Factsheet

# Testing Sodium Percarbonate (producing $H_2O_2$) as an algaecide for control of cyanobacteria

## Background

**Cyanobacteria can be a significant issue for both water and wastewater systems due to the taste and odour and toxic metabolites they produce. Water treatment technology is available to remove these metabolites, but it usually requires advanced oxidation or adsorption techniques, which may not always be available and can be expensive in terms of both capital and operating costs. It is therefore desirable and attractive to treat or remove cyanobacteria at the source.**

Algaecides provide an effective short-term chemical control method for cyanobacteria in circumstances where alternative drinking water sources are either not available or preventive measures are not feasible. Algaecides provide an effective short-term chemical control method for circumstances where alternative drinking water sources are either not available or preventive measures are not feasible. For many years copper sulphate has been widely used in both the US and Australia to control cyanobacteria due to its effectiveness, cost efficiency and general safety to humans at the doses used. However, copper can adversely affect a variety of non-target freshwater organisms and in recent years environmental regulations in many countries, including Australia, now prohibit or limit its use. These issues have elicited a need to develop an alternative. Hydrogen peroxide has been identified as a possible option.

Other national and international researchers have shown the potential for hydrogen peroxide $H_2O_2$ to be used as an algaecide (Barrington & Ghadouani 2008, Barrington et al. 2011 & 2013, Geer et al. 2016, Mattheiss et al. 2017, Weenink et al. 2015, Yang et al. 2018, Zamyadi et al. 2020). In particular, Matthijs et al. 2011 successfully treated a recreational lake in the Netherlands using liquid $H_2O_2$. However, OH&S issues associated with liquid $H_2O_2$ would limit its use and the safer dry form, sodium percarbonate, is seen as a preferred option. There are several commercially available sodium percarbonate products available in the US, where they are EPA approved for use in lakes, reservoirs and farm dams. Sodium percarbonate dissolves in water to produce hydrogen peroxide and sodium carbonate. The algicidal activity of hydrogen peroxide is achieved through its ability to oxidise the proteins, lipids and nucleic acids of cyanobacteria. Hydrogen peroxide decomposes to produce innocuous by-products of water and oxygen.

$$2Na_2CO_3.3H_2O_2 \xrightarrow{H_2O} 2Na_2CO_3 + 3H_2O_2$$

$$2\,H_2O_2 \xrightarrow{\text{Oxidation and Decomposition}} 2\,H_2O + O_2$$

## Key Points

- Environmentally friendly algaecide needed for control of cyanobacteria in water and wastewater storages.
- Sodium percarbonate shows great potential as a cyanobacteria control option in small water and wastewater storages.
- Targeted application of chemical is important for effective treatment of a water body.
- Sodium percarbonate will need APVMA approval before widespread use as an algaecide is allowed.


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- Catchments, Wastewater and Environmental Science
- Land Management and Reservoirs
- Production and Treatment Support
- South Para Workshop
- Wastewater Treatment and Operations

# Testing Sodium Percarbonate (producing $H_2O_2$) as an algaecide for control of cyanobacteria

Following positive results from a South Australian Water Corporation (SA Water) led laboratory and small scale in-situ based investigations to assess the efficacy of sodium percarbonate as an algaecide (Hobson 2014), it was decided to further test its applicability as a copper sulphate replacement using larger scale in-situ testing (Hobson 2017, Hobson 2019). As part of the investigation a treatment method for control of cyanobacteria in small wastewater lagoons was also developed. Sodium percarbonate is not currently registered for use as an algaecide in Australia and work presented here was conducted under a research permit from the Australian Pesticides and Veterinary Medicines Authority (APVMA).

## Use of Algaecides in Australia

Agricultural chemicals and veterinary medicines (Agvet chemicals, which include algaecides) are regulated through a cooperative National Registration Scheme for agricultural and veterinary chemicals (NRS). Under the NRS, a single national Agvet Code operates throughout Australia. Assessment and registration of Agvet chemicals, as well as control of supply activities up to the point of retail sale, is undertaken by the Commonwealth authority, APVMA. The control of Agvet chemical use after sale is the responsibility of individual states and territories.

Several algicides have been registered by the APVMA but with specific provisions:

- Copper sulphate – approved for specific locations. Use at other locations would need approval.
- Chelated Copper Products – approval given for use in water storages including potable water supplies, farm dams, industrial and ornamental ponds, and irrigation channels.
- Simazine – use in dams in WA only.
- Halogen Based Broad Spectrum Biocides – irrigation lines only.

Any use of these chemicals needs to comply with state and territory legislation usually via agricultural and/or environmental agencies. It is recommended that these state agencies be contacted before any algaecide is used.

