Chemically Surfaced Modified Zeolites

ZMM® CSMZ

October 1, 2014

LuVerne E.W. Hogg

ZMM® CANADA CORP.

NATURAL MINERAL ZEOLITE

The high purity Clinoptilolite zeolite provides an excellent matrix for making Surface Modified Zeolites (CSMZ). A Zeolite mineral deposit that is unique as it has a high mineral purity. The zeolite is classified as a hydrated, aluminosilicate and the crystal crystal structure has a two-dimensional 8-ring and 10-ring channel configuration, with the largest cavity dimension measuring 4.4 by 7.2 Angstroms. The basic aluminosilicate structure consists of infinitely, extending, three-dimensional networks of AlO_4 and SiO_4, tetrahedral, crystal linked to each other via shared oxygen atoms. These oxygen atoms occupy two, structurally different positions representing framework oxygen and cavity/void (or channel water) oxygen.

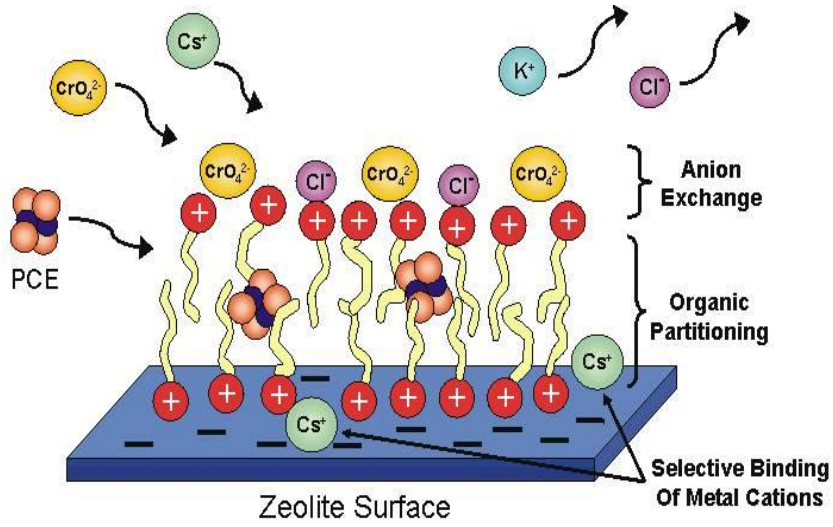
The Zeolite has high surface area (24-25 m^2/gm @ Dry Bul Wt.; ~50% Void Volume; a network of channels in the mineral; and net negative surface charge. The net negative surface charge imparts cation exchange capacity to the mineral, but no affinity for anions or for nonpolar organics. Treatment of the natural zeolites, with certain surfactants dramatically alters their surface properties from hydroscopic to hydrophobic and imparts adsorbent properties analogous to GAC. For example, the surface treatment chemicals react, with the mineral to form a stable, coating on the external surfaces of the zeolite to sorb nonpolar organic solutes and anions.

ZMM® CSMZ COMPOSITION AND FUNCTION

Treatment of the natural zeolites, with certain chemical that alters the mineral, surface properties from hydroscopic to hydrophobic and imparts adsorbent properties analogous to GAC. The net negative, surface charge and a high mineral purity is used as the "carrier" for surface modifying chemical molecules. The modifying ZMM® chemicals are applied to the zeolite mineral, using spray techniques. The ZMM® chemicals applied to the zeolite mineral surface to form an active layer. Calcium, Potassium or Sodium ions in the crystal structure of the zeolite function as cation exchange ions for this phenomena. Figure 1 illustrates how the molecules are associated, with the surface of the zeolite mineral, surface to form the CSMZ granules.

A bilayer of molecules forms on the zeolite mineral surface that reverses the charge on the zeolite from negative to positive. This molecular, bilayer provides sites for exchange of anions such as arsenate and functions as solvent-like coating into, which nonpolar, organic solutes can partition. Inorganic cations exchange via internal, ZMM® cation exchange sites and/or are selectively bound on external, mineral, surface sites. Importantly, the chemically applied molecules are stable on the zeolite to provide an efficient, adsorption surface when used in water. Or when added to sumps or lagoons. The ZMM® CSMZ zeolite adsorbent product having the chemical molecules on the zeolite provides an effective, adsorbent, absorbent for removal of a wide range of anionic and cationic contaminants. The ZMM® CSMZ removes nonpolar, organic solutes, toxic heavy metals plus organic and hydrocarbon contaminants from water.

Figure 1. Conceptual model for the ZMM® CSMZ illustrating sorption mechanisms for anions, cations and non-polar, organics [D. Schulze-Makuch et al (2002): EOS Transactions, American Geophysical Union, April 30, 2002].



