

## AERATION MEMBRANE PORE SIZES

### Bulletin Brief

What pore size should I use in my diffuser membrane? This is a question that must be resolved on each application for superior performance. Pore sizes in membranes can vary from very small openings of a pin hole up through openings that are as much as 2.5 mm in length. There can be potential benefits of each of these types of opening under ideal circumstances. Clearly the performance of the membrane is significantly impacted by the decision on the materials of construction of the membrane, plus the size of the opening and how openings are distributed over the surface of the membrane.

### General

Oxygen transfer efficiencies of membranes have been demonstrated to improve slightly as the pore size gets smaller, as long as the airflow is maintained at a low airflow rate. Having a very small amount of airflow going through a small opening gives smaller bubbles and a modest improvement in oxygen transfer efficiency. That is the good news. The bad news is that the small opening also creates major issues with pressure losses through the membranes and magnifies the potential for fouling and/or loss of performance over time by using the very small membrane openings.

Practical applications of membrane diffuser systems would suggest that oxygen transfer and process mixing are both primary criteria. When you look at the combination needs of these two variables it suggests the air volume requirements for proper biological reactor performance will be a fairly significant gas flow rate per unit of membrane in order to satisfy these needs. At the higher or elevated gas flow rate for the membranes, the small hole sizes have two major disadvantages:

- a. The small hole size will have significant pressure losses as the airflows increase in order to satisfy the biological needs.
- b. As the gas flow rate per unit of membrane area or per hole in the membrane increases, the size of the bubble equalizes or stabilizes. There is little improvement in efficiency with small membrane openings that are running at high gas rates.

In reviewing the overall potential for membrane performance, the balance between gas flow to be handled, the perforation size, the headloss, and long term membrane life is to be managed. EDI's ability to engineer these perforations and openings and the ability to engineer a total system for the specific application is very helpful. The ability to perforate the membranes in any perforation pattern optimized for the application, can benefit the customer significantly.

EDI membranes are available in openings of 0.5 mm up through 2.5 mm as standard. A brief discussion of the benefits of each is appropriate. It should be noted the opening sizes are available in all materials including EPDM, silicone, polyurethane, and the

PTFE coated membranes or special materials. The membrane opening size is engineered to match to the operating conditions expected of the diffuser.

### 0.5 mm Membrane Openings

0.5 mm openings in membranes are used for maximum oxygen transfer efficiency applications where you have a very low gas flow going through the individual diffuser units. In order to have sufficient aeration in the basin it is necessary to have a large number of diffuser units installed to maintain the low gas flow and still get the sufficient oxygen and mixing for the biological process. EDI typically employs the 0.5 mm openings in its Nano Pore™ and Micro Pore™ membrane applications. These applications are for full floor coverage (up to 80% cover) at very low gas flux rates in each unit. It is required to keep these gas flux rates low because of controlling the pressure drop and loss through the system.

### 1.0 mm Membrane Openings

For the traditional applications in municipal or industrial wastewater treatment plants a compromise sizing of membrane opening at 1 mm is typically employed. This gives very good gas transfer efficiencies and a full range of operation of the membrane. It provides a modest pressure loss through the overall system. It will give the same oxygen transfer efficiencies as the 0.5 mm or smaller openings in the membrane at the gas flow rates per diffuser typically employed in municipal wastewater treatment systems. The 1 mm opening has also demonstrated long term serviceability in performance by minimizing the potential for fouling or maintenance issues on most systems. This compromise for maximum oxygen transfer efficiency at the intermediate gas flow rates, with long term serviceability for reduced maintenance have been the reason for selection of 1.0mm membrane perforations as the primary opening size on most membrane diffuser systems.

### 1.25 to 1.5 mm Membrane Openings

For the perforation patterns of 1.25 to 1.5 mm, this would typically be a preferred perforation pattern for those systems that have demonstrated a potential for fouling. Using the larger openings minimizes this condition. In addition, the oxygen transfer efficiency of this size membrane opening is consistently equivalent to the 1 mm or the 0.5 mm when diffusers are running at or near the upper airflow ranges of most membrane diffuser systems.

### 1.75 to 2 mm Membrane Openings

This is a standardized general purpose opening in membrane diffusers. Most system replacement membranes are without background information on the total system or project are supplied at 1.75 to 2 mm in order to give a broad range of performance without limiting factors. This size membrane is typically employed where there is a lack of information about the application process or service.

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## 2.25 to 2.5 mm Membrane Openings

This is a medium bubble perforation typically employed in digesters or other specialty applications. The system is designed to handle high airflow rates at low pressure losses and provide long term service with a very minimum of fouling or clogging issues. This is a size membrane perforation that is typically only employed for specialty services.

As a summary, the size of the opening in the membrane is important for overall performance. You must balance the oxygen transfer capability, the gas flow requirements, the pressure loss requirements, and maintenance requirements. In general the perforation pattern is not the controlling factor in most of the oxygen transfer capabilities of a membrane. The controlling factor is actually the surface energy or surface tension characteristics of the specific membrane materials. Hydrophilic surfaces of premium quality membranes are more desirable for the performance versus perforation size. The opening has a modest influence, but the surface characteristics of the membrane have huge influence. As an example, systems that have a EPDM have a very low surface energy (are hydrophilic) and tend to give improved performance versus systems that have a high energy such as silicone. The oxygen transfer efficiency or bubble size is influenced more by that surface energy than the perforation in the membrane itself.

For additional information regarding your specific application contact Environmental Dynamics Inc. at (573) 474-9456.