TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

January 26, 2022

Mr. Tony Powell, P.Eng., B.A.Sc
Purifics Water Inc.
340 Sovereign Road
London, Ontario N6M 1A8
Canada

Re: Purifics Ceramic Continuous Ultrafiltration (Cuf®) Membrane Modules
Review and Approval of Challenge Testing Method
Removal of Microbial Contaminants

Dear Mr. Powell.:

In accordance with Title 30 of the Texas Administrative Code (30 TAC) §290.42(g)(3), membrane filtration systems installed on, or replaced after, April 1, 2012 for the removal of *Cryptosporidium* and *Giardia* must undergo challenge testing to evaluate the membrane module's pathogen removal efficiency and for the Texas Commission on Environmental Quality (TCEQ) to establish a challenge test log removal value ($LRV_{C\text{-}Test}$). The membrane unit must also be designed to conduct and record the results of direct integrity tests (DITs) in a manner that demonstrates a pathogen removal efficiency equal, or greater than, the removal credit awarded to the membrane filtration process. **This letter replaces our previous letters dated December 15, 2017, March 15, 2018, October 17, 2018, and October 22, 2021.**

Based on review of previous challenge testing results (performed in July 2017) and the factory non-destructive performance test (NDPT) method, **the TCEQ has determined that an $LRV_{C\text{-}Test}$ for the Purifics Ceramic Cuf® membranes can be approved**. Conditions on the following pages list the approved $LRV_{C\text{-}Test}$ and the NDPT for production membrane modules that do not undergo challenge testing.

TCEQ-APPROVED $LRV_{C\text{-}TEST}$

For the Purifics Ceramic Cuf® modules, the TCEQ is approving an **$LRV_{C\text{-}Test}$ of 5.7** for the removal of *Cryptosporidium* in cross-flow (suspension) mode. The following are the parameters of the approved challenge study:

Full-scale modules tested	Purifics Ceramic Cuf® membrane module[1]
Number of Independent Modules Tested	1 housing containing 10 modules tested in 10 separate tests[2]
Criterion of Selected Modules	No Criteria
Serial Number of Tested Housing with 10 Modules	Serial Number 1309, Part Number 155-009-003 (5th Generation Module)
NDPT	A marker-based test using titanium dioxide (TiO_2) particles between 2 and 3 microns
Quality Control Release Value (QCRV) for NDPT	4.0-log
Challenge Particulate	TiO_2 marker (as a surrogate for *Cryptosporidium*)
Detection Limit	1.667 particles between 2 and 3 microns per 100 milliliters (mL)
Feed Concentration Range	Approximately 1.32 milligrams per liter (mg/L) of TiO_2 marker resulting in a particle concentration between 2 and 3 microns per 100 mL of 5.75 to 5.80-log
Max Filtrate Flux Rate	500 gallons per square-foot per day (gfd) 21 gallons per minute permeate flow for the test unit

[1] This letter also **applies to** the Purifics Ceramic Cuf® membrane modules in production at the time of this letter, which have the specifications listed in item 1 below. Since the time of the challenge test, Purifics has changed the diameter and length of the membrane modules. The maximum recommended flux and the diameter of each individual membrane channel in the modules have not changed. The newer modules have more channels of longer lengths which results in greater surface area.

[2] Data collected from tests 2,3,5,6 & 8 were not used. In tests 2 and 6 the post-test particle counts on the feed side water were over 125% greater than those found during the test. Tests 5 and 8 showed lower than expected base-line readings. Finally, the filtrate particle count readings in test 3 showed errors. Thus, none of these test results were included.

LIMITS OF TCEQ-APPROVED MARKER-BASED METHOD

The TCEQ-approved $LRV_{C\text{-}Test}$ is valid for only the Purifics Ceramic Cuf® membrane modules operated under the parameters used for the challenge testing, and only for modules that have passed the NDPT. From our review of the challenge study, an acceptable Purifics Ceramic Cuf® membrane module must comply with the following specifications to receive the TCEQ-approved $LRV_{C\text{-}Test}$.

1) Specifications of the approved Purifics Ceramic Cuf® membrane modules:

- Constructed of silicon carbide ceramic;
- Module surface area:
  - 6.12 square feet (ft^2) (0.6 square meters) for the modules in the challenge test;
  - 45.23 ft^2 (4.2 square meters) for modules currently in production;
- Module length:
  - 40.2 inches (1,020 millimeters (mm)) for the modules in the challenge test;
  - 65.0 inches (1650 mm) for modules currently in production;
- Flow direction: inside to outside;
- Operational mode: crossflow;
- Maximum operating temperature range of 0°C to 100°C (32°F to 212°F);
- Maximum design transmembrane pressure (TMP) of 50 psi;
- Operating pH range: 0.5 to 13.5;
- Maximum oxidant tolerance during a cleaning of 10,000 mg/L as chlorine; and
- Maximum permeate (filtrate) flux per module of 500 gfd.

