VACUUM AIRLIFT

RAS WATER MANAGEMENT USING A VAL™

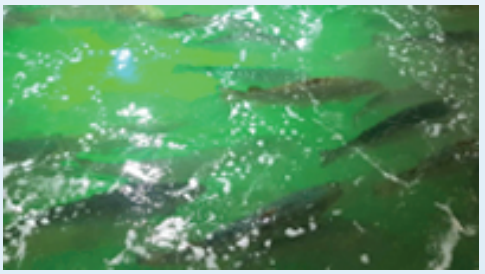
A Case Study Review of the Performance of a Vacuum AirLift™ in Recirculating Aquaculture Systems

Situation

The intensified rearing conditions present in Recirculating Aquaculture Systems (RAS) present numerous challenges to the fish farmer. Management of water quality becomes paramount in the high density rearing conditions. The fish rapidly deplete the O_2 supply while producing CO_2 and solid waste. These actions quickly create an adverse environment if not properly addressed.

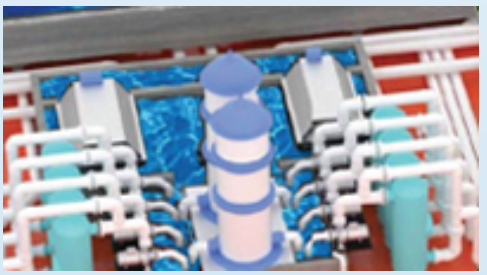
Requirements

The essential elements of RAS water management are circulation, clarification, biofiltration, degassing, and aeration. These elements provide an environment conducive to the health and growth of the fish by removing unwanted fine particulates, dissolved solids and waste gases produced by the fish while replenishing the O_2 consumed in respiration by the fish. Due to the competitive market created by wild caught fish, the water management system must have low acquisition and operating costs while providing simple and reliable operation.



Our Solution

The Vacuum AirLift™ (VAL™) provides a multi-functional solution to RAS water treatment and management. The VAL™ is a patented technology that provides gas exchange, particulate extraction and water circulation in a simple, reliable and energy efficient device. The VAL™ extracts CO_2, N_2, H_2S and other undesirable dissolved gases while replenishing the O_2 consumed in the rearing and denitrification processes. In addition, the VAL™ continuously extracts fine particulates and pathogens through foam fractionation that contaminate finfish rearing water. If left untreated this contamination leads to off flavor, biosecurity issues and risk of human illness or death.



The multifunctional performance capabilities of the VAL make it a uniquely powerful tool for sustainable RAS water management. A number of benefits accrue as a result of this performance:

1. Lower CAPEX due to reduced equipment cost
2. Lower OPEX due to lower power consumption and low maintenance
3. Increased reliability and reduces risk due to simpler equipment
4. Decreased CO_2 and other undesirable dissolved gas levels due to VAL™ vacuum stripping
5. Increased O2 levels due to VAL™ aeration and reduced BOD
6. Faster growth and higher survival rate due to improved fish health
7. Increased biosecurity due to removal of pathogens and contaminants as well as more effective UV dosing
8. Increased margin due to superior product quality and higher biomass production

