



# Reverse Hot Water Flushing of Vitipore® II and Vitipore II Plus Filters

## Validation Background

To prolong final filter service life and improve filtration economics many beverage manufacturers have instituted the use of reverse flow hot water flushing (hot water backflushing). While Millipore makes no specific claims or recommendations regarding the general use of hot water backflushing, some facilities have experienced that Millipore cartridge filters are able to withstand a considerable number of backflashes while remaining integral. This study was carried out in order to provide guidelines in qualifying the use of hot water backflushing with Vitipore II and Vitipore II Plus filters.

## Description of Analysis Performed

Testing was carried out using standard operating procedures in place at various manufacturers. A typical hot water backflush is 15 – 20 minutes of hot water in the reverse flow. The water starts out at ambient temperature but quickly reaches levels of 180 – 190 °F (82 – 88 °C). The hot water backflush can be both preceded and followed by a cold water rinse. Using an estimated value of 7 back-flushes per filter housing per week, the goal of the testing was to verify that the filters would be integral after simulating 4 months of backflushing. (Backflushing frequencies and durations will vary between facilities and manufacturers). The total length of simulated backflushing time can be used to obtain the relative length of simulated processing time at any particular site.

**Table 1.**

## Test Basis

Length of Backflush	20 Minutes
End T of Backflush	180 – 190 °F (82 – 88 °C)
Est. Number of Backflashes per Housing per Week	7
Hours of Simulated Backflush Testing	37.5
Minutes of Simulated Backflush Testing	2250
Simulated Number of Backflashes	112.5
Simulated Processing Time	4 Months

**Note:**

*Millipore does not recommend or validate reverse hot water flushing of filters. If performed improperly it can cause filter integrity failure. Temperature and differential pressure need to be carefully monitored when performing any hot water backflushing.*

## Filter Cartridges Used for the Test

**Table 2.**

### Test Filters, Lot Numbers

Cartridge Type	Abbreviation	Lot Number	Number Tested
Vitipore II, 0.45 µm	CVBB	F5JN96494E	2
Vitipore II, 0.45 µm	CVBB	F5JN96485E	1
Vitipore II Plus, 0.45 µm	CVPB	F5KN04620E	3
Vitipore II Plus, 0.45 µm	CVPB	F5DN55944E	2

All cartridges used were 30-inch code 7, often standard for use in beverage processing.

**Table 3.**

### Vitipore II and Vitipore II Plus Pre and Post-Test Filter Integrity

Cartridge	Cartridge Lot Number	Initial Integrity (cc/min)	Post-Backflush (cc/min)
Vitipore II	F5JN96494E	20.5	12.3
Vitipore II	F5JN96494E	19.0	11.9
Vitipore II	F5JN96485E	18.4	13.0
Vitipore II Plus	F5KN04620E	20.3	11.2
Vitipore II Plus	F5KN04620E	19.9	14.5
Vitipore II Plus	F5KN04620E	21.8	12.9
Vitipore II Plus	F5DN55944E	10.6	20.5
Vitipore II Plus	F5DN55944E	7.2	21.0

The Millipore specification for an integral 30-inch 0.45 µm CVBB or CVPB membrane filter at 22 psi is  $\leq 45$  cc/min. All test filters were well below the diffusion specification both pre and post backflushing.

## Experimental Design

Three code 7 filter housings were used for the test. Housings were filled with cartridges. Cartridges were plugged in the reverse flow direction using a bentonite and water slurry. After plugging, clean 80 °C RO water was used in the reverse flow at a  $\Delta P$  of 5 psi to simulate backflushing in the actual process. This pressure was maintained throughout testing. The backflush testing was done in five intervals of 7.5 hours each, totaling 37.5 hours of backflushing.

After the backflushing was finished, the cartridges were integrity tested. Integrity testing was performed as air diffusion through a wet membrane at a forward pressure of 22 psid.

Following the integrity tests, one Vitipore II and one Vitipore II Plus cartridge was taken apart and inspected. The inspection was first performed on the membrane, support, and prefilter layers as a whole, followed by the individual dissection and inspection of each layer separately.