2) Prior to shipment to a Texas public water system (PWS), each new Purifics Ceramic Cuf® membrane module must have passed the NDPT and a marker-based test as specified by Purifics and as described below:

   - Prepare 5.7-log concentration TiO_2 challenge particulate solution.
   - Set the permeate flux rate for NDPT to 500 gfd.
   - Allow a minimum of 20 minutes for the sample lines to purge and stabilize before baseline particle counts are recorded on both.
   - Once baseline particle counts have been recorded, inject the TiO_2 challenge particulate solution.
   - Record particle counts on both the feed and filtrate sides of the membrane.
   - Calculate the log removal value (LRV) for the NDPT using the particle counts between 2 and 3 microns and the following formula:

$$LRV = Log_{10}\left(\frac{average\ counts_{feed}}{mL} - \frac{baseline_{feed}}{mL}\right) - Log_{10}\left(\frac{average\ counts_{filtrate}}{mL} - \frac{baseline_{filtrate}}{mL}\right)$$

3) If the NDPT result for a Purifics Ceramic Cuf® membrane module is below the QCRV, the Purifics Ceramic Cuf® membrane module will not be allowed at a Texas PWS for microbial contaminant removal credit.

4) The Ceramic Cuf® manufacturer must notify the TCEQ in writing if the Purifics Ceramic Cuf® membrane modules are modified or if the marker-based test method is modified in any manner. After receiving written notification, the TCEQ will determine if the modified Purifics Ceramic Cuf® membrane module will be required to undergo new challenge testing or if the modified NDPT method is acceptable.

5) The Ceramic Cuf® manufacturer must record the results of each Purifics Ceramic Cuf® membrane module's NDPT with the module's assigned unique serial number. The NDPT result for each Purifics Ceramic Cuf® membrane module delivered to a Texas PWS must be provided upon delivery of the Purifics Ceramic Cuf® membrane modules. Each Texas PWS must provide the TCEQ with the NDPT result for each module installed for microbial contaminant removal credit.

6) The TCEQ shall grant Texas PWSs using membrane filtration log removal credit for *Giardia* and *Cryptosporidium* that does not exceed the lower of:
   a) The TCEQ approved $LRV_{C\text{-}Test}$; or
   b) The maximum removal efficiency that can be verified through the site-specific direct integrity test (LRV_{DIT}) of the membrane filtration unit.

7) Each Purifics Ceramic Cuf® membrane module must conform to American National Standards Institute/NSF International (ANSI/NSF) Standard 61 and be certified by a testing organization accredited by ANSI.

8) Please note that the approved $LRV_{C\text{-}Test}$ is for the current Federal and Texas statutes and the Environmental Protection Agency (EPA) and TCEQ rules. If any of these statutes or rules are revised, the TCEQ approved $LRV_{C\text{-}Test}$ in this letter may also be revised.

GENERAL INFORMATION ABOUT THE PURIFICS CERAMIC CUF® MEMBRANE SYSTEM OPERATION

Each Purifics Ceramic Cuf® membrane unit consists of one or two membrane housings, and each housing contains a varying number of ceramic membrane modules depending on the required capacity. During production, the raw water is mixed with a coagulant and enters a feed tank. The coagulated water is then pumped to the membrane housing(s) at a flow of approximately 4 times the raw water flow to the feed tank. Filtrate is produced and concentrate

exits the housing; the concentrate either becomes the feed water for the next housing (if two housings are used in a unit) or returns to the feed tank to be mixed with raw water. The total filtrate flow is approximately equal to the raw water flow to the feed tank, and the total concentrate produced is approximately 3 times the raw water flow to the feed tank. A site-specific portion of the concentrate is sent to waste instead of returning to the feed tank. During normal operation, the unit operates in cross-flow mode with some of the concentrate sent to waste which concentrates the coagulated solids in a concentrate loop until a steady state is reached.

During the challenge study, the unit tested consisted of one housing containing 10 membrane modules. The challenge test and the direct integrity tests (DITs) are performed in the same manner. The challenge test was conducted in cross-flow mode where the concentrate flow was approximately 3 times the total filtrate flow, which is the same as normal operation. During the challenge test, the waste valve was shut so that all the concentrate was used. Additionally, instead of the raw source water being added to the concentrate before the membrane housing, the filtrate flow from the challenge test was added to the concentrate before the membrane housing. During the challenge test, the concentrate and filtrate were blended together and pumped to the membrane housing instead of introducing raw water to blend with concentrate. This creates a steady concentration of marker instead of the increasing level of particulates (until steady state is reached) typically seen in the concentration loop with waste during normal operation. Elimination of the waste flow during the study is acceptable because the lack of waste flow produces a more conservative challenge test condition. The blending of filtrate with the concentrate is acceptable because the DITs will be performed in the same manner. When the TCEQ approves the DIT parameters, the parameters will account for the level of particle concentration seen during full-scale operation.

Please provide a copy of this letter to each of your Texas PWS customers and their consulting engineers. This letter is **not** to be construed as:

- A granted TCEQ exception for any Texas PWS to use the Ceramic Cuf® membrane modules. Each Texas PWS must request and receive site-specific approval through the exceptions process outlined in 30 TAC §290.39(l) to use membrane filtration in accordance with 30 TAC §290.42(g);
- TCEQ approval for a Texas PWS to install a Ceramic Cuf® membrane module; or
- TCEQ approval for a Texas PWS's required concentration time (CT) Study or direct integrity test (DIT).

If you have any questions about this letter, or if we can be of additional assistance, please contact me., at the letterhead address, by e-mail joel.klumpp@tceq.texas.gov, or by telephone at (512) 239-4453.

Sincerely,

Joel Klumpp, Section Manager
Plan and Technical Review Section
Water Supply Division
Texas Commission on Environmental Quality

JPK/mew