Viaflex

Protecting Earth. Promoting Industry.

EVOH GAS BARRIER GEOMEMBRANES

True Vapor Intrusion Protection

Joe Ryan—Construction Market Sales Director
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ABOUT VIAFLEX

- We develop and manufacture *thinner, lighter, and stronger* product solutions to help solve application and product challenges across the globe
- Our solutions protect the environment – and customers' assets
- We are fully integrated, providing products from pellet to plastic; from design through installation

EVOH VS. POLYETHYLENE

Polarity

EVOH VS. POLYETHYLENE

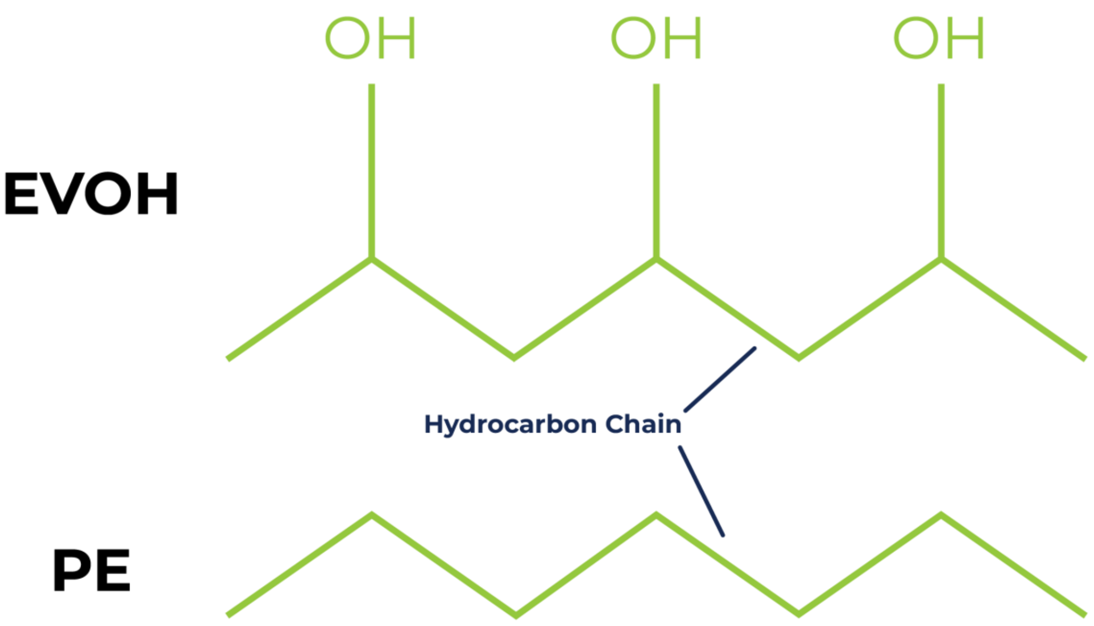
Polar / Non-Polar

- EVOH is a polar molecule, making it a strong barrier to non-polar contaminants such as VOC's.
- Polyethylene (PE) is a non-polar molecule and great barrier to polar molecules such as water.

WHAT IS EVOH?

- A semi-crystalline thermoplastic resin (Ethylene Vinyl Alcohol)
- Excellent barrier to:
  – Gasoline
  – Oils
  – Solvents
  – Hydrocarbons
  – Radon
  – Methane
  – PFAS/PFOA

