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TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

August 3, 2012

Mr. Daryl Gisch
The DOW Chemical Company
DOW Water Solutions
1691 North Swede Road
Midland, MI 48674

Subject: DOW Model SFD-2880 Ultrafiltration Membrane Module
Review of Challenge Testing
Removal of Microbial Contaminants

Dear Mr. Gisch:

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's removal efficiency and for the Texas Commission on Environmental Quality (TCEQ) to establish a challenge test log removal value ($LRV_{C\text{-}Test}$) as required by Title 40 of the Code of Federal Regulations (40 CFR) §141.719(b)(2) and Title 30 of the Texas Administrative Code (30 TAC) §290.42(g)(3). In addition, these regulations require a membrane manufacturer to provide the non-destructive performance test (NDPT) and associated quality control release value (QCRV) that will be used to verify that all manufactured membrane modules that were not subject to challenge testing will achieve at least the same log removal as those that were challenge tested.

On March 12, 2012, the TCEQ received notice from the City of Brownwood (City), a Texas public water system, of their intent to install DOW SFD2880 ultrafiltration (UF) membrane modules as one barrier for the removal of microbial contaminants a drinking water treatment plant. Mr. Doug C. Hearn, P.E., the City's consulting engineer, submitted a preliminary engineering report that included a copy of an Environmental Technology Verification (ETV) Joint Verification Report by the Environmental Protection Agency (EPA) and National Sanitation Foundation (NSF) International for the DOW SFD-2880 UF module. This report presents the challenge test results that for microbial reduction performance under the membrane challenge requirements of the USEPA Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR). Mr. Hearn requested that the TCEQ review the challenge testing data, NDPT and QCRV for the DOW SFD-2880 ultrafiltration membrane module.

TCEQ Approved $LRV_{C\text{-}Test}$

1. The TCEQ is approving a **$LRV_{C\text{-}Test}$ of 3.76** for the DOW SDF-2880 UF membrane modules' removal of *Cryptosporidium* and *Giardia*.

Only six DOW SFD-2880 ultrafiltration membrane modules from the same lot (serial numbers ranged from PE09B00007 to PE09B00028) were challenge tested. Since only six modules were challenge tested and the modules were not selected from multiple production lots, the TCEQ based our evaluation on the lowest log removal achieved during the challenge testing. The TCEQ converted all reported feed water concentrations of *Bacillus atrophaeus* endospores, *Cryptosporidium parvum* oocysts, and MS2 bacteriophage (MS2) to units per liter.

The TCEQ agrees that *Bacillus atrophaeus* endospores are an acceptable surrogate for challenging testing in lieu of using *Cryptosporidium parvum* oocysts. However, only two modules were challenge tested with this surrogate at an acceptable feed water concentration as required by 40 CFR §141.719(b)(2)(iii). The TCEQ did not accept the capped challenge test results where the feed water surrogate concentration had exceeded this federal regulations maximum allowable feed concentration Log_{10} 6.5(3.16×10^6 colony forming units per liter, CFU/L). Of the 18 acceptable analytical results (three analyses for the feed and filtrate concentration after startup, at 2 minutes, 15 minutes and 30 minutes) the $LRV_{C\text{-}Test}$ results ranged from 3.76 to 4.14.

For the two modules tested with *Cryptosporidium* oocysts, Module No. 3 (PE09B00007) failed the Cryptosporidium's post-challenge test direct integrity test (DIT). Therefore, the TCEQ did not consider the challenge test results for this module as representative of a module free of integrity breaches. While Module No. 2 (PE09B00010) had a minimum $LRV_{C\text{-}Test}$ of 5.92, this was data for only one DOW SDF-2880 UF membrane module and was not representative of the best approach described in 40 CFR §141.719(b)(2)(vi).

