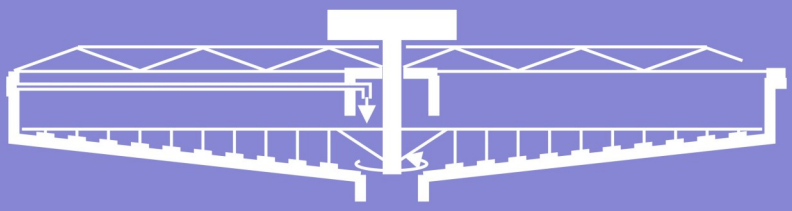
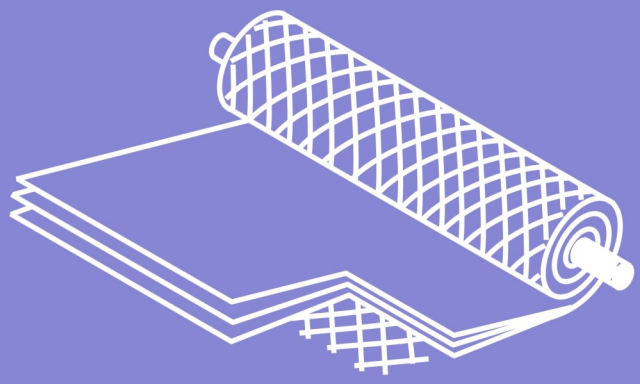
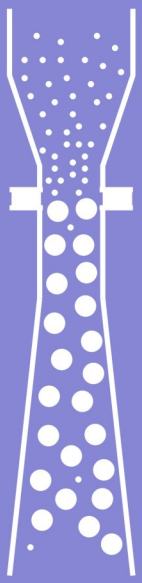
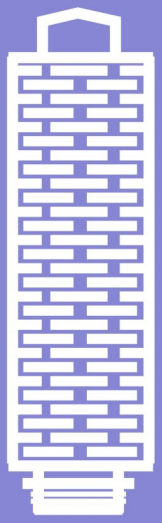
Dictionary of Filtration and Separation









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Dictionary of Filtration and Separation

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Preface

The Filtration Dictionary was first published in 1975 and subsequently built upon in 1985 with the publication of the Filtration Dictionary and Glossary. Both of these books were designed to provide a quick reference to the terminology of filtration and separation. With the publication of this new book, which provides an A to Z coverage of filtration topics, the authors have brought together an authoritative and up to date text which not only has numerous new additions, but is also cross-referenced and illustrated throughout. The aim is to provide a source of reference for all practitioners of filtration and separation as well as a valuable educational resource.

The Dictionary is not intended to provide full details of fundamental theories or process design; for these the reader is directed to the authors' other books which are listed in the Bibliography. While some entries are necessarily highly specialised, the aim has been to provide an explanation accessible to the general reader or casual user. It is our intention that the Dictionary should be of use to anyone who finds themselves working with filtration technologies.

The Dictionary is uniquely structured. The user may look up any entry or open any page and will be provided with cross-referencing to related topics. Toward the end of the book additional entries which are more specific to the Filter Design Software™ are listed together with a description of the software itself.

