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A Cantel Medical Company

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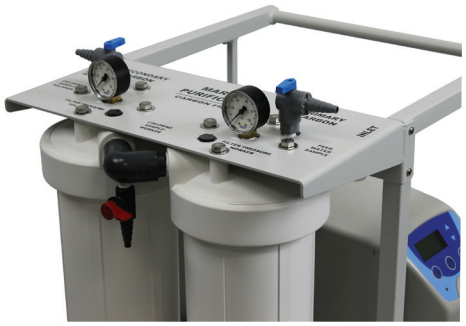
PTG-520 Compact Carbon Filtration

Application Brief: The Use of Carbon Block Technology for Portable RO Dialysis Applications

Introduction

The use of carbon filtration prior to a Reverse Osmosis (RO) system in single patient and acute situations is very critical. Not only does the carbon prevent chlorine from permeating through the membrane and compromising patient safety but it also protects the RO membrane from being irreversibly damaged. For these reasons, the use of carbon filtration includes specific design and operating parameters to help ensure chlorine is removed prior to the RO.



PTG-520 Carbon Filtration System

The specific regulations pertaining to the use of carbon are detailed in ANSI/AAMI RD52:2004 and specifically Amendments 1-3, Annex's C, D, and E that have been adopted by CMS. In the document, the regulations state that "where practical" two (2) carbon filtration beds should be arranged in series such that the incoming water has a minimum contact time of 5 minutes per bed or 10 minutes total Empty Bed Contact Time (EBCT) or two carbon block filters in series arrangement can be used provided that performance can be verified by the manufacture/supplier. This equivalency was demonstrated by Mar Cor Purification (MCP) for the two carbon block filters in series as shown below under Results.

At this time, in order to achieve 10 minute EBCT, most users utilize 2 carbon filtration beds in series using an exchangeable carbon vessel holding from 0.66 to 0.85 cu. ft. of carbon media (depending on the RO flowrate and recovery), which weighs between 200-300 lbs. This arrangement results in a very heavy and unstable setup when situated on a portable cart. A cart is necessary, particularly in acute settings, in order to transport the water system to the bedside of the patient to be treated. Because the cart has to be narrow (less than 30" wide) and compact due to usage and storage considerations, the portable cart becomes heavy and unstable resulting in difficulty in moving and thereby leading to possible injury to the care giver. A duplex carbon block filtration arrangement would result in a total weight of 50 lbs.

Current Cart Design

Dialysis providers have appealed to the water system suppliers to develop an alternative that will ensure chlorine and chloramines are fully and reliably removed prior to the RO in a package that is lighter, not so cumbersome, and cost effective. MCP investigated carbon block technology and found that specific testing to verify performance for dialysis applications had not been done. MCP has now performed this testing to allow safe use of carbon block technology in dialysis applications.

Testing Procedure

In order to determine the efficiency and life of the carbon block technology, MCP set-up a test apparatus that would closely mimic the worse case field conditions that the carbon block would encounter. Once the test environment was established, the operating conditions and product water chemistry needed to be continuously monitored to identify carbon

block life and any breakthrough of chloramines.

Because chloramine is used as a disinfectant in many municipal water systems in the country and is more difficult to remove, MCP decided to use chloramine as the performance indicator. EPA water regulations recommend a maximum chloramine concentration of 3.0 ppm in drinking water; MCP used this level of chloramine as the test challenge. For the case of chlorine, which is easier to remove, most drinking water will never approach the equivalent level of chloramine; in fact the maximum recommended value is 1.0 ppm of free chlorine in drinking water.

For the test, two carbon block cartridges were plumbed in series and flushed for 5 minutes at 1.10 gpm prior to testing. Chloramine reduction testing was conducted with an intermittent cycle with 600 seconds on/600 seconds off (to simulate a worse case on/off condition that would challenge the carbon block). Tap water was pre-filtered. Sodium Hydroxide, Ammonium Chloride and bleach were added to achieve a challenge level in the water of 3.0 mg/L (+/-10%) chloramine at a pH of 8.75-9.25 and excess ammonia of 2.0-3.0 mg/L at a maintained flowrate of 1.10 gpm. Inlet pressure was maintained at 60 psi.

Serim® HiSense Ultra 0.1 Test Strips were used, as well as, the DR/2010 Hach® Instrumentation (an off-line analytical instrument more accurate than test strips) was used to analyze/monitor for total free chlorine residual. The strips gave a reading of 0.0mg/L for the effluent samples at every sample point that was taken. The DR/2010 Hach Instrumentation gave readings around the minimum detection limit of 0.05mg/L. Both analytical techniques produced results that were less than 0.05 ppm from the effluent of each carbon block cartridge during the whole study.