Polar Hydroxide Groups Stop VOC's

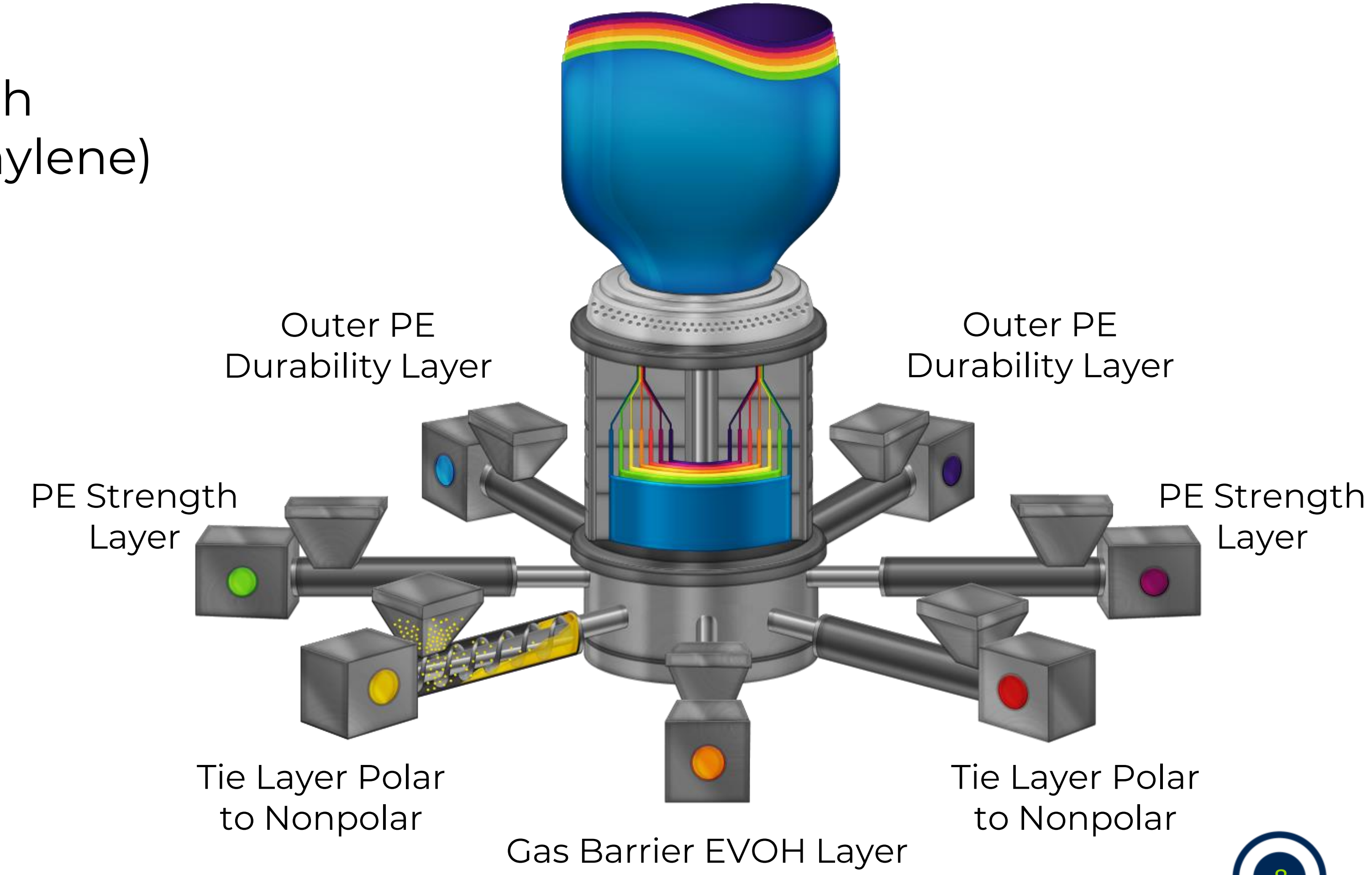


COMMON EVOH APPLICATIONS

7-LAYER GAS/MOISTURE BARRIER

Strength and Durability of LLDPE with Gas Barrier Properties of EVOH

- Obtain best properties of both polymers (EVOH and Polyethylene)
- Unmatched barrier to:
  - Water
  - Radon
  - Methane
  - VOC’s



GAS BARRIER GEOMEMBRANES

How are they different than standard geomembranes?

- True Gas Barrier membranes contain a center core of EVOH, Nylon or Metallized/Aluminum film which is over 300 times less permeable to VOC's

PERMEABILITY COMPARISONS

Permeability of Select Gases Through EVOH and HDPE

Gas	EVOH*	HDPE**
	cc.20μm / m^2.day.atm	
Oxygen	0.25	2300
Nitrogen	0.019	190
Carbon Dioxide	0.6	17520
Sulfur Dioxide	0.3	21840
Methane	0.4	2845

Conditions: 23°C, 0% Relative Humidity
* ASTM D1434 – 32mol% Et. EVOH
** Permeability Properties of Plastics and Elastomers, Massey, 2nd Edition

Edgard Chow, 10th IGC, Berlin, 23 Sept 2014

BROWNFIELD PCE / TCE

- Draft Evaluation of diffusion of PCE and TCE through high-performance geomembranes