Steve Tarleton and Richard Wakeman, October 2008

Acronyms

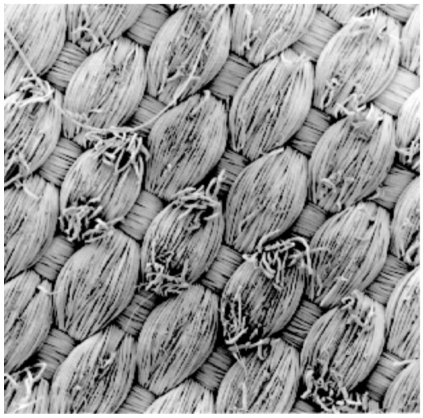
AC	Alternating current
ACCTD	AC coarse test dust
ACFM	Actual cubic feet per minute
ACFTD	AC fine test dust
ACGHI	American Conference of Governmental Industrial Hygienists
ACS	American Chemical Society
AFNOR	Association Française de Normalisation
AFS	American Filtration and Separations Society
AHRI	Air-Conditioning, Heating and Refrigeration Institute
AIHA	American Industrial Hygiene Association
AMC	Airborne Molecular Contamination
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute
API	American Petroleum Institute
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWCI	American Wire Cloth Institute
A.W.G.	American Standard Wire Gauge
AWWA	American Water Works Association
BET	Brunauer, Emmet and Teller
BFE	Bacterial filtration efficiency
BAF	Biological aerated filter
BOD	Biological oxygen demand
BSI	British Standards Institute
B.W.G.	Birmingham Wire Gauge
cGMP	Current good manufacturing practice
CEN	Comité Européen des Normalisation (European Committee for Standardisation)
CFD	Computational fluid dynamics
CFM	Cubic feet per minute
CFU	Colony forming units
CGS	Centimetre-gram-second
CIP	Clean-in-place
CMC	Critical micelle concentration
COD	Chemical oxygen demand
COP	Clean-out-of-place
C-P	Compression-permeability
CPC	Condensation particle counter
UF	Ultrafiltration
UHEPA	Ultra high efficiency particulate air

ULPA	Ultra low penetration air
UNI	Ente Nazionale Italiano di Unificazione
USP	United States Pharmacopeia
VDI	Verein Deutscher Ingenieure
VFE	Viral filtration efficiency
VOC	Volatile organic compound
WG	Water gauge

A

ABATEMENT
The reduction of pollutant **discharge** by means of process modification or the addition of pollution control equipment.

ABRASION
Surface damage due to a rubbing contact, a process that is usually increased when rough surfaces and/or more vigorous motion are present. Abrasion resistance of **filtration** media is important in a **deep bed filter** (e.g. where there is a gradual reduction in size of the granules in the **filter bed** as a consequence of **fluidisation** during cleaning), **continuous** filters where motion of the **cloth** is involved (e.g. **horizontal belt filter**, **vertical diaphragm filter press**), and cloths and other **filter** components that are in contact with abrasive **particles** in the **feed**.



Abrasion damaged plain weave fabric (Madison Filter).

ABRASION INDEX
A numerical value that is indicative of a material's tendency to wear (i.e. abrade) when exposed to a rubbing force such as that induced by a flowing fluid or **suspension**. When more vigorous motions are present, such as in a **cyclone** or **hydrocyclone**, the inclusion of hard linings may be required to give an acceptable service life.

ABSOLUTE (FILTER) RATING
In **liquid filtration** 'absolute' is frequently used to imply the size above which no **particles** will be found in the **filtrate**. Commonly used to describe a **membrane**. Previously applied to high **efficiency air filters** but modern terminology prefers **HEPA filter**.

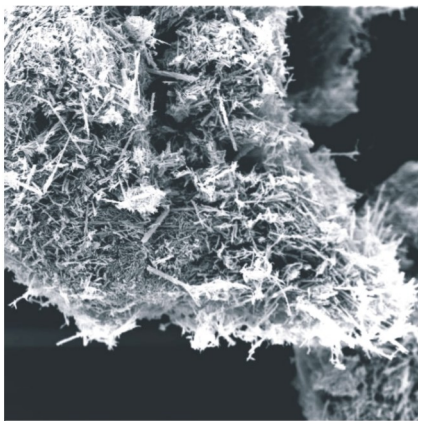
ABSOLUTE PRESSURE
The pressure above zero pressure, i.e. above an absolute vacuum. The same as one atmosphere (101.3 kPa, 14.7 psi etc.) above **gauge pressure**.

ABSORPTION
Physico-chemical process in which a substance associates with another to form a homogeneous mixture which has the characteristics of a **solution**, e.g. absorption of a gas into a liquid.

AC FINE TEST DUST – SEE ARIZONA TEST DUST

ACICULAR
Used in **particle** characterisation to describe a needle like shape.

ACIDITY
The degree to which a **solution** or substance is acid. Can also be defined in a number of



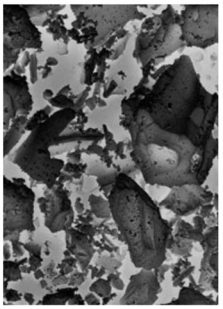
Agglomerate of acicular shape particles.

other similar ways, e.g. the capacity to neutralise alkalis.

