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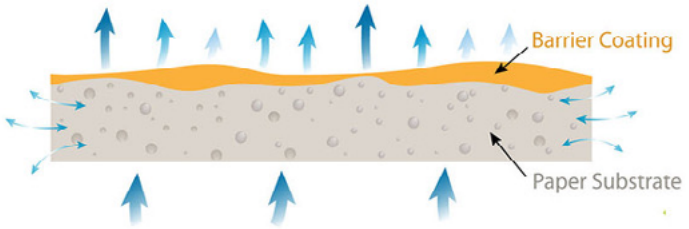
ACCESSORY BROCHURE

FILM TEST CARTRIDGES:
PAPER-BASED SINGLE CELL

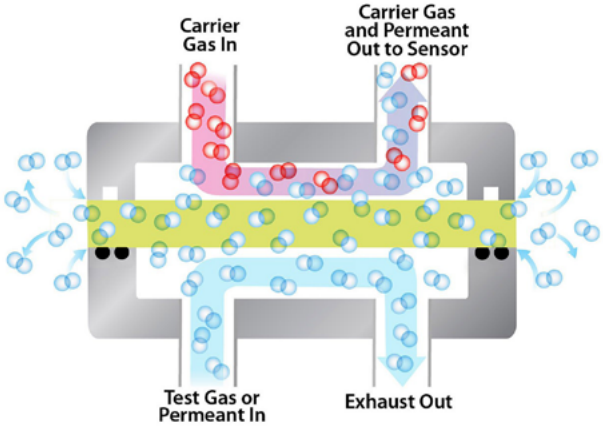
Testing Paper-Based Barriers

Permeation testing of paper-based barriers is by far the most confusing material to characterize properly and repeatably. Applying a consistent barrier coating to a paper substrate that is uniform in thickness is not as easy as some may think because paper substrates are porous. Often the coating will have regions with inconsistent thickness making it more difficult to predict the barrier level. So, it is important to thoroughly evaluate the material through permeation testing.

Permeation test cells use the film to separate two gases, the test gas (permeant) and the carrier gas. Any porosity allows the two gases to intermix skewing data and creating an inconsistent driving force for permeation. A barrier layer is coated over the surface of the paper substrate to impede the permeant. During analysis, the permeant gas enters one side of the film and randomly moves in every direction throughout the porous substrate, causing some of the gas to leave through the edges of the sample while some permeates through the film. This phenomenon known as "edge diffusion" causes erroneous test results. If edge diffusion is taking place, this must be remedied to produce reproducible permeation data.



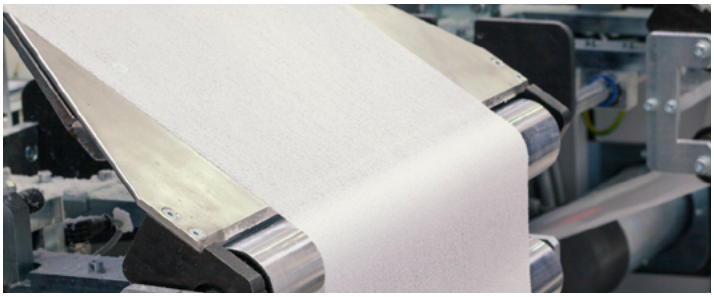
Inconsistent barrier coating and edge diffusion in film substrate.



Edge diffusion of paper substrate in test cell.

CHOOSING THE CORRECT CARTRIDGE FOR YOUR PAPER-BASED FILMS

Film characteristics determine cartridge choice.