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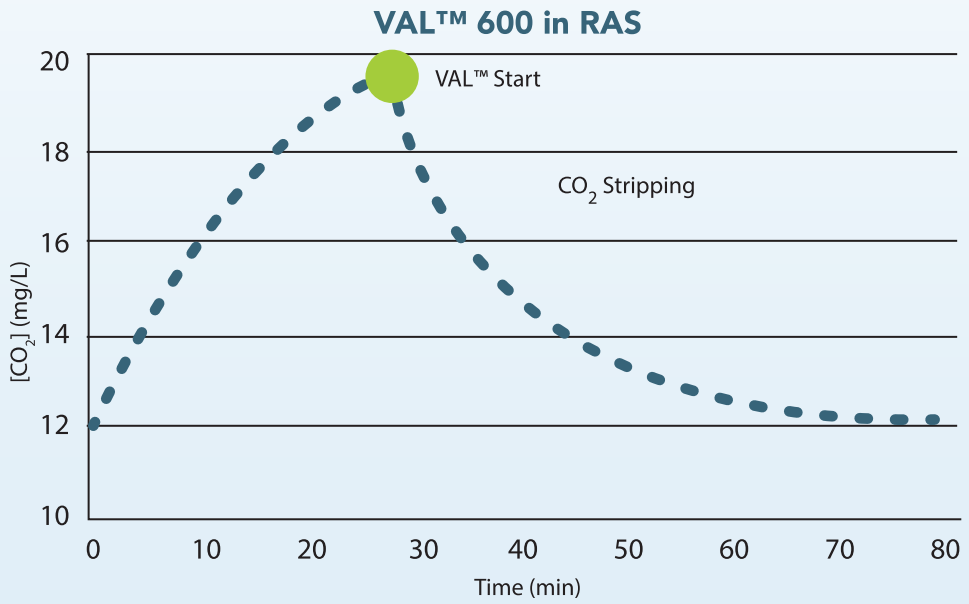
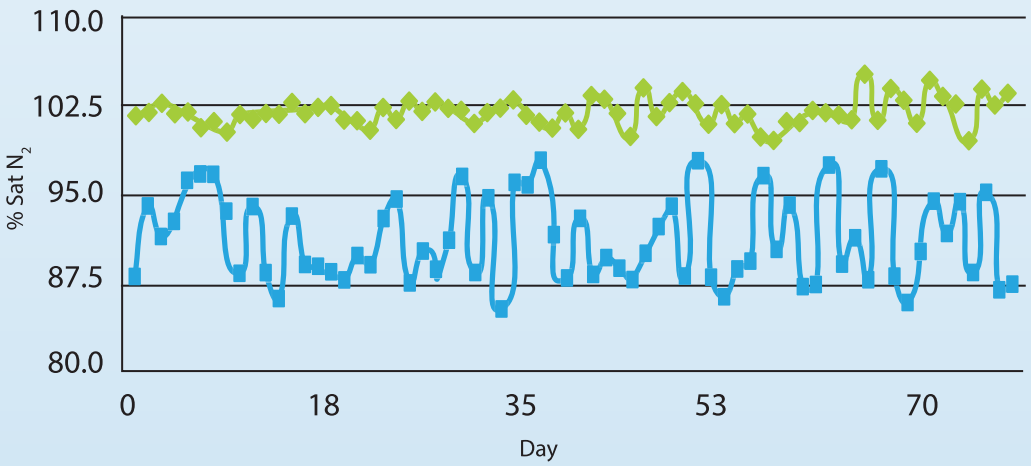
Gas Stripping Capacity

The vacuum makes the VAL™ an efficient gas stripping device. The VAL™ has a Standard CO_2 Transfer Rate (SCTR) of around 11.2x10-5 $KgCO_2\ m^{-3}s^{-1}$ providing a stripping efficiency around 15-20 $gCO_2/m^3/h$ of air injected. The combined effect of the vacuum and airlift microbubble injection results in low stripping energy, around 5-10Wh per m^3 of water treated.

Model	CO_2 Stripping Capacity
VAL™ 400	200 g to 600 g/h
VAL™ 600	500 g to 1.5 kg/h
VAL™ 900	1 kg to 3 kg/h
VAL™ 1200	2 kg to 6 kg/h
VAL™ 1400	2.5 kg to 7.5 kg/h
VAL™ 2000	6.5 kg to 20 kg/h



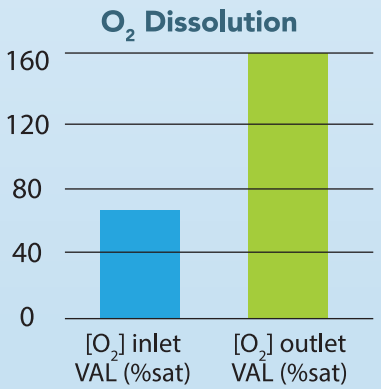


The VAL™ is also effective at stripping other problematic dissolved gases such as N_2 thereby preventing hyper saturation and its consequence, gas bubbling disease.

