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Some Important Words in Regards to Filter Ratings

By:

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As we review advertising literature, packaging, product claims, blog comments and other information that circulates in regards to filter performance, we are often intrigued by the misunderstanding and misuse of important terms used to describe filter performance. It is no wonder that many consumers are confused and bewildered when trying to make informed decisions in regards to personal filtration devices. The purpose of this article is to clear up some of the confusion about filter ratings and claims and provide valuable information to the consumer that will aid in making an informed decision as it relates to the selection of a personal filtration device.

First of all, we should discuss some terms and definitions. By understanding the correct meaning of these terms, a consumer can pull out important information that will lead to making an informed decision.

The most misrepresented or confusing terms are pore size, porosity and removal ratings.

Pore size: correctly refers to the actual opening size of the pores (holes) in a membrane filter.

Porosity: refers to the ratio of open space in a filter matrix to the amount of volume taken by the filter media itself. Typically, a filter with high porosity will have a more open structure, and therefore, higher flow with lower pressure drops. High porosity does not necessarily mean that the filter will remove particles better than a low porosity filter.

Removal Rating: refers to the statistical probability of the filter's ability to remove a certain size particle when challenged under controlled conditions. This should not be confused with the actual **pore size** of a filter. There are two types of ratings: **nominal** and **absolute.** These terms are misused to a great extent in filter claims and marketing literature which can mislead the consumer.

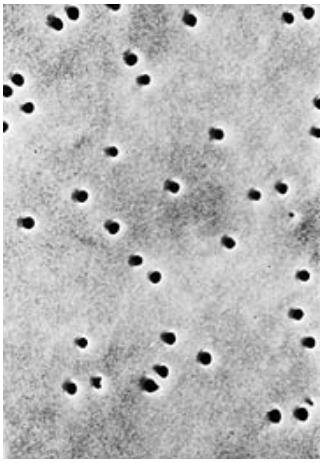
A **nominal** rating is attached to filters that can be shown under controlled conditions to remove an acceptable statistical amount of particles of a certain size, even though the actual pores or openings of the filter may be much larger that the particles being removed. The typical way that a nominal filter rating is reported would be in the form of a statement such as: "Removes >99.9% of particles 3µm (micron) or larger." This means that under field conditions, a user can be confident that the filter will remove greater than 99.9% of pathogenic organisims larger than 3 µm. This information is obtained by challenging filters with test waters containing suspensions of 3µm spheres. A similar cryptosporidium or giardia claim would require a challenge using live cryptosporidium or giardia organisims. Nominal ratings are usually applied to **depth filters** (see definition below).

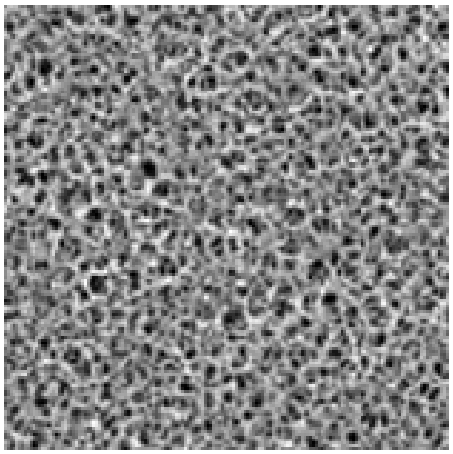
An **absolute** rating can only be applied to a filter that the end user can actually determine the size of the largest pore. Such a filter can be integrity tested using a non-destructive test method and the data can be used to determine the actual size of the largest pore. Absolute ratings can only be applied to **membrane filters** (see definition below) due to the requirement of a definable pore. If a filter manufacturer applies an **absolute** rating to a filter, they should be able to provide the user with a non-destructive test protocol that will allow the user to verify the absolute rating.

In order to understand these concepts and definitions correctly, the consumer needs to understand the difference between a **membrane** filter and a **depth** filter.

Membrane filters are very thin and are usually cast or extruded in a variety of proprietary processes. Membrane filters retain over 90% of the particles to be removed on the surface of the filter due to the fact that the well-defined holes or pores are smaller than the particle being retained. Membrane filters tend to have lower porosity than typical depth filters requiring higher operating pressures and they typically achieve lower flow rates. During the casting and curing processes pores are formed that are uniform in size, shape and length. A bubble point or diffusional flow test can be performed to confirm the actual size of the largest pore in the filter being tested. This type of test confirms the pore size without exposing the filter to the actual particle or organism and is called a **non-destructive** test. Membrane filters can be integrity tested multiple times, and in most cases are tested prior to, and after use to verify that the filter maintained integrity during the entire time it was in use.

