Technical Bulletin 161

How Deep Can I Design my Aeration Tanks?

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BULLETIN BRIEF

In the water and wastewater treatment field there are many needs and/or opportunities to upgrade existing facilities or to construct new facilities where space is limited. The available space can severely constrict the capacity of treatment facilities, or reduce the options available for design and implementation of the treatment process. Some of the needs facing many potential facilities is the need to increase the capacity of the aeration basins for existing facilities or the need to get a substantial volume of aeration basins for a new facility. When space is limited this can be a challenge to obtain adequate reactor volume and the question is often asked how deep can I make my aeration basins? Will your diffusers work in deep aeration basins?

Environmental Dynamics has worked with many types of aeration applications with different types of diffusers as indicated in our catalog materials. In all cases it is generally established the physical size or depth of the aeration basin is not typically a diffuser issue. Generally the diffusers will be installed and work effectively at any aeration basin depth. The use of aeration basins is traditionally in the range of 10 ft to 25 ft water depth (3 m to 8 m depth). Very few aeration basins are constructed outside those ranges. The issue of basins deeper than 25 ft (8 m) is one that routinely comes up for discussion. This technical bulletin will address some of the issues facing designs of aeration basins in excess of 25 ft.

A general summary of the items that will need to be considered are outlined numerically below:

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For more information regarding this bulletin or your specific aeration application, contact Environmental Dynamics International at +1 (573) 474-9456.
1. **Will the air diffusers handle the water depth/pressure?**

   The diffuser units are quite capable of handling the water depth. The geometry and construction of the diffusers and the piping is such that it resists pressure from the outside very effectively. The only time that pressure is applied from the outside of any significance is when the aeration is shut off. During operation of the aeration basin, the pressure is normalized with the air inside the pipe being modestly greater than the pressure outside. Because of this, the actual pressure on the aeration system is nominal during operation. It is possible to evacuate the pipe in some fashion and create the full load of the water pressure but even that is well within the operating characteristics of the diffusers.

2. **How about heat?**

   Operation of an aeration basin at depths greater than 25 ft will almost always involve hot air from compression that needs management in applying the diffusers or the piping systems. Air temperatures from compressing air for deep tanks at high pressures are generally too hot to allow use the traditional UPVC materials. Probably 90% of all projects are installed with UPVC piping for economics and because the basins are shallow the temperature may not be an issue.

   With the deep tanks, the air temperatures will exceed the approximately 60°C mean wall temperature allowable for UPVC pipe meaning you must make some design considerations or accommodations:

   a. You may need to cool the air from the compressors in order to get down below the thermal characteristics and capability of the PVC or plastic piping.

   b. You may need to use metal piping throughout the entire aeration basin in order to accommodate the heat.

   c. Using high efficiency compressors can sometimes drop the temperature to a point the diffuser piping and diffusers would be able to accommodate the use of regular UPVC piping.
3. **Are there any process limitations with the deep tanks?**
The deep tanks require some consideration of the type of diffuser to be employed. There have been cases where the use of very deep tanks, very high efficiency diffusers, and a modest density of activated sludge cause the small gas bubbles to carry sludge to the top of the tank and create operational issues by flotation of the mixed liquor sludge. Proper mixing and reasonable tank depths can avoid this issue.

4. **What is the efficiency of diffusers on these deep tanks?**
Fine Bubble Diffuser Systems – For the fine bubble diffusers systems it must be recognized that the high efficiency systems are using up a considerable amount of the O2 in the first few meters of the tank depth. After you proceed past 8 m, the amount of O2 remaining has been reduced to the point that the efficiency of the fine bubble diffusers can be compromised and significantly reduced with greater water depths. As an example if you have a traditional fine bubble diffuser system that is delivering 7% O2 transfer per meter, at 8 m of submergence on the diffusers you have used up 56% of the O2 in the air. Even if you continue to have high efficiency diffusers in the tank you are working with only half of the available O2 in the driving force for depths over 8 m the O2 available to enter the liquid is reduced. The actual O2 transfer efficiency for diffusers that are doing 7% per meter in a tank that is 8 m deep can be reduced to as little as 4% per meter for the depth above 8 m. This can be a huge energy penalty that may need to be considered.

