Definition of terms and assumptions used in the FBDA system designer and pricing programme

Purpose

This programme produces **outline designs** and **budget prices** only using our PVC floor equipment system with membrane or ceramic disc diffusers.

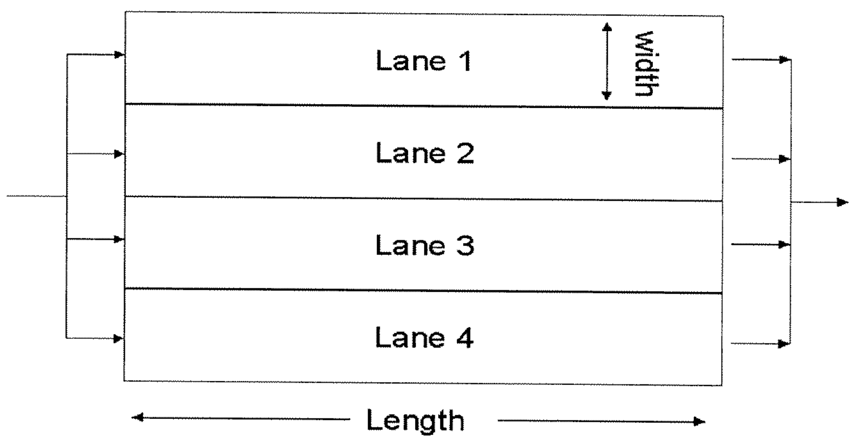
We have checked the procedure extensively, however we hope you will understand that we cannot guarantee the accuracy of the output. Since this is an automatic procedure, we have had to place limits on the design in order to make it robust. Our human designers can usually do better than the computer!

Please do not hesitate to contact us (by email, fax or phone) for a guaranteed and optimised quote.

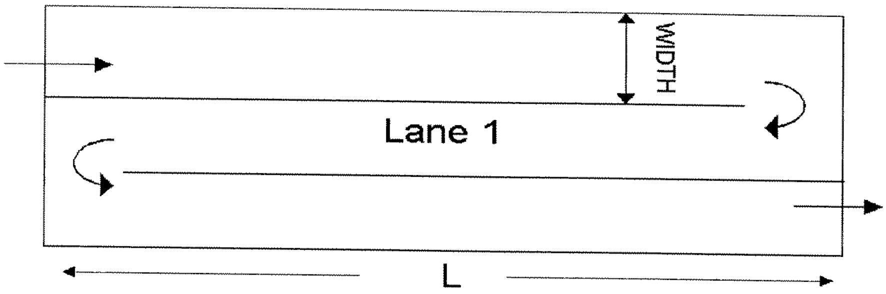
Terms and assumptions

We hope the following instructions and explanations are clear, if not, please call.

"Lanes" Aeration tanks are normally divided into a number of separate tanks or lanes, so called as they are usually long and narrow (high length to width ratio).



Very narrow lanes are often constructed with a serpentine flow with three passes.



Length = 3 x L

For simplicity, we have assumed the lanes are rectangular, of equal size, and uniform depth (serpentine tanks are "straightened out").

For other configurations such as concentric tanks, circular tanks, oxidation ditches etc. please call.

"Length and Width" please refer to the above sketches.

"Zones" In this procedure a zone is defined as the length of an aeration lane covered by one aeration grid fed by a single downpipe and TAM.

The maximum length of a double sided aeration grid is ~ 42 m. Where baffle walls are present, separate grids are normally required in each section.

Lanes less than 42 metres in length (particularly if the L:W ration is very high) may still have more than one zone in order to match demand more closely. If a section of tank requires separate control of DO concentration, a separate aeration grid will be required.

In practice, double sided aeration grids are often constructed with tapered aeration, with differing diffuser densities either side of the grid (usually ~60:40 ratio). The designer programme cannot (as yet) cope with this, for budgetary purposes the number of diffusers, airflow and price are not significantly affected by assuming the diffuser density is the same on either side of the TAM.

Single Sided/ Double Sided grids The limit for the length of diffuser pipe arrays is ~24 metres, after which experience shows diffuser distribution suffers. In order to reduce costs, for tank lengths longer than 24 metres the diffuser pipes are arranged on either side of the TAM (double sided) to give a double sided grid.

Taper In plug flow systems, the oxygen demand falls as the sewage passes along the lane. To avoid under or over aeration, the aeration rate is therefore varied along the lane ("tapered").

Typical tapers are:

60:40 for a low L:W ratio lane

35:27:23:15 for a high L:W ratio lane

SOTR - Standard Oxygen Transfer Rate.

The actual oxygen transfer rate ("OTR") required for an aeration system is normally estimated from the BOD or COD load (plus the ammonia load for a nitrifying system). The oxygen transfer rate is affected by a number of factors including the composition of the wastewater, temperature and dissolved oxygen concentration.

In order to account for these factors, the OTR is normalised to a set of "standard" conditions to give the Standard Oxygen Transfer Rate ("SOTR"), which is then used to select the required number of diffusers and air flow rate.

