

# What's old is new again in refrigeration efficiency



By Mark Holden, Director, Business Development and Engineering, Oomiak

***With rising energy costs, there would be few winery operators in Australia who wouldn't be looking at ways to reduce their consumption. But, where do you start, and is there any new technology that can assist?***

The rising cost of electricity and gas, coupled with the impact of the carbon tax and the requirement for many businesses to report on their energy usage, ensures that finding ways to improve energy efficiency remains a critical discussion topic for all business.

With refrigeration generally consuming 50%-70% of a winery's energy, it is not surprising that in any discussions about improving the energy efficiency of a winery, the focus is on refrigeration. While it is refrigeration relating to the winemaking process that is predominately reflected in the significant energy consumption, there remains a significant refrigeration requirement to serve cellaring, barrel storage and office air-conditioning.

So, where should you start if you are really focussed on reducing your winery's energy consumption, and what is new to assist? Refrigeration plant efficiency has been a strong topic of discussion for more than 10 years. In that time, we have seen the development and implementation of a wide range of new technologies and improved equipment efficiencies. We have also seen the construction of new wineries designed around these technologies.

**.....Not all efficiency improvements are costly or difficult to implement and, when planned, can also be incorporated as part of ongoing replacement or expansion activities, thereby further reducing the cost of implementation.**

While much of the initial activity was led by big business that could afford to take a long-term view to investment in efficiency, we have since seen the price of such technology come down and the range of energy efficient equipment broaden to make smaller facilities and retrofit projects financially viable.

Knowing what you want achieve from any project is a significant start to meeting your objective. Understanding your refrigeration needs and how you currently meet them will allow you to effectively plan the reduction of energy consumed by refrigeration and, as is often the case, deliver a better operational outcome.

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## CRITICAL APPROACH TO ASSESSING YOUR REFRIGERATION SYSTEM AND WHERE TO LOOK FOR OPPORTUNITIES

When considering how to assess and improve the efficiency of your facility, it is important to work through the process in an order that will ensure any investment you make is consistent with your needs, both current and future. For that, we recommend the following approach.

### System design

Tremendous opportunities to influence energy efficiency can be found in an analysis of the refrigeration system design compared with the needs of your business. This must include:

- a thorough understanding of the site process requirements, including load profiles, processing temperatures and winery layout



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- assessment of all product from coolant to heat exchange equipment, including tank jackets, spears, must and juice chilling, etc
- secondary glycol cooling infrastructure (where utilised), including pipework, pumps and control
- primary refrigeration cooling plant.

An energy efficient refrigeration system should be designed to:

- achieve the required product conditions with the highest possible evaporating temperature (increasing compressor efficiency)
- operate with the lowest realistic operating condensing temperature (reducing compressor energy consumption for the same output)
- minimise compressor stop/start, particularly at periods of low load
- consider the splitting of large refrigeration loads working at different operating conditions, such as crushing versus cold stabilisation, barrel store conditioning, etc (higher temperature loads can be met more efficiently with chillers operating at higher conditions)
- minimise pumping distances for secondary refrigerants and unnecessary line losses (reduces pump energy input and parasitic loads)
- consider refrigerant choice (for highest operating plant COP-coefficient of performance)
- avoid or eliminate the use of liquid injection oil cooling on screw compressors (these are parasitic loads and affect compressor efficiency)



**An evaporative condenser with variable speed drives for fan and floating condensing pressure control.**

- utilise VSD (variable speed drives) on pumps, fans and compressors (to optimise operational performance and control of selected equipment across all operating load conditions)
- take advantage of heat reclaim from the refrigerant plant for heating processes in the winery (reduces refrigeration plant energy and heat source requirement for heating process)
- the use of power factor correction technology.

While many of these design elements are being used across the industry to varying degrees, the following is a relatively new technical development that should be considered:

#### **VOLTAGE OPTIMISATION TECHNOLOGY**

Voltage optimisation technology is an example of a relatively new technology that can have significant energy savings in situations where motors and equipment operate at voltage levels higher than what they were designed for. In these situations, there is degradation of the equipment and energy is lost through heat, vibration, etc. The over-voltage results in higher electricity consumption as energy is wasted. Voltage optimisation reduces the supply voltage to be in line with what the connected load requires.

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are dependent upon where a winery is located on the electricity grid. Reduction in energy consumption of up to 13% has been achieved with this technology.

#### EQUIPMENT SELECTION

One of the most significant areas of opportunity for improving energy consumption is equipment selection. Two critical aspects about equipment selection are:

- selecting the right equipment for the task e.g., pumps with the correct curve for the duty, correctly sized compressors for the compression ratio, pipework and valving for minimum pressure loss, etc
- choosing efficient equipment e.g., electric motors with high efficiency, compressors with high COP, evaporators with minimal pressure loss and a suitable allowance for fouling factor. A very good example of a new technology

being applied to packaged, air-cooled chiller equipment is the EC fan motor.

