptable range of oral intake (AROI), a concentration of up to 4 mg/L in water would not pose a human health risk.

GENERAL DESCRIPTION

Boron can be present in drinking water through the natural leaching of boron-containing minerals, or by contamination of water sources. The environmental chemistry of boron is not well understood.

In water, the predominant form is probably boric acid, which does not dissociate readily.

Boron compounds are used in glass manufacture, cleaners, wood and leather preservatives, flame retardants, cosmetic products, antiseptics, and occasionally food preservatives; and as agricultural fertilisers, algicides, herbicides and insecticides.

In other countries, concentrations of boron in uncontaminated water sources are usually less than 1 mg/L. Concentrations up to 6.5 mg/L have been reported in ground water supplies, but these higher concentrations are associated with seawater intrusion.

Boron is present naturally in many food products, with high amounts found in foods of plant origin, especially fruits, leafy vegetables, nuts and legumes. It has been estimated that intake of boron from food is about 10 times that from water. The daily consumption of boron is 10–25 mg. This value however, will vary from country to country depending on population dietary habits, geographical area and soil geochemistry. In Australia, the estimated dietary intake for boron is 2.2 mg/day (Samman *et al* 1998).

TYPICAL VALUES IN AUSTRALIAN DRINKING WATER

Boron is not often monitored in Australian drinking water supplies but the limited information available indicates that boron concentrations are less than 0.1 mg/L.

TREATMENT OF DRINKING WATER

The concentration of boron in drinking water can be **reduced by the use of granular activated carbon, or by lime softening**.

Not true for Boron in seawater (90% Borax) as in a desalination plant.

If it was true desalination plants would use activated carbon filters to exclude Borax. Homes cannot exclude Borax using a carbon filter.

MEASUREMENT

The boron concentration in drinking water can be determined using inductively coupled plasma emission spectroscopy (APHA Method 4500-B Part D 1992). The limit of determination is approximately 0.05 mg/L.

HEALTH CONSIDERATIONS

Boron, as soluble borate (borax) or boric acid, is rapidly and completely absorbed after ingestion. It is widely distributed throughout the body and up to 90% is excreted in urine as unchanged compound.

There have been a number of reported cases of poisoning following the ingestion of high doses of boron. Symptoms include gastrointestinal disturbances, skin eruptions, and central nervous system stimulation and depression. Long-term occupational exposure to boron can lead to similar symptoms.

Short-term studies with rats and dogs reported testicular atrophy at high doses (5000 mg/kg bodyweight) of boric acid and borate. This condition was also observed in longer term studies with rats, mice and dogs over 2 years. Reproductive studies reported that rats became sterile at the highest doses. No increase in the incidence of tumours was observed in long-term studies using mice.

Tests for mutagenicity using bacteria and mammalian cells have been mostly negative. Neither boric acid nor borate induced chromosomal aberrations in mammalian cells.

Human studies have shown that boron is potentially an essential trace element that can affect the metabolism and utilisation of other substances including calcium, copper, magnesium, nitrogen, glucose, triglycerides, reactive oxygen and oestrogen (Nielson 1996). Boron may be involved in a wide range of biochemical processes and have a role in the prevention of chronic diseases such as osteoporosis, arthritis and coronary heart disease.

DERIVATION OF GUIDELINE

Using a standard toxicological approach a guideline value for boron in drinking water can be derived as follows:

0.6 mg/L = (9.6 mg/kg bodyweight per day x 70 kg x 0.1) divided by (2 L/day x 60)

where:

• 9.6 mg/kg bodyweight per day is the no observable adverse effect level (NOAEL) from a

developmental toxicity study using Sprague Dawley rats (Price *et al* 1994)

• 70 kg is the average weight of an adult

• 0.1 is the proportion of total daily intake attributable to the consumption of water

• 2 L/day is the average amount of water consumed by an adult

• 60 is the safety factor derived from using toxicokinetic and toxicodynamic data from animal

and human studies (6 for intraspecies variations and 10 for interspecies variations).

