For Coarse Bubble Diffused Aeration Systems the criteria for determining the volume of air required to achieve adequate mix is a volumetric ratio depending on the concentration of solids within the solution. The ratio applied is Airflow rate (scfm) per unit volume of liquid (1000 cuft). Once the mass volume of air is determined the distribution pattern for the diffused air is evaluated based on tank geometry and solids concentration.

There are two general types of mixing arrangements applied; 1) directional / controlled roll-over and 2) even distribution / turbulent mix. Roll-over arrangements provide better velocities within the tank and reduce short circuiting through the tank and can be applied as long as design criteria guidelines for rise/run ratio’s, tank geometry and solids concentrations are satisfied. This type of arrangement is typically less expensive than a turbulent mix arrangement due to reduced piping. When the design parameters exceed the recommended limits for a roll-over arrangement then the turbulent mix arrangement is typically applied. Maintaining the suspension of solids across the tank bottom is primarily dependant on the submergence depth of the diffuser units, refer to the related document ‘Process and Operational Benefits of Tideflex’s Coarse Bubble Diffused Aeration Systems’.

Arrangement Type 1. - Directional / Controlled Loop

The first guideline in the design of controlled roll-over mixing arrangements is to evaluate the ‘rise’ distance which is the distance the air bubbles travel from the point of emittance to the water surface. This distance determines the upward momentum achieved through eduction of the wastewater following the rising bubble path. This mass flow of wastewater will travel across the top section of the water level until it contacts an opposing wall or opposing loop flow. The flow path then travels to the tank bottom (at a depth equivalent to the emittance depth) and returns to the point of emittance. The distance this mass flow of wastewater can travel and maintain sufficient momentum to sustain solids suspension is referred to the ‘run’ distance which is measured across the water surface. The maximum recommended rise to run ratio is 1:3, typically a ratio of 1:2 is applied to ensure constant velocity through the entire loop. If decanting processes are to be utilized within the tank then the variable depth should be considered with respect to the duration of the low level periods.

The level of solids concentration within the wastewater solution should be considered when applying the rise/run ratio. The total volume of air required to mix the solution is adjusted in reference to the solids concentration by applying unit mix ratios as previously discussed. By increasing the mass of air applied the upward momentum force is increased therefore increasing the ability to move liquids with higher densities. Consideration should be given to the settleability rate of the solids within the solution for further adjustment of the rise/run ratio applied (i.e. solutions containing portions of grit and inert particles).

Tank geometry becomes a factor in optimizing the roll-over arrangements. Long rectangular tanks are ideal for this configuration where the distribution manifold is located parallel to the long wall and rolled across the shortest distance. If the run distance approaches maximum conditions then a distribution pipe can be placed along both sides of the tank resulting in a run distance of one half the distance because the flow loops will converge in the middle and turn to the bottom. For larger square tanks this multiple distribution pipe arrangement can be applied across the entire area of the tank creating multiple circulation loops.
There are two types of arrangements for providing a controlled roll-over mixing pattern within a circular tank. One method is to configure the distribution manifold as an octagon around the base of the outside wall. This arrangement produces a mass flow upward along the tank wall which travels to the tank center moves downward and travels back along the bottom to the emittance point. The other method is to apply parallel manifolds which extend from the tank centerline to the intersection of the outer wall. Typically the spacing distance between manifolds will be less than rectangular tanks allow because of the adjustments made in manifold lengths for tank curvature. These close mixing loops will also be beneficial during decant operations to ensure adequate mixing is maintained.

Arrangement Type 2. – Even Distribution / Turbulent Mix

When tank geometry is not conducive to maintaining laminar flow paths where there may be a potential for pockets or areas of low velocity or limited influence by a flow loop then a distribution pattern of diffusers located proportionally across the plan view area of the tank bottom can be applied. The spacing between diffusers is limited to the area of influence for each unit at the operating airflow rate for each unit. This arrangement produces a turbulent and random mixing pattern where return flow paths are variable and random around the rising bubble paths for each unit. This non-directional pattern results in dissipation of upward momentum at the surface by interaction of the random flow paths. This arrangement typically requires more diffusers to ensure that adequate floor coverage is provided. Fine bubble diffused aeration systems typically utilize this arrangement because the smaller bubbles have limited upward velocity and eduction force. This also optimizes the oxygen transfer capabilities by spreading the emitted bubbles apart to prevent convergence and maximize the bubble surface area for gas/liquid interface.