Vanessa di Battista and Dr. Kerry Rowe

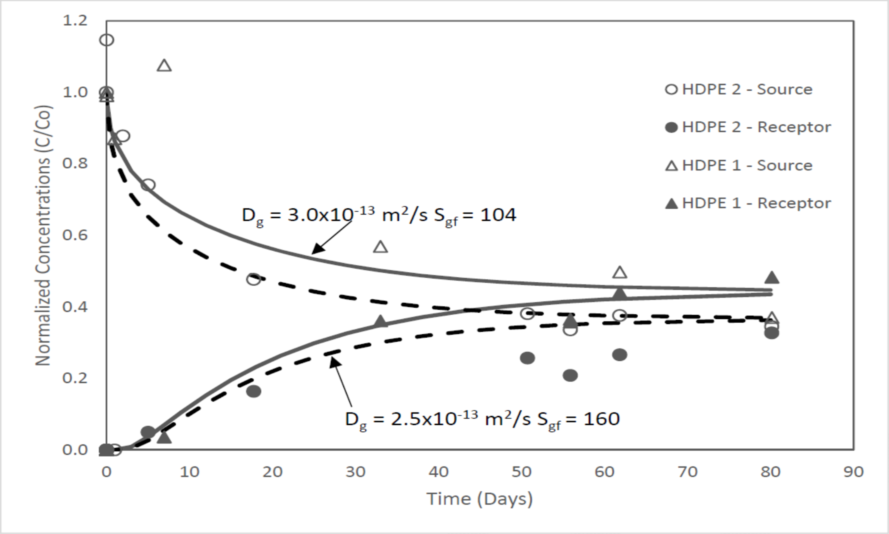
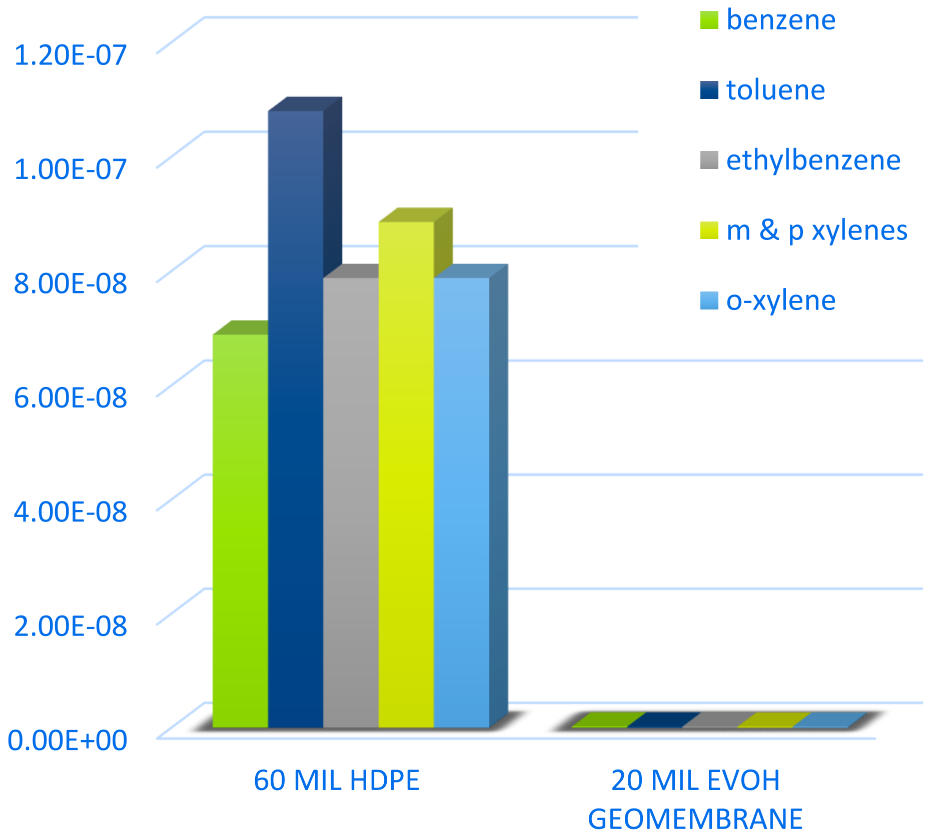


Figure 2: HDPE with TCE

20 MIL EVOH GEOMEMBRANE VS. 60 MIL HDPE GEOMEMBRANE



Permeance Difference

- Benzene = 312x Lower
- Toluene = 517x Lower
- Ethylene Benzene = 402x Lower
- M & P Xylenes = 452x Lower
- Oxylene = 428x Lower

ONGOING TESTING

Rebecca S. McWatters[1] and R. Kerry Rowe, F.ASCE[2]

