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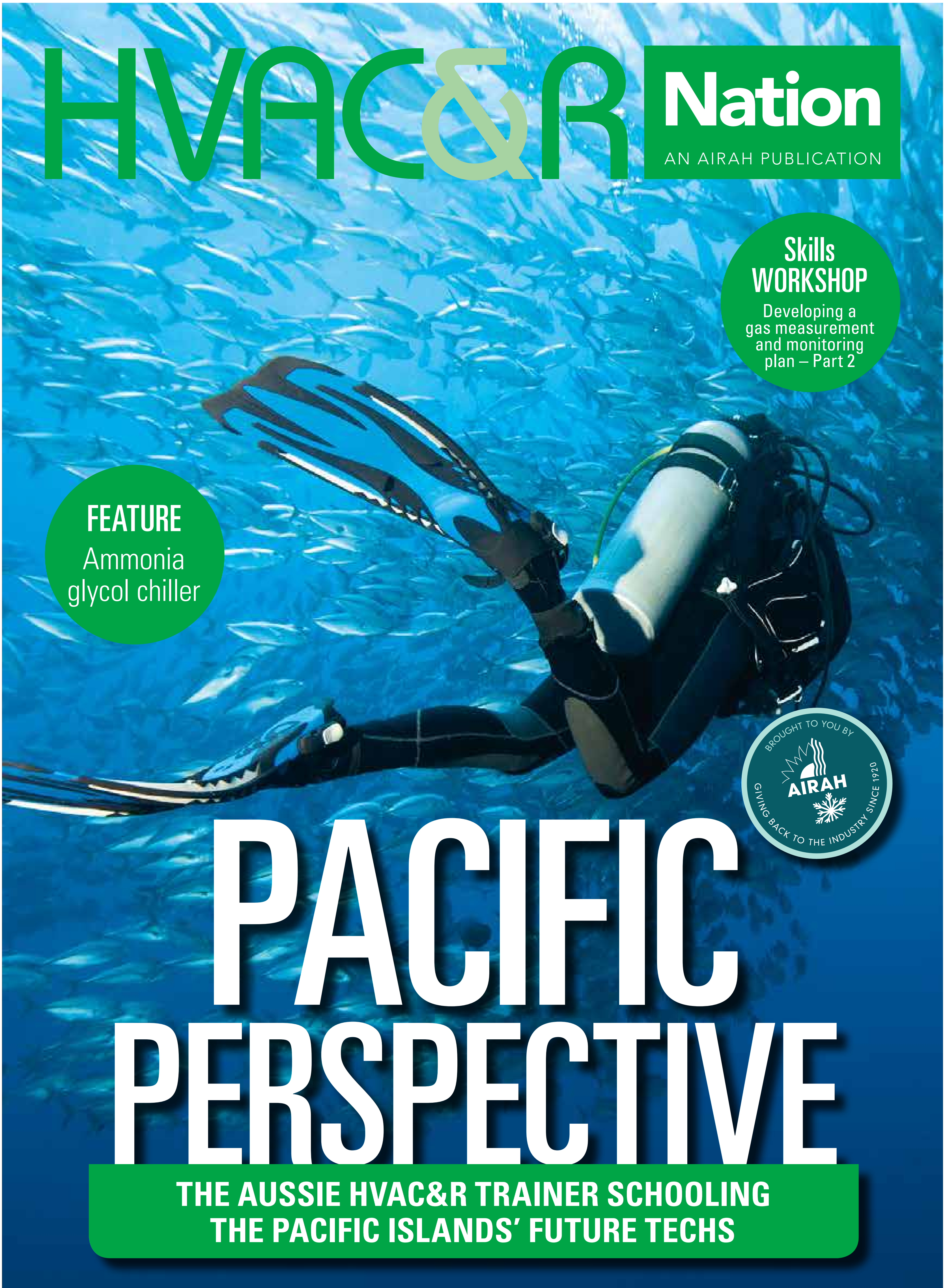

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Ammonia glycol chiller

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# PACIFIC PERSPECTIVE

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# A 'SHROOM OF THEIR OWN

Out with the old, in with the new. An innovative glycol system delivers significant savings and streamlines production at the Slyvan Australia mushroom spore factory.

An aging glycol temperature-control system critical in the cultivation of mushrooms has been replaced with an innovative glycol-ammonia dry cooler combination to deliver significant operational savings and production-cycle improvements. **Sean McGowan** reports.

