

This information sheet is intended to assist the waterworks designer, owner, manager or operator in understanding the use of Potassium Permanganate and the related requirements of *The Waterworks and Sewage Works Regulations*.

## WSA 509 – Potassium Permanganate

### What is Potassium Permanganate?

Potassium Permanganate ( $\text{KMnO}_4$ ) is an oxidant used primarily to control taste and odors, remove color, control biological growth in water treatment plants, and in the regeneration of Manganese Greensand filters to remove iron and manganese. It is also used in controlling Disinfection Byproducts (DBPs) by oxidizing precursors and reducing the demand for other disinfectants. Potassium permanganate has many potential uses as an oxidant it is however a poor disinfectant. Potassium permanganate is generally available in granular form as free flowing crystals. Note that all chemicals used to treat water intended or used for human consumptive or hygienic use must be approved for that purpose as per section 27 of *The Waterworks and Sewage Works Regulations*.

### Do I need a permit to add Potassium Permanganate to my water treatment plant?

Yes, you must get a Permit for Construction of Waterworks from the Water Security Agency (WSA) prior to adding potassium permanganate to your water treatment system. The application must include an alteration design plan stamped by a Professional Engineer licensed to practice in Saskatchewan that includes the equipment, piping/feed system to be installed and target dosage rates, a startup plan describing the dosage rate of  $\text{KMnO}_4$  during commissioning, and all other routine application requirements seen in section 1 of the WSA's document *EPB 501 – Waterworks Design Standard*.

### Is Potassium Permanganate the only chemical used to regenerate Manganese Greensand?

No, chlorine can also be used to continuously regenerate manganese greensand filter media however, potassium permanganate is typically the popular choice as it provides other benefits such as a strong oxidant for iron and manganese removal processes. In order to achieve continuous regeneration of manganese greensand filter media, the operator normally adjusts the dosage rate such that a slightly pink color can be observed in the filter influent, and clear water is observed in the filter effluent. The following is the typical color progression found prior to entering filters: light yellow, straw yellow, brown, slightly pink, pink, dark pink. It is important to remember that each water treatment system will require a different dosage, and resulting color, to achieve the optimum Iron and Manganese removal. If questions exist with regards to the proper dosing of potassium permanganate specific to your waterworks please contact a qualified consultant, contractor or chemical supplier for assistance.

### How do I prepare a dilute solution?

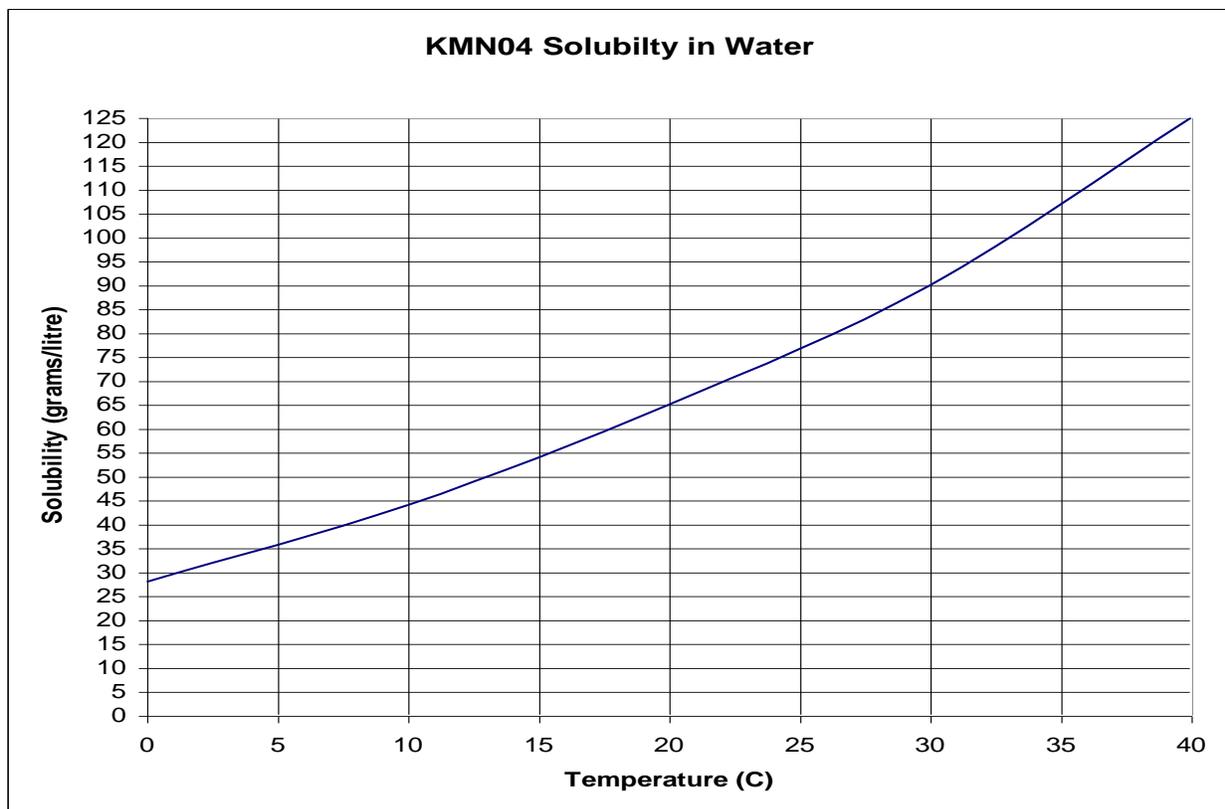
Potassium permanganate is usually supplied in dry form. A concentrated  $\text{KMnO}_4$  solution (typically 1 to 4 percent) is generated on-site for water treatment applications. The solution is pink or purple in color.  $\text{KMnO}_4$  has a bulk density of approximately 1.602kg/l (100lbs/ft<sup>3</sup>) and its solubility in water is 0.064 g/mL at 20°C.

