*Technical Bulletin 167*

# Air Piping Design for Diffuser Systems

by:

**Environmental Dynamics International**

Published: 2/2018

## BULLETIN BRIEF

Design for aeration system piping follows good engineering practice. As in all fluid mechanics designs, aeration pipe sizing is based on pressure loss as primary criteria. In these designs there is the pressure loss controlling but noise or harmonics can also be a consideration for air piping above the li  uid level, i.e. primarily a consideration for e  posed air mains.   or drop pipes and submerged aeration systems harmonics or noise is not a major issue because of water attention of noise in submerged piping.

## DISCLAIMER

Environmental Dynamics International, headquartered in Columbia, Missouri, USA, presents these Technical Bulletins as a service to our customers.
For more information regarding this bulletin or your specific aeration application, contact Environmental Dynamics International at +1 (573) 474-9456.

System Aeration Pipe Sizing must consider 2 primary piping components:

1. Drop pipe sizing.

2. Air lateral sizing.

Drop Pipe Sizing –

Sizing of drop pipes must consider the following:

1. Pressure limits of blower.
2. Harmonics – not typically a key factor.
3. The short length of the piping.
4. Technically no significant penalty for major pressure losses in the drop pipe.
a. Very little contribution to total system loss.
b. Little contribution to energy consumption.
c. No significant impact on system air distribution.
d. Air uniformity maintained with manual or automatic valves adjusted to deliver proper air flow/drop.

In summary the primary consideration for drop pipe Ø selection is blower capability for pressure, particularly significant for centrifugal blowers, or positive displacement machines designed at the upper limit of the blower motor capacity.

What limits are to be considered for typical drop pipe sizing?

EDI typically evaluates and designs pipe sizes for each project as hard rules seldom deliver best design or best value.

It is common to see specifications on drop piping based on “rules of thumb” velocities. EDI reviews specifications with velocity limits of 10 m/sec to 30 m/sec. While this criteria is easy to apply, it does not deliver minimum value. Several issues arise with a fixed velocity limit: (Note most common specification 15 to 25 m/sec).
Issues from using m/S to select drop pipe Ø:
1. Ignores effects on capital cost for oversizing pipes, valves, actuators, etc.
2. Ignores actual pressure drop of a system.
3. Ignores pressure loss per m or per 100 m is much higher for small Ø vs. large Ø pipe at that same velocity limit.

Single fixed velocity limit specifications in a plant are particularly hard to rationalize when there are multiple size pipes in the systems are high pressure loses per m is OK in smaller pipes but not acceptable in large pipes? Clearly the blowers are impacted just as much by losses in any part of the aeration system.

Design suggestion for drop pipes:

Select pipe Ø based on pressure loss not velocity. Yes pressure loss and air velocity values are related but the actual losses allows direct pressure calculations and control of total system losses i.e. blower operation pressure. Easy selection of pipe Ø for drop pipes or any piping in the aeration system are then achieved.

What is a reasonable pressure loss? EDI typically reviews each design for special consideration. If no overreaching design limit on pressure we typically use a maximum allowable loss value for drop pipe selection of about 6” per 100 ft as an upper limit (150 mm/ 30m). With short drop pipes this typically results in less than 2 in. (50 mm) pressure loss in the drop pipe. In special cases higher values may be justified such as retrievable, aeration grids where access and functional handling may dictate slightly elevated pressure loss rates.

Typical approximate max air flows with this criteria. (Note type pipe, inside Ø, roughness, coefficients and drop pipe length all impact the typical values).

| | | |
|---|---|---|
| 3” Ø at 170 SCFM ± | (269.28) | 8” at 2,000 SFCM |
| 4” Ø at 350 SCFM ± | | 10” at 2,800 SCFM |
| 6” Ø at 900 SCFM ± | | 12” at 9,000 SCFM |

Diffuser Air lateral Sizing:

Air laterals are more sensitive to pressure losses as these losses create greater impact on system air distribution (uniformity):

1. Large grids can generate excess losses impacting energy consumption.

2. Air distribution must be controlled internally for each grid. Orifices are used at each diffuser or diffuser assembly to distribute air between units along each lateral or throughout each grid.

3. Orifice losses are designed to deliver air distribution and typically will have at least 2 to 3 times the pressure losses in the lateral piping. This loss delivers good uniformity over the aeration grid but the accumulative effect of high losses in the air lateral plus 3 times that amount for the orifice can significantly impact design of lateral piping to assure:

a. Good air uniformity.
b. Control total pressure losses for energy efficiency.
c. Prevent overload on blowers or minimize blower motor size.

Design suggestions for air laterals –

For small laterals with only a few diffusers, friction losses not critical to process or uniformity. With small systems, little energy is used at any design.

Medium and large grids –

Total pressure loss in piping plus orifice controls pipe Ø selection. Usually air distribution and uniformity of air release over the grid are the controlling factors for allowable pressure losses and may require iterative calculations for system design. Design flexibility to control losses includes:

1. Up size Ø of piping to control losses.
2. Reduce size of grids to control loss in piping.
3. Re-orient lateral piping to control piping losses

Typically air laterals are either 3” ID or 4” Ø for support of disc diffusers which are mounted on the pipe. Tube and panel diffuser pipe sizes offer more choices, all based on the independent mounting of tube and panel diffusers which allow much wider selection of pipe sized to control pressure losses and maintain proper air uniformity over the system.

Disc units select 3” or 4” Ø pipe to match air flow tolerance of any system, i.e. control losses.

Tubes and panels typically can utilize any Ø piping 4” to 8” for control of pressure losses and in some cases even larger pipes are needed and used or alternate pipe configurations are selected.

The above sizing of drop pipes is bases only on air hydraulic considerations.  Ø of drop pipe can sometimes be a factor in the thermal design or temperature control for the aeration system. See Tech Bulletin 147.