

Validating adsorptive treatment systems

based on Street map 5

Water is being recycled all over Australia for a variety of uses. To protect the health of people and the environment, treatment technologies used in water recycling schemes need to meet agreed performance targets. Across Australia there is currently no consistent approach to validating that they do so. The Australian Water Recycling Centre of Excellence engaged Water Quality Research Australia to deliver a national framework for validating treatment technologies.

After much consultation, the project team, comprising researchers, industry specialists and regulators, has designed a workable, accepted framework. The next steps are to fill some of the knowledge gaps and negotiate with industry and government to have the framework implemented.



Photo sourced from CSIRO

What is validation?

The *Australian Guidelines for Water Recycling (2006)* require that a treatment technology or process be validated before the water recycling scheme is operational. Validation is the confirmation that the treatment technology meets the specified performance targets. The guidelines describe the concept of and need for validation but do not specify how the validation should be done.

What is an adsorptive treatment system?

Adsorptive treatment systems treat wastewater by using fine particles (called 'adsorbents') to trap contaminants. The contaminants stick to the adsorbent particles which are then removed from the water.

Examples of adsorbents are:

- activated carbon
- sand
- anthracite (a type of coal)
- silica gel.

Adsorptive treatment systems can reduce the levels of:

- organic compounds
- inorganic compounds (such as nitrogen and heavy metals)
- pathogens (microorganisms that cause disease).

Current and emerging validation techniques

Adsorptive treatment systems are generally well understood, though in Australia they are not often used for water recycling and there is no specified method for validating them. Water treatment guidelines do not include details about validation of activated carbon treatment, for example. As a result, operators create validation methods on a case-by-case basis.

Standard validation methods would make validation more consistent, simpler and cheaper—and could, as a result, make adsorptive treatment systems more appealing.

Described below are examples of how some operators approach operational monitoring of their individual or combined adsorptive treatment systems

- **Sand and/or anthracite.** The 'before' and 'after' levels of various microorganisms, turbidity, suspended solids, biological oxygen demand, pH, and chlorine are measured.
- **Granular or biologically activated carbon.** Levels of nutrients and organic compounds are measured.
- **Ozone and biologically activated carbon.** Levels of dissolved organic carbon, biological oxygen demand, suspended solids, nitrogen, phosphorus, and microorganisms are measured.

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The need for backwashing (a way of cleaning) the system is assessed.

- **Dual-media filtration and biologically activated carbon.** Levels of organic compounds, inorganic compounds, turbidity, suspended solids, dissolved solids, conductivity and pharmaceutical compounds are measured.
- **Powdered activated carbon.** Levels of organic compounds, inorganic compounds and suspended solids are measured.
- **Moving-bed counter-current ion exchange.** In this new system, levels of organic compounds, inorganic compounds, microorganisms, turbidity, suspended solids, dissolved solids, hardness and colour are measured.

Validation limitations and difficulties

Validating adsorptive treatment systems can be difficult due to frequent cleaning (or regeneration) which changes the operational condition of the adsorptive media.

Some particular challenges for removing pathogens and micropollutants are outlined below:

Removing pathogens

- Many factors affect how well an adsorptive treatment system removes pathogens. Factors include adsorptive particle size, water flow rate, clogging, the type of organic matter, pH, temperature, microorganisms growing on the adsorbents. It is not yet fully understood how much each of these factors affects the removal of pathogens.
- Operators need to choose appropriate microorganisms ('surrogates' or 'indicator organisms' that operators measure to determine how much actual pathogen has been removed) to measure pathogen removal.

Removing micropollutants

Contaminants that are present in very small concentrations, such as pharmaceuticals and steroid hormones, are known as micropollutants. Their removal can be hard to validate for the following reasons:

- It is possible to measure how well activated carbon, for example, adsorbs various organic or inorganic compounds; however, when compounds mix in the wastewater, they may be adsorbed in unexpected ways.
- If further validation is needed beyond current methods, researchers need to decide which chemicals to test at each stage and which tests to use.
- Hydrophobic ('water hating') substances such as oil are adsorbed differently to hydrophilic ('water loving') substances such as pesticides and each presents its own validation challenges.

Research gaps

The main knowledge gaps are:

- How well chemical characteristics such as total or dissolved organic carbon (which are most often measured to assess the effectiveness of water treatment) reflect the removal of contaminants, or represent the overall toxicity of the water.
- How pathogens are removed within packed-bed processes (where adsorptive treatment systems are put into tubes/pipes), and whether or how they come out during backwashing.
- How to validate and adapt computer models that predict adsorption of contaminants and pathogens in wastewater systems.
- How regeneration (cleaning of the adsorbent particles) affects adsorption effectiveness.

Recommendations

Address the research gaps listed above.

Conduct a national survey to:

- confirm and further identify industry, regulator and emerging research concerns
- give a holistic, integrated approach to adsorption treatment system validation knowledge
- track which treatment plant/design people have already provided input.

From the survey results, create a database of industry practices and issues.

National Validation Framework factsheet suite

This brochure is based on a 'road map' report funded by the Australian Water Recycling Centre of Excellence. The 'road map' describes a national approach for validating treatment technologies, and was based on extensive consultation with stakeholders.

This brochure is one of a series that describes the outcomes of the first stage of this national validation project.

Other brochures in the series cover:

- > An overview of the draft National Validation Framework
- > Perspectives of water recyclers, technology suppliers and regulators
- > Validation of various treatment systems
- > Building capacity in the industry

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