



Technical Bulletin 109

Typical Diffuser Fouling
Conditions

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BULLETIN BRIEF



Fine bubble diffuser systems have demonstrated major energy operating cost efficiencies in most water and wastewater treatment industry applications. Fine bubble diffuser systems have evolved and currently incorporate two basic types of diffusers:

1. Rigid fixed opening or fixed pore diffuser units such as coarse polyethylene and/or porous ceramic diffusers.
2. Flexible membrane diffusers.

Porous ceramic or rigid polyethylene pipe diffuser units are older technology that has been available for many years with modest refinements and/or adjustments in technology. The same basic design capabilities and performance capabilities exist today as when they were first introduced back in the 1920's. The mechanical method for delivering ceramic components to the basin has improved substantially; however, the basic operational issues of today are identical to the initial installations.

Fouling of media is a common problem in many applications. Fouling of the membrane can increase system operating pressures (more energy cost to operate) and shorten the economic life of a membrane. Proper recognition and correction of fouling can enhance system operation and life.

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Rigid fine pore media has excellent oxygen transfer efficiency characteristics. Rigid fine pore media properly installed can deliver proper oxygen and mixing to activated sludge and other aeration applications. Difficulties which limit the suitability and attractiveness of design with rigid type media are itemized below:

1. The rigid media has fixed openings which remain open at all times. Any interruption of air supply causes water and/or solids to backflow into the media itself. Repeated cycles of on/off operation or extended off operation cause mechanical fouling of the diffuser units with solids. Rigid media systems are recommended to have the blowers run all the time even when sitting idle with clean water in the basins.
2. Backflow into rigid pore diffuser units can create gradual inorganic salt buildup from evaporation, which creates a fouling on or in the units. Items such as calcium carbonate can be particularly troublesome unless some form of cleaning using HCL or other acid is employed.
3. The surface of rigid pore media is rough in texture and an excellent support for biological growth in the aeration environment. Biological fouling can become a problem when on/off operation is employed or when the system is operated at very low airflows.
4. At very low airflows the gas distribution across the surface of rigid media is reduced. These media remain open even though there is a modest amount of gas discharging from the active zones of the media, the remaining zones are subject to flooding, clogging, and/or biological fouling. It is necessary to maintain a flushing or cleaning flux rate to keep the openings clear.
5. Rigid pore diffuser units are difficult to install and maintain in many applications.
6. Rigid pore diffuser units are generally limited to fixed concrete basin installations.
7. Cleaning and refurbishing of the units is sometimes necessary and a very time consuming and/or expensive operation.

The second type of diffusers that deliver fine pore technology is the membrane diffuser system. Membranes have been developed over the last 15 years and are demonstrating superior operational and process capabilities in almost every environment. Advanced technology membrane diffuser systems by EDI can outperform older membrane technology or rigid media technology as defined under type 1 diffusers. There are many benefits to the new technology membrane diffuser systems including the following:

1. System capital costs are reduced.
2. Installation costs are only 20-25% the installation costs for ceramic diffuser systems or rigid media systems.
3. Membrane diffuser units offer superior oxygen transfer efficiency over a full range of operating conditions. Because membranes only open when air is applied, any low flux rate applications open only the holes necessary to operate the diffuser. This prevents backflow and any clogging or fouling of the membrane during low air flow or on/off operation.
4. On/off operation is suitable for any type process including aerobic digesters where decanting may be required; SBR technology that cycles on and off as part of the operating process (generally every four hour cycle); and anoxic zones where the units may not be operated for extended periods of time. Successful operation of EDI advanced technology membrane diffusers has been demonstrated in all of these difficult applications which would definitely destroy or limit the success of rigid pore medias as described in type 1.
5. The membrane media flexes as air is applied and/or reduced. This has the potential to minimize any chemical or inorganic fouling, and minimizes the impact of biological fouling.
6. Because the membrane opens in response to air supply, any liquid or solids reaching inside of the membrane through the piping system can be purged automatically through the system and minimize operation and maintenance problems.
7. Life cycle cost of aeration mixing systems with the membrane diffuser components is substantially lower than life cycle costs with older technology rigid media designs.

Current experience would suggest that over 90% of projects are now being designed to incorporate advanced technology membrane diffuser systems for optimum performance and minimum operating cost in aeration mixing systems.

In all aeration mixing systems there are maintenance issues to be resolved. The discussion above for the rigid media vs. the flexible membrane points out the ability of the flexible membrane to minimize potential operating and maintenance issues.