No VAL With VAL

Oxygen Dissolution Capacity

The high water retention time in the VAL™ outer column makes it an effective device for O_2 dissolution. The airlift circulation combined with the high water column created by the vacuum provides a mechanism for counter flow injection of O_2 in the down coming water. As a result O_2 dissolution efficiency of up to 98% is obtainable. This results in an O_2 dissolution as high 160% of saturation at the VAL™ outlet.



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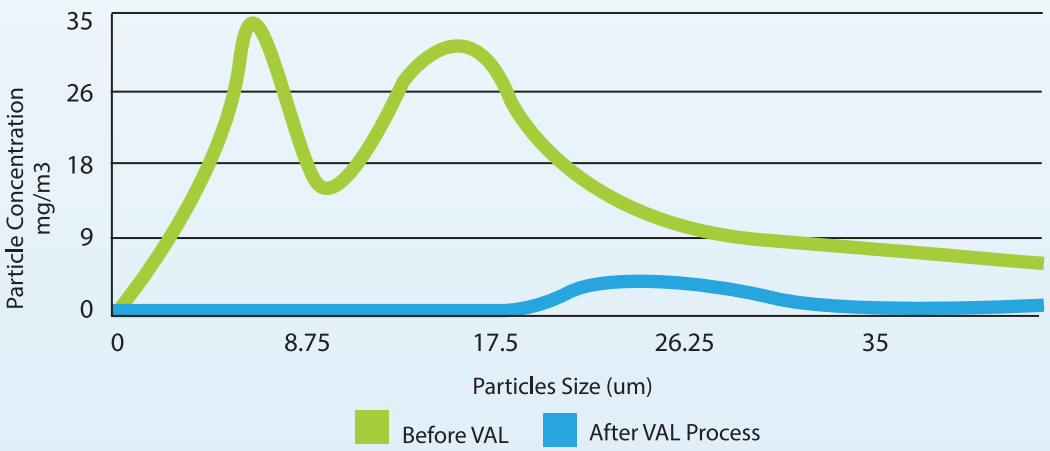
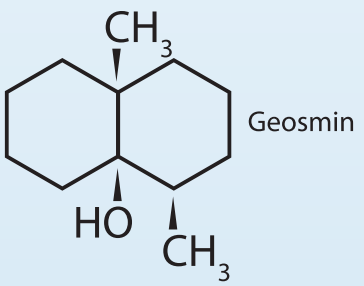
Foam Fractionation Capacity

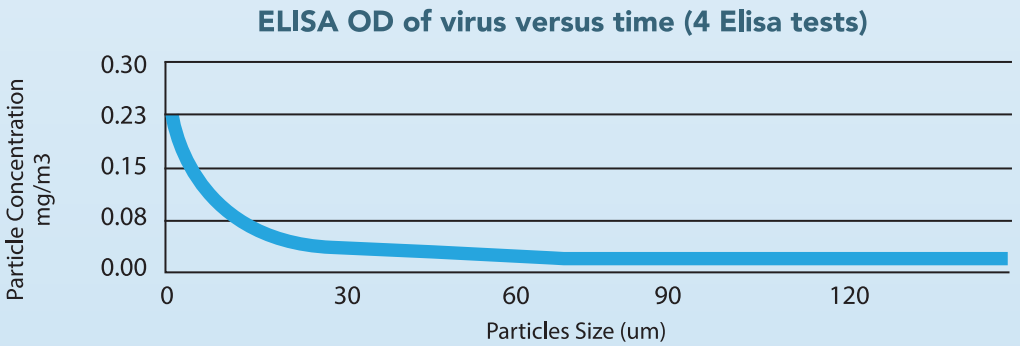
The microbubble airlift of the VAL™ provides foam fractionation capture of the fine particulates from the rearing water. This particulate laden foam is then removed by vacuum extraction making the VAL™ a highly efficient and effective particle skimming device. The VAL™ removes up to 99% of suspended particles less than 30 µm in size. As a result it provides a drastic increase in water clarity and UV transmittance while reducing the BOD load and clogging of the bio-filter. The VAL™ performs this particulate removal at low energy input. Depending on the application, energy input for particulate removal can range from 30 to 115 Wh per m^3 of water treated.