Sylvan Australia – a local subsidiary of American company Sylvan Inc., – is Australia's largest mushroom spore producer. It operates a high-tech facility in Windsor, New South Wales.

In the wild, mushroom spores (the equivalent of seed, and only one one-hundredth of a millimetre long) are naturally dispersed from the fungi and carried long distances in the air before coming to rest.

If conditions and the substrate allows, the spore will grow into mushrooms.

However, the cultivation of mushrooms for the food market is a much more closely controlled process, beginning in a laboratory to ensure the integrity.

Mushroom spawn are the products from which mushrooms are commercially cultivated. They require a number of temperature-controlled processes in the production process, including the sterilisation of a substrate.

And for almost 20 years, Sylvan Australia relied on a purely glycol temperature-control system for the process of substrate sterilisation.

## GLYCOL STERILISATION

Sylvan Australia's old system relied solely on glycol as the heat-transfer medium.

Heated by a gas-fired boiler to 120°C, the heat was used to sterilise the raw materials (wetted grain) for the growing medium.

To achieve an even temperature throughout the process, the glycol was pumped around a jacketed vat (known as the blender) which in turn rotated around the grain.

Once the grain reached its sterilisation temperature, the glycol was cooled to 6°C. This enabled the growing medium to be cooled before the introduction of the mushroom spore and subsequent product bagging.

To achieve this temperature drop, an air-cooled heat exchanger had been used to reduce the glycol temperature from 120°C to 30°C, before an R22 air-cooled chiller further reduced the temperature to 6°C.

Eventually, the age of the system and associated costs to keep it in service reached a point whereby replacement was necessary.

Rather than adopting a like-for-like replacement utilising R134a for example, Sylvan Australia sought to reduce both the energy consumption of the plant, as well as the site's environmental footprint by as much as possible.

This led Strathbrook Industrial Services to design a new system, which incorporates a dry cooler and ammonia chiller to dramatically reduce operating costs and improve production capabilities.

The system features a water-cooled, braised-plate heat exchanger to provide heat transfer. Because this has been incorporated into a closed-loop system, the need for cooling towers has been removed.

In their place, a dry cooler featuring eight electronically commutated (EC) fans provides basic heat-rejection capacity. A water pump circulating water between the plate-heat exchanger and dry cooler ensures the heat can be transferred from the hot glycol to the ambient air.

Once the glycol temperature is reduced to 30°C, a pair of existing motorised valves diverts the glycol flow from the plate-heat exchanger to a 2000L buffer tank, which is held at 6°C by an ammonia chiller.

According to Strathbrook's Ian Wilson, M.AIRAH, the warm glycol mixes with the cold glycol to further reduce the temperature, thereby creating an instant cooling load for the ammonia chiller.

"When the glycol-diverting valves change position, the primary water pump is shut down and a secondary pump circulates the cooling water between the dry cooler and the chiller's water-cooled condenser," says Wilson.

This configuration means the dry cooler becomes the heat-rejection heat exchanger for the ammonia chiller.

The ammonia chiller features a heat-recovery system that pre-warms water supplied to the boiler, as well as the water used to achieve the correct moisture content in the substrate (grain).

## AMMONIA CHILLER

The ammonia chiller set designed by Strathbrook is a self-contained, critical-charge system featuring its own, dedicated on-board controls and power.

It delivers a cooling capacity of 105kW at -2.5°C SST (saturated suction temperature) and is water-cooled by water from the dry cooler.

The system's water heater features a variable heating capacity, which increases in capacity as the water temperature entering the heat-recovery heat exchanger falls.

The refrigeration circuit features a single DX (direct expansion) ammonia plate-heat exchanger evaporator with a single, six-cylinder reciprocating piston compressor that circulates 4.9kg of anhydrous ammonia (R717).

**Ammonia chiller with weather-proof panels.**

The compressor has a variable-speed drive with an operating range of 25Hz to 50Hz (60Hz if required), and a single unloading cylinder-head capable of reducing the compressor's capacity by 33 per cent. Individually controlled, the compressor can operate at a minimum speed in an unloaded state so that it doesn't short-cycle during low-load operation.

The compressor is also fitted with a positive-displacement oil pump and oil-pressure safety control to monitor oil-pressure during operation. The oil level is controlled by an oil watch bolted to the sight glass position in the side of the crankcase, which displays the current operating state of the oil system.

The oil pump and oil-pressure safety control can also stop the compressor in the event of low oil level or pressure.