Even with proper design and/or proper installation and operation, some flexible membranes will experience maintenance issues that require special attention. These maintenance issues are substantially fewer than some of conditions that might exist with rigid media; however, questions regarding fouling, clogging, or other potential issues can be resolved on an individual discussion basis.

Membrane diffuser systems seldom foul from inside unless there has been a major rupture of the pipng system to allow gross amounts of biological solids inside the system. For the membrane diffusers, if this gross solids attack from the inside of the piping occurs it may be necessary to physically clean the diffuser unit by removal, cleaning, and reinstallation. By comparison, rigid media would be damaged beyond repair and would need to be replaced. Replacement of the flexible membrane would also be an option in lieu of cleaning depending on the economics of the particular installation.

1. Biological fouling – for rigid media, biological fouling can be substantial and may be difficult to control. For flexible membrane type medias, the biological fouling factor is limited and has less long-term effect. Because the openings are designed to be variable orifice to release the air supply, modest amounts of fouling has little impact on oxygen transfer or mixing capability. In cases of excess biological growth (excessive biological growth is defined as approximately as one-fourth inch thickness or more of biological growth on the exterior of the membrane), it may be necessary to review the operating procedures of the facilities to minimize this condition. Generally some change in the biological process or operation of that process can resolve most biological fouling conditions. If biological fouling persists, high-pressure hosing or similar maintenance to remove the bio film may be desirable.

2. Calcium carbonate fouling – with rigid media, calcium carbonate fouling can be a major deterrent to successful application of the process. In cases of extreme or severe calcium carbonate fouling activities, gas cleaning using anhydrous HCL has been successfully employed with recognition that it is very expensive. For membrane diffusers, calcium carbonate fouling seldom occurs. To clean membrane diffusers a light muriatic acid rinse can be quite successful in changing the operating pressure characteristics generated by this calcium carbonate formation. Injection of dilute muriatic acid into the piping system of membrane diffusers has also been successfully employed on a full-scale basis. It is anticipated these cleanings would be a one to three year requirement even in very difficult operating circumstances.

The membrane diffuser option minimizes operator attention and the service requirement of an aeration mixing system. Many membrane diffuser units are not routinely cleaned or even maintained! Generally, membrane diffusers offer self-management opportunities and are operated for extended periods of three to five years with little operator attention. At the end of the economic life of the membrane (See Technical Bulletin No. 110 for discussion of economical life), membranes are then removed, discarded and replaced by new membrane units that fit onto the existing holders. The success of membrane diffusers has been driven by the low maintenance and long term performance of these products compared to other types of fine bubble diffuser systems. The economics of the fine bubble diffuser system with this low maintenance capability, using advanced technology membranes, is quite attractive for almost every aeration mixing application.

Fine pore flexible membrane aeration devices offer maximum benefits for oxygen transfer and mixing. Proper operation and maintenance of membranes can provide years of long term performance with minimum energy cost and minimum maintenance cost. For all fine pore diffusers, it is necessary to follow preventive maintenance procedures to sustain peak or optimum performance, prolong equipment life, and avoid emergency situations or a system failure. Proper maintenance procedures will also minimize the frequency of system interruptions.

1. EPDM diffuser sheaths should be protected from petroleum products, such as mineral oils and aromatic hydrocarbons. Contact with such substances will degrade the membrane.
2. Good air filtration is required with all fine bubble diffusers including FlexAir® units. The blower system should be equipped with paper inlet filters having a performance efficiency of 93% removal of 10 micron particles to prevent clogging of the diffuser media.
 - The inlet filters of the blower system should be changed before the inlet filter headloss reaches 20 inches water column. This headloss is normally measured with a spring-type gauge mounted on the filter housing or with a manometer. Improper maintenance of the air filtering system may overload the blower system due to a high inlet loss or may result in reduced filtration efficiency which could lead to diffuser clogging.
3. Some evidence of increased headloss through the diffuser unit may be experienced over a long period of operation. This pressure build-up is often the result of biological and/or inorganic materials building up on the media surface.
 - The propensity for this condition is job specific and is a function of the type of waste and the specific operating characteristics of the system. To restore media performance and decrease the operating headloss, system performance (pressure, treatment, etc.) should be monitored and routine maintenance performed.

EDI recommends membrane diffuser units be inspected on a routine schedule. Typically, an aeration system is designed to allow the diffuser units to be accessed by dropping the water level in the basin being serviced or individual units or groups of units to be accessed without interfering with ongoing operations. The air to the basin being serviced should be turned off to prevent damage to the blower unit or the possibility of excessive airflows to the units.

Properly operated and maintained membranes for aeration and mixing systems as provided by Environmental Dynamics International will provide years of high efficiency treatment with minimal operator attention.

