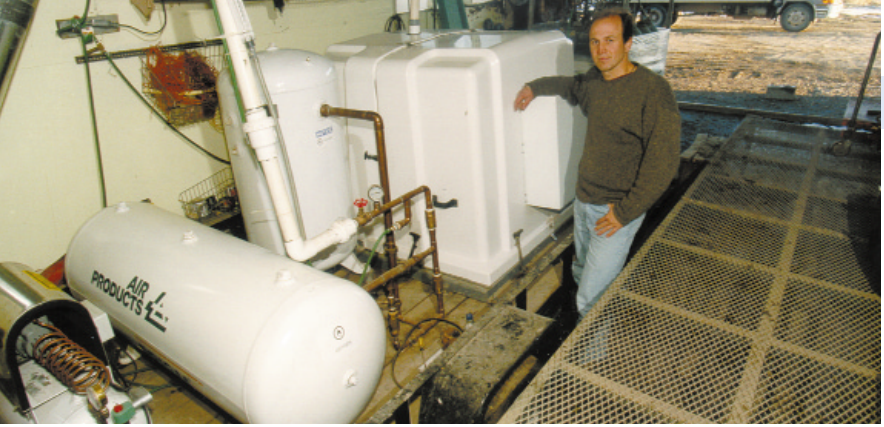
Greenview AquaFarm

Our work together

"The neat thing about Air Products is that they are developing not just a way of producing oxygen but a complete solution for aquaculture."

Darwin Monita, President, Greenview AquaFarm



An environmentally-aware tilapia farm in Canada is making the most of new VSA oxygen generator technology from Air Products

A reliable supply of oxygen is a priority for Canadian tilapia producer Greenview AquaFarm. This small-to-medium fish farm recirculates more than 99% of its water and has long outgrown its original air-based oxygenation system. “We depend absolutely on oxygen,” says company president Darwin Monita. “If we lost our oxygen supply the fish would be dead within two-and-a-half hours.”

Yet reliability must come at a reasonable price. “For a farm like ours, oxygen is typically the third biggest operating cost, so it’s important to look closely at how much we pay,” Darwin Monita continues. “We used to use liquid oxygen in Minitanks, but we needed a more economical source.”

The solution has turned out to be a new oxygen generation system developed by industrial gas specialist Air Products. Based on a technology known as vacuum swing adsorption (VSA), the new generators are low in cost, mechanically simple and highly reliable. For fish farms requiring a round-the-clock supply of oxygen, they provide a cost-effective alternative to liquid oxygen in Minitanks or bulk tankers.

Greenview worked closely with Air Products in the development of this unique, patented system. “We have now logged more than 10,000 hours of operation with the new oxygen generator, which has shown itself to be reliable and cost-effective,” says Darwin Monita.

VSA: keeping it simple

Conventional adsorption generators use pressure swing adsorption (PSA) to separate oxygen from nitrogen and the other gases that make up atmospheric air. At the heart of a PSA system is a vessel containing a porous material with a special affinity for nitrogen molecules. As compressed air passes through the vessel, the nitrogen is trapped in the pores of the adsorbent, while the oxygen remains in the product stream.

When the adsorbent can hold no more nitrogen, the vessel is taken off-line and the pressure reduced. This allows the adsorbent to release the trapped nitrogen, which is vented to atmosphere. Typical operating pressures are 8 bar for adsorption and 4 bar for desorption.

Tarik Naheiri, a product development manager at Air Products' headquarters in Allentown, Pennsylvania, realised that lowering the operating pressure could make the process more efficient. His VSA design uses an adsorption pressure of 0.5 bar above atmospheric, and a moderate vacuum (–0.5 bar) for desorption. "It's like dipping a sponge in water, then squeezing it to release the water," he says. "By squeezing the sponge gently you mop up relatively more water than if you keep it squeezed hard, and the sponge also lasts longer."

The low operating pressure possible with VSA brings another significant advantage: it allows the use of a positive-displacement blower. The blower is cheaper and more reliable than the compressor required for PSA, and eliminates the need for a separate air dryer. But Tarik Naheiri realised he could simplify the VSA system even further.

Because adsorption is a cyclic process, conventional systems use two adsorber vessels operating alternately to provide a continuous supply of oxygen. But if the cycle is short enough, Tarik Naheiri reasoned, then a single adsorption vessel and an oxygen buffer tank will do the job. After trials, he settled on a total cycle time of 30-60 seconds for both adsorption and desorption.

The resulting Air Products VSA system has just a handful of parts: the vessel containing the adsorber and a prefilter, a blower to provide compressed air and vacuum, a four-port automatic valve to control the airflow, an oxygen buffer tank, two check valves, a pressure control valve and a programmable logic controller. A skid-mounted system to provide 250 kg of oxygen every 24 hrs measures around 2 m^2.

"The major costs in a traditional PSA generator arise from the need to compress large volumes of air. With our VSA generator, I realised that by lowering the operating pressure, I could make the entire process much more energy efficient."

Tarik Naheiri, Product Development Manager, Air Products

Clean and green on the prairie

Looking for somewhere to test the newly-developed VSA system, Tarik Naheiri hit upon Greenview AquaFarm near Calgary in the middle of the Canadian prairies. With its innovative approach to technology and environmental protection, and a demanding customer base, Greenview was an ideal reference site.

