CAIROX® potassium permanganate and CARUSOL® liquid permanganate products are commonly used in drinking water treatment, industrial applications, and wastewater treatment. Both permanganates are strong oxidizers and require careful handling. During the course of the application of permanganate, there is the chance that the neutralization and/or disposal of excess permanganate may be required. Regardless of whether the need is for the clean up and removal of a small spill, the neutralization of excess permanganate solution from equipment, the rinse water produced when cleaning buckets and drums or any other activity where excess permanganate may cause a concern, following a few simple rules will ensure that the process will be safe and easy.

If neutralization is required because of a spill, and the spill is a CAIROX product, it can be swept or shoveled and transferred to a clean, metal container. Dilute the product with water, and mix the solution until all the crystals are dissolved prior to neutralization.

If the spill is a liquid CARUSOL solution, contain the liquid by diking or collecting and neutralize. If the spill is CARUSOL, the first step is to contain or collect the spill. Prior to any neutralization, sodium permanganate MUST BE DILUTED with water to a concentration of 6% or less. Once the product has been diluted, it can be safely neutralized.

There are a number of different chemicals that will neutralize permanganate solutions. Below are some of the commonly used chemicals, their reactions with permanganate, and the stoichiometric requirements.

**Sodium thiosulfate**

\[ 8 \text{KMnO}_4 + 3 \text{Na}_2\text{S}_2\text{O}_3 + \text{H}_2\text{O} \rightarrow 3 \text{K}_2\text{SO}_4 + 3 \text{Na}_2\text{SO}_4 + 8 \text{MnO}_2 + 2 \text{KOH} \]

Weight Ratio: 0.375 parts \( \text{Na}_2\text{S}_2\text{O}_3 \): 1 part \( \text{KMnO}_4 \)

**Manganous sulfate**

\[ 2 \text{KMnO}_4 + 3 \text{MnSO}_4 + 2 \text{H}_2\text{O} \rightarrow \text{K}_2\text{SO}_4 + 2 \text{H}_2\text{SO}_4 + 5 \text{MnO}_2 \]

Weight Ratio: 1.43 parts \( \text{MnSO}_4 \): 1 part \( \text{KMnO}_4 \)

**Hydrogen peroxide**

\[ 2 \text{KMnO}_4 + 4 \text{H}_2\text{O}_2 \rightarrow 2 \text{KOH} + \text{MnO}_2 + 3 \text{H}_2\text{O} + 4 \text{O}_2 \]

Weight Ratio: 0.43 parts \( \text{H}_2\text{O}_2 \): 1 part \( \text{KMnO}_4 \)

Note: at pH <9, more may be needed due to self decomposition of peroxide

**Citric Acid**

\[ 6 \text{KMnO}_4 + \text{C}_6\text{H}_8\text{O}_7 + 6\text{H}^+ \rightarrow 6 \text{MnO}_2 + 6 \text{CO}_2 + 7 \text{H}_2\text{O} + 6 \text{K}^+ \]

Weight Ratio: 0.20 parts \( \text{C}_6\text{H}_8\text{O}_7 \): 1 part \( \text{KMnO}_4 \)

**Ascorbic Acid**

\[ 20 \text{KMnO}_4 + 3 \text{C}_6\text{H}_8\text{O}_6 + 20 \text{H}^+ \rightarrow 20 \text{MnO}_2 + 18 \text{CO}_2 + 22 \text{H}_2\text{O} + 20 \text{K}^+ \]

Weight Ratio: 0.167 part \( \text{C}_6\text{H}_8\text{O}_6 \): 1 part \( \text{KMnO}_4 \)
In addition to the previously mentioned neutralizing agents, permanganate solutions can be neutralized using the following:

Cleaning/Neutralizing Solution
This solution consists of products that can be purchased from a local food or drug store. This solution is especially effective for removal of brown stains on skin; however, it has also been used as a neutralization solution for small spills. It would not be economical for anything but the smallest volumes of dilute permanganate.

30 parts water: 40 parts white vinegar: 30 parts 3% hydrogen peroxide

Sugar
White sugar is also readily available and can be used to neutralize permanganate solution. The reaction of permanganate and sugar is relatively slow, taking about 30 minutes for a complete reaction. The by-product of the reaction is typically a gelatinous residue.

Sugar (C₁₂H₂₂O₁₁) Weight Ratio: 0.18 parts sugar : 1 part KMnO₄

The following chart summarizes the amount of neutralizing agent required, in pounds, to neutralize one pound of permanganate.

- Never use any of these solutions on sensitive tissues such as eyes, mucous membranes, open wounds, etc.
- Do not add directly to concentrated permanganate solutions.
- Dilute the permanganate solution to less than 6% before using any of these solutions.