ENERGY RECOVERY SOLUTIONS

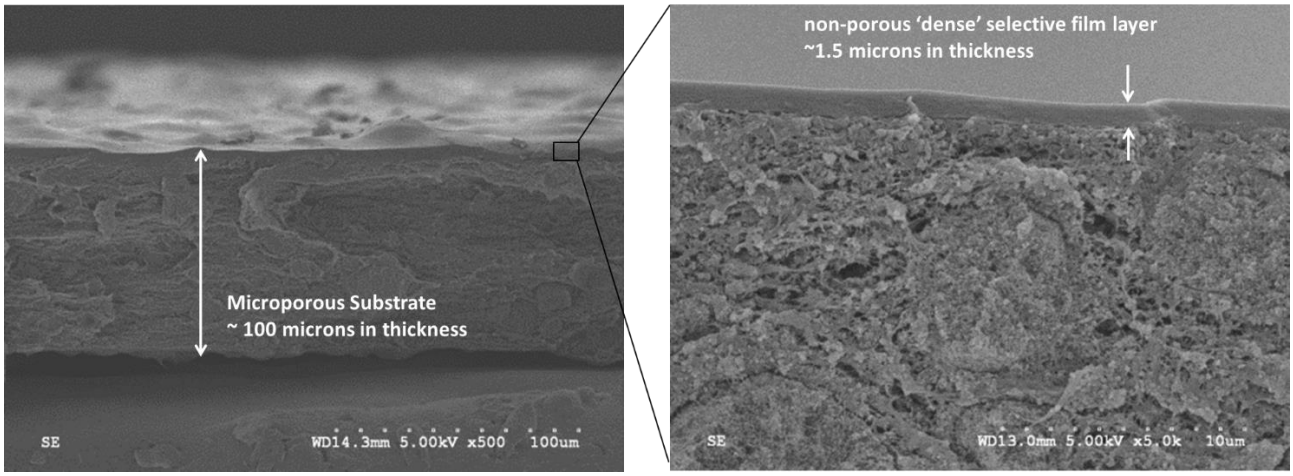
Background

With the current global COVID-19 pandemic ongoing, concerns have been raised about the potential for air-borne contamination of viral particles in building ventilation systems. So far, no known transmission has occurred due to airborne particles through ventilation systems, however concerns have arisen about this possibility through ventilation systems that recirculate air or use certain types of heat or energy recovery ventilation systems [1].

CORE manufactures membranes and membrane-based exchangers for building ventilation energy recovery applications. Our exchangers use a membrane to separate exhaust and supply airstream in building ventilation, allowing heat and moisture to transport, but blocking gases and contaminants such as viral particles. As industry leaders and manufacturers of high-quality ventilation components, our R&D team has previously completed validation testing of the hygiene-related functionality of our ERV membrane materials, including viral penetration testing.

CORE Membranes

As can be observed in the membrane cross-sectional microscopy image below, CORE's membrane consists of two layers: a microporous layer and a dense selective polymer layer. The dense selective layer is impermeable to gases, and only allows water vapour to absorb and transfer through. All particles, viruses, and bacteria will also be blocked by this layer. The membrane can be pressurized with air on one side and, and no air will pass through.



The microporous layer in our membrane acts a support layer for the active selective layer. The microporous layer has pore sizes in the range of 10 to 60 nanometers and will also act as a barrier to the transport of viruses and bacteria. This is because the average pore size and geometry of the microporous layer is less than that of the diameter of viruses. Coranaviruses such as COVID-19 have been reported to have an average diameter of 125 nm with a range of 60-140 nm which is larger than the pore size of our substrate layer [2]. For comparison, N95 respirator masks are rated to block 95% of particles >0.3 micron (300 nm) [3].

In summary, our membrane has two layers (a dense layer and microporous layer) through which viral particles **cannot** penetrate, ensuring that no viruses will transfer through the membrane between air-streams in building ventilation systems using our membrane.

Viral Penetration Testing

To confirm this, we completed viral penetration tests to the ASTM F-1671 standard for our membrane materials. This is a standard test for medical garments, gloves, and gowns. This test uses a viral substitute (bacteriophage ΦX174) to measure transfer of particles in a liquid under pressure though a material [4]. The ΦX174 particle is ~25 nm in diameter, which is much smaller than an individual corona virus particle. For both our Mx4 'T4' and HP 'Gryphon' membranes, no transfer of viral surrogates were observed in the ASTM F-1671 test, confirming that our membrane materials act as a viral barrier. See the test report below for reference.

CORE Exchangers

Some types of ventilation energy recovery devices (such as enthalpy wheels and push-pull systems) do not ensure that the ventilation air streams are completely separated, allowing exhaust air to periodically interface with the same surfaces as the supply air. Plate-type membrane-based ERVs (and plate-type HRVs) allow 100% separation of incoming and outgoing exhaust air streams in buildings. Since the membrane is impenetrable to air and to viruses, and the supply airstream remains fluidly separated from the exhaust air stream in CORE's plate-type membrane ERV exchangers.