Activated Carbon

Porous carbon, obtained by the carbonization of organic materials of synthetic or vegetable origin and activated to develop a large surface area per unit volume with strong adsorptive properties. Typical sources include coconut shells, peat, **anthracite**, and soft and hard woods according to their characteristics. Uses include the removal of odours (e.g. in **air conditioning**), the recovery of organic **solvents** from gases, the decolourization of liquids, and the removal of **contaminant** from aqueous **effluents**. Some **filter media** incorporate activated carbon within their structure to facilitate simultaneous **filtration** and **adsorption**.

Deep bed filter media



Filter aid

Examples of activated carbon (Derwent Water (*left*), SeitzSchenk (*right*)).

Activated Sludge

Biologically active **sludge** created from sewage or other slurries containing organic matter, and consisting of **bacteria** and fungi in a gelatinous **matrix**. Formation is by **aeration** of the **slurry** until the organic matter is flocculated. The **flocs** are allowed to settle and the **supernatant** liquid is withdrawn. The process is repeated with further slurry added to the earlier batch of deposited flocs to produce more flocs. In this manner an appreciable **concentration** of sludge is built that can amount to between 10% and 20% of the total liquor.

Activator

A form of **regulator** that aids the **froth flotation** process. Typically a soluble salt, an activator is used to render a **particle** surface more hydrophobic due to the action of a **collector** and thus promote **selective** flotation of that particle.

Additive

A substance which by its action leads to an improvement in the operation of a **filtration** or separation process. In general, the objective is to control selected characteristics of the **particles** so that subsequent processing is accomplished more effectively than would otherwise be the case. Examples include **coagulants** and **flocculants**.

Adhesion

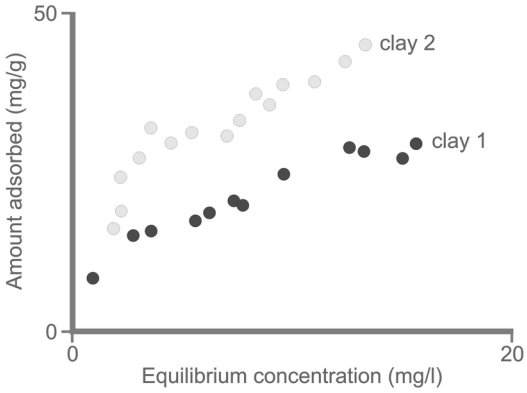
Joining of materials by intermolecular forces. Also used to describe the sticking of a **particle** to a surface, or to a **fibre** or to another particle. The main factors affecting the adhesion of particles are London **van der Waals forces** which are electrical in origin, electrostatic forces and **surface tension** due to films of moisture on particles or on the adhering surface. Other factors include the nature of the surfaces, surface contaminants, **particle size**, shape and roughness as well as time of contact. See also **Cohesion**.

ADSORBATE
Material which is adsorbed, i.e. the gas, **vapour** or liquid which adheres or is chemically attracted to the surface of a solid or **gel**.

ADSORBENT
Material, frequently a **particulate** solid or a gel, onto which the **adsorbate** is adsorbed. Examples include **activated carbon**, aluminosilicates, and **silica gel**.

ADSORPTION
Adhesion of a substance at the internal or external surfaces of a liquid or solid **adsorbent**. The term is used, for example, to describe the attachment of a vapour **adsorbate** to the surface of a solid adsorbent, from which the **vapour** may be subsequently recovered (e.g. by **desorption**). Adsorption is often used to extract pollutants from liquids and gases.