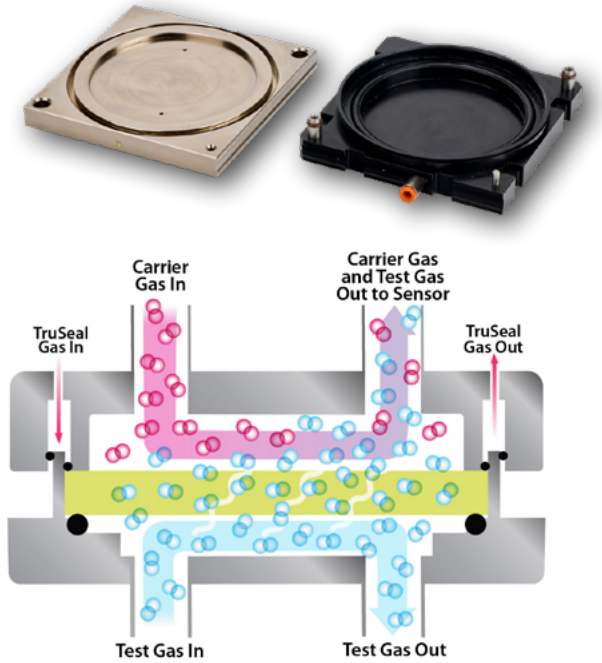


Surface roughness and film thickness are the two main elements to consider when choosing the right test approach for paper-based barriers. Surface roughness from the coating process may cause the film to not seal properly in the diffusion cell, which allows moisture or oxygen from the atmosphere to leak into the cell. Most often this will cause a test failure due to the sensor becoming saturated with permeant gas. Film thickness plays an integral role in how much surface area is available for edge diffusion to take place. Paper-based films generally fall into four categories:

1. Smooth and thin
2. Rough and thin
3. Smooth and thick
4. Rough and thick

AMETEK MOCON provides different solutions to analyze these paper-based structures that exhibit edge diffusion. For smooth-finished surfaces, the Edge Effect Cartridge has had good success testing both thin and thick films (up to 40 mils).

Edge Effect Cartridge:
Physically blocking out Edge diffusion.



Edge Effect Cartridge blocking edge diffusion of paper-based film.

The Edge Effect Cartridge (EEC) is designed to analyze coated paper structures that exhibit edge diffusion. This cartridge has a raised perimeter edge to block any atmospheric moisture or oxygen from entering the film's porous structure disrupting the permeant driving force. This cartridge works well for testing both single and double-sided coated paper films with thicknesses up to 40 mils.

EEC Benefits.

- Increased reproducibility
- Increased accuracy
- Easy, fast and convenient versus foil masking
- Able to test full sized samples (50 cm^2)
- Non-consumable

CHOOSING THE CORRECT CARTRIDGE FOR YOUR PAPER-BASED FILMS

Edge Compression Cartridge:
Mechanically removing edge porosity.

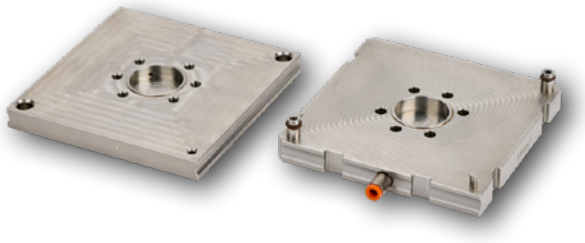
For coated paper films with a rough surface, the Edge Compression Cartridge (ECC) applies a compressive force to the perimeter of the film's test area removing porosity to negate edge diffusion. This ensures the permeation test's driving force is consistent to deliver accurate values. Although the test exposure areas are 5 cm^2 and 10 cm^2, most coated paper films are not high barriers, so extending the high-end detection limit is serviceable for most coated paper films. This cartridge works best for films approximately < 15 mils thick.

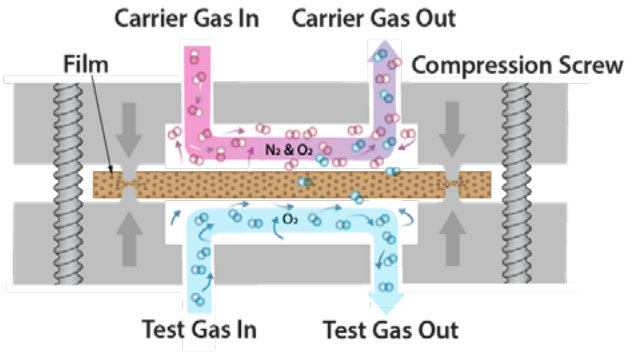
The six radial screws can be torqued to seal each sample with the same force for every test increasing repeatability. The test area is well-defined by the cartridge, allowing more accuracy versus using epoxy to seal the sample/mask interface and having to calculate the test area. This is not recommended for films having fragile coating structures.

