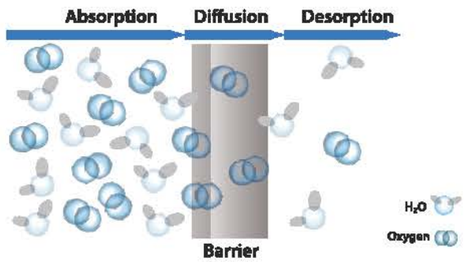
PERMEATION TESTING OVERVIEW

What is Permeation?

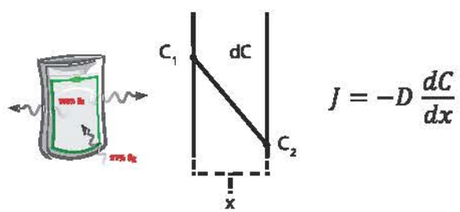
Diffusion of a gas through a material.

Permeation is the movement of gas from an area of high concentration through a semipermeable material to an area of low concentration. The mechanisms of permeation are:

- Absorption of gas penetrant into barrier
- Diffusion of penetrant through barrier
- Desorption of penetrant from the surface



Defined by Fick's Law.



$$J = -D\frac{dC}{dx}$$

Transmission rate (Flux, J) is proportional to the permeant diffusivity (D) through the barrier and concentration gradient (dC) across the barrier (dx)

Measured as a Transmission Rate

$$J\,[=]\,\frac{m^2}{day}\cdot\left(\frac{g}{m^3\cdot m}\right)[=]\,\frac{g}{m^2\cdot day}$$

Units of Measure

Water Vapor Transmission Rate

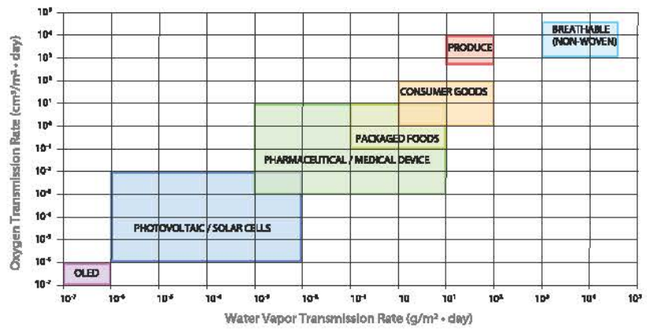
$$WVTR\,[=]\,\frac{g}{m^2\cdot day}$$

Oxygen Transmission Rate

$$OTR\,[=]\,\frac{cm^3}{m^2\cdot day}$$

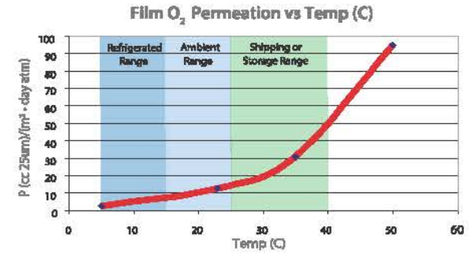
Why Permeation Matters

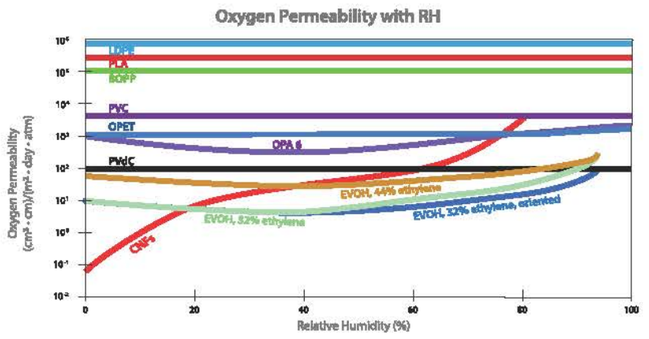
Material permeability needs differ by application.



Permeation can be affected by many factors.

- Temperature
- Relative Humidity
- Time
- Material Type
- Material Thickness
- Barometric Pressure





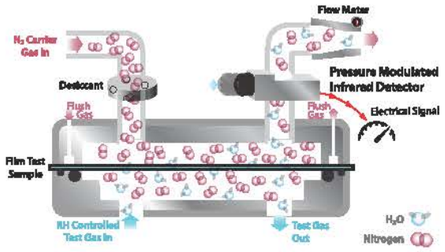
Source: Jinyu Wang, Douglas J. Gardner, Nicole M. Stark, Douglas W. Bousfield, Mehdi Tajvidi, Zhiyong Cai; Moisture and Oxygen Barrier Properties of Cellulose Nanomaterial-Based Films. ACS Sustainable Chem. Eng. 2018, 6, 49–70

Testing Methods

Water Vapor Transmission Rate method.

Typical Test Conditions
23°C / 50% RH 38°C / 90% RH 38°C / 100% RH

ASTM F1249, ISO 15106-2, JIS K 7129-2, GB/T 26253



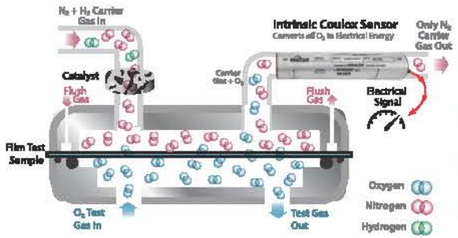
Modulated IR Sensor Benefits

- Most accurate results
- Short exam times
- Very long sensor life

Oxygen Transmission Rate method.

Typical Test Conditions
23°C / 0% RH

ASTM D3985, ISO 15105-2, JIS K 7126-2, GB/T 19789, DIN 53380-3



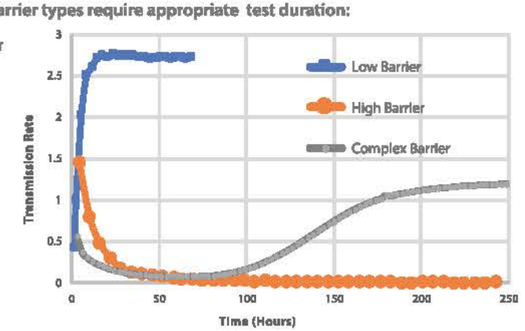
Coulox® Sensor Benefits

- Intrinsic sensor never needs calibration
- Fast response reduces exam time
- Most accurate results
- Lowest limits of detection (LOD)

Common Transmission Rate curves with time to equilibrium.

Different barrier types require appropriate test duration:

- Monolayer
- Multilayer
- Coatings



Testing Applications

Complete package testing.

ASTM F1307, GB/T 31354

Reusable Testing Cartridges for:

- Bottles and cups
- Trays and lids
- Flexible pouches
- Tubes, caps and more

PackRack® Testing Fixture

Barrier film testing.

Horizontal Test Cartridges for Films:

- 50 cm² standard area
- Edge effect for paper barriers
- Reduced area for small samples or high range
- Dual film cartridge

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