The ZMM® CSMZ adsorbent product has a low, abrasion loss coefficient; is chemically stable in terms of the molecule association, with the zeolite; and is thermally stable over the range of temperature water filters. Table II outlines the physical properties of the CSMZ adsorbent product.

Table II. ZMM® CSMZ Physical Properties

Bulk Density	55 lbs. per cubic foot
Mesh Size	As per use
Surface Area	Avg. 25 m^2/g
Ions soluble chlorinated hydrocarbons	35-40% by Wt. (~20 lbs/ft^3)
Thermal Stability	Stable to 150°C

Table III. Water Processing with Natural and ZMM® CSMZ

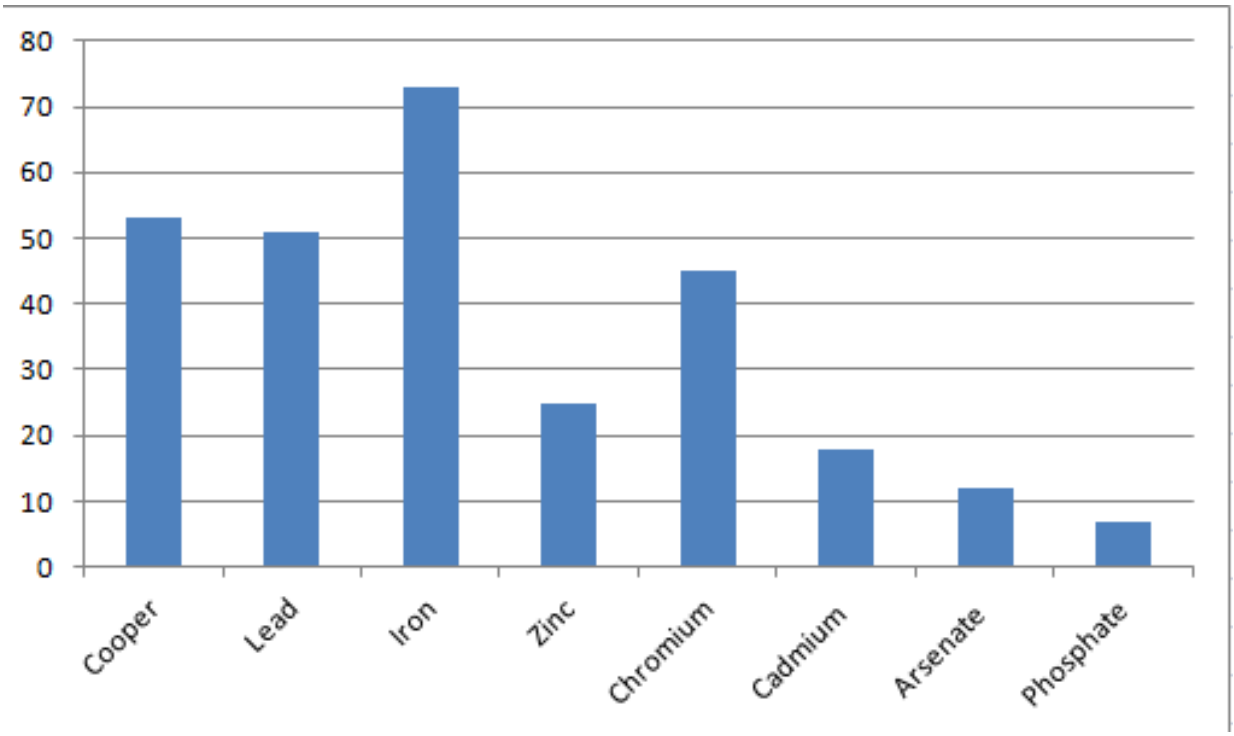
Testing conducted at a leading northeastern state university has demonstrated that Natural Clinoptilolite Zeolite, Hydrous Sodium Aluminosilicate and treated Clinoptilolite Zeolite ("ZMM® CSMZ") can effectively treat contaminated water.

Natural Clinoptilolite Zeolite, Hydrous Sodium Aluminosilicate provides economical ion exchange properties. Under the appropriate conditions Clinoptilolite Zeolite can exchange with common cations such as:

Lithium	**Magnesium**	**Chromium**	**Zinc**
Rubidium	**Calcium**	**Iron**	**Cadmium**
Cesium	**Strontium**	**Nickel**	**Aluminum**
Ammonium	**Barium**	**Lead**	**Mercury**
		Copper	

Tests show that 50-70% of Copper, Lead and Iron cations in the concentration ranges of 1-2,000 ug/L can be removed with a single pass treatment of Zeolite at 500 mg/L. Multi-pass column treatment indicated Copper, Lead and Iron cation removal can approach the 80-90% range.