Greenview was set up in 1994 by a group of people from the University of Calgary, explains Darwin Monita. They saw a business opportunity in selling live tilapia and bigmouth buffalo, a native North American fish, to the Chinese community in Calgary and Edmonton. Chinese cooks' insistence on buying their fish alive has two advantages to the fish farmer: live fish fetch a good price, and they avoid the regulatory complexities of running a filleting and packaging plant.

The team learned about fish farming the hard way, Darwin Monita admits, and the plant as it now exists bears little resemblance to the original startup. One thing that has characterised Greenview from the start, however, is an insistence on the highest standards of environmental protection. With almost complete recirculation, the plant requires only small amounts of water. Solid waste is turned into compost, with the help of wood chips that a local company previously had to pay to dump. Contaminated water undergoes natural biological treatment in a wetland area, and the team is also experimenting with hydroponic agriculture as a method of nutrient removal from the water.

A combination of natural gas and passive solar heating keeps the tilapia ponds at the ideal temperature of 27–30°C. Greenview grows its tilapia to around 1.5 lbs, compared to the 1.25 lbs or so favoured by many farms. Although tilapia have a reputation for hardiness, growing them successfully at high stocking densities and for long periods demands high standards of husbandry, says Darwin Monita.

Greenview breeds all its own fry from a Chinese stock that is disease-free as well as fast-growing, but sometimes has to buy in full-size fish to keep up with customer demand. In the end, he says, disease management largely comes down to water quality: "If you can provide the fish with a very comfortable environment, they generally take care of diseases on their own."

An essential part of this comfortable environment is a good supply of oxygen. Greenview began as a semi-intensive operation using air, and then switched to liquid oxygen in Minitanks. "But this was a temporary measure," says Darwin Monita. "We always intended to install either an oxygen generator or a bulk liquid oxygen system, and it was just a question of comparing overall costs."

When he was investigating oxygen generators, Darwin Monita made contact with Air Products and Tarik Naheiri, who explained his idea for a cost-effective VSA system. The Greenview team jumped at the chance to test a prototype of the new oxygen generator, which was installed in late 1999.

"We installed the unit ourselves — which isn't saying a lot, since you pretty much just plug it in," says Darwin Monita. Ever since then, with just a few breakdowns of the sort to be expected on a prototype, the generator has been working round the clock to pump out 120 l/min of oxygen. Air Products installation technician Tom Gosling and Greenview farm manager Clinton Harris have worked together to make the system as effective as possible.

Listening to the customer

Along with small improvements to the generator, such as a redesigned casing and more reliable check valves, Air Products has worked with Greenview to create an installation that best meets the farm's needs. One example is the addition of a small compressor to boost the oxygen pressure for certain applications.

For the mechanical contactors mostly used at Greenview, the VSA system's standard oxygen delivery pressure of 3 psi is adequate — higher pressures, as from a PSA generator, would simply waste energy.

A cost effective solution

In the high-density tanks from which the fish are taken to market, however, Greenview uses diffuser stones to maintain a higher oxygen concentration, and these require higher oxygen pressures. The add-on compressor developed by Air Products is a compact unit that boosts the oxygen pressure to 50 psi.

The next project is to use the VSA unit to supply Greenview's ozone generator, used to kill aquatic micro-organisms. "The nice thing about working with Air Products has been the partnership," says Darwin Monita. "They listen to our ideas and our feedback."

After nearly a year's experience with the new oxygen generator, the Greenview team is convinced of the benefits of VSA in terms of both cost and reliability.

For fish farms that require oxygen throughout the year, and especially in remote areas, the costs of VSA compare favourably with those of bulk liquid oxygen. For example, at 90 l/m, with a $0.60 m^3 cost of oxygen, and a $500 (Canadian dollars) per month tank rental (5 year commitment), Greenview would have spent over $2,832 per month to satisfy its oxygen requirement. Pad construction costs (concrete, bumpers, roadway, etc.) for a liquid oxygen tank were estimated at between $8,000-$10,000. Using the Air Products oxygen generator, the operating cost (electricity) to Greenview is now $242 per month with a $0.06 kWh power charge generating 120 l/min of 90% oxygen. Greenview spent a considerable amount of time managing their liquid oxygen supply. With on site generation, the generator runs continuously and the time spent and the worry associated with managing their oxygen supply have been eliminated.

A combination of simple, robust design and easy maintainability have produced a system that is highly reliable, as extensive field trials at Greenview and elsewhere have shown. The specially-developed adsorbent lasts for the lifetime of the unit. Maintenance is limited to checking the oil, drive belt and valves every few months, says Tom Gosling: "If you can do simple jobs on a car, you can maintain our VSA unit. And if you need spares, you can get them easily from local suppliers."

With unit capacities from 5 l/min to 120 l/min, and a modular construction that allows them to match any desired output, the new VSA generators and their accessories are suitable for almost any aquaculture application. The last word goes to Darwin Monita of Greenview: "The neat thing about Air Products is that they are developing not just a way of producing oxygen but a complete solution for aquaculture."

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Tom Gosling, Senior Product Development Engineer, Air Products

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