KMnO<sub>4</sub> solution is made up of dry crystalline permanganate solids added to make-up water and then stirred to obtain the desired permanganate concentration. Shipment containers are typically buckets or drums. Potassium

permanganate is supplied in various grades. Pure  $KMnO_4$  is non-hygroscopic but technical grades will absorb some moisture and will have a tendency to cake together. For systems using dry chemical feeders, a free-flowing grade is available that contains anticaking additives (Hazen and Sawyer, 1992). Contact your chemical supplier for approved products appropriate for your waterworks.

Potassium permanganate is a strong oxidizer and should be carefully handled when preparing the feed solution including following all applicable Occupational Health and Safety / Workplace Safety requirements. This typically dark purple/black crystalline solid can cause serious eye injury, is a skin and inhalation irritant, and can be fatal if swallowed in its concentrated form. As such, special handling procedures include the use of safety goggles and a face shield, an MSA/NIOSH approved dust mask, and wearing impervious gloves, coveralls, and boots to minimize skin contact. The Material Safety Data Sheet (MSDS) must be reviewed prior to handling.

The table below indicates the solubility of  $KMnO_4$  in water at various temperatures. For example, if the water temperature in your solution barrel is  $5^\circ C$ , then the maximum strength the solution can be is 3.6%. Trying to mix stronger solutions will result in  $KMnO_4$  not dissolving, therefore settling in the bottom of the solution barrel.



Temperature		Solubility		
$^\circ C$	$^\circ F$	gm./litre	oz./gal	lb./100 gal
0	32	28	3.75	23
10	50	44	5.85	36
20	68	65	8.6	54
30	86	90	12	75
40	104	125	16.7	104

## How do I feed Potassium Permanganate?

In conventional treatment plants, potassium permanganate solution is added to the raw water intake, at the rapid mix tank in conjunction with coagulants, or at clarifiers upstream of filters. In direct filtration plants, this oxidant is typically added at the raw water intake to increase the contact time upstream of the filter units. In all cases, potassium permanganate is added prior to filtration. For improved Manganese removal increased detention time is generally required.

Potassium permanganate solution is typically pumped from the concentrated solution tank to the injection point. If the injection point is a pipeline, a standard injection nozzle protruding midway into the pipe section is used. Injection nozzles can also be used to supply the solution to mixing chambers and clarifiers. Permanganate is a reactive, fast-acting oxidizer and does not require special mixing equipment at the point of injection to be effective. Some factors that affect removal efficiency include pH, temperature and the water chemistry.

In utilizing potassium permanganate in water treatment, caution should be taken to prevent overdosing, in which case, excess manganese will pass through the treatment plant. Proper dosing should be maintained to ensure that all of the permanganate is reduced (i.e., forming MnO<sub>2</sub> solids) and removed from the plant upstream of, or within, the filters. If residual manganese is reduced downstream of the filters, the resulting solids can turn the finished water a brown/black color and precipitate in the homes of consumers on heat exchange surfaces such as hot water heaters and dishwashers. Use of potassium permanganate can also be a source of manganese in the finished water, which currently has a maximum aesthetic residual of 0.05 mg/L.

Any questions regarding the proper application methods and/or location of potassium permanganate injection points within your waterworks should be referred to a qualified consultant or industry professional. In some cases relocating chemical injection points can alter aspects of the treatment process such that a permit to construct and/or alter may be required from the WSA.

## What should I do if I receive complaints about pink water?

If you are getting complaints about pink water from residents, or pink water is detected within your finished water reservoir, you have an upset condition at your water treatment plant, which may have originated from a potassium permanganate overfeed. Contact your EPO immediately as this is considered an "Upset Condition" as defined in Section 34 (1) of *The Waterworks and Sewage Works Regulations*. If your EPO is not available, call the 24 hour Upset Reporting line at 1-844-536-9494. Staff at the upset reporting line will record your contact information as well as information regarding the upset condition. They will contact the EPO on call, and he or she will contact you. Some of the information the EPO will be looking for is the strength of the solution, the estimated volume of solution used, and the estimated volume of water affected. The Maximum Use Level (MUL) for Potassium Permanganate is 50 mg/l. Pink water will be detected by the consumer well before this level is reached, therefore pink water is not usually considered a threat to public health. It may result in staining laundry and plumbing fixtures.

In some instances such as a very high or unknown degree of overdose it may be advisable for customers to be informed that if they observe any pink water they should flush the tap until it clears up. Although "pink water" may be safe from a toxicological viewpoint, it is recommended that customers do not drink the pink water. A flushing program may be needed to eliminate any excess residual permanganate in the distribution system.

### Is more information on potassium permanganate available?

Additional information on design and safe use of potassium permanganate is available from engineering consultants and water treatment chemical suppliers.

Additional information on the regulation of potassium permanganate is available from the WSA's Environmental Project Officers and Approvals Engineers. To speak to an Environmental Project Officer or an Approvals Engineer please call 306-787-0726.