Table 8. Permeation Coefficients (P_g) for EVOH Thin Films, Coextruded LLDPE/EVOH Geomembrane, and Traditional LLDPE and HDPE Geomembranes

Geomembranes (EVOH Content)					
Contaminant	**LLDPE geomembrane[a] (0 mol%), P_g X 10^{14} ($m^2 \cdot s^{-1}$)**	**HDPE geomembrane[b] (0 mol%), P_g X 10^{14} ($m^2 \cdot s^{-1}$)**	**EVOH Thin Film (32 mol%), P_g X 10^{14} ($m^2 \cdot s^{-1}$)**	**EVOH Thin Film (44 mol%), P_g X 10^{14} ($m^2 \cdot s^{-1}$)**	**EVOH Layer in Coextruded Geomembrane (38 mol%), P_g X 10^{14} ($m^2 \cdot s^{-1}$)[c]**
Benzene	7,000	1,000	19	2.3	0.4
Toluene	11,000	3,000	25	2.6	0.5
Ethylbenzene	8,000	5,000	13	1.6	0.6
m&p-Xylenes	9,000	6,000	11	1.5	0.7
o-Xylene	8,000	4,000	11	1.4	0.4

[a] McWatters and Rowe (2010).
[b] McWatters (2010).
[c] EVOH layer best estimate.

ONGOING TESTING

Rebecca S. McWatters[1] and R. Kerry Rowe, F.ASCE[2]

Table 1. PFOA and PFOS best estimate D_g, S_{gf}, and P_g values for LLDPE and CoEx membranes at multiple temperatures

Material	Temp.	PFOA			PFOS		
	(℃)	D_g ($\times10^{-16}m^2/s$)	S_{gf} (-)	P_g ($\times10^{-16}m^2/s$)	D_g ($\times10^{-16}m^2/s$)	S_{gf} (-)	P_g ($\times10^{-16}m^2/s$)
0.75 mm LLDPE	23	≤10	0.9-1.4	≤9-13	≤6.5-6.7	2.8-5.3	≤19-34
0.75 mm LLDPE	35	≤9.3-10	0.9-1.4	≤9-13	≤7.6-7.8	2.8-5.3	≤22-40
0.75 mm LLDPE	50	≤10-19	0.9-1.4	≤14-19	≤9.8-9.9	2.8-5.3	≤27-52
0.75 mm CoEx EVOH	23	-	-	≤8.6	-	-	≤6.8
0.75 mm CoEx EVOH	35	-	-	≤11	-	-	≤8.3
0.75 mm CoEx EVOH	50	-	-	≤10	-	-	≤8.2

*38 mol% et. EVOH film removed from the 0.53 mm LLDPE with EVOH GM

BOYD RAMSEY WHITE PAPER

"Containment of PFAS Type Materials with Geomembranes"

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Date: July 25, 2020 Title: Containment of PFAS type materials with geomembranes

Introduction:

This paper contains new data and references to additional testing on the permeation of PFAS through geomembrane materials. This testing was (and is) occurring at Queen's University, Kingston, Ontario Canada. The newly reported results are attached and the data and information are summarized here.

Proper storage of waste materials is a landmark of civilized human society. While reduction of waste and increased recycling are clearly essential for continued human life, in the current time and near-term future, humankind needs places to store waste that will not negatively impact sub-surface and ground and surface water quality and the general environment. Traditionally, and generally successfully, this has meant storing waste in engineered and technically designed landfills that are constructed with materials specifically installed to contain the waste and provide a barrier between the waste and the environment. This is generally accomplished with a geomembrane barrier (most commonly polyethylene due to broad based chemical resistance) used in combination with a compacted clay or geosynthetic clay liner.

Polyethylene (generally HDPE, or High-Density PolyEthylene) is used for multiple reasons, but key to the selection and successful performance is the chemical resistance of HDPE geomembranes. However, until recently there has been no direct testing or available data for geomembranes in the containment of PFAS type materials. That changes with the publication of the attached paper: "PFOA and PFOS Diffusion through LLDPE and LLDPE Coextruded with EVOH at 22°C, 1 35°C, and 50°C" authored by V. Di Battista et.al and accepted for publication in *Waste Management*.