For our exchangers made with our membranes, we complete end of line inspection for cross-leakage ensuring that all exchanger seals have adequate air tightness. For our products in North America we also complete certification testing to the AHRI 1060 standard ensuring that the exchangers have <1% exhaust air transfer ratio (EATR) [5]. For our products in Europe we test according to DIN EN 308 with a threshold for leakage of <1% of the nominal airflow [6]. This way, we can guarantee that all CORE exchangers fulfill the highest standards and guidelines in the respective markets regarding the accepted leakage and tightness.

We continue to follow the research activities around COVID-19 and any potential for viral transmission in ventilation systems, and we will continue to manufacture and develop products that offer both high performance and excellent hygienic functionality.

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Disclaimer: CORE is a membrane and exchanger supplier to ventilation system designers and manufacturers. Although our exchangers have low leakage and complete separation of air-streams, and our membranes block contaminants and viruses from transferring between air-streams, these exchangers must also be installed in ventilation systems in such a way ensures that no leakage and recirculation of air can occur in order to ensure that exhaust air streams cannot mix with incoming air streams.

References

[1] https://www.rehva.eu/fileadmin/user_upload/REHVA_covid_guidance_document_2020-03-17_final2.pdf

[2] N. Zhu et al., "A Novel Coronavirus from Patients with Pneumonia in China, 2019," New England Journal of Medicine, vol. 382, no. 8, pp. 727–733, Feb. 2020, doi: 10.1056/NEJMoa2001017.

[3] NIOSH (2019) "Procedure No. TEB-APR-STP-0059, Revision 3.2. Determination of particulate filter efficiency level for N95 series filters against solid particulates for non-powered, air-purifying respirators, Standard Testing Procedure (STP)". [Online] Available at https://www.cdc.gov/niosh/npptl/stps/pdfs/TEB-APR-STP-0059-508.pdf

[4] F23 Committee, "ASTM F-1671 Test Method for Resistance of Materials Used in Protective Clothing to Penetration by Blood-Borne Pathogens Using Phi-X174 Bacteriophage Penetration as a Test System," ASTM International, 2013.

[5] "AHRI, ANSI/ARI Standard 1060, Standard for Rating Air-to-Air Exchangers for Energy Recovery Ventilation Equipment, Air-Conditioning & Refrigeration Institute, Arlington, VA, 2005.

[6] DIN: (1997). "DIN EN 308. Heat exchangers - Test procedures for establishing performance of air to air and flue gases heat recovery devices"; EN 308:1997

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Viral Penetration ASTM Method F 1671 Final Report

Test Article:	DPT-T4 DPT-HP
Purchase Order:	1429
Laboratory Number:	741704
Study Received Date:	28 Feb 2014
Test Procedure(s):	Standard Test Protocol (STP) Number: STP0062 Rev 12

Summary: This test method was performed to evaluate the barrier performance of protective materials which are intended to protect against blood borne pathogen hazards. Test articles were conditioned for a minimum of 24 hours at 21 ± 5°C and 30-80% relative humidity (RH), and then tested for viral penetration using a ΦX174 bacteriophage suspension. At the conclusion of the test, the observed side of the test article was rinsed with a sterile medium and assayed for the presence of ΦX174 bacteriophage. The viral penetration method complies with ASTM F1671. All test method acceptance criteria were met. Testing was performed in compliance with US FDA good manufacturing practice (GMP) regulations 21 CFR Parts 210, 211 and 820.

Number of Test Articles Tested:	2
Number of Test Articles Passed:	2
Test Article Side Tested:	Either Side
Test Article Preparation:	Cut from Material at Random
Exposure Procedure:	B (Retaining Screen: Woven Polyester Mesh, with >50% Open Area)
Compatibility Ratio:	24.7 (DPT-T4), 1.0 (DPT-HP)
Environmental Plate Results:	Acceptable

Results:

Test Article	Pre-Challenge Concentration (PFU/mL)	Post-Challenge Concentration (PFU/mL)	Assay Titer (PFU/mL)	Visual Penetration	Test Result
DPT-T4	4.1×10^9	3.4×10^9	<1[a]	None Seen	Pass
DPT-HP	2.2×10^8	1.9×10^8	<1[a]	None Seen	Pass
Negative Control	4.1×10^9	3.4×10^9	<1[a]	None Seen	Acceptable
Positive Control	2.2×10^8	1.9×10^8	TNTC[b]	Yes	Acceptable
Blank Control	N/A	N/A	<1[a]	None Seen	Acceptable

[a] A value of <1 plaque forming unit (PFU)/mL is reported for assay plates showing no plaques.
[b] TNTC = PFU were too numerous to count.

ACLASS ACCREDITED TESTING

Study Director — Adam Meese, B.S.

19 Mar 2014
Study Completion Date