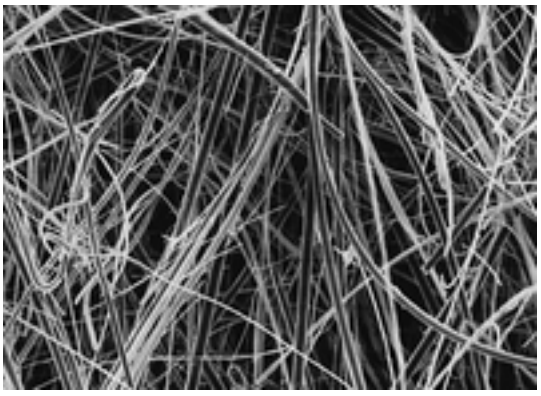
Note the two examples of membrane filters below: On the left is a low porosity filter with very well defined pores; On the right is a high porosity filter with a more open, and yet still well-defined pore structure. Both filters are 0.2µm absolute rated, and in both cases the largest pore diameter can be verified using a non-destructive integrity test.

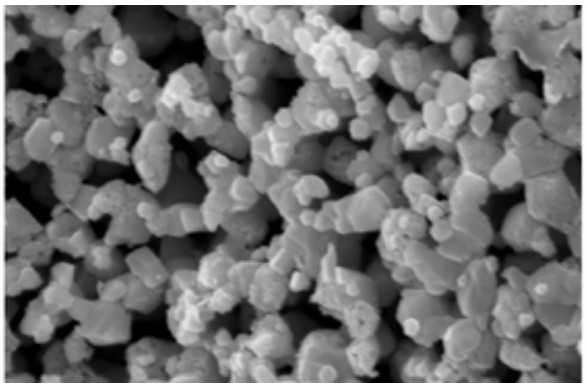




Membrane Filter (Low Porosity) **Membrane filter (High Porosity)**

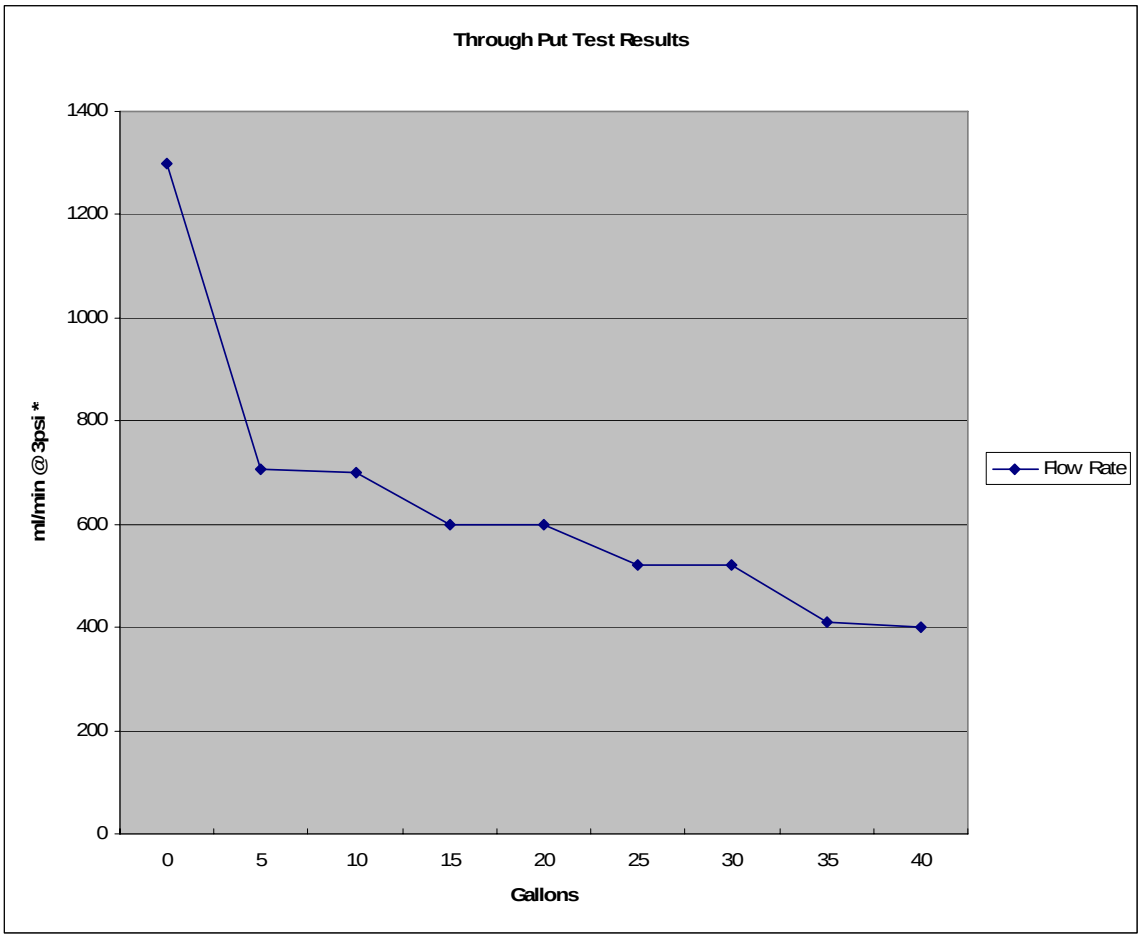
Depth filters rely on a torturous path to capture particles within the matrix or depth of the filter. Simply put, particles are caught within the depth of the filter as they come in contact with obstructions. There is rarely a uniform, defined pore structure in a depth filter. Even though there may not be defined pores, depth filters can be performance rated based on challenge testing. In these tests, the filter is challenged with pre-set quantity of defined size particles or organisms. This type of testing renders the filter unusable and is referred to as **destructive** testing. Manufacturers will perform these tests on a representative sample of each filter batch. Since every filter cannot be tested and verified individually, a nominal rating is associated with depth filters. Depth filters can be produced using several methods. The most common types are **fiber filters** and **sintered filters** (see illustrations below). **Fiber filters** are either spun or woven into a cloth or felt. S**intered filters** such as ceramic, metal or porous plastic filters are formed by fusing particles together under heat and pressure. The spaces between the particles form the flow path or pores of the filter. **Filter aids**, such as activated charcoal, may be added to improve the filtration capability of the filter. Many filter aids use attractive forces to pull particles out of the water stream and hold them to the surface of the filter aid. This process is called **adsorption**.