The only other option for testing rough surface films is foil masking with epoxy otherwise the sample will also leak at the mask/test area interface.

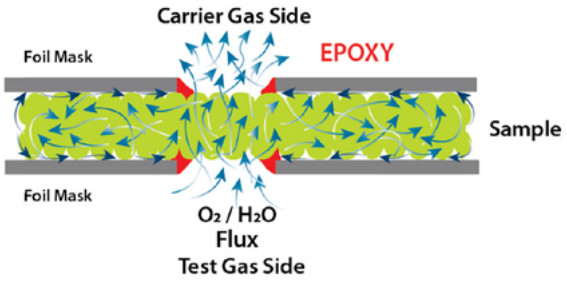
ECC Benefits.

- More accurate values
- Faster prep time versus foil masking with epoxy
- Increased repeatability
- Ability to test textured paper-based films
- Non-consumable





Edge Compression Cartridge eliminating edge diffusion by compressive force.



Double foil masking with epoxy.

Applications

Paper-based barriers have a wide range of applications from healthcare to food packaging and are growing over time with increased sustainability incentives. Taking the proper test approach is critical in determining the barrier properties for this fast-growing segment of materials as novel structures must be accurately profiled to replace historical polymer barriers.

CHOOSING THE CORRECT CARTRIDGE FOR YOUR PAPER-BASED FILMS

ACCESSORY BROCHURE

How to choose the best cartridge for your substrate.

There are three main parameters one must understand when selecting the correct paper-based barrier film cartridge. General guidance begins with understanding your film's thickness and surface roughness. The Edge Effect Cartridge may work well for thin films (up to 40 mils) having a smooth surface/s, while textured films ≤ 15 mils may work well using the Edge Compression Cartridge. These two film characteristics help guide which cartridge to choose while the transmission rate of the films dictates optimal test area.

Surface	Cartridge	Recommended Thickness Range	Size Options
Rough/textured	Edge Compression	1 to 15 mils	5.0 cm^2, 10.0 cm^2
Smooth	Edge Effect	1 to 40 mils	5.3 cm^2, 50.0 cm^2

Maximize signal through sample without over-ranging the sensor.

Ideally, using the largest exposure area is best practice, although this is not always possible depending on the permeation analyzer used for the testing. Refer to the test area table below which details the instrument test ranges for OTR and WVTR analysis based on film test area. After preliminary cartridge selection, testing with the potential cartridge using actual samples is necessary prior to purchase to ensure accuracy.

Instrument	Units	Edge Effect		Edge Compression	
		50.0 cm^2	5.3 cm^2	10.0 cm^2	5.0 cm^2
OX-TRAN 2/12 R	$cc/m^2 \cdot day$	0.05 to 28.8K	0.47 to 271K	0.25 to 144K	0.5 to 288K
OX-TRAN 2/22 H		0.05 to 200	0.47 to 1887	0.25 to 1000	0.5 to 2000
OX-TRAN 2/22 L		0.005 to 200	0.047 to 1887	0.025 to 1000	0.05 to 2000
OX-TRAN 2/22 10X		0.0005 to 200	0.0047 to 1887	0.0025 to 1000	0.005 to 2000
AQUATRAN 3/34 H	$g/m^2 \cdot day$	0.05 to 100	0.47 to 943	0.25 to 500	0.5 to 1000
AQUATRAN 3/34 L		0.005 to 100	0.047 to 943	0.025 to 500	0.05 to 1000
	Part Numbers				
	Single	Precise RH: 052-179 100% RH: 052-186	Precise RH: 054-652	Precise RH: 054-738	Precise RH: 054-743
	Set of 2	Precise RH: 052-339 100% RH: 052-340			

Note: Paper-based barrier cartridges should be vetted for sample compatibility prior to purchase. Please contact your local sales representative to discuss free pre-sales testing options.

Our experts listen to your needs and offer customized solutions.

AMETEK MOCON continually expands our extensive cartridge line based on customer testing requirements to ensure accurate and consistent test results. With over 55 years of industry experience behind the designs, our interchangeable cartridges address general industry challenges as well as specific customer requests.

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AB-PPS-0171-Film Test Cartridges: Paper-Based Single Cell-1224-1.3

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