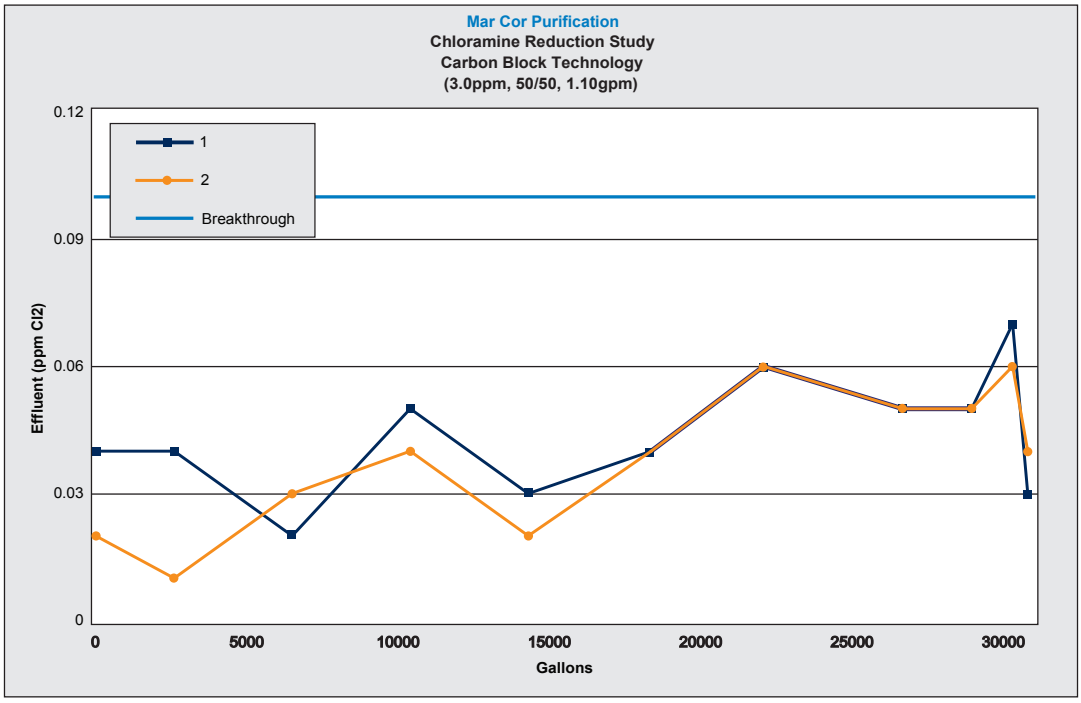
Results

The test system was allowed to operate until breakthrough of carbon between 0.05-0.1 ppm total free chlorine or 30,800 gallons, whichever came first. The 30,800 gallons was selected because it represented a scenario where the usage pattern would allow for 1 treatment usage per day (338 gallons) for 3 months (13) weeks. The 30,800 gallon target was reached before any chloramine breakthrough was detected by either analytical method. No further testing or challenges were performed.

Application

Based on test results developed under controlled conditions, MCP determined carbon block technology can be used by portable RO users under a variety of conditions.

1. In order to reduce weight and provide a more stable cart arrangement, the carbon block technology can be used in a worker/polisher configuration. Once breakthrough of chlorine less than 0.1 ppm is identified or 30,800 gallons processed, the user would remove the worker cartridge, move the polisher to the worker position and install a new cartridge in the polisher position. A user would continue



to monitor the effluent from the worker cartridge and replace it when measurable chlorine residual is detected. This may result in the cartridge having to be replaced at an inopportune time. The patient is protecte because the data indicates there was no detectable leakage in either cartridge for 30,800 gallons.

M2 Ergo Cart Design

2. Another option would be to monitor the worker and change the worker carbon block cartridge every 3 months (13 weeks). The 30,800 gallon amount was chosen to match up with 1 treatment per day for 13 weeks (91 total treatments). Each treatment would consist of processing approximately 338 gallons of feed water. Under this plan, the cartridge is changed on time rather than gallons processed or chlorine breakthrough.
3. A third option would be to have a service carbon vessel (SCV) in the first position followed by a single carbon block cartridge in the second (polisher) position. This configuration provides for chlorine removal while the components weigh 45% (85 lbs.) less weight than 2 - SCV vessels in series. If leakage of chlorine from the first SCV vessel is detected, testing has demonstrated the carbon block cartridge is capable of removing 3 ppm of chloramine for over 30,800 gallons; so patient care is not compromised. If breakthrough is detected, dialysis can be continued until the spent carbon block is replaced provided there is testing after the second carbon block. Under this condition, if the first SCV vessel is changed before any chlorine breakthrough has been detected, the carbon block could continue to be used; although it may be more practical (recommended) to change both at once.

Summary

Testing results demonstrated the carbon block technology used by MCP in the study were equivalent to performance results from a carbon tank. The weight reduction from replacing 2 carbon tanks, including water with 2 carbon block cartridges, was over 170 lbs. (85% reduction in weight).

Based on the data presented above, MCP recommends any portable RO user interested in reducing the weight and increasing the stability of a portable RO on a cart should consider the carbon block cartridge design. The results of testing demonstrate that the carbon block cartridges by MCP can be used in a manner that is related to time, gallons processed, or breakthrough without compromising patient care. The cartridges are convenient and less costly than changing out or rebedding the SCV vessels. Each carbon block cartridge weighs less than 10 lbs. when the cartridge is drained; so change out by care givers should not be a problem.

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