Briefing Note
EcoLogo^{M} Program Criteria Review

CCD – 170 Closed Water System Corrosion Inhibitors

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1 Introduction

EcoLogo^{M} is proposing certification requirements for closed system water corrosion inhibitors The purpose of this briefing note is to inform the development of audit criteria for these products.

2 Information on the product group: Function and background

The function of corrosion inhibitors is to control corrosion and deterioration within the piping of closed water systems. This serves to maintain heat transfer efficiency and prolong the life of the system. Closed water systems are designed to distribute heated or chilled water throughout a designated area. Common closed water systems are hot water heating of apartments and offices, and chilled water systems used for air conditioning in large buildings.

Corrosion is caused mainly by oxygen dissolved in the water and corroding steel and iron. Corrosion can be minimized by reducing air-leakage and changing filters on a routine basis, and use of chemical treatments (Yuzwa, 1987).

There are several types of chemical treatments. Most have nitrite as active ingredient, a smaller proportion have molybdenum as active ingredient. The mechanism of action is described by Yuzwa, (1987). Sodium nitrite and sodium molybdate react with iron to form a protective film. Other common ingredients are an azole for inhibiting corrosion on copper and sodium borate (borax) to buffer pH and further reduce corrosion on steel and copper. "Organic" based treatments based on phosphonates are less common. Silica based treatments make up another very small portion of products sold.

Note that corrosion inhibitors are also available for open water systems. These treatments differ from those typically used for closed systems. Open systems use cooling towers and evaporation of water. Make-up water is used to replace water and periodically a "blowdown" of the system is down to eliminate built up solids. Treatments for open water systems usually include a biocide (Yuzwa, 2000).

3 Market Details

Table 1 sets out the estimated market share for various types of closed water system corrosion inhibitors. Sodium nitrite based formulations are highly typical.

Table 1 – Estimated market share – Closed water corrosion inhibitors (North America)

Active ingredient	market share
Sodium nitrite	80%
Molybdate	15%
Molybdate-nitrite	4%
Other (phosphonate, silica)	1%

(based on estimates from Produits Chimique Magnus, 2007)

There are a large number of manufacturers making these products. Multinational producers inlcude Nalco, GE Betz, and Drew Ashland. Regional manufacturers include, Aquarian, Buckman, Chem-Aquq, Chemtreat, ControlChem, IPAC Chemicals, Jacklyn Chemicals, Keytech, Klenzoid, National Chemsearch, Rochester Midland, Pace Chemicals and State Chemical

4 Environmental Impacts Over Life Cycle

The major impact with corrosion inhibitors is in the disposal (end of life) phase. Using sewage by-laws as a benchmark the American Society of Plumbing Engineers (2004) identified phosphonate / "organic" treatments as having the least impacts.

Table 2 – Relative Disposal Impacts for closed system treatments (adapted from Table 6 - American Society of Plumbing Engineers, Ottawa Chapter (2004) identified)

	Molybdate Mo, mg/l	Zinc Zn, mg/l	Total Phosphorous P, mg/l	TKN mg/l	BOD mg/l	COD mg/l	LC50 96 hr, Rainbow Trout mg/l as product
Nitrite, 1000 mg/l NO2	0	0	0	312	2.1	300	30
Nitrite/Molybdate, 300 mg/l NO2	45	0	0	105	120	400	158
Molybdate (60 mg/l)	60	0	1.6	5	168	183	707
Phosphonate based ("organic") 2000 ppm	0	0	9.95	96.7 (14.9)	9.0	260	354 (1414)
Sewage by-law[1]	5	3	10	100	300	--	--

As shown in the table, nitrite treatments were high in TKN (Total Kjeldahl Nitrogen) and relatively aquatically toxic. Molybdenum based treatments involved excessive levels of

[1] City of Ottawa limits http://ottawa.ca/city_services/waterwaste/sewer_use/sewer_use_4_1_en.shtml

molybdenum. Phosphonate treatments have a good aquatic toxicity profile, acceptable TKN, no molybdate releases and acceptable phosphorous. The values in brackets for the phosphonate treatment correspond to a second sample tested independently (Produits Chimiques Magnus, 2007). A typical sewage by-law (City of Ottawa) is used as a basis for comparison.

EcoLogo has not yet been able to obtain similar profile for silica based treatments. We anticipate that these product will be absent of Molybdenum and will have acceptable TKN limits.

4.1 Discussion of impacts

Table –1 indicates that only the phosphonate based treatments meet all requirements when compared against sewage requirements. It is on this basis that EcoLogo proposes to set certification criteria favouring these products.

Impacts across other life cycle stages (extraction, manufacturing) do not appear to have significant distinguishing features between various treatment chemicals

Presence of molybdenum in cooling system water is a high profile impact and currently efforts are being made to reduce use of molybdenum based treatments (e.g., BOMA BC, 2006).

In the past chemical water system treatments involving the carcinogen hexavalent chromium were used. These treatments are banned in various jurisdictions (e.g., South Coast Air Quality Management District in 1990)(City of Los Angeles, undated).

4.2 Other ingredients

One other ingredient of concern in these products is boron, present as borax ($Na_2B_4O_7$ – H_20). Borates are commonly used in closed system water corrosion inhibitors to buffer pH and The US Environmental Protection Agency (1997) describes the reproductive toxicity hazard of boron and related compounds.

EcoLogo has evaluated the use of borax and is proposing to permit borates based on 1) a risk assessment of borates[2] which concluded that "the toxicological endpoint of concern for boric acid from studies in rodents were effects on fertility with the most sensitive endpoint being histopathological changes in male sex organs and developmental toxicity at high dose levels. Such doses are not possible under conditions of normal handling and use" (HERA, 2005) and 2) Borates are commonly used in these products and until alternatives exist for >20% of products sold on the market, any decision to restrict to products without borate would be overly strict and counter to the goals of the EcoLogo program to identify existing products on the market place with a better environmental profile than competing products.

[2] Note that this assessment was conducted on borax in detergents at 2x lower amounts than that in water corrosion inhibitor formulations.

4.3 Performance Standards

Standard methods for measuring corrosion are published via the American Society for Testing and Materials (ASTM) via ASTM D2688 – 05 "ASTM D2688-05 Standard Test Methods for Corrosivity of Water in the Absence of Heat Transfer (Weight Loss Methods)". This method measures the corrosivity of water via the weight loss in steel and copper pieces (coupons).

5 Other EcoLabelling standards

No other current ecolabelling standards were found for corrosion inhibitors. The US EPA Design for Environment Program which operates an environmental labelling program has done work with these products and is working with EcoLogo^{M} to develop ecolabelling criteria for the product category.

References

American Society of Plumbing Engineers, Ottawa Chapter. 2004. Environmentally Responsible Advances in Cooling Water Treatment.

BOMA, BC. (2006) Reducing Molybdenum Discharges from Commercial Building Heating/Cooling Systems. Presentation.

City of Los Angeles, undated. City of LA Board of Public Works. FactSheet: Eliminating Hexavalent Chromium from cooling towers. undated

Produits Chimique Magchem. Application to EcoLogo^{M} Program. 2007

Yuzwa G.F. 1987. Water Treatment of Closed Hot Water Heating and Chilled Water Systems. Presentation to Alberta Infrastructure Property Management

Yuzwa G.F. 2000. Propietary Scale and Corrosion Inhibitors. Presentation to Alberta Infrastructure Property Management

US EPA 1997. TSCA New Chemicals Program Chemical Categories. Boron Compounds. http://www.epa.gov/oppt/newchems/pubs/cat02.htm#Boron%20Compounds