Coarse Bubble Diffusers – Coarse bubble diffuser units are much less efficient in shallow basins vs. fine bubble and on a typical basin would require much greater air volumes and higher energy consumption. In cases where the tank is extremely deep, the coarse bubble diffuser difference in efficiency vs. fine bubble is considerably offset by this O2 transfer efficiency reduction for fine bubble in depths over 6 m to 8 m. A coarse bubble unit that is operating at 8 m water depth might have an efficiency of 4% per meter. At 8 m of water depth that is only 32% of the O2 that has been used; therefore, the impact on the transfer efficiency for tanks greater than the 8 m depth is much reduced. This has the effect of making the fine bubble and the coarse bubble diffusers have operating energy consumption that is much closer as the tanks get deeper.
5. **How about the safety issues or personnel protection?**

Safety issues are broken into 2 considerations on the use of the deep tanks.

a. **High Heat** – High heat from the compression means that the piping is going to be very hot. This suggests the piping must either be insulated in order to protect the individuals or piped to an elevation or location preventing individuals coming in contact with the piping. This of course assumes there is no cooling of the air and the hot air is available for delivery to the tank. This temperature issue and the need to insulate the piping can be a major cost item and it is a major potential safety item that must be considered.

b. **Operating Pressure** – Operating pressure for the system is a key element in the design. Aeration systems that use low pressure air (less than 15 psi) traditionally are considered as low pressure and do not require special welding and are not considered a code pressure vessel for special inspection and safety requirements. This is a critical item in the economics and the safety of the personnel as well. As an example, a system that is 6 m deep would have an operating pressure for the compressors that might be 10 psi to 11 psi. That falls well within the 15 psi limit for low pressure or non-pressure vessel systems. Let us take case of the system now with the basin at 10 m water depth. At 10 m water depth that means the operating pressure of the system would be approximately 36.8 ft of water column or approximately 11.3 m of water column! That translates into 15.93 psi! At this water depth you are operating in excess of the 15 psi limit. This means that all of the air piping has to be considered as a pressure vessel, special code construction, welding, special safety precautions, special protection, and major cost is associated with designing at a system pressure in excess of 15 psi!

6. **How about the blowers?**

Traditional blowers that have been used in the aeration systems have been the rotary positive or lobe type roots type blowers. Those units are traditionally designed to deliver air effectively at operating pressures of 5 psi to 12 psi. It is unusual machines that are capable of economically delivering greater than 12 psi. The amount of cost associated with those rotary positive blowers for those high pressures is substantial and dramatic increase over the traditional blower designs.

Centrifugal blowers of the multistage type are also limited traditionally to about 12 psi to 15 psi. Anything beyond those capabilities are major economic impact on the system cost generally discouraging the use of the higher pressure blowers.

New blowers that are currently available are more interesting for high pressure applications. Some of the high speed turbo machines have capability of operating efficiently at increased pressures and the new positive displacement screw compressors are particularly attractive if high pressures are desired. The screw compressors can be very attractive from a capital cost standpoint but the pressure in excess of 15 psi must still overcome the safety issues and the cost of the piping and accessories on the system may still make the deep tank and the high pressure systems more expensive than considered practical.
In summary the use of deep tanks is certainly feasible. Very few deep tank systems are currently being installed because of the safety and cost items indicated above. Recent projects have been presented for design at water depths of 9 m to 12 m and EDI will be working with those applications using our Advanced Technology Diffuser Systems. It should be noted that there are some options in using of the deep basins that may be worth considering. EDI is currently presenting an aeration system that can be installed and suspended in the aeration basin at a partial depth of 6 m to 8 m. This can be significant because it allows use of the standardized blowers, minimizes temperature effects so standardized diffusers and hardware can also be employed. Diffusers that are designed and installed at less than the full depth of the tank then must have an integrated system for managing the full suspension of solids and managing the mixed liquor concentration throughout the deepest portion of the tank. The diffusers would do an excellent job of mixing to the depth of up to 2 m below the diffusers; however, it may be necessary to use supplemental mixing and/or pumpage for mixing the solids at depths substantially below diffusers installed at intermediate depths.

Deep tank aeration systems are special designs and EDI is pleased to offer and support those designs on a case-by-case basis. Contact the Corporate offices of Environmental Dynamics for information or for assistance in design of any aeration system; particularly for deep tank facilities.