Chlorine filtration in dialysis – how advanced sensing is raising the bar

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In 2022, more than 30,000 people in the UK were undergoing kidney dialysis. For every one of those patients, water quality is not a background consideration but a frontline safety issue. Dialysis machines rely on large volumes of treated water, and any trace contaminants that remain can pass directly into the bloodstream. Among the most critical of these contaminants is chlorine.

Chlorine is essential for the disinfection of drinking water, protecting public health by controlling microbial growth. However, what is beneficial at the municipal supply level becomes dangerous once water is used for haemodialysis. Even trace levels of free chlorine or chloramines can damage red blood cells, cause haemolysis and lead to serious patient harm. As a result, dialysis water treatment systems must reliably remove chlorine and continuously verify that removal is effective.

The role of carbon filters in dialysis water treatment

Granular activated carbon (GAC) filters are the established solution for removing chlorine in dialysis plants. Installed upstream of reverse osmosis (RO) membranes and dialysis machines, these filters adsorb chlorine and in most cases chloramines too, protecting both patients and sensitive downstream equipment, helping to ensure a continuous supply of purified water.

However, GAC filters are consumable assets. Their performance degrades over time depending on inlet chlorine concentration, water flow rates and total throughput. If a filter becomes saturated with chlorine without detection, chlorine breakthrough can occur suddenly. For dialysis centres and hospitals, this makes effective monitoring essential.

Best practice requires chlorine to be measured both before and after the carbon filters. At the inlet, operators need to understand the incoming chlorine load and track trends over time. At the outlet, they must confirm “zero chlorine” conditions continuously. Any delay in detection increases the risk of exposure, which is why response time and measurement reliability are so critical.

Limitations of traditional chlorine monitoring

Historically, chlorine measurement has relied on either amperometric sensors with electrolyte buffers or colourimetric analysers. While both technologies are well established, neither is ideally suited to high-criticality healthcare applications.

Traditional amperometric probes typically have T90 response times of two to three minutes and require frequent maintenance. Electrolytes must be replenished, membranes cleaned and electrodes manually serviced to remove scaling. Measurement accuracy is also sensitive to pH drift, often necessitating offline verification.

Colourimetric analysers offer good accuracy but at the cost of speed and complexity. Reagents must be handled and replaced, and while full reaction times can be completed in 2-3 minutes, sampling frequency is often reduced to once every 15 minutes to an hour, to save on costly reagent consumption. For dialysis water systems, where rapid response to chlorine breakthrough is essential, these delays can compromise safety margins.

A new approach to verifying filter performance

This is where Bürkert's MS02 Chlorine Cube sensor offers a new solution. Originally developed for demanding pharmaceutical and drinking water applications, the MS02 has proven particularly well suited to monitoring GAC filters in dialysis water treatment systems.

The MS02 uses an innovative amperometric-on-chip design protected by an immobilised membrane, eliminating the need for electrolyte buffers. This allows it to achieve a T90 response time of around 30 seconds, dramatically faster than conventional technologies. For dialysis applications, that speed means faster alarms, quicker intervention and reduced risk to patients.

Crucially, the MS02 is sensitive enough for zero-chlorine measurement, making it ideal for monitoring the outlet of carbon filters. Its stable floating zero point avoids polarisation effects and removes the need for artificial chlorine dosing, simplifying system design and validation. With no reagents and minimal maintenance requirements, the sensor supports long service intervals – users have reported continuous operation for over two years without recalibration.

Bürkert's wider role in dialysis technology

Chlorine monitoring is only one part of the dialysis process, and Bürkert's involvement goes far beyond sensing. The company works closely with dialysis machine manufacturers through its global network of Systemhaus locations, supporting projects from concept development through to full-scale production.

A notable example is Bürkert's collaboration with a leading manufacturer on its latest dialysis machine. By developing a compact, integrated fluidic assembly incorporating valves, sensors and pumps, Bürkert helped simplify setup, reduce error risk and improve workflow efficiency for clinical staff. All components are

designed to meet stringent medical standards for hygiene, durability and biocompatibility, while also supporting quieter operation for home and nocturnal dialysis environments.

This systems-level expertise is increasingly important as dialysis treatment evolves. With more patients opting for home haemodialysis or overnight therapies, manufacturers face growing demands for compact, reliable and user-friendly equipment that does not compromise on safety.

Recognition for innovation

The significance of Bürkert's advances in chlorine measurement has recently been recognised by the industry. The MS02 Chlorine Cube sensor was recently awarded Highly Commended – Sensor Product of the Year by a leading industry magazine, underlining its impact in high-criticality applications such as healthcare and water treatment.

Safeguarding patients

As the global incidence of chronic kidney disease continues to rise, the pressure on dialysis infrastructure will only increase. Ensuring that every litre of water used in treatment is free from harmful chlorine is a non-negotiable requirement.

By combining proven carbon filtration with fast, accurate and low-maintenance chlorine sensing, dialysis users can significantly reduce risk while improving operational confidence. Bürkert's MS02 sensor, alongside its broader expertise in fluid control and medical system integration, demonstrates how innovative engineering can translate directly into safer outcomes for patients and greater assurance for clinicians and operators alike.

Image captions:

Image 1: Periodic maintenance is simple with plug-and-play design.

Image 2: An example of Bürkert's compact solutions for measuring free-chlorine after a granular activated carbon filter.

About Bürkert

Bürkert Fluid Control Systems is one of the leading manufacturers of control and measuring systems for fluids and gases. The products have a wide variety of applications and are used within food & beverage, pharmaceutical and water industries as well as in medical engineering and space technology. The company employs over 3,700 people and has a comprehensive network of branches in 36 countries world-wide."

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