Current situation:

PFAS, PFOS and AFFF chemical compounds are nearly ubiquitous in today's world. They have been manufactured for decades and are components in items from firefighting foam for aviation and critical electronic installations to coatings on kitchenware, carpeting and fabrics. While these material types offer useful functionality and utility, in recent years these materials have come under increasing scrutiny, investigation, regulation and concern. The materials have demonstrated extreme environmental durability and are very long-lasting within the earth's ecosystem. The products have

The testing clearly indicates that the standard of practice for PFAS type containment is the use of multilayer (Ethylene vinyl alcohol) containing geomembranes, offering a two order of magnitude improvement in barrier properties.

Finally, it should be noted that a potential strategy that may be most appropriate at this time is one of mitigation rather than remediation. Covering contaminated areas, even those with footprints of 20 or more hectares is often a reasonable and best-practice plan for eliminating additional water intrusion and minimizing or halting the spread of some contaminates/sites. This option merits consideration.

DETAILED INSTALLATION INSTRUCTIONS

THE ULTIMATE IN GAS CONTAINMENT

ABSOLUTE BARRIER
UNDERSLAB INSTALLATION GUIDELINES
X-SERIES AND Y-SERIES

Note: Read these instructions thoroughly before installation to ensure proper use of Absolute Barrier® vapor/gas under-slab barriers.

When installing Absolute Barrier®, ASTM E1465, ASTM E2121 and ASTM E1643 also provide valuable information regarding the installation of vapor/gas barriers. ASTM D4437 outlines test procedures for determining the quality of bonded seams. When installing this product, contractors shall conform to all applicable local, state and federal regulations and laws pertaining to residential and commercial building construction. Depending on the complexity and project specific requirements, a qualified design engineering firm may be required for design and installation specifications of the under-slab gas barrier. In those cases, all work shall be in accordance with the project drawings, specifications, and quality control requirements.

When Absolute Barrier® gas barriers are used as part of an active control system for radon or other gas, a ventilation system will be required.

If designed as a passive system, it is recommended to install a ventilation system that could be converted to an active system if needed.

Elements of a moisture/gas-resistant floor system. General illustration only.
(Note: This example shows multiple options for waterstop placement.)

Absolute Barrier® Material List:
- HDPE Welding Rod if using X-Series
- LLDPE Welding Rod if using Y-Series
- Preformed Pipe Boots (or additional membrane if field fabricated)
- Aluminum Batten Strip
- Butyl Seal 2-Sided Tape
- POUR-N-SEAL™ (optional)

Absolute Barrier® Install Equipment List:
- Extrusion Welder
- Hot Air Welder and/or
- Single or Dual Track Wedge Welder
- Vacuum Box Test Device and/or
- Air Lance Testing Device
- Center Air Channel Testing Device (if using Dual Track Wedge Welder)