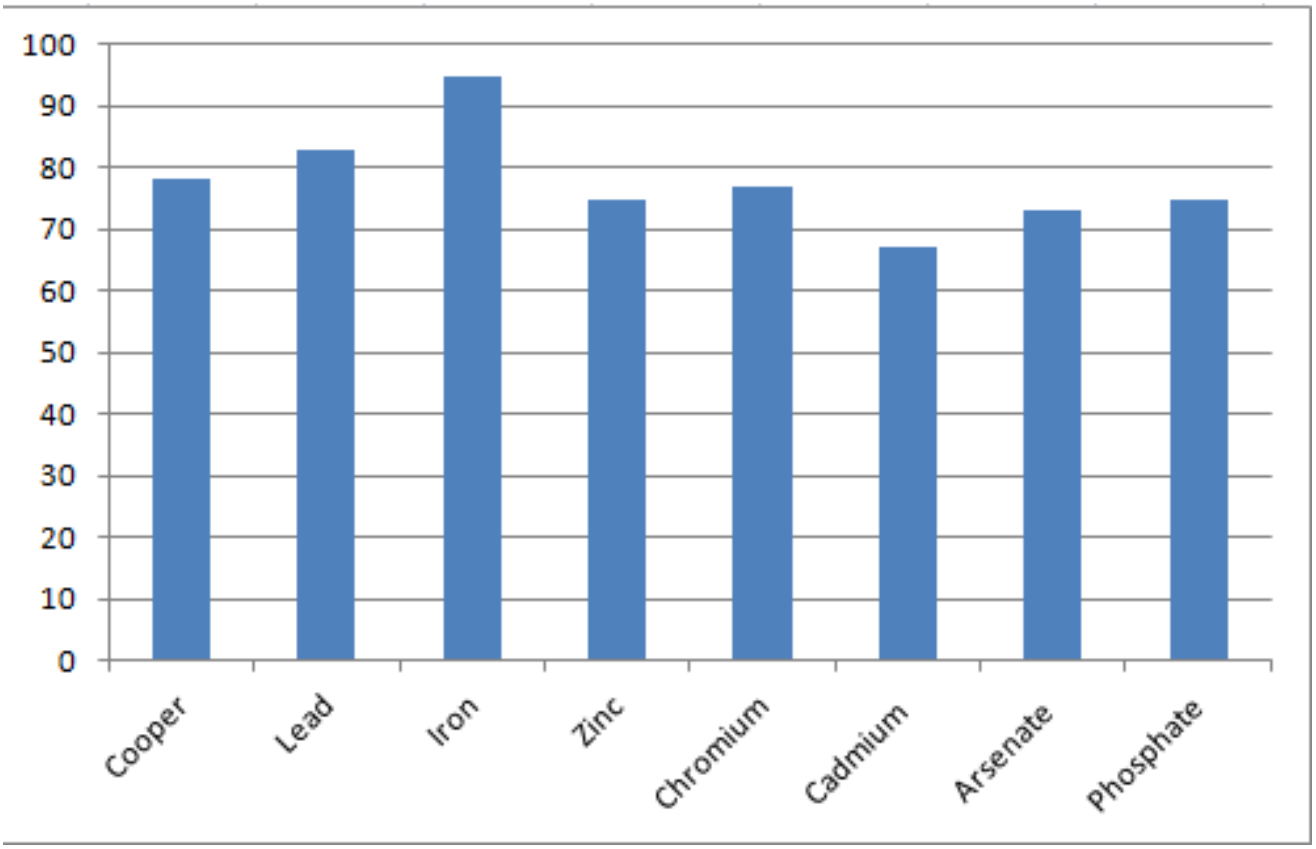
% Removal from Aqueous Solutions with Clinoptilolite Zeolite



ZMM® CSMZ (1-6% of additives) is far more effective in removing 70-90% Copper Lead and Iron as well as metal cations of Zinc, Manganese, Mercury, Cadmium and Chromium under similar condition

ZMM® CSMZ (3-6% of additives) have demonstrated removal of 70-80% of Arsenate and Phosphate anions.

% Removal from Aqueous Solutions with ZMM® CSMZ



LuVerne E.W. Hogg
President & CEO
ZMM® CANADA CORP.
6459 Mack Road
Peachland, BC V0H 1X8
P: 250 767-6788
F: 250 767-6134
vernehogg@shaw.ca