ARSENIC REMOVAL FROM MINING INFLUENCED WATER (MIW)

CAIROX® Potassium Permanganate / CARUSOL® Liquid Permanganate Technical Brief

INTRODUCTION

Treatment of the wastewater or process water produced during mining operations involves several key considerations, including:

- Water scarcity, reuse and recycling
- The type and concentration of contaminants
- The type of chemical and physical treatment strategies
- Effluent discharge location, permit requirements, toxicity testing

Permanganate products are used in municipal and industrial settings to oxidize and precipitate metals, sulfides, and other contaminants. This process occurs before the addition of coagulants or polymers, which are then used for solids separation and clarification. The treated water is subsequently discharged or reused.

TECHNICAL SUMMARY

Arsenic (As) is a particularly potent toxin and occurs in many minerals, usually in combination with sulfur and metals. Sources of human exposure include food, weathering of minerals and ores, mineralized groundwater, and inhalation of atmospheric gases and dust. The USEPA maximum contaminant level (MCL) for public water supplies is currently 10 µg/L.

Key advantages of using permanganate for **arsenic** removal include:

- Rapid oxidation of arsenic to low levels while also oxidizing iron and manganese.
- Manganese dioxide adsorbs arsenic (V).
- Iron oxidized by permanganate can also adsorb arsenic (V) meaning the addition of iron coagulants is often not necessary.
- No formation of disinfection by-products (DBPs) in organic laden waters.

CHEMISTRY & DOSAGE

$$3As^{3+} + 2MnO_4^- + 4H_2O \rightarrow 3As^{5+} + 2MnO_2 + 8OH^-$$

- Arsenic (III) is easily oxidized to arsenic (V) with permanganate at 1.26 mg KMnO4-/mg As.
- While As (III) does not adsorb to common alum or ferric oxide coagulants, the oxidized As (V) adsorbs readily to manganese oxides produced in-situ via permanganate treatment.

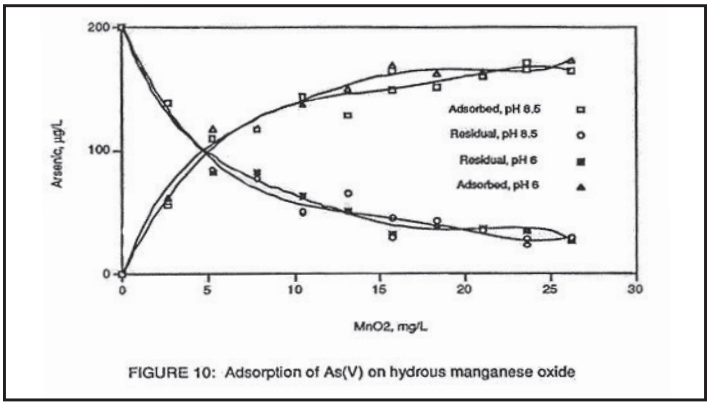

FIGURE 10: Adsorption of As(V) on hydrous manganese oxide

CASE STUDY: MIW DEWATERING (NORTH AMERICA)

An effluent treatment plant (ETP) was built in 2022 to accelerate the dewatering of a wastewater pit containing approximately 80-90 million m^3 of water accumulated since 1930 during previous mining operations. The pit bed is unlined and contains arsenopyrite, with dewatering taking place over the next 7 – 10 years, depending on surface water accumulation. Water quality analysis of the influent water showed a neutral pH with negative ORP and revealed two major elements of concern: **arsenic and cobalt**. The treatment process is required to meet ppb level effluent discharge limits, prior to discharge to a nearby river. This is one of the lower limits in the mining industry, so ultrafiltration (UF) membranes are used to remove up to 5-micron particles if necessary.

The basic treatment process is described below:

1. Oxidation with CARUSOL® liquid permanganate. Permanganate residual is controlled visually
2. Solids coagulation with ferric sulfate
3. pH adjustment with lime (up to 10.6) to prevent cobalt escaping the treatment plant
4. Flocculation and clarification with cationic polymer
5. Filtration with 200-micron pre-filter and 5-micron UF, prior to discharge. UF is used only if there are solids carried over from clarification and pre-filtration
6. Sludge transferred to geotubes for dewatering to 50% solids. Dewatered sludge is landfilled to tailings area.

CHALLENGE

- Lower arsenic to a goal of less than 9 ppb
- Lower cobalt to a goal of less than 7 ppb

SOLUTION

- 2,000 m3/hr of pit water was treated using 20 L/hr of CARUSOL® liquid permanganate and 30 L/hr ferric sulfate, 24 hours per day

RESULTS

- Both arsenic and cobalt levels were reduced below required discharge limits using just 10 ppm of CARUSOL® liquid permanganate
- Influent water ORP is negative as it is collected from the bottom of the pit. After treatment, the effluent ORP is positive

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During its more than 100-year history, Carus' ongoing reliance on research and development, as well as its emphasis on technical support and customer service, have enabled the company to become the world leader in permanganate, manganese, oxidation, and base-metal catalyst technologies.

For further information on CAIROX® potassium permanganate or CARUSOL® liquid permanganate product characteristics and availability, contact Carus at 1(800) 435-6856.

Permanganate products are not registered as a pesticide under the Federal Insecticide, Fungicide and Rodenticide Act administered by U.S. EPA or similar state laws. Use as a pesticide is not government approved.

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