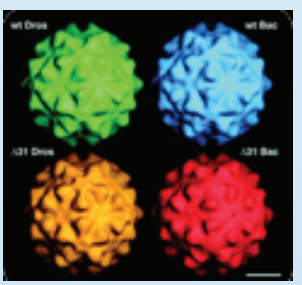


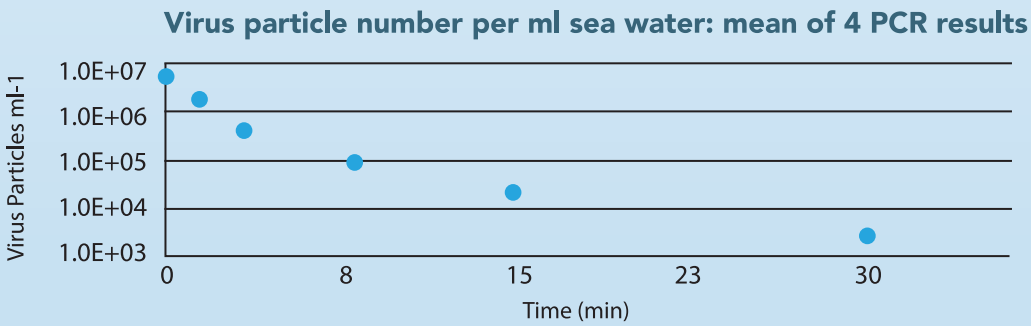
Biosecurity Effects

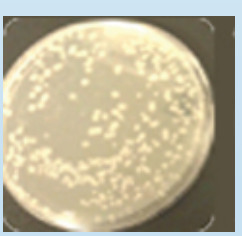
The unique foam fractionation capabilities of the VAL™ make it an effective tool for the enhancement of RAS biosecurity. The VAL™ can provide a 3 log reduction in virus concentration by foam fractionation and vacuum extraction. A 40% reduction in bacteria that produce off flavors such as Geosmin and MIB (DOM) has been achieved without the use of ozone. The VAL™ reduces the need for or enhances the effectiveness of ozone or UV treatment.











