Potassium Permanganate
A Versatile Oxidant for Water & Effluent Treatment

Potassium permanganate ($KMnO_4$) is most widely used for odour control in sewage and waste water treatment, and taste/odour improvement and manganese removal in the preparation of potable water.

It has received wide accreditation in the USA (and Europe) for the treatment of drinking water, where it is used by 37% of plants treating surface water. All products meet the standard of BSEN 12672:2000 for use in drinking water in the United Kingdom and Europe and the American Waterworks Association (AWWA) Standard B603 details the product standards required for potassium permanganate. Potassium permanganate reacts more rapidly than other oxidants, eg. hydrogen peroxide, iron salts, nitrates. Its distinctive pink colour in water is an advantage since it indicates when overdosing is occurring in destructive oxidation applications, eg. Water and effluent treatment. Potassium permanganate has a solubility of 65 g/l in water (at 20°C; see Figure 1), a decomposition temperature of 150°C, and a bulk density of 1602 kg/m³. It is readily soluble in water with vigorous mixing.

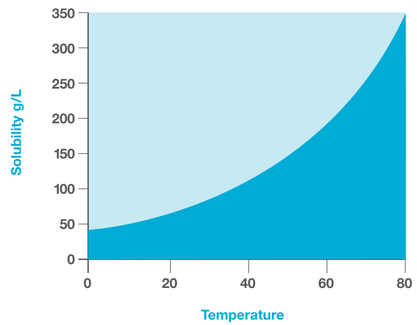

Figure 1
Solubility of potassium permanganate in water

Potassium permanganate works over a wide pH range, but generally is most effective in the range pH 5 - 10 because permanganate oxidations of organic compounds are catalysed by hydroxyl ions. Elemental sulphur is formed under acidic conditions, the reaction requiring 0.66 moles of permanganate per mole of sulphide. As the pH is increased, sulphate formation increases and under alkaline conditions becomes the dominant oxidation product with 2.66 moles of permanganate required per mole of sulphide.

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Compounds Oxidised by Potassium Permanganate in Various Industries

	Aldehydes	Amines	Phenols	Organic Acids	Mercaptans	Ketones	Organic S compounds	Hydrogen sulphide
Water treatment	●	●		●			●	●
Pulp/paper					●		●	●
Petroleum refining			●		●		●	●
Foundries	●	●	●					
Rendering	●	●		●		●	●	
Food processing	●	●		●	●		●	
Paints/Varnishes			●	●		●		
Grain drying	●	●		●				
Fats/Oils	●	●		●				
Asphalt roofing			●			●	●	●
Plastics	●	●	●			●		

Table summarises the uses of permanganate for the oxidation of waste compounds encountered in a range of processing industries.

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Water Treatment

Potassium permanganate is used to oxidise organic matter in the purification of drinking water, the cause of taste, odour and colour problems. Approximately 40% of the permanganate used in the USA is in the treatment of drinking water.

Its main use in treating surface waters is to control odour and taste, manganese and trihalomethane (THM) contamination. It also oxidises hydrogen sulphide, thereby eliminating the rotten egg smell present in raw water supplies. A number of other benefits are reported by users including improved coagulation and colour. It is also used for the elimination of bacterial growth in raw water pipelines, Zebra mussel and Algal toxin control.

It is widely used for treating ground waters for the removal of iron, manganese, sulphide and colour problems. It oxidises dissolved iron and manganese to produce insoluble oxides which can then be settled and filtered out. It is also used in conjunction with manganese-treated greensand to reduce high concentrations of radioactive nucleides and arsenic.

The potassium permanganate dosage level needed in most water treatment situations is usually about 1ppm. The dose for manganese removal in drinking water is equal to the manganese level and that for iron about 66% of the iron level. Permanganate is best added ahead of other chemicals in the water treatment process.

This allows it to react efficiently and effectively, often leading to a reduction in the amount of other chemicals subsequently needed (eg. chlorine, flocculants). For example, a water treatment plant found that the addition of 1 ppm potassium permanganate was able to reduce the amount of downstream activated carbon needed for taste and odour control from 30 ppm to 8 ppm, resulting in a significant cost saving.

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