We use the following "standard conditions"

- Temperature 20°C
- Alpha factor =1 (actual operating values range from 0.4 -0.9)
- Beta factor = 1 (actual operating values range from 0.7-0.95)
- Dissolved oxygen concentration = 0 mg/l. (actual values vary from 0 to 2.5 mg/l)

SOTR is also often referred to as the "clean water oxygen demand"

For a fuller explanation of OTR and SOTR see "Wastewater Engineering" Metcalf and Eddy, section 6-9 page 277 onwards.

If you require assistance in calculating SOTR from your raw data, please contact us.

The **SOTR** requested by the system designer is the **total** for the system. The value entered is then divided equally between the lanes, and by percentage to each zone.

Water Depth The water depth has a pronounced effect on oxygen transfer and system design, since at greater water depths the residence time of the bubbles is longer and more oxygen is transferred per m^3 of air. The area of the tank also reduces increasing diffuser density and therefore efficiency.

Although blower power increases with depth, the relationship is not linear (see below) and the increased transfer rate more than compensates.

Deeper tanks therefore require less air, less power and fewer diffusers.

The programme assumes the tank depth is uniform throughout each lane.

The programme will currently accept depths from 2 - 6 metres. Please call us for tanks deeper or shallower than this.

"Nm^3/hr" - The volume of air varies with temperature and pressure. It is therefore customary to quote air flows as Nm3/hr (where N stands for normal").

The air-flows quoted in this procedure are at the inlet to the blower at:

15°C, 1013 mbar for ceramic diffusers and
10°C, 1013 mbar for membrane diffusers

It is important to define this when discussing blowers with manufacturers.

"Blower power"

The blower power quoted by the programme is the absorbed power estimated using the following formula for roots blowers:

$$\text{Power} = (((Pd/Pi)^{0.283}) - 1) * 600 * \text{air flow}$$

Where Pd = absolute discharge pressure of blower mbar
Pi = absolute inlet pressure of blower mbar (~1013 at sea level)
Air flow in Nm^3/sec

The discharge pressure is approx. Pi + (water depth * 98) + 80 mbar

Actual blower powers will be dependant on actual friction losses in pipework, blower speed, model, type, numbers operating, motor efficiencies, inverter efficiencies etc.

The calculated values are believed to be accurate to approximately $\pm$ 10 -15%.

Please check with ourselves and/or blower manufacturers if greater accuracy is required.

Tank shape

The shape of aeration tanks can have a profound effect on diffuser efficiency, particularly if the bottom or top of the tank has a fillet or curve which may disturb the upward path of the air bubbles.

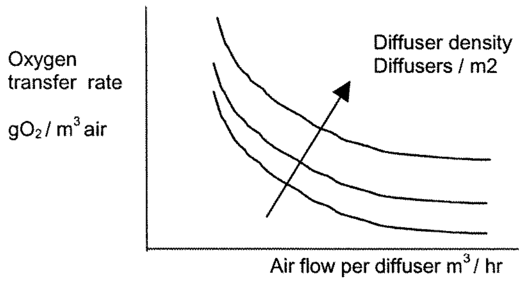
We have assumed the tank walls are straight with a flat floor and sharp corners at the walls (as is the case with most modern aeration tanks).

Please contact us for advice if this is not the case.

Efficiency options.

Due to the variation in diffuser OTE ("Oxygen transfer efficiency") with diffuser density and air flow rate, it is possible to have a number of solutions to the question "how much air and how many diffusers do I need".

In general, the higher the density of diffusers and the lower the air flow per diffuser, the better the efficiency.



The user will be asked to choose between higher efficiency systems with larger numbers of diffusers using less air, or lower efficiency systems with smaller numbers of diffusers using more air.

Normally we find systems operating around 3.5 - 4 kg oxygen per kWh give a good balance of capital vs operating costs. With very lowly loaded systems, 4 kg/kWh may be difficult to meet due to the low diffuser density.

When investigating ceramic designs, the procedure will allow airflow rates per diffuser as low as the minimum air flow rate of 0.85 Nm^3/hr. We suggest that airflows around 2.55 Nm^3/hr be selected where possible, as this gives a 3:1 turndown capability.

For membrane designs we similarly suggest air flows per diffuser >3.5 Nm^3/hr where possible.

Mixing

In order to prevent sludge settlement, a minimum air flow per m2 of tank floor of 2 Nm^3/m^2hr is normally required and ideally > 4 $m^3/m^2 \cdot hr$.

Pricing

The price quoted includes all "in-tank" equipment, i.e. diffusers, diffuser pipes, floor fixings, moisture blow out, transverse air main, downpipe, and orifice plate, terminating at a flange connection approximately 1 m above TWL.

At this stage we are not able to include air mains or blowers, please call us for a full quotation if these are required.

Installation and delivery.

Our budget price includes delivery to a mainland UK site, installation and commissioning.

We assume that we will have free, continuous access to clean, dry tanks, free issue water for leak testing, operational blowers and controls and that the installation can be accomplished in a single period.

Contact

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