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Water Permeability units and conversion between units

The very wide set of different units that are used for vapour permeability often make it incredibly difficult to compare samples, gasses and results. Not only are different sets of units used in different geographical regions, but also in different applications!

The permeability coefficient measures relative permeation behaviour and is used to compare the permeability of different polymers.

In an effort to clarify the differences between the units we hope the following information is useful though, in a note from the lawyers, although we believe all of the information is accurate, you use these conversions entirely at your own risk

The normalized units for vapor permeability are called the vapor transmission rate, and are expressed as g mm/m^2 day in standard SI (System International) nomenclature. However, in practice, for largely historic reasons, a wide and confusing variety of different units are commonly used. This page gives the conversion factors between these vapour permeability units

According to the definition given in EN 31092:1993, water-vapour permeability is "a characteristic of a textile material or composite depending on water vapour resistance and temperature

Technically the vapour permeability of a material is given by the equation

$dM_{gas}/ dt = P \times A\ dp /l$

where:-

P is the **vapour permeability** of the barrier
dM_{gas} is the amount of gas that flows through the barrier
dt is the time it takes
A is the area of the barrier
l is the thickness of the barrier
dp is the partial pressure difference across the barrier

Effectively a moisture vapor transmission rate (MVTR) is a measure of the passage of vapor through a material (such as a vapor barrier, film or fabric) of a given unit area per unit time under pre-specified temperature and humidity conditions.

WVTR is the same as MVTR when the vapour it water vapour

The lower the MVTR the smaller the amount of moisture passes through in a given time.

In metric units, MVTR and WVTR are expressed in kilograms, grams, milligrams or nanograms per square meter per 24 hours (g/m^2 /day). In the US, however, it is often expressed in grams per 100 square inches per 24 hours (g/100 in^2 /day).

The SI unit for permeance is the kilogram (or gram or nanogram) per second per square meter per pascal. For example, 1 kg s^{-1} m^{-2} Pa^{-1} ≈ 1.74784x10^{10} US perms≈ 1.15191x10^{10}

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metric perms. However, when it is also expressed as nanograms per second per square meter per pascal. In this case 1 $ng \cdot s^{-1}\ m^{-2} \cdot Pa{-}1 \approx 0.0174784$ US perms≈ 0.0115191 metric perms

The US perm is defined as 1 grain of water vapor per hour, per square foot, per inch of mercury. 1 US perm = 0.659045 metric perms$\approx 57.2135\ ng \cdot s^{-1}\ m^{-2} \cdot Pa^{-1}$

The metric perm (which is **not** a SI unit) is defined as 1 gram of water vapor per day, per square meter, per millimetre of mercury. 1 metric perm = 1.51735 US perms $\approx 86.8127\ ng \cdot s^{-1}\ m^{-2} \cdot Pa{-}1$

A material does not have a single vapour permeability for all gasses / vapours the transmission rate depends critically on the specific vapour, and sometimes on a vapour's specific isotopes. For example, water vapour may flow easily through one material, but that same material may put up much greater resistance to another vapour - such as oxygen, carbon dioxide or a hydrocarbon. The pressure difference of the vapour across the material can also make a big difference, as can temperature. Thus, the vapour permeability of a material is given for specific materials at specific temperatures, specific material thicknesses and specific vapour partial pressures.

Common Units	**Multiply By**	**Normalized SI Units**
g mil/1 00 in^2 day	3.937008×10^{-1}	g mm/m^2 day
cc mil/1 00 in^2 day atm	3.937008×10^{-1}	cm^3 mm/m^2 day atm
m^2/sec Pa	8.754480×10^{-1}	cm^3 mm/m^2 day atm
cm^3 mils/m^2 day atm	2.54×10^{-2}	cm^3 mm/m^2 day atm
cc mm/m^2 sec cm Hg	6.566397×10^{6}	cm^3 mm/m^2 day atm
cc mm/m^2 sec atm	8.64×10^{4}	cm^3 mm/m^2 day atm
in^3 mil/1 00 in^2 24 hrs atm	6.4516	cm^3 mm/m^2 day atm
cm^3 mm/m^2 day bar	1.01325	cm^3 mm/m^2 day atm
mm^3 mm/m^2 24 hrs Pa	1.01325×10^{2}	cm^3 mm/m^2 day atm
μm^3 mmfm^2 sec Pa	8.75448×10^{-3}	cm^3 mm/m^2 day atm
cm^3 mmfm^2 24 hrs Pa	1.01325×10^{5}	cm^3 mm/m^2 day atm
cm^3 (@STP) cm/atm sec cm^2	8.64×10^{9}	cm^3 mm/m^2 day atm
cm^3 mils/cm^2 sec atm	2.19456×10^{7}	cm^3 mm/m^2 day atm
ft^3 mils/ft^2 day psi	1.137749×10^{5}	cm^3 mm/m^2 day atm
mMPa day	1.01325×10^{-1}	cm^3 mm/m^2 day atm

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Vapour permeability conversion factors

	g/(s MN)	g/(cm^2 s mbar)	g/(m^2 24h mmHg)	lb/(ft^2 h atm) (see note 2)	gr/(ft^2 h mbar) (see note 4)	gr/(ft^2 h inHg) =1 perm	Temperate (g/m^2 24 h) 25C 75% RH	Tropical (g/m^2 24 h) 38 C 90%RH
(g/s MN)	1	1x 10^{-8}	1.152 x 10	7.471 x 10^{-2}	5.161 x 10^{-2}	1.749 x 10	2.052 x 10^{2}	5.149 x 10^{2}
g/(cm^2 s mbar)	1x 10^{8}	1	1.152 x 10^{9}	7.471 x 10^{6}	5.161 x 10^{-7}	1.749 x 10^{9}	2.052 x 10^{10}	5.149 x 10^{10}
g/(m^2 24h mmHg)	8.681 x 10^{-2}	8.681 x 10^{-10}	1	6.486 x 10^{-3}	4.481 x 10^{-2}	1.517	1.782 x 10	4.472 x 10
lb/(ft^2 h atm) (see note 2)	1.339 x 10	1.339 x 10^{-7}	1.542 x 10^{2}	1	6.909	2.339 x 10^{2}	2.747 x 10^{3}	6.896 x 10^{3}
gr/(ft^2 h mbar) (see note 4)	1.937	1.937 x 10^{-8}	2.233 x 10	1.447 x 10^{-1}	1	3.388 x 10	3.975 x 10^{2}	9.980 x 10^{2}
gr/(ft^2 h inHg) =1 perm	5.719 x 10^{-2}	5.719 x 10^{-10}	6.590 x 10^{-1}	4.275 x 10^{-3}	2.951 x 10^{-2}	1	1.174 x 10	2.048 x 10
Temperate (g/m^2 24 h) 25C 75% RH	4.874 x 10^{-3}	4.874 x 10^{-11}	5.613 x 10^{-2}	3.641 x 10^{-4}	2.515 x 10^{-3}	8.514 x 10^{-2}	1	See note 3
Tropical (g/m^2 24 h) 38 C 90%RH	1.942 x 10^{-3}	1.942 x 10^{-11}	2.236 x 10^{2}	1.450 x 10^{4}	1.002 x 10^{-3}	3.392 x 10^{-2}	See note 3	1

Note 1. To convert units in the first column to units in the heading multiply by the factor given at the intersection of the row and column
Note 2. This was the term used by the building industry
Note 3. No conversion from temperate to tropical is shown for reasons given in clause 46 of BS 2972 : 1975
Note 4. The symbol gr refers to grams

Disclaimer: Although every effort has been made to ensure the figures are accurate, you use it at your own risk

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