Scientific formulae relevant to the MVTR calculator

The following text provides details of the formulae used in the development of the MVTR calculator which is described in full in the Journal of Wound Care in October 2011.[1]

Moisture vapour transmission rate (MVTR),

Moisture vapour transmission rate (MVTR), sometimes called water vapour transmission rate (WVTR), is a measure of the rate of passage of water vapour through a given area of material in a specific time. In Europe this value is usually expressed as $g/m^2/24h$ or $g/10cm^2/24$ hours but in the USA as $g/100in^2/day$.

The MVTR of a membrane can be described by a modification of Fick's First Law shown in Equation 1, where 'P_1 - P_2' represents the difference in partial pressure of water vapour across the membrane, 'a' is the area under test, 'd' is the thickness, and 'k' is an experimentally derived constant which is determined by the porosity and internal structure of the material.

$$MVTR = \frac{ka(P_1 - P_2)}{d}$$ ……… **Equation 1**

For a specific test sample of constant area and thickness and a test of standard duration, this equation may be simplified as follows when K is based upon a fixed film thickness and test area.

$$MVTR = K(P_1 - P_2)$$ ……… **Equation 2** or $$K = \frac{MVTR}{P_1 - P_2}$$ …….. **Equation 3**

Relative Humidity

Relative humidity is commonly described as the ratio of partial vapour pressure and saturated vapour pressure at a particular temperature and is expressed as follows.

$$RH = \frac{P}{SVP} \times 100$$ or $$P = \frac{RH \times SVP}{100}$$ ……… **Equation 4**

Saturation vapour pressure

Saturation vapor pressure (SVP) is achieved when the vapour of a substance is in equilibrium with the same substance in a pure liquid or solid phase and is dependent upon the temperature of the system. Numerous equations have been proposed to calculate the SVP of water vapour but the complex Goff Gratch equation is generally regarded as the most accurate generalised equation.[i] For the purpose of this study, a simpler formula previously proposed by Buck was adopted,[ii] which is more accurate than Goff Gratch over the temp range -80 to 50º:

$$SVP = 6.1121 \exp\left(\left(18.678 - \frac{t}{234.5}\right)\left(\frac{t}{257.14 + t}\right)\right)100$$ …….. **Equation 5**

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i http://cires.colorado.edu/~voemel/vp.html i

ii (Buck Research Manual (1996); updated equation from Buck, A. L., New equations for computing vapor pressure and enhancement factor, J. Appl. Meteorol., 20, 1527-1532, 1981

In equation 5, SVP is the saturation vapour pressure in Pascal (Pa), exp is the natural base *e* exponential function and *t* is the temperature in degrees Celsius.

By calculating the SVP both inside and outside the membrane using Equation 5, and substituting these values into Equation 4, using the corresponding experimental RH values, it is possible to obtain values of 'P_1' and 'P_2'. These in turn may be substituted into Equation 3 along with the experimentally determined MVTR to estimate the value of the constant 'K'

Once 'K' is known, using Equation 2, it is possible to predict the MVTR of the same sample of film under any selected conditions of temperature and RH.

References

1. Thomas S, Barry L, Fram P, Phillips PJ. The effect of temperature and humidity on the permeability of semipermeable film dressings. *J Wound Care* 2010;**20**(10):484-489.