Bubble point

Definition and principle

The bubble point method is the most widely used for pore size determination. It is based on the fact that, for a given fluid and pore size with a constant wetting, the pressure required to force an air bubble through the pore is inverse proportion to the size of the hole.
The theory of capillarity states that the height of a water column in a capillary is indirectly proportional to the capillary diameter.

Surface tension forces held up the water in the capillary and as its diameter gets smaller, the weight in the water column get higher. Water can be pushed back down in a pressure which has the same equivalent height as that of the water column. Thus by determining pressure necessary to force water out of the capillary, the diameter of the capillar can be calculated.
In practice, the pore size of the filter element can be established by wetting the element with the fluid and measuring the pressure at which the first stream of bubbles is emitted from the upper surface of the element.

Procedure

The procedure for bubble-point test is described in American Society for Testing and Materials Standard (ASMT) Method F316.

The top of the filter is placed in contact with the liquid, the bottom with air, the filter holder is connected to a source of a regulated pressure. The air pressure is gradually increased and the formation of bubbles on the liquid side is noted. At pressures below the bubble point, gas passes across the filter only by diffusion, but when the pressure is high enough to dislodge liquid from the pores, bulk flow begins and bubbles will be seen.

The initial bubble test pressure determines the size (and location) of the largest hole, the open bubble point pressure determines the mean pore size of the element. The latter can be affected by flow velocity as well as pressure.

The theoretical relation between this transition pressure and the bubble-point pressure is:

$D = (4g \times \cos q) / P$

where:

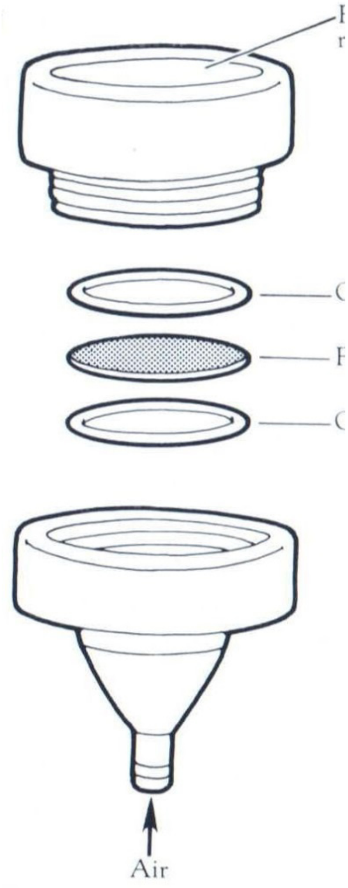
P = bubble-point pressure
g = surface tension of the liquid (72 dynes/cm for water)
q = liquid-solid contact angle (which for water is generally assumed to be zero)
D = diameter of the pore

Since no pores in a practical filter element are likely to be shaped like capillary tubes it is necessary to introduce a shape correction factor K into the formula.

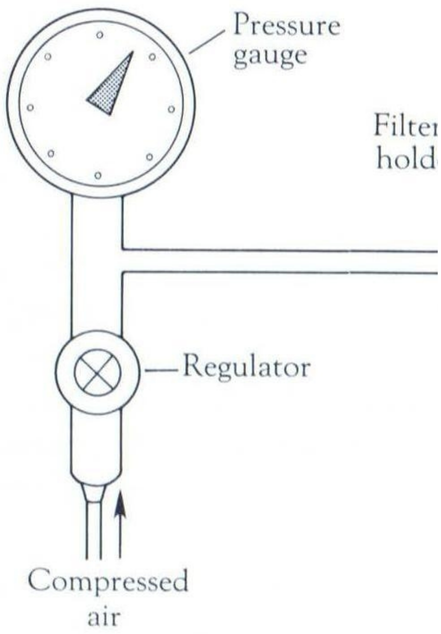
Since g and q are constant, the formula can be simplified by introducing an empirical factor K_1 dependent on the filter material and form of the units employees:

$D = K_1 / P$

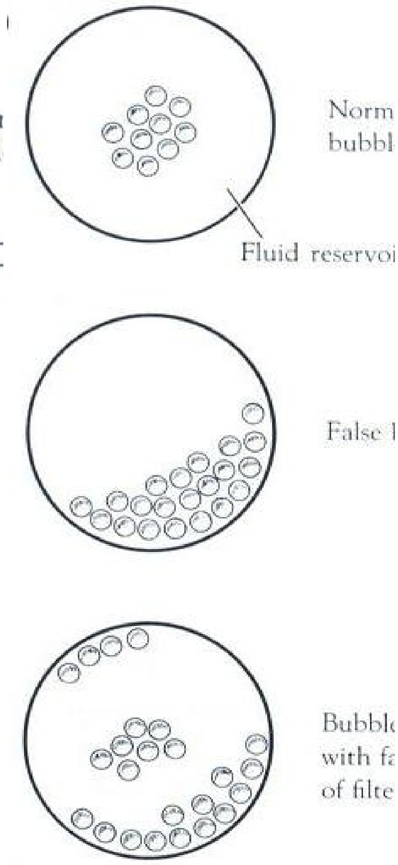
D is again the maximum average diameter of the pores in mm.



Arrangement of filter and filter holder



Connection of filter holder to a pressure regulated system



Appearance of bubbles

Advantages

One of the great advantages of the bubble point test is that it can be performed of filters under actual use conditions and with any filter. It is a non-destructive test, thus it does not contaminate the filter and so can be used to determine the integrity of a filter at any time, as well as establishing the absolute rating.
In the future, with further advantages in computer software and control, it may be possible to use the data on flow rate or pressure increases to more accurately determine what happens in a sample before the bubble point is reached, such as diffusion.

Sources

'*Filters and Filtration Handbook*', T Christopher Dickenson, Elsevier, January 1, 1997
'*Membrane filtration*', Thomas D. Brock, Science Tech, Inc. Madison