Lets use the same formula for a 6 kg baby taking six 0.5 litre bottle feeds/day

0.32 mg/L = (9.6 mg/kg bodyweight per day x 6 kg x 1) divided by (3 L/day x 60). This assumes the formula has no boron. On this number there is no RO desalination plant in Australia that could supply water not mixed for consumption by babies using the MH&MRC Guidelines.

However we now know Infant formula has up to 0.12 mg/L. This means an allowable boron in the water used for infant formula of 0.2 mg/L. Australian reservoir water is less than 0.1 mg/L. Unmixed RO desalinated water at Kurnell, Gold Coast, Perth & Wonthaggi could never get down to 0.2 mg/L.

For 150 GL of Wonthaggi water (assuming 0.05 mg/L in Cardinia Reservoir water & 0.5 mg/L as per desalination contract) means that 300 GL is required for mixing. Australian Drinking Water testing is only accurate to 0.05 mg/L.

(0.05V + 0.5*150)/(V + 150) = 0.2 V = 300GL of Mixing water to get 0.2 mg/L

The maximum capacity of the Wonthaggi system is 200 GL, far less than the 450 GL required for safe mixing.

The contracted volume for the infrastructure (200 GL/year) cannot be met.

However, on the basis that boron is a potential essential trace element, an alternative approach to calculating a guideline value is proposed. The International Program on Chemical Safety (IPCS) has recommended that for all essential trace elements there is a zone for safe and adequate exposure termed the acceptable range of oral intake (AROI) (IPCS 2002).

The WHO indicates that the mean minimum dietary intake **for adults** to avoid boron deficiency is 1.0 mg/day (WHO 1996), while the maximum tolerable daily intake calculated from the study of Price *et al* (1994) is:

11.2 mg/day = (9.6 mg/kg bodyweight per day x 70 kg) divided by 60

On this basis, the AROI for boron is 1.0-11.2 mg/day. Food is the major source of dietary boron and in Australia it has been determined that the average dietary intake is 2.2 mg/day (Samman *et al* 1998).

Other oral sources (e.g. from medicinal, cosmetic and consumer products) are considered minimal.

Consumer products have been estimated to contribute to a geometric mean of 0.1 mg/day to total boron exposure (WHO 1998).

Based on the AROI approach, a guideline value for boron (rounded down) in drinking water was derived as follows:

4 mg/L = (11.2 mg/day – 2.2 mg/day – 0.1 mg/day) divided by 2 L/day

This could not be applied to infants.

REFERENCES

APHA Method 4500-B Part D (1992). Boron: Inductively Coupled Plasma method. Standard Methods for the Examination of Water and Wastewater, 18th edition. American Public Health Association, Washington.

Neilson FH (1996). Evidence for the Nutritional Essentiality of Boron. *Journal of Trace Elements in Experimental Medicine,* 9: 215–229.

Price CJ, Marc MC, Myers CB (1994). Determination of the NOAEL for developmental toxicity in Sprague-Dawley (CD) rats exposed to boric acid on gestational days 0 to 20 and evaluation of postnatal recovery through postnatal day 21. Report 65C-5657-200. Research Triangle Institute, Research Triangle Park, NC.

Samman S, Naghii MR, Lyons Wall PM and Verus AP (1998). The nutritional and metabolic effects of boron in humans and animals. *Biologic Trace Element,* 66,1–9.

IPCS (International Programme on Chemical Safety) (2002). Principles and methods for the assessment of risk from essential trace elements. Environmental Health Criteria 228. World Health Organisation, Geneva, Switzerland.

WHO (World Health Organization) (1996). Trace elements in human nutrition and health. Prepared in collaboration with the Food and Agriculture Organization of the United Nations and the International Atomic Energy Agency. World Health Organisation, Geneva, Switzerland. Chapter 13, 175-179.

WHO (World Health Organization) (1998). Guidelines for drinking-water quality. Second edition.

Addendum to Volume 2. Health criteria and other supporting information. World Health Organisation, Geneva, Switzerland

RO Desalination plants were not mentioned in relation to boron in the Australian Drinking Water Guidelines.