



## Calculating Pressure Drop Specifications

Pressure hold integrity testing is the preferred method for checking the integrity of membrane filter housings larger than 3- Rd 30" in beverage processes. The maximum allowable pressure drop specification is a function of membrane, pore size, test time, and housing size, among other things, and can be calculated as shown below.

**The maximum allowable pressure drop for a multi-round filter housing is calculated using the following equation:**

$$\text{Pressure drop (psi)} = \frac{\text{diffusion spec (ml/min)} \times \text{test time (min)} \times \text{atm pressure (14.5 psi)}}{\text{upstream volume of housing and piping (ml)}}$$

- The diffusion specification (ml/min) is provided by the filter manufacturer and varies with each filter type, integrity test gas, cartridge length, pore size, and test pressure<sup>1</sup>.
- Test time is the length of time the test will be run. Test time is generally 10 minutes.
- Atmospheric pressure is a constant. When the calculation is performed in psi this constant is equal to 14.5 psi. The Metric equivalent is 1,000 mbar (1 atm).
- The denominator of the equation is the entire upstream volume of the integrity test system. The upstream volume of the filter housing must be taken into consideration as well as the volume of upstream piping between the housing and isolation valve. The volume occupied by the filters is considered part of the downstream volume and is not included in this calculation.

<sup>1</sup> The test pressure is given with the diffusion specification. It is important not to pressurize above the specification pressure during the test. Doing so will change the diffusion value and risks removing water from the pores and requiring a re-wetting of the membrane.

## Example:

A 12-round 30" high Bevliner filter housing using EMD Millipore Vitipore II Plus 0.45 µm cartridge filters is to be integrity tested. Calculate the pressure hold specification in psi.

The diffusion specification must first be calculated. It is  $[(17.1 \text{ ml/min per } 10" \text{ element}) \times (3 \text{ } 10" \text{ elements per } 30" \text{ cartridge}) \times (12 \text{ } 30" \text{ cartridges})] = 615.6 \text{ ml/min}$ . Test time will be 10 minutes. The atmospheric constant is 14.5 psi. The housing is a 12-round Bevliner and has a manufacturer's pre-calculated upstream integrity test volume of 53,000 ml. This information is given for Bevliner housings in the product specification guide.

The pressure drop calculation becomes:

$$\text{Pressure drop} = (615.6 \text{ ml/min} \times 10 \text{ min} \times 14.5 \text{ psi}) / (53,000 \text{ ml}) = 1.68 \text{ psi.}$$

The maximum allowable pressure drop for this system during a 10 minute pressure hold integrity test is 1.68 psi.

Pressure hold integrity testing is a measure of gross integrity failure. Cartridges that fail in production, during shipping, or during installation will typically experience failure so that there is an immediate and noticeably large loss of pressure during an integrity test. Because of this, most beverage plants add a safety factor to make the pressure drop specification easier to read and remember, or for consistency over many similar housings. A universal specification of 5 psi is commonly used and will detect any gross failures. One hundred percent of final membrane filters manufactured by EMD Millipore are individually integrity tested during production to ensure that no membrane or cartridge defects are released from production.

Please contact your local Gusmer Enterprises representative with any questions or if you require any assistance on integrity testing or process filtration.