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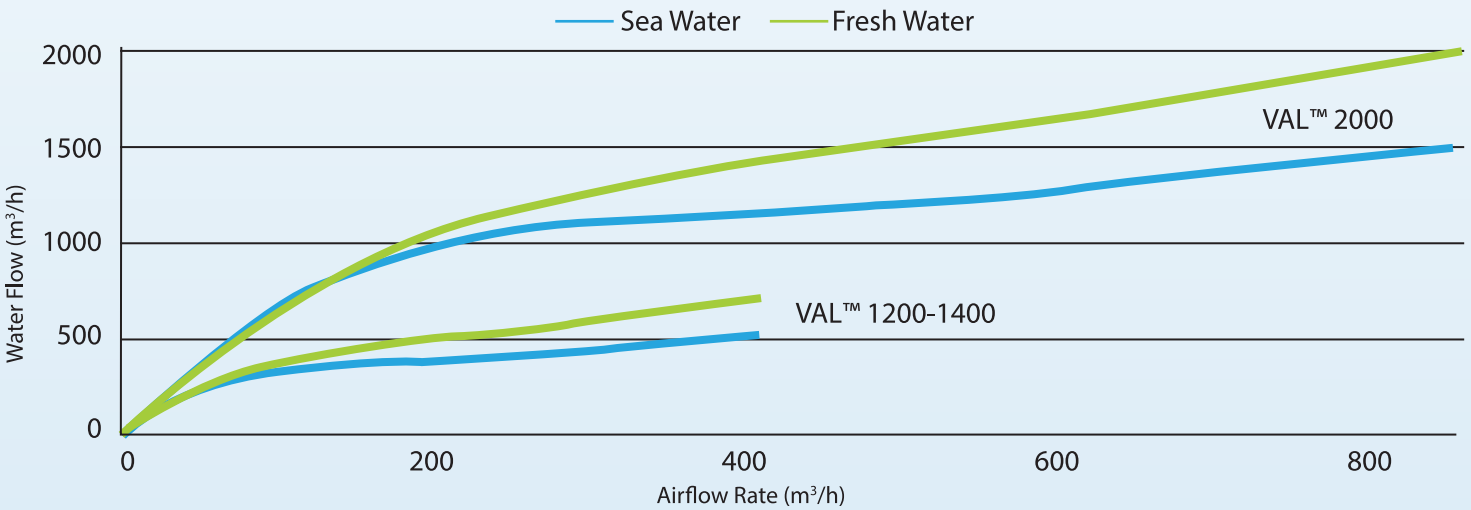
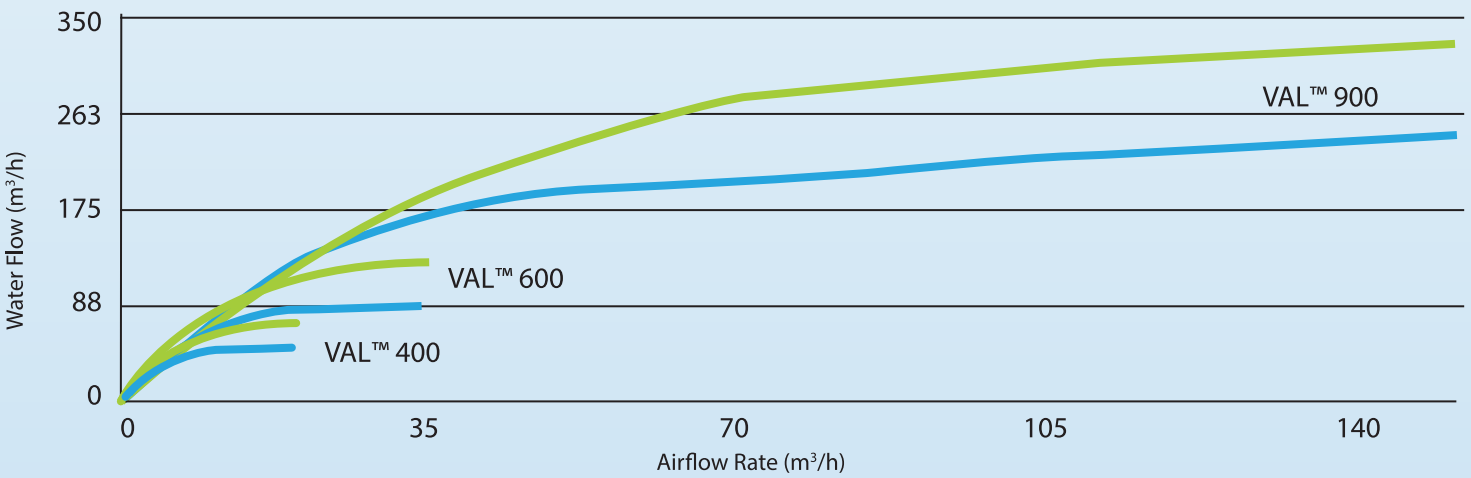
Water Circulation Capacity

The airlift makes the VAL™ an effective water circulation device. Standard airlift water transport is around 3 times the water volume per volume of air injected. With low air injection it is possible to lift 3 to 10 times the volume of water per volume of air. Water circulation is accomplished with low pumping energy, around 3Wh per m^3 of water circulated.

Model	Water Flowrate (gpm)	Water Flowrate (m^3h^{-1})
VAL™ 400	220	50
VAL™ 600	600	135
VAL™ 900	1,300	300
VAL™ 1200	2,400	550
VAL™ 1400	3,000	680
VAL™ 2000	8,800	2,000





This case study review validates the VAL™ as a highly effective tool in addressing water circulation, particulate removal, degassing, aeration and other aquaculture water management and biosecurity issues.

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