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Technical Brief

Bubble Point Testing with Integritest® 5

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Introduction

The Integritest® line of automated integrity testing instruments uses pressure decay measurements to determine the integrity of a filter. Along with a system volume measurement, one pressure decay measurement is taken to determine the relevant flowrate for diffusion and HydroCorr™ tests. The Tangent Method is used to determine a filter bubble point from a series of pressure decays performed at increasing transmembrane pressures. The Integritest® 5 improves on test speed by optimizing the algorithm. This instrument identifies optimum pressures at which to take measurements based on test parameters and ongoing readings, which reduces the number of measurements needed to reliably map the filters' profile and return an accurate result.

Background on automated filter integrity tests

With stable temperature and system volume, the ideal gas law can be applied to calculate a volumetric flow rate from a pressure decay. For diffusion tests, the gas flowrate through a wetted filter is determined. For HydroCorr™ tests, the apparent water flowrate from compressing a pleated filter's structure is determined.

During a bubble point test, pressure decay measurements are taken at increasing applied transmembrane pressures to map the filter's integrity profile. Analysis of the resultant flow versus pressure measurements leads to the determination of the filter bubble point[1]. At pressures below the bubble point, diffusion is the dominant form of gas flow across the membrane. At pressures far above the bubble point, convective flow dominates as water is evacuated from the largest pores. By mapping the profile of the filter through both types of flow, the intersection of these curve tangents can be calculated to determine the bubble point of the filter in a reproducible manner[2].

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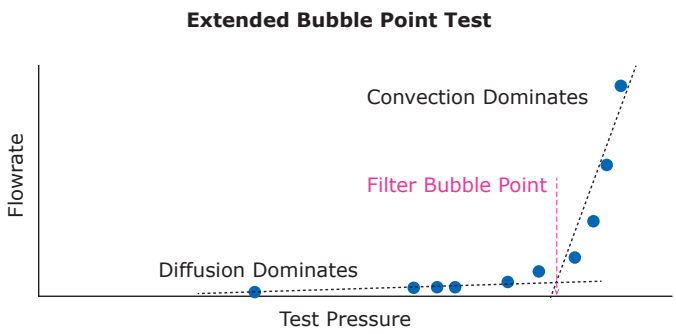

Figure 1. Flowrate versus pressure chart showing the filter integrity profile, along with tangents of the diffusive and convective flow portions to determine the filter bubble point. The maximum applied pressure must be small enough to only evacuate a few pores and thus maintain a sensitive bubble point measurement. Pressure increments settings are dynamically adjusted with the flowrate profile to achieve this.

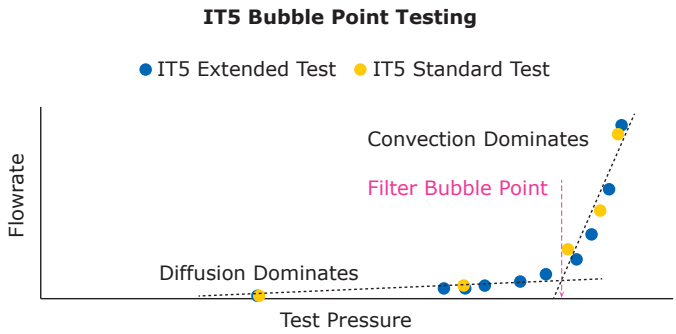

Figure 2. Example of a bubble point test taking fewer measurement points, but producing a filter integrity profile that mirrors a test that takes more points. Two measurement points are taken along the stable diffusive flow curve. Two, three, or more points are taken as needed along the convective flow curve, depending on the stability and completeness of the data.

The Tangent Method has been used to perform millions of filter integrity tests beginning with the Exacta® instrument in 1998, followed by the Integritest® 4, and now the Integritest® 5 instrument.

Methodology for optimizing bubble point test speed

Empirical data has shown that groups of filters exhibit similarities in behavior that can be modeled to help estimate where the stable portions of the diffusive and convective curves exist. This allows emphasis to be placed on measurements in those stable areas instead of the volatile transition portion. Filters can be grouped based on inputs such as size, wetting fluid type (aqueous, solvent), minimum bubble point specification, and symmetry. Along with shortening test time, another benefit is better sensitivity in defining acceptable limits of measured points. This helps to identify invalid tests and trigger alarms appropriately.

Summary on testing and validation

Over fifty types of filters were selected to represent filters on the market, ranging from extreme test cases to average cases. Testing and validation data has proven that the Integritest® 5 algorithm accurately and reliably determines a filter's bubble point[3].

References

1. Johnston, P. (1985). Fluid Filter Media: Measuring the Average Pore Size and Pore Size Distribution and Correlation with Results of Filter Tests. *Journal of Testing and Evaluation, 13 (4),* 308-315.

2. Reti, A. R. (1977). An assessment of test criteria in evaluating the performance and integrity of sterilizing filters. *Bull. Parenteral Drug Assoc., 31,* 187-194.

[1]The definition of bubble point was first proposed based on characteristic flow rate in response to pressure, as liquid wetted membrane filter pores were evacuated under high pressures (Reti, 1977). [2]The characteristic flow rate versus pressure curve was further investigated to define the pore size distribution of a filter, and showed that determining the transition between diffusive flow and the onset of convective flow was important for the accurate estimation of the bubble point (Johnston, 1985). [3]Validation data shows that the Integritest® 5 is more accurate than the claimed specifications, however, the claimed specifications have been set to account for usability and for accuracy limitations of measuring devices on site to qualify the instrument.

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