Figure 1: Absolute Barrier Overlapping Roll-out Method

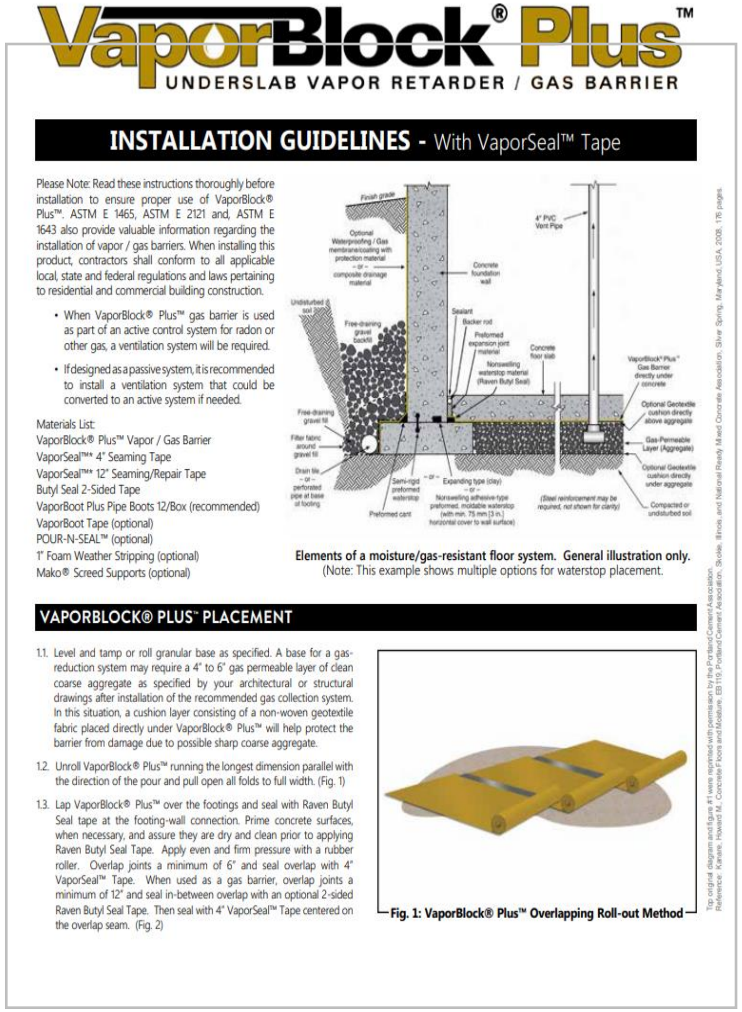
STEP 1 BARRIER PLACEMENT & DEPLOYMENT

1.1 Level and tamp or roll granular base as specified. A base for a gas-reduction system may require a 4" to 6" gas permeable layer of clean coarse aggregate as specified by your architectural or structural drawings after installation of the recommended gas collection system. In this situation, a cushion layer consisting of a non-woven geotextile fabric placed directly under Absolute Barrier® will help protect the barrier from damage due to possible sharp coarse aggregate.

1.2 Unroll Absolute Barrier® running the longest dimension parallel with the direction of the pour and pull open all folds to full width, remove as many wrinkles as practical (Figure 1). Overlap edges 6" in preparation for thermal seaming. This overlap area must be cleaned of all dust, dirt, water and foreign debris no more than 30 minutes prior to the heal seaming operation.

1. Cut one of the preformed boot steps (1" to 4").
2. Force the boot over the pipe.
3. Use Raven Butyl-Seal Tap between pipe and boot.
4. Secure Boot with a stainless steel clamp.
5. Hot Air or Extrusion Weld perimeter of boot to barrier.

Figure 2



VaporBlock® Plus™
UNDERSLAB VAPOR RETARDER / GAS BARRIER

INSTALLATION GUIDELINES - With VaporSeal™ Tape

Please Note: Read these instructions thoroughly before installation to ensure proper use of VaporBlock® Plus™. ASTM E 1465, ASTM E 2121 and, ASTM E 1643 also provide valuable information regarding the installation of vapor / gas barriers. When installing this product, contractors shall conform to all applicable local, state and federal regulations and laws pertaining to residential and commercial building construction.

- When VaporBlock® Plus™ gas barrier is used as part of an active control system for radon or other gas, a ventilation system will be required.
- If designed as a passive system, it is recommended to install a ventilation system that could be converted to an active system if needed.

Materials List:
VaporBlock® Plus™ Vapor / Gas Barrier
VaporSeal™* 4" Seaming Tape
VaporSeal™* 12" Seaming/Repair Tape
Butyl Seal 2-Sided Tape
VaporBoot Plus Pipe Boots 12/Box (recommended)
VaporBoot Tape (optional)
POUR-N-SEAL™ (optional)
1" Foam Weather Stripping (optional)
Mako® Screed Supports (optional)

Elements of a moisture/gas-resistant floor system. General illustration only.
(Note: This example shows multiple options for waterstop placement.)

VAPORBLOCK® PLUS™ PLACEMENT

1.1. Level and tamp or roll granular base as specified. A base for a gas-reduction system may require a 4" to 6" gas permeable layer of clean coarse aggregate as specified by your architectural or structural drawings after installation of the recommended gas collection system. In this situation, a cushion layer consisting of a non-woven geotextile fabric placed directly under VaporBlock® Plus™ will help protect the barrier from damage due to possible sharp coarse aggregate.

1.2. Unroll VaporBlock® Plus™ running the longest dimension parallel with the direction of the pour and pull open all folds to full width. (Fig. 1)

1.3. Lap VaporBlock® Plus™ over the footings and seal with Raven Butyl Seal tape at the footing-wall connection. Prime concrete surfaces, when necessary, and assure they are dry and clean prior to applying Raven Butyl Seal Tape. Apply even and firm pressure with a rubber roller. Overlap joints a minimum of 6" and seal overlap with 4" VaporSeal™ Tape. When used as a gas barrier, overlap joints a minimum of 12" and seal in-between overlap with an optional 2-sided Raven Butyl Seal Tape. Then seal with 4" VaporSeal™ Tape centered on the overlap seam. (Fig. 2)

Fig. 1: VaporBlock® Plus™ Overlapping Roll-out Method

QUESTIONS?

Thank you!