CALCIUM CARBONATE FOULING OF FINE PORE DIFFUSERS

Bulletin Brief

Enviromental Dynamics has experience in over 4,000 installations for fine pore membrane diffuser systems. Our experience in a wide range of industry types, municipal applications and treatment processes suggest calcium carbonate fouling is not a major concern for properly sized, properly engineered and properly applied membrane diffuser systems.

Historical development of fine pore diffusers for energy efficiency employed rigid media diffusers, primarily of silica, aluminum oxide, or rigid polyethylene materials. Improved oxygen transfer efficiency was evident from these high efficiency systems by saving 50% energy verses other types of diffusers. Results of operation on rigid media diffusers were overall successful; however, a significant number of the rigid media applications suffered calcium carbonate build-up with deterioration in the performance of the diffuser units. It is instructive to review why the calcium carbonate build-up occurred in the rigid media:

1. A rigid media fine bubble diffuser is always open. When air supply is interrupted such as a process interruption or a power outage, there is no check valve capability so liquid and solids enter the upper layers of the thick rigid media.
2. The media materials are very hydrophilic and liquid enters in the top layer of the media during operation with gradual long term evaporation of the liquid at this air – liquid – media interface. This long term evaporation of liquid deposits salts on the surfaces inside of the media itself. Long term operation creates build-up of salts, many times calcium carbonate.
3. For those media where air distribution was poor during operation, the evaporation of salts and build-up calcium carbonate was accelerated in the top surface layer of the inactive media.

Water evaporation at the surface of the rigid media diffusers accumulated calcium carbonate deposits, gradually built up the operating pressure of the system, and would gradually deteriorate overall performance. This calcium carbonate build-up was a major maintenance condition and was a deterrent from use of fine pore diffusers in systems where calcium carbonate might be of concern.

Membrane diffuser systems are completely different and resist calcium carbonate fouling. Some characteristics of membrane diffusers are very important in calcium carbonate resistance including:

1. The membranes are normally closed until sufficient air pressure opens the units to begin operation.
2. When the air is interrupted, the membranes close preventing liquid/solids entry.
3. Membrane diffusers have only an exterior surface phenomena as the liquid and air interface is at the exterior surface of the membrane compared to the interior of a ceramic rigid media material.
4. Operation of a membrane unit involves major flexing during on/off operation with major flexing even during normal airflows. This flexing tends to minimize the accumulation of surface inorganic materials.
5. Surface of some membrane materials is quite smooth and slick. It has been demonstrated that these smooth slick surfaces minimize or eliminate calcium carbonate build-up.

When applying the membrane diffuser systems, water chemistry is the key factor to preventing calcium carbonate build-up. There is the mistaken belief that a high calcium carbonate concentration in the water or the wastewater will automatically create fouling of membrane diffusers. Wrong conclusion!! Calcium carbonate concentration of a wastewater is only one factor necessary to create a precipitate or fouling problem. Calcium carbonate can be present in quite high concentrations as long as the proper pH, and alkalinity factors are available. The characteristic of fouling with calcium carbonate is very similar to the water chemistry necessary for proper boiler water maintenance and treatment utilizing the Langlier Index. Once the Index is properly balanced with pH, alkalinity, calcium carbonate will remain in solution and the water will be stable, i.e. no calcium carbonate precipitate.

A proper maintenance of wastewater chemistry and the biological process avoids this issue, as normal wastewaters are quite stable. In a few wastewaters the precipitation of calcium carbonate can be a factor not driven by the calcium carbonate content, but controlled by the stability of the wastewater and controlled by the biological process operations.

The good news with membrane diffusers is the ability to operate with little attention even in difficult calcium applications. For those unique applications where some calcium carbonate precipitate is accumulating or would accumulate, there are treatment procedures suitable to maintain the system and provide long term operation with high efficiency. Those treatment procedures are variable depending on the type of installation and type of maintenance desired by the owner/operator of the system. Some procedures that have been demonstrated to successfully maintain high performance of membrane diffuser systems in those occasions where calcium carbonate becomes troublesome are as follows:

1. Milwaukee Method – For systems that employ multiple basins it is quite logical and simple to dewater a basin for diffuser access, use a hand garden sprayer to spray diluted muriatic acid on the surface of the membrane, then place the membrane back in service after only a couple of minutes contact. This method has been very effective because it is safe, economical, and could be accomplished in a matter of minutes once access to the diffusers occurs.
2. For those systems where there is a single basin or where it is impossible to dewater the basin it is possible to employ insitu cleaning. Insitu cleaning for membrane diffusers has been demonstrated utilizing different techniques with the most common techniques employed as follows:
    a. Dilute liquid solution of muriatic acid pumped into the air supply piping and allowed to sit for a matter of minutes, then at a low airflow rate the material is purged through the diffuser membranes. This has been successfully used to restore full performance of membrane diffusers without taking the total system out of service.
    b. Anhydrous HCL gas or formic acid application to the system during operation. This gas application is generally very successful in removing calcium carbonate build-up and can be done online without taking any systems out of service. These gas materials are difficult materials to handle so proper care and caution should be employed in their utilization.

In summary, the history for both municipal and industrial applications suggest calcium carbonate build-up is not an operating condition or problem in most wastewater treatment plant designs. Quality membrane diffuser manufacturers that can engineer a system with proper selection of membrane materials, proper selection of perforation patterns in the membranes, proper selection of airflow and capacity, and proper application of the product will assure quality and long term performance in wastewater aeration applications, even in waste with major calcium carbonate concentrations.

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