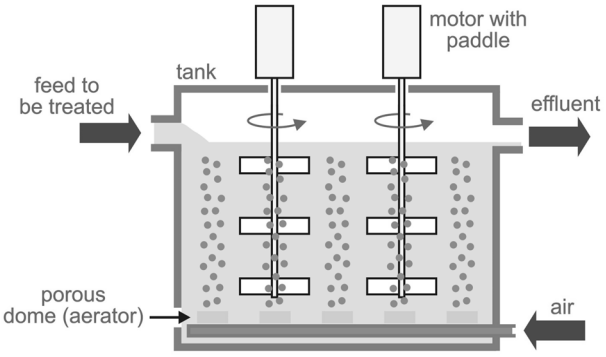
ADSORPTION ISOTHERM
The relation between the amount of substance adsorbed (i.e. **adsorbate**) onto another material (i.e. **adsorbent**) and its pressure or **concentration**. Commonly modelled by, for instance, the Langmuir and Freundlich equations.



Adsorption isotherms for two clays – iron compound adsorbate from a xylene solvent (Filtration Solutions, UK).

AERATION
The controlled admission of air via **nozzles** or a **sinter** into a liquid for a specific purpose, often to purify **water** by oxidation and to reduce the **biological oxygen demand** (BOD). In the form of long **perforated** tubes, the air admission equipment is referred to as a **sparger** unit.

AEROBIC BACTERIA
Organisms that require oxygen in order to live.



Aeration tank (Filtration Solutions, UK).

AERODYNAMIC DIAMETER
The **particle size** for **aerosols** that categorises constituent particles of different shapes and densities with a single dimension. Defined as the diameter of a spherical particle having a **density** of 1 g/cm^3 that has the same inertial properties (i.e. **terminal velocity**) in the gas as the particle of interest. For spherical particles the aerodynamic diameter (d_a) is related to the Stokes diameter (d_{st}) by the particle density (ρ_p, measured in g/cm^3):

$$d_a = d_{st}\sqrt{\rho_p}$$

With other **particle shapes** more complex relationships have been proposed. The aerodynamic diameter is measured in common forms of **aerosol** sizer.

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B

BACK DIFFUSION
A **diffusion** process that arises from **concentration polarisation** in **membrane filtration**. The accumulation of **solute** species at the **membrane** causes a concentration gradient that promotes transport of solute back into the **feed**. Also, when a **pool** of clean **wash** liquid lies on the top of a **filter cake** any solute present in the cake liquors back diffuses into the pool.

BACKDRAFT DAMPER
Damper used in a system to relieve air pressure in one direction and to prevent **air flow** in the opposite direction.

BACKFLUSH
A periodic cleaning process in which **filtrate**/**permeate** and/or air is passed in the reverse direction to the filtrate flow such that the **filter media** is cleaned by the fluid motion. Examples include the removal of **foulants** from a membrane to help maintain the level of permeate flux and the cleaning of previously deposited material in **deep bed filters** such as **sand filters**. An alternative name for **backwash**.

BACKING CLOTH, BACKING
A strong, coarse mesh **cloth** fitting directly over a **filter plate** to provide support for a finer **mesh** filter medium, or to protect a **filter medium** from damage, or to provide improved seals between adjacent filter plates and frames, or to provide improved conditions for **filtrate** flow over the filter plate **drainage surface**.

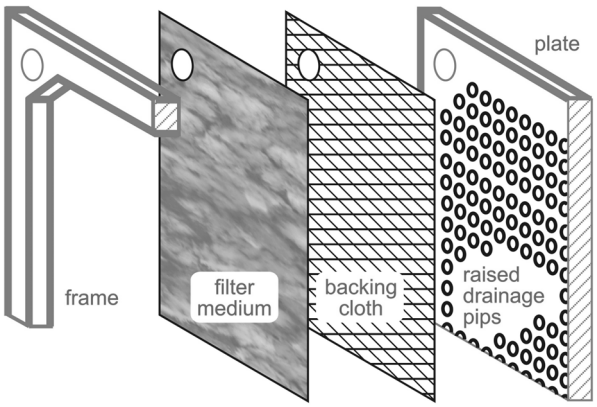
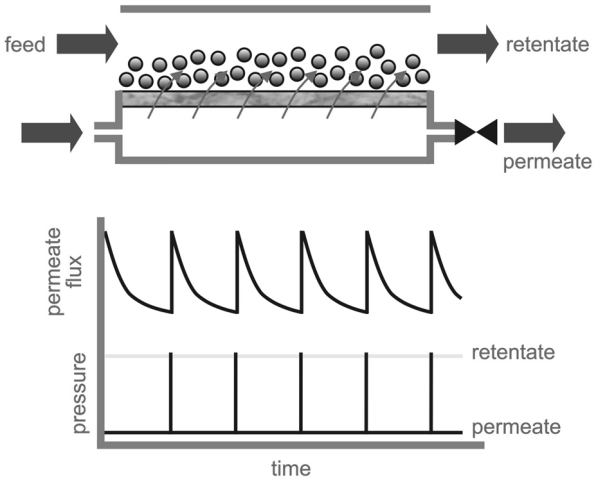