## Validation Test Results

Post-backflush integrity testing showed that all 8 of the Vitipore II and Vitipore II Plus cartridges remained integral with diffusion rates well within specifications (Table 3.)

## Discussion of Results

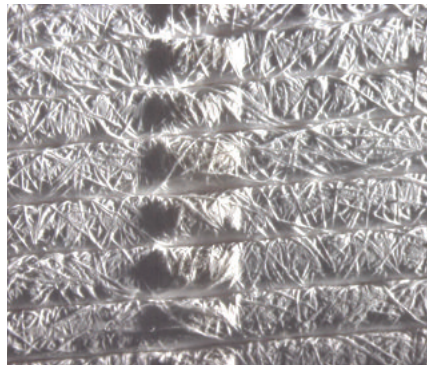
Testing showed that the procedure of hot water backflushing alone will not cause a Vitipore II filter to fail prior to 4 months of usage (based on 7 back-flushes per filter housing per week). All Vitipore II and Vitipore II Plus cartridges successfully passed post-backflushing integrity tests. It is important to note that the hot water backflushing was carried out at a constant  $\Delta P$  of 5 psi. All cartridge filters are most susceptible to failure when at elevated temperatures and with flow from the reverse direction. Because hot water back flushing combines these two factors, monitoring and controlling the  $\Delta P$  during hot water backflushing is critical to ensuring that the filters are not damaged during cleaning.

After cartridge dissection, as illustrated in Figures 1 and 2, the membrane was noticed to have been pushed against the outer support cage in both the Vitipore II and Vitipore II Plus filters. The pushing created raised surfaces on the membrane surface corresponding to the openings of the outer support cage. This is understandable given the pressure of water flowing in the reverse direction. The raised surfaces could only be detected once the cartridges had been dissected. It was observed that the raised surfaces in the Vitipore II Plus were more prominent than those of the Vitipore II due to the prefilter layer being pushed farther into the support cage openings. After the dissection of the cartridges, the membrane, membrane support layers and, in the case of the Vitipore II Plus, prefilter layers were separated and individually examined. The membrane, support, and prefilter layers were intact with no degradation detected.

There was some slight discoloration of the Vitipore II membrane material which had a dull orange color. This was determined to be residual bentonite trapped by the membrane due to the reverse plugging procedure used in the testing. Such discoloration should not be seen in normal customer operations. The Vitipore II Plus filter did not have the same slight discoloration. It is possible that the outer pre-filter layer further provided support in the test's reverse direction of flow.

**Figure 1.**

## Vitipore II Plus Membrane/Prefilter Layer



**Figure 2.**

## Vitipore II Membrane Layer



### Backflushing Considerations

As previously noted in the test discussions, it is very important to monitor differential pressure during any hot water backflushes. Due to the elevated temperatures and reduced strength of cartridge filters in the reverse flow, improperly performing a hot water backflush can easily lead to membrane integrity failure. It is always recommended to perform a proper integrity test post-backflushing.

It is important to always precede a hot water backflush with a cold water rinse. It has been observed that immediately using hot water at such elevated temperatures after processing can "bake" on certain proteins and other materials often found in the process streams of beverage manufacturers. Similarly, a cold water flush, in the forward flow, is recommended

after the backflush to give a final forward rinse and cool down to the cartridges and housings.

As with most cleaning regimens it is recommended to always use clean filtered water when performing a hot water backflush to maintain membrane performance.



### Backflushing Procedure\*

Based on the experimental data results, if backflushing is to be performed, a recommended backflushing sequence is:

1. Cold water rinse at ambient water temperature and no more than 5 psid reverse for 5 – 10 minutes.
2. Hot water backflush at 180 °F (82 °C) and no more than 5 psid reverse for 15 – 20 minutes.
3. Cold water cool-down in the forward direction using ambient water temperature. Use an appropriate volume of cold water to adequately cool down the filter housings.
4. Filter integrity test.

\*Recommendations based upon experimental data results. Millipore does not validate reverse hot water flushing. Performance of filters is not guaranteed.

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