EC (electronically commutated) fan motors are, in simple terms, brushless DC motors. While brushless DC motors have been around for many years, the EC technology integrates electronics that can be connected directly to an AC mains supply. In addition, the electronics convert AC to DC and control the fan speed by regulating the power to the motor.

A DC motor is around 30% more efficient than an AC motor because the secondary magnetic field comes from permanent magnets rather than copper windings. An AC motor consumes additional energy solely to create a magnetic field by inducing current in the motor.

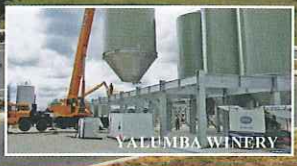
They are now being offered by some packaged chiller manufacturers for condenser fans but mainly as an option.

#### CONTROL STRATEGIES

Another important component of the refrigeration system is the control strategies that are in place to run the refrigeration plant and system. A well-designed control system will monitor and measure plant operation to enable the control of whatever plant type or size is in place.

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In simple terms, an effective control strategy matches the equipment and components of the refrigeration system to the required cooling load at all times, minimising energy input, reducing stop/start, short cycling (excess starts), etc. Effective control strategies include:

- control compressor and chiller capacity to meet the load, minimising over-cooling or losing control of product temperature (reduced compressor input energy)
- combined with VSDs on compressor motors to infinitely match compressor capacity to the applied load (eliminates over-cooling and excessive stop/starting)
- provide the ability to vary condensing temperature to take advantage of favourable ambient conditions (reducing compressor energy consumption for the same output when conditions allow)
- combined with VSDs to match the pump capacity to match the required secondary glycol flow rates (reduces pump energy input and the parasitic pump energy added to the glycol)
- allow the floating of secondary glycol temperatures to match the process load (improving chiller efficiency when conditions allow)
- enable shifting peak daytime loads to lower ambient night time conditions (e.g., over-cooling stored wine and juice to act as thermal storage for use during the day or at periods of high crushing load).

### COMMISSIONING

Ensuring the system design is implemented and the selected equipment is correctly installed to deliver the desired capacity and operating efficiency is critical to achieving the design goals. This is a vital function in the delivery of both new installations and the installation of new equipment. The importance of accurate commissioning of plants is often overlooked with a lot of good plants installed but never achieving the intended operating performance. Important considerations for commissioning plant are:

- commissioning documentation is in place, setting out a control strategy and all required operational settings
- completed commissioning sheets confirm final settings and functional testing for review and sign-off by the design engineer
- a copy of the final commissioning documentation saved on-site for future reference by maintenance personnel
- operator and maintenance personnel training in the specific operation of the plant and settings.

A regular 're-commissioning' of the refrigeration plant is a relatively new service being offered, which ensures that the plant and equipment are functioning at desired levels and settings are optimised for the operating conditions. This is best achieved

with engineering personnel and skilled technicians working in combination in assessing the operating conditions and the plant performance.

### MAINTENANCE

The importance of maintenance as a strategy for energy efficiency cannot be overstated. Poorly maintained equipment not only increases the risk of breakdown, but can significantly reduce the operating efficiency and increase energy consumption. Maintenance routines should ensure:

- a planned and systematic approach to all maintenance activities is undertaken
- all activities are scheduled and the scope of work is clear
- all necessary repairs are attended to
- any work undertaken is documented for future reference.

### AUDITS AND FORWARD PLANNING

Beyond maintenance there is a need to assess equipment performance and sustainability of plant condition for a changing load, and to benchmark performance. This can include changes to operation, changes to plant and capacity, and the ability to identify new opportunities for improvement and areas of performance that may have slipped.

Planning for improvement and implementation of change is vital, not only from a financial perspective, but also operationally. Planning for the future must take into consideration the many external factors that can influence the refrigeration requirement and its effect on an individual winery, including:

- site processing requirements
- plant and equipment performance, including supporting services
- equipment condition
- maintenance regimes
- compliance.

### SO, WHAT IS REALLY NEW?

What has changed in the last few years is awareness of the importance of altering the way we approach the use of energy and, also, the amount of information and products available to allow change. Along with accessibility, the cost of these technologies has greatly reduced, making them more affordable and easier to justify.

There is no end to the improvements that will continue to occur in design and the range of efficient equipment being offered to the market, therefore, greater efficiency opportunities will continue to be introduced. Willingness to commit to improve and the support of a highly skilled technical service provider that understands your business goals and drivers are critical for achieving greater energy efficiency.

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