According to Wilson, the condenser has been located below and beside the heat-recovery heat exchanger. It is fed with cool water from the closed-loop dry cooler.

"The condenser will condense the ammonia into a liquid, and gravity will feed it out the bottom of the heat exchanger and through the liquid drier-shell isolation valve," he says. "The liquid then enters the drier shell, which also acts as a liquid receiver, and is fitted with three bullseye sight glasses to allow the liquid level in the drier to be known."

The liquid then passes through the drier-shell outlet isolation valve into the liquid line, which delivers liquid refrigerant to the liquid-expansion valve station. A motorised valve controls the supply of liquid refrigerant into the evaporator, with a valve controller maintaining the flow so that 6K of superheat is maintained.

The evaporator pressure is monitored by a pressure transducer located in the suction line after the evaporator. The leaving gas temperature is monitored by a sensor in a pocket in the suction line.

## SYSTEM CONTROLS

The new system features a proprietary controller to control the operation of the ammonia chiller. It takes readings from suction-and-discharge pressure transducers, plus condenser-water temperature and product-water temperature sensors.

The controller displays the current operating pressures for suction and discharge, as well as the percentage of load.


Dry cooler with expansion tank and water-spray system.

"The controller has a set point of 270kpa (-4°C) and has a dead band of 40kPa either side of the set point," says Wilson.

If the suction pressure falls below the set point, the compressor will slow down. Likewise if the pressure rises above, the compressor will speed up.

"Once the compressor is at maximum or minimum speed, it will remain at that point until the operating conditions either return within the normal range or go outside that safety cut-out set points," Wilson says. "And if the high (2000kPa) or low (180kPa) pressure safety is exceeded, the compressor will stop."

Manual safety-pressure controls are also provided.

The system also features condenser-water flow control and chilled-glycol flow control that will both stop the compressor if there is no flow. An anti-freeze safety control will also stop the system if it detects glycol below -10°C.

## PROJECT AT A GLANCE – SYLVAN AUSTRALIA

### THE EQUIPMENT

**Chiller:** Strathbrook Industrial Services
**Compressor:** Bitzer
**Controllers:** Danfoss
**Dry cooler:** Guntner
**Oil watch:** Traxon
**VSDs:** Danfoss

## IN PRODUCTION

After the glycol is heated to 120°C to sterilise the "batch" of grain, the batch is then ready to be cooled.

At this point, the production control system changes the valves in the production room from heating to cooling, and the glycol is pumped to the heat exchanger outside the boiler room.

When the cooling cycle begins, the dry-cooler pump starts and its fans are enabled. Cool water from the dry cooler is then pumped through the heat exchanger and back to the dry cooler.

At this time, the condenser-water pump also starts, allowing the chiller to start if the glycol in the buffer tank is above the set-point temperature.

After the hot glycol passes through the plate-heat exchanger, the heat is transferred to the water in the dry cooler. Its speed-controlled fans start when the water temperature reaches above 25°C so that this temperature is maintained in the dry-cooler exit pipe whenever possible.

As the leaving water temperature increases, the speed of the fans also increases. Once the fans reach maximum speed, the dry cooler's water-mist sprays are activated in four stages.

If the water temperature is above 27°C, the water-mist system will spray water into the air around the dry cooler. As the water droplets evaporate, the air is cooled, which in turn increases the cooling capacity of the dry cooler.

When the glycol temperature in Sylvan Australia's production room drops to 30°C, the system automatically changes the valves over from the heat exchanger to the glycol-buffer tank.

As the 30°C glycol enters the buffer tank, increasing the tank temperature, the chiller is called on to cool the glycol to 6°C or below before cycling-off.

Once the batch reaches the set temperature, the production glycol pump shuts down and the chiller cooling call is cancelled. ■

## EFFICIENT OPERATION

The combination of an ammonia chiller and dry cooler at Sylvan Australia's production facility has shown to be significantly cheaper to operate than the existing, aging system – as well as alternative systems utilising R134a.

According to Wilson, the installed system is 90 per cent cheaper to run compared to an air-cooled R134a system. Even when compared to a water-cooled R134a system, the annual operating cost of the selected ammonia system is 39 per cent lower.

As well as delivering significant operational savings, the innovative system design has also reduced the production-cycle time in Sylvan Australia's process.

So, next time you grab a handful of mushrooms at your local supermarket or fruiterer, know that HVAC&R has played a role from the earliest stages of their cultivation.