Plate and frame with cloth and backing cloth, one corner shown (Filtration Solutions, UK).

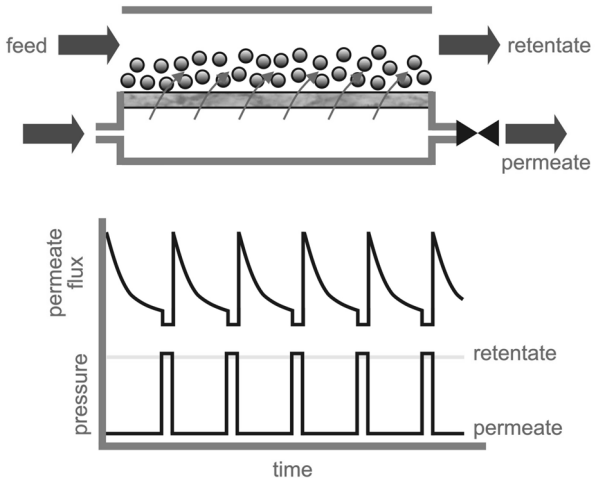
BACK PRESSURE
A surge of pressure from **downstream** to **upstream** which is in the reverse direction to that normally applied. In a **filter** system back pressure may result from, for instance, closing a valve.

BACKPRESSURE REGULATOR
A device that controls and responds to changes in its **upstream** (inlet) pressure. The regulator functions in the same way as a **relief valve** in that it opens when the upstream pressure increases.

BACKPULSE
Membrane cleaning process where **permeate** is caused to flow back through the



Membrane cleaning using backpulse (Filtration Solutions, UK).



Membrane cleaning using backwash (Filtration Solutions, UK).

membrane for short periods (as short as 0.1 s) on an intermittent basis.

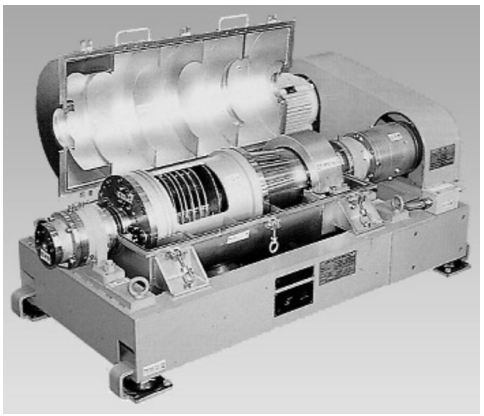
BACKWASH
A method for **filter medium** washing in which **wash** liquor is caused to flow in the reverse direction to that of the **feed** flow, to clean or regenerate the medium. In the case of a **filter bed** the purpose of backwashing is to regenerate the bed; if there is sufficient flow then the bed can become fluidised (see also **Fluidisation**). In **membrane filtration**, a periodic backwash is conducted by pumping **permeate** back into the feed **channel** to lift deposited material off the **membrane** and help maintain the level of **permeation**.

BACTERIA
Plural of bacterium. Small (often 0.5-8 microns in their largest dimension), unicellular **microorganisms** that multiply by cell division and whose material is contained by a cell wall. They occur in spherical, rod-like, spiral or curving shapes.

BACTERIAL CHALLENGE
Testing in which **bacteria** are used to challenge a **filter medium** in order to determine its **retention** capacity. Filter membranes rated at 0.2 micron remove a majority of contaminating **microorganisms** and are regarded to yield a **sterile filtrate** when challenged with 10^7 microorganisms of **Brevundimonas Diminuta** (previously known as **Pseudomouas Diminuta**) per cm^2 of **membrane** surface under a pressure of ≥ 30 psi (207 kPa). See also **Challenge Test**.