2. The TCEQ was **unable to complete our evaluation** for a $LRV_{C\text{-}Test}$ for the removal of viruses.

   Currently the TCEQ is granting microfiltration (MF) and ultrafiltration (UF) membranes 1.0-log removal for viruses if continuous coagulation, mixing and flocculation are provided prior to a MF or UF membrane unit. This virus removal credit has been based on a case-by-case basis depending on the operating parameters, results of a site-specific membrane study, full-scale design and operation of a membrane filtration treatment plant. If removal credit is requested for viruses and continuous coagulation, mixing and flocculation will not be provided, challenge test results are required.

   To detect a virus-sized pathogen, a DIT test pressure of approximately 4,347 pounds per square-inch (psi) would be required to have an appropriate resolution to detect a 0.01-micron defect. This test pressure significantly exceeds the DOW SFD-2880 ultrafiltration module's maximum allowable inlet pressure of 44 psi. Unless the TCEQ approves an alternate DIT method, the virus LRV_{DIT} for a DOW SFD-2880 UF membrane water treatment plant would always be zero, thus no virus log removal credit would be given.

   The virus challenge testing using MS2 is a TCEQ acceptable method to request virus removal credit. However, the reported NDPT would not detect a 0.01-micron defect. Without a NDPT using a resolution of 0.01-micron conducted by DOW on each future

manufactured DOW SFD-2880 UF membrane module (with an acceptable corresponding QCRV), the TCEQ could not approve a virus $LRV_{C\text{-}Test}$.

As we noted above for the $LRV_{C\text{-}Test}$ for *Cryptosporidium* and *Giardia*, the TCEQ has the same concerns regarding the fact that only six modules from the same production lot were challenge tested. Since at least 20 modules were not challenge tested from multiple production lots, the reported geometric mean values could not be used. The modules should have been selected either randomly across several manufacturing lots or based on historical quality control data with QCRVs at the lower end of the statistical distribution.

Limits of TCEQ Approved $LRV_{C\text{-}Test}$

The TCEQ approved $LRV_{C\text{-}Test}$ is only valid for DOW SFD-2880 UF membrane modules operated under the parameters that were used for the challenge testing and only for modules that have passed the NDPT. From our review of the challenge study, an acceptable DOW SFD-2880 UF membrane module must comply with the following to receive the approved $LRV_{C\text{-}Test}$:

1. Specifications of the challenge tested module without any modifications to the construction as it was challenge tested by NSF International and reviewed by the TCEQ:
    a. Constructed of polyvinylidene fluoride (PVDF);
    b. A module outside diameter of 8.9 inches;
    c. A module length of 92.9 inches;
    d. A module volume of 10.3 gallons;
    e. A nominal pore size of 0.03 microns;
    f. A maximum pore size of 0.05 microns;
    g. An average feed side area of 829 square-feet;
    h. An outside to inside flow path;
    i. Operated in dead-end mode;
    j. An operating filtrate flux rate range of 24 to 70 gallons per square-foot per days (gfd) at 25 degrees Celsius (°C) (13.6 to 40.9 gallons per minute (gpm));
    k. A temperature operating range of 34 to 104 degrees Fahrenheit (°F) (1 to 40 °C);
    l. A maximum module inlet pressure of 44 psi;
    m. A maximum transmembrane pressure of 30 psi;
    n. A pH operating range of 2 to 11;
    o. A maximum sodium hypochlorite tolerance of 2,000 milligrams per liter (mg/L);
    p. A maximum allowable feed water total suspended solids level of 100 mg/L; and
    q. A maximum allowable feed water turbidity level of 300 Nephelometric Turbidity Units (NTU).

2. Prior to shipment to a Texas public water system, each new DOW SFD-2880 UF membrane module must have passed the DOW Chemical Company's NDPT as described below:
    a. Water must be drained from the module's feed side.
    b. The feed and concentrate valves must be closed.
    c. The module is to be pressurized with oil free air from the inlet valve, slowly raising the air pressure to a minimum of 30 psi and allowing displaced water to flow out through the filtrate side for approximately two minutes.
    d. The air inlet valve is to be closed and the pressure held for ten minutes to determine the integrity of the membrane fibers, potting, and o-rings.
    e. A module passes the NDPT if the pressure decay (initial pressure after the inlet valve is closed minus the pressure after ten minutes) does not exceed the QCRV of 0.1 psi after ten minutes.

