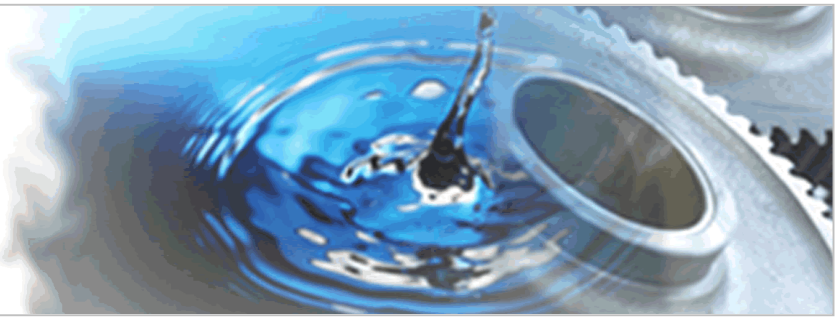

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How Fish Farms Select the Best Oxygen System at the Lowest Cost

by John Haworth, Managing Director, Newton Industrial Group Ltd

The Problem

Many large fish farms have now concluded that to remain competitive, they will have to increase stocking densities and fish growth rates by adding large quantities of oxygen to the raceway or tank. The only way to achieve this is to mix pure oxygen with the available water and this requires a supply of pure oxygen and oxygenators to mix oxygen and water.

To get the best value-for-money system you need to compare the performance and costs of oxygen generators, bulk gas supply and oxygenators. Very quickly you will find that comparing the costs of the different methods of oxygen supply is simple compared to calculating the *real* costs of oxygenation. Frequently there is little *real* data that can be applied directly to a fish farm. As a result suppliers of oxygenators make claims that cannot easily be verified or compared.

Reduced Cost Oxygenation

There is an obvious overriding goal – to establish an efficient method of supplying sufficient oxygen to the fish in the raceway or tank at the lowest possible cost.

Working back from this requirement it is possible to estimate the true cost by using a straightforward formula. This simple guide shows you how to use this formula, how to question suppliers and how to evaluate their claims.

The Need for Oxygen Systems

Many fish farmers have concluded that oxygenation is a necessity in order to remain commercially viable. This is especially true in summer when river flows decline and water temperatures rise, both factors contributing to a significant reduction in naturally occurring oxygen in water.

So as to maintain stocking density and feed programmes it is necessary to introduce additional oxygen to the limited supply of water. Traditionally this was achieved by aeration which uses air as the feed gas but intensified stocking and feed rates have now led many fish farms to accept that sufficient oxygen can only be introduced by using oxygenation systems.

Oxygen has two major disadvantages compared to air. Firstly air is always available in abundance and secondly it is free. Oxygen must be sourced, paid for and stored. Adding to those additional costs is the complexity and cost of oxygenators compared to aerators.

Calculating the True Cost of Oxygen Systems

So how do you compare the different systems and evaluate each supplier's claims? The best way is to focus on the cost of delivering oxygen to the fish in the raceway or tank. If systems appear to have similar costs, you should then base your decision on reliability and trust/guarantees.

Calculating the cost of delivering oxygen is a 3 stage calculation

1. Oxygen Demand
2. Cost of Oxygen Supply or Generation
3. Cost of Oxygenation (Mixing the Oxygen and Water)

The result should be expressed as the cost per kilogram of oxygen mixed with the water in the raceway or tank. This is an objective measure that can be used to compare all the different system types.

1. Calculate Oxygen Demand

The first step is to calculate how much oxygen is required. Oxygen demand needs to be calculated for monthly/annual demand and also for peak demand. Annual demand is needed to compare the capital and operating costs of the various oxygen supply methods and peak demand determines the required capacities of the oxygen supply and mixing equipment. Peak demand usually occurs during late summer when river flows are at their lowest and water temperatures are at their highest.

2. Calculate Oxygen Supply Costs

Once demand is known, the next step is to compare the methods of oxygen supply. There are two main methods of supply, both with various options. The fundamental decision is whether oxygen should be generated on-site or delivered to the farm. Generally the higher the demand the more attractive on-site generation becomes.

Getting oxygen delivered has the lowest capital cost but higher cost per kg of oxygen. Capital costs are minimal if bottled oxygen is used but rise if a bulk oxygen store is built. However the cost per kg of oxygen reduces if the supplier can supply by tanker rather than filling and delivering many small oxygen bottles. If you have an estimate of annual oxygen demand, it is a simple process to compare capital and running costs of the various methods. To obtain an accurate estimate, make sure you get comparable quotes from more than one oxygen supplier such as BOC and Air Products.

Key Questions To Ask the Suppliers of Oxygen Generation or Supply System		
Capital Cost		Include delivery and installation
Maintenance Cost		
Delivery Cost	Cost per Delivery	
Capacity	kgO_2 per Hour	
Oxygen Purity	%	
Energy Efficiency	KgO_2 per kWHr	Guarantees?
Backup System		Generator failure?

Onsite generation of oxygen requires a significant capital investment but the running costs will be much lower – primarily the electrical cost of powering the generator. There are two main types of oxygen generator. The more common type is the PSA high pressure generator. The alternative VSA works at a lower pressure and uses less electricity for each kg of oxygen produced. However the purity of the oxygen is slightly lower than that generated by the PSA. Also check whether a VSA system works safely with a high pressure oxygenator. There is a danger that the combination will super-saturate the water with nitrogen – a dangerous mixture for the health of the fish.