BACTERIAL FILTRATION EFFICIENCY (BFE)
A standard test that is used to determine the **filtration efficiency** of media when challenged with an **aerosol** of *Staphylococcus aureus*. **Face masks** and **air filters** (for example) are tested by counting aerosol particles upstream and downstream of the constituent media from which the BFE is determined. The viral filtration efficiency (VFE) can be determined in a virtually identical test by using a ϕX174 Bacteriophage aerosol in place of *Staphylococcus aureus*. The ϕX174 virus has a diameter *circa* 27 nm and is one of the smallest known.

BAFFLE
Obstruction for making a fluid, **suspension**, cake or **sediment** change its direction of flow. For example, as sometimes used in the **scroll decanter centrifuge** and **baffle centrifuge**.



Scroll decanter centrifuge fitted with baffles (Mitsubishi Kakoki Kaisha).

BAFFLE CENTRIFUGE
A family of specialist **filtering centrifuges**. Both the baffle ring and screen baffle centrifuge can achieve very low **residual moistures** when separating **granular** solids by causing **particles** to bounce against **baffle** type obstructions inside the filtering **bowl**. This action releases **occluded** liquids from the solids. Although these **continuous** centrifuges are relatively expensive and restricted to operations with certain types of solids such as **polymers**, their use can prove advantageous when other alternatives are unsuitable.

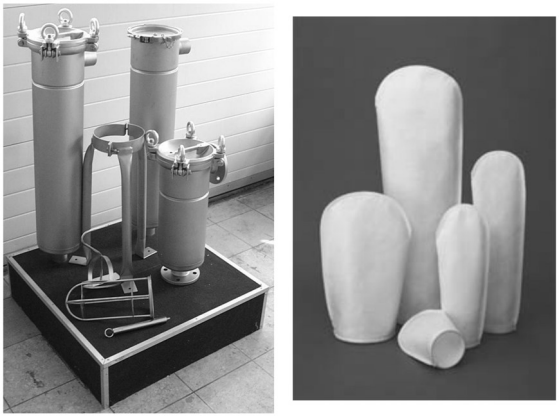
BAFFLE COLLECTOR
A device consisting of one or more plates or **louvres** which, by changing the direction of the flow of air, assists the **collection** of larger **dust** or **grit** particles that might otherwise pass through the **settling chamber** to which the plates are attached. Simpler designs enable low flow rates to avoid turbulence which might hinder deposition or give rise to **re-entrainment**, and remove **particles** with sizes above about 70 microns. More complex designs can offer good **separation efficiency** at 20 microns.

BAFFLE RING CENTRIFUGE – SEE BAFFLE CENTRIFUGE

BAG
A common form of **element** in an **air filter**, also known as a tube or stocking. Can be unsupported (**dust cake** forms on the inside) or used on the outside of a **cage** (grid) support (dust cake forms on the outside). See also **Bag Filter**, **Baghouse**.

BAG FILTER
Equipment for gas or liquid cleaning.

In liquid applications, bag filters are used for straining/**classification** of slurries to remove **particulates** down to a specific size. A highly **porous** (> 80%) polymer **felt** or woven textile in the form of a **bag** is used to trap **particles** above a certain size whilst allowing finer particles to pass through largely unhindered. The simplest arrangement comprises a single bag which is attached over the end of a pipe. Relatively dilute **feed** is pumped through the pipe and into the bag until the pressures generated become excessively high and/or separation rates become unacceptably low. At this point the flow is interrupted and the bag changed manually (and then often discarded). In more sophisticated versions, multiple bags are attached to a **manifold** system and the whole assembly is placed inside an enclosing vessel. Although suited to a wide range of slurries, unless special precautions are taken bag filters are not generally used with **toxic** or **volatile** feeds as some spillage occurs when the bag(s) are replaced. The **fabric** used to form the bag must be carefully chosen, in terms of **pore**



Bag filter housings (*left*) and examples of filter bags (*right*) (Lenntech).

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