Fiber type depth filter **Sintered depth filter**

Flow Rate: refers to the flow of material (usually water) through a filter at a defined pressure difference between the upstream side of the filter and the downstream side. Flow rate is always reported in units of volume over time at a specified pressure drop (example: liters/min. @ 3 psi.). As the filter begins to plug, the flow rate will decrease. The filter is considered exhausted when the flow rate through the filter decreases to a point that it is too difficult to use. The graph below illustrates a typical flow rate curve showing a decrease in flow as the time and volume of through put increases.



Pressure Drop: or **differential pressure** is the difference in pressure from the upstream side of the filter to the down stream side of the filter. Pressure drop is reported using the Greek symbol "∆" (delta) followed by the letter "P" and is stated "delta-p".

Through Put: is the expected amount of fluid (usually water) that a user should be able to pass through the filter prior to the filter plugging. This number is set by the manufacturer based on test criteria. At Aquamira Technologies, we consider a filter to be exhausted when the flow rate falls below 200ml/min @ 3psi ∆p even though the filter may have more usable life at a higher pressure drop. We determine the **through put** of the filters by testing the actual amount of water that can pass through the filter at the

specified ∆p prior to the filter falling below the minimum flow rate. If at any time the flow rate falls below 200ml/min @ 3psi ∆p, the test is concluded. To be conservative, our products carry a rating that is one half of the measured **through put**. This assures the user that the filter will always provide the published amount of water.

If a **filter aid** such as activated charcoal are incorporated into a filter, the **through put** may be determined by the capability of the **filter aid** to remove contaminants, rather than the total amount of water that can be put through the filter. Testing can be done to determine that the adsorptive capability of the **filter aid** is effective throughout the entire filter life.

Filter manufacturers should always be able to provide test results to verify published claims. For example, if a **through put** claim is 50gallons of water, the manufacturer should be able to provide test results showing the filter was able to meet or exceed this requirement. If the filter incorporates a filter aid, the manufacturer should be able to show that the adsorptive capability of the aid was still viable at the rated **through put**. If a manufacturer claims the filter removes cryptosporidium, there should be a corresponding cryptosporidium test. If a pore size claim is made, testing acceptance data and procedures should be made available that would provide the user with the ability to integrity test the filter to verify the pore size claim. If a filter manufacturer cannot provide this information, be very wary of an **absolute** claim. Remember, as a consumer you have the right to information that will support the claims of a manufacturer. Don't be afraid to ask.