3. Calculate Oxygenation Costs

Choosing an oxygenation device is far more complicated than choosing the best method of supplying the oxygen. One major reason for this is that data on the performance of oxygenators is often not comparable nor verifiable. For many devices it is very difficult to measure performance and the only standards available are focused on the needs of the waste water treatment industry. So the main lesson to be learnt is that you need to ask each supplier for accurate performance data, how it was measured and whether the data can be verified..

If the supplier claims that nearly 100% of oxygen supplied is absorbed by the water, you should proceed with great caution.

When comparing oxygenators, you should focus on energy efficiency. This is normally expressed in kgO_2/kWHr and determines the operating cost of the oxygenator.

As an example let's compare the operating costs of two oxygenators, A & B, that supply $2kgO_2$ per hour to a raceway. The cost of electricity is 6p per kilowatt hour.

Oxygenator A has an energy efficiency of $2kgO_2$/kWHr whilst oxygenator B has an efficiency of $1kgO_2$/kWHr. In this scenario, oxygenator B will use an extra kilowatt of electricity per hour at a cost of 6p to introduce $2kgO_2$ into the raceway.

Now if the oxygenator is run 24 hours per day for 6 months per year, the increased electrical energy used by oxygenator B will cost the fish farmer around £250 per annum extra. This increase needs to be multiplied by the number of raceways in the fish farm.

Key Questions To Ask the Suppliers of Oxygenators		
Capital Cost		Include delivery and installation
Annual Maintenance Cost		
Capacity	kgO_2 per Hour	Measured in river water?
Energy Efficiency	KgO_2 per kWHr	Measured in river water?
Oxygen Transfer Efficiency	%	Measured in river water? What % oxygen purity was used?

As with oxygenation, oxygenators can be classified into two types based on pressure. A comparison of the two types and their impact on the cost of oxygenation is given in the paper that can be found by clicking on
http://www.newtongroup.co.uk/White_Paper/WP_OxygenScience.pdf

Free Oxygenation

If you wish to reduce the running costs of an oxygenator to the minimum, you need to select one that can operate using the natural head between the input water and the water level in the raceway or tank..

If this can be used, operating costs shrink to zero because no water has to be pumped. A minimum head of around 400mm is required but, if it is available, it can save you several thousand pounds per annum. You will also derive further cost savings as you will not be purchasing a pump and maintenance costs will be much lower.

If you would like to know more about the Newton Gravity Oxygenator, please click on the link below.

http://www.newtongroup.co.uk/aerator.htm

Oxygenation Cost Calculator

When you have collected all this data from suppliers, you then need to enter it into a model that will predict your actual costs.

The focus of this calculation should be on the cost per kilo of oxygen delivered to the fish. You can think of it in the same way as you view your feed costs.

Sample Calculation of the Annual Cost of Supplying 1 Kg0_2/hr

In order to modify the calculation for your own purposes you will need to get the performance data for each part of the system. This data needs to be verifiable in a fish farm environment. Also you need to make your own assumptions about number of hours per year use, capital amortisation and cost of electricity.

Assumptions

Capital Amortisation – Straight line 5 years
Cost of Electricity – 6p per kWHr
Operates 6 months per year = 4380 hours per annum

Calculate Oxygenation Costs

Oxygenator	Capacity	2.5kgO_2/hr
	Capital Cost	£1500
	Energy Usage	2.5kgO_2/kWHr
	Oxygen Transfer Efficiency	85%

Amortising Capital Cost
= 1500/4380*5 (hours)/2.5(capacity)
= 2.7p per kgO_2

Operating Cost
= 6p (cost per kWHr)/2.5 (kgO_2/kWHr)
= 2.4p per kgO_2

Total Oxygenation Cost per kgO_2 = 5.1p

Note: If the fish farm has sufficient head to use a non-pumped oxygenator, the cost of oxygenation is reduced by 50% (includes lower capital cost)

Calculate Oxygen Generation Cost

Capacity	13.5 kgO_2/hr
Capital Cost	£15000
Energy Usage	1.0 kgO_2/kWHr
Oxygen Purity	95%

To supply 1kgO_2 to the raceway you need to generate a larger quantity of gas as some is lost in oxygenation and the gas does not contain 100% pure oxygen

Oxygenator Transfer Efficiency	85%
Oxygen Purity	95%
kg Gas generated per kgO2 supplied	= 1/0.85/0.95
	= 1.24 kgO_2

Amortising Capital Cost
= 15000/4380*5 (hours)/13.5(capacity)*1.24
= 6.3p per kgO_2

Operating Cost
= 6p (cost per kWHr)/1.0 (kgO_2/kWHr) *1.24
= 7.44p per kgO_2

Total Oxygen Generation Cost per kgO_2 = 13.71p

Total Cost of Oxygen Supplied to Raceway =18.81p

Cost Calculator

We have developed a Cost Calculator that uses all the data that you have collected to calculate the cost of each kilo of oxygen supplied to your fish. You can obtain a free copy of this spreadsheet by clicking on the link below.

http://www.newtongroup.co.uk/White_Paper/OxygenationCalculator.xls

If you have comments on this guide or calculator or you would like us to help you to compare the alternative systems as they apply to your fish farm, please contact us by any of the following means

Telephone (44) (0) 151 632 4780 Fax (44) (0) 151 632 6580

Email : info@newtongroup.co.uk