## Sodium Percarbonate

**Wastewater Lagoon**

The test site experiences high numbers of *Microcystis flos-aquae* which under certain circumstances may need to be controlled to meet government guidelines. Sodium percarbonate offered a potential control method to reduce cell numbers to meet these guidelines. A design for a solution tank and spray system was developed by SA Water (Figure 1). The tank is filled with tap water before sodium percarbonate is added and mixed to produce a 2% hydrogen peroxide solution. An electric pump is used to distribute the hydrogen peroxide solution through a spray system floating on the surface of the lagoon to achieve a uniform application. Results showed that a dose of 40 mg $H_2O_2$/L (800 kg of sodium percarbonate) resulted in a 50 to 80% reduction in *Microcystis flos-aquae* after 7 days. There was minimal impact on other non-problem cyanobacteria and green algae which are beneficial for oxygenation of waste stabilisation lagoons. Water chemistry variables of pH and dissolved oxygen were relatively unaffected and returned to levels observed prior to dosing after 7 days

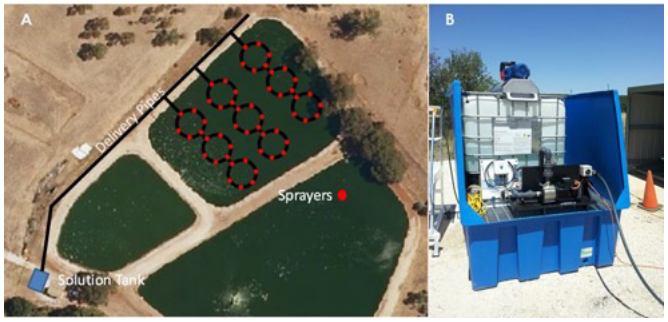


*Figure 1: Wastewater lagoon hydrogen peroxide delivery system (A) with mixing tank and pump (B).*

**Reservoir**

The test reservoir has had a history of geosmin producing *Dolichospermum circinale* and due to the limitations of the treatment plant the operators have removed this cyanobacteria from the source by dosing with copper sulphate. An important component of the project was the successful development of a dosing boat that safely dosed sodium percarbonate (oxidising agent) and achieved a uniform distribution of the chemical both spatially and through the water column to ensure maximum exposure of cyanobacteria to the algaecide (Figure 2). The equipment adds dry sodium percarbonate to a pumped stream of water via a hopper and returns the solution to the reservoir through two spray units located at the rear of the boat.

*Figure 2: Dosing boat*

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Two experimental approaches were used at the reservoir to investigate the efficacy of sodium percarbonate as a copper sulphate replacement:

1. Large Curtain Trial - isolation of *D. circinale* in one arm of the reservoir using a large aquatic silt curtain from top to bottom of the water column (Figure 3). This enclosed arm was treated with sodium percarbonate using the purpose-built dosing boat. This tested the efficacy of the boat to distribute the chemical on a large scale as well as the impact on cyanobacteria growth.
2. Mesocosm Trial - Four circular mesocosms of same size containing similar numbers of *D. circinale* were dosed with either copper sulphate or sodium percarbonate to compare the efficacy of each algaecide under the same experimental conditions (Figure 4).


*Figure 3: Curtain located in reservoir arm.*

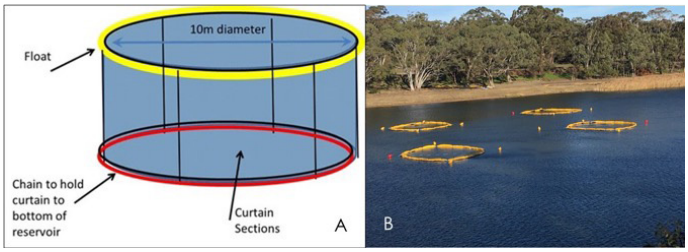


*Figure 4: Mesocosm design (A) and reservoir installation (B).*

Studies showed that sodium percarbonate at a dose of 1.5 mg $H_2O_2$/L achieved a comparable reduction in *D. circinale* to a copper sulphate dose of 0.5 mg Cu/L which is the current application rate used by reservoir operators. There was minimal impact on beneficial green algae and no significant impact on water chemistry. Eco-toxicological studies in reservoir water showed that there would be minimal impact of sodium percarbonate on commonly used test organisms (adult and juvenile fish, midge larvae, shrimp, snail and waterflea) at the dosed concentrations.

A dose of 1.5 mg $H_2O_2$/L equates to approximately 60 tonnes of sodium percarbonate for a whole reservoir application. This is significantly more than the current copper sulphate dose of 20 tonnes and would require new infrastructure for chemical handling and dosing. Further assessment of sodium percarbonate as a viable option for this reservoir is being considered in conjunction with proposed changes to catchment management and treatment plant upgrades. Sodium percarbonate is also being considered for use in smaller reservoirs where less algaecide would need to be dosed and the current dosing equipment is suitable.

## Conclusion

Sodium percarbonate shows great potential for control of problem cyanobacteria in both water and wastewater storages. Its effectiveness will be dependent on correct dose quantities to suit water quality conditions and optimised application procedures to ensure maximum exposure of cyanobacteria. While dosing large reservoirs may not be logistically or economically possible, it could be a viable option for small reservoirs or spot dosing localised concentrations of cyanobacteria in larger storages. However, sodium percarbonate will need to be approved by APVMA before its widespread use as an algaecide in Australia is allowed.

## References

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