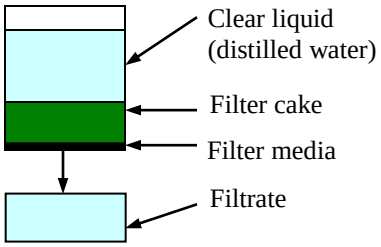
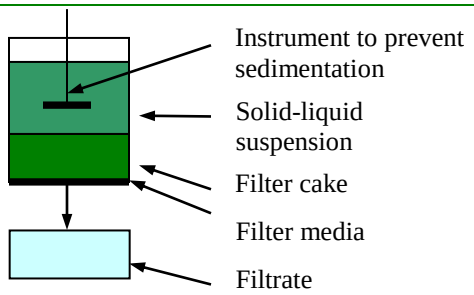
Filter Aid Permeability Test Method

Permeability is a measure of rate of liquid flowing through a porous medium or a particulate filter cake. It is an important characteristic that filter aid manufacturers use in their product specification. Currently in the US, there has not been a standard filter aid permeability test method. Companies use own standards for filter aid product specifications.

There are two methods in permeability determination: the liquid flowing through already formed cake approach (Method I) and the cake filtration approach (Method II). A detailed comparison of the two methods including test methods and fundamental basis is shown in the Table.

Method I and Method II Permeability Tests

	Method I: Liquid flow through already formed cake	Method II: Cake filtration
Schematic Diagraph		
Test Method	(1) Cake formation under certain constant pressure or vacuum; (2) Clear liquid poured above already formed cake without damaging the cake; (3) Liquid flowing through already formed cake under a certain constant pressure or vacuum. (4) Volume of filtrate V against time, and final cake thickness collected for permeability calculation.	(1) Constant pressure filtration with an instrument to avoid sedimentation effect during cake formation; (2) Volume of filtrate against time, final cake thickness collected for data analysis.
Fundamental Basis	Darcy's law $q = \frac{dV}{Adt} = \frac{K\Delta p_c}{\mu L}$ (1) Δp_c is the pressure drop across cake. Neglecting filter medium resistance, Δp_c can be replaced by applied pressure p. Permeability equation is then given by:	The following equations are used to develop permeability calculation (Tiller, Li, 2002; Tiller, 1990): Two resistance model: $q = \frac{dV}{Adt} = \frac{p}{\mu(\alpha_{av}\omega_c + R_m)}$ (3) Material balance: $v = V/A = (\varepsilon_{sav}/\varphi_s - 1)L$ (4) $\omega_c = cV/A = cv$ (5) $c = \varphi_s/(1-\varphi_s/\varepsilon_{sav})$ (6)

$$K = \frac{\mu L dV}{pAdt} \qquad (2)$$

With known p, V vs. t, L, A, and μ, cake permeability can be calculated.

Volume vs. time:

$$pdt/\mu dv = (\alpha_{av} cv + R_m) \qquad (7)$$

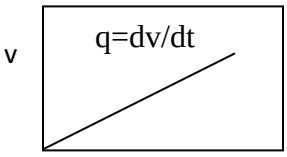
$$pt/\mu v = \alpha_{av} cv^2/2 + R_m v \qquad (8)$$

Average cake resistance and cake permeability:

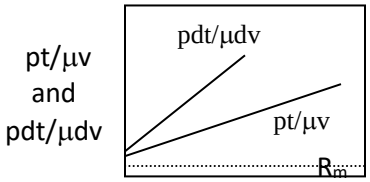
$$\alpha_{av} K \varepsilon_{sav} = 1 \qquad (9)$$

With known p, V or v against t, φ_s, V and L at the end of filtration, ε_{sav} (from Eq. 4), c (from Eq. 6), and α_{av} (from Eq. 7 and 8) will be calculated. Permeability K is then calculated based on Equation (9).

Data analysis



Permeability is then calculated based on Equation (2).



According to Equations 7 and 8, slopes of the straight lines give the average specific resistance α_{av}. Permeability can be then calculated from α_{av} based on Equation (9).

Permeability determined by the Method I depends upon how the filter cake is initially formed and how the liquid is poured on the top of filter cake without cake disturbance. Filter media resistance is not included in the cake permeability calculation. With a substantial media blinding and increase of filter media resistance, an error will occur for calculation of cake permeability without considerations of filter media resistance. It can be only used to determine permeability of incompactible material.

The Method II approach is based on fundamental filtration theory (Tiller, 1990, 2002) assuming there is no effect of sedimentation during cake formation, and a parabolic volume of filtrate vs. time curve. The equipment and calculations are more complicated. However, it include filter media resistance, and gives dynamic permeability during cake formation period under constant pressure, or varying pressure tests. It can be also used to test cake permeability or filterbility of solid-liquid suspensions including highly compactible materials.

Reference:

Tiller, F. M., and W. Li, Theory and Practice of Solid/Liquid Separation, Fourth Edition, 2002, University of Houston

Tiller, F. M., "Tutorial: Interpretation of Filtration Data, I", Fluid/Particle Separation Journal, Vol. 3, 85-94, 1990

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