3. The TCEQ will not grant the microbial contaminant removal credit in this letter for any DOW SFD-2880 ultrafiltration membrane module where the NDPT result exceeds the QCRV.

4. The DOW Chemical Company must notify the TCEQ in writing if the DOW SFD-2880 UF membrane modules as challenge tested by NSF International are modified or the NDPT method is modified in any manner. After receiving written notification, the TCEQ will determine if the modified DOW SFD-2880 UF membrane modules will need required to undergo challenge testing or the modified NDPT method is acceptable.

5. The DOW Chemical Company must record the results of each DOW SFD-2880 UF membrane module's NDPT with the module's assigned unique serial number. The NDPT result for each DOW SFD-2880 UF membrane module delivered to a Texas public water system must be provided upon delivery of the DOW SFD-2880 UF membrane modules to a system.

6. The TCEQ shall grant Texas public water systems using DOW SFD-2880 UF membrane filtration log removal credits for *Giardia* and *Cryptosporidium* that do not exceed the lower of:
    a. The TCEQ approved $LRV_{C\text{-}Test}$; and
    b. The maximum removal efficiency that can be verified through a membrane unit's site-specific direct integrity test (LRV_{DIT}).

7. Each DOW SFD-2880 UF membrane module must conform to American National Standards Institute/National Sanitation Foundation (ANSI/NSF) Standard 61 and be certified by a testing organization accredited by ANSI.

8. Please note that the approved $LRV_{C\text{-}Test}$ will conform with Federal and Texas statutes and 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.

Submitted Data

The TCEQ reviewed the following data provided by The DOW Chemical Company and NSF International:

- Environmental Technology Verification Report: Removal of Microbial Contaminants in Drinking Water, Dow Chemical Company – DOW Water Solutions, SFD-2880 Ultrafiltration Module (January 2011) for challenge tests with *Cryptosporidium parvum* oocysts, *Bacillus atrophaeus* endospores (as a *Cryptosporidium* surrogate) and MS2 for six DOW SFD-2880 UF membrane modules with the following serial numbers:
    - Module No. 1 with serial No. PE09B00016;
    - Module No. 2 with serial No. PE09B00010;
    - Module No. 3 with serial No. PE09B0007;
    - Module No. 4 with serial No. PE09B00028;
    - Module No. 5 with serial No. PE09B00017; and
    - Module No. 6 with serial No. PE09B00027.
- NSF Certification for Public Drinking Water Equipment Performance, Final Report: Dow Chemical Company – DOW Water Solutions, SFD-2880 Ultrafiltration Module, Product-Specific Challenge Tests for *Cryptosporidium*, Removal Efficiency for LT2ESWTR (December 16, 2010);
- NSF Test Reports for February 11, 2010, March 4, 2010, and March 29, 2010;
- Lab technician work sheets and equipment calibration data for October 2009, February 2010, and May 2010; and
- April and May 2012 email correspondence between NSF International and TCEQ staff.

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

- A TCEQ granted exception for any Texas public water system to use the DOW SFD-2880 UF membranes. Each Texas public water system must request and receive site-specific approval to use membrane filtration in accordance with 30 TAC §290.42(g) and §290.39(l).
- TCEQ approval for a Texas public water system to install DOW SFD-2880 UF membranes; or
- TCEQ approval for a Texas public water system's required concentration × time (CT) study.

If you have questions or need further assistance, please contact James "Red" Weddell, P.E. of my staff by telephone at (325) 481-8056 or by email at james.weddell@tceq.texas.gov or by correspondence at the following address:

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Sincerely,

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