MOTOR, PUMP AND FAN EFFICIENCY – F5

Energy eco-efficiency opportunities in Queensland Foundries

More drive, less work

Motors, pumps and fans are intrinsic to all foundry operations. However, they can incur significant running costs. For example, an electric motor uses 4-10 times its purchase price in electricity annually.[1] Therefore careful selection and design is essential taking into consideration both operating and capital costs. While high-efficiency alternatives may be more expensive initially, energy savings often quickly recover the extra cost.[2]

It is also essential that the operation of these motors, fans and pumps are optimised, well maintained and serviced regularly.

Changes to motors, pumps and fans should only be undertaken in consultation with service providers.

Many foundries engage third-party service providers to manage aspects of their plant. This makes good use of the provider's specialist expertise and allows the foundry to focus on their core business. However, to achieve efficiency, it is essential that the foundry has some understanding of how their system should operate in order to work more closely with service providers and to adequately verify their performance. Foundries may even wish to consider a performance-based contract related to reducing energy consumption. It is essential that service providers know efficiency is a priority.

Motor efficiency

High efficiency motors

High efficiency motors can cost up to 40 per cent more than standard motors. However, the payback period can be less than two years with the associated energy savings. Table 1 demonstrates the benefits that can be achieved through the purchase of a high efficiency motor.

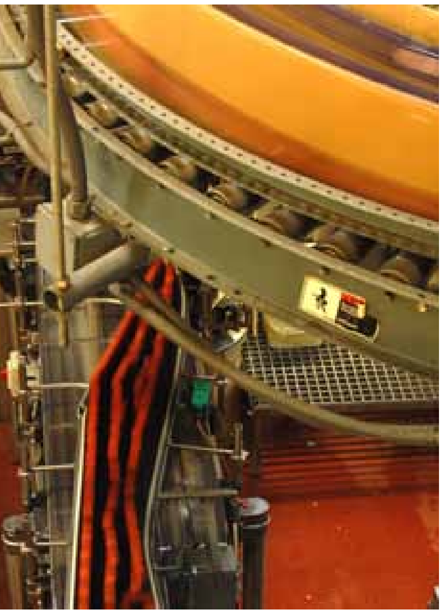
1 Australian Department of Environment, Water, Heritage and the Arts, 2003, Motor Solutions Online – Selecting the Best Motor and Equipment, **www.environment.gov.au/settlements/energyefficiency/motors/reference/r2.html.**

2 Australian Greenhouse Office, 2008, Motor Selector Software **www.environment.gov.au/settlements/energyefficiency/motors/motorselector/m2.html**.

Table 1 - Payback periods for purchasing high efficiency motors[3]

Motor rating	High efficiency 11 kW	Standard 11 kW	High efficiency 45 kW	Standard 45 kW
Efficiency (%)	92	89	95	93
Hours of operation per year	6,000	6,000	6,000	6,000
Purchase price ($)	$922	$877	$2,390	$1,680
Annual operating cost ($)	$7,176	$7,458	$28,541	$29,004
Payback on premium	Less than 2 months		Less than 18 months	

Assumptions: Pole 4 and average energy costs per year (10 cents/kWh)



Motors are essential in foundries for mechanical movement. For example, they drive pumps, fans, manufacturing equipment, compressors, dryers and conveyors.

Instead of rewinding motors, consider replacing them with energy efficient motors. Often motors are described as 'high', 'super' or 'premium'. However, to be considered energy efficient, motors must meet the Australian Minimum Energy Performance Standards (MEPS). In April 2006 the Australian efficiency levels (AS/NZS 1359 5:2004) were increased so the previous 'high efficiency' standards are now standard and a new more stringent level has been created. The new level is targeted to reduce energy losses by 15 per cent compared to the 2001 MEPS.[4] A list of motors registered under MEPS can be found at **www.energyrating.gov.au/emmenu.html**

The Australian Department of Environment, Water, Heritage and the Arts – Motor Solutions Online provides free downloadable software programs to assist businesses compare new or existing motors based on purchase price, efficiency, life cycle costs, noise and greenhouse emissions. For more information visit: **www.environment.gov.au/settlements/energyefficiency/motors**

Use the correct size motor

Avoid purchasing oversized motors to cater for future production increases or to override load fluctuations. Table 2 illustrates the energy losses and associated costs of an oversized motor.

Table 2: Cost comparison for an oversized motor

Motor size	110 kW (68 % loaded i.e. ~75kW load)	75 kW (sized to match needs)
Annual energy use (kWh)	694,737	473,684
Annual energy cost ($)	69,474	47,368
Annual energy savings ($)	22,106	

Assumptions: Operating 2000 hours/year, electricity costs 10 cents/kWh, 95% efficiency, power factor not considered

Better selection and motor management practices can save 10-25% of the energy costs![5]

Variable speed drives on oversized motors or for motors dealing with variable loads

Variable speed drives (VSDs) reduce energy consumption by adjusting the motor speed to continually match the load of the equipment such as pumps, fans and compressors.

Energy consumed by ventilation, cooling tower and baghouse extractor fans and pumps is proportional to the cube of the motor speed. If a variable speed drive reduced the speed by 20 per cent, the power consumed would drop by 49 per cent![6]

3 Teco Australia, 2003, Premium Efficiency Motors MAX-E2 Information Brochure **www.teco.com.au**
4 Group Instrumentation, 2008, Sustainability Matters - Towards a New Age of Electric Motor Efficiencies **www.sustainabilitymatters.net.au/feature_article/article.asp?item=1700**
5 Australian Department of Environment, Water Heritage and the Arts, Motor Solutions, Reference Manual, **www.environment.gov.au/settlements/energyefficiency/motors/reference/index.html**
6 US Department of Energy, 2001, Green Federal Facilities An Energy, Environmental, and Economic Resource Guide for Federal Facility Managers and Designers - 5.7.1 High Efficiency Motors **www1.eere.energy.gov/femp/pdfs/29267-0.pdf**

The financial viability of installing a VSD depends on the motor application and operating hours. VSDs tend to be most economical on large motors. They also enable 'soft starting' to prevent the electrical system overloading which drops the voltage and affects other equipment.[7]

Install energy efficient belts

Cogged belts on motors are more energy efficient because they slip less than smooth belts. They reduce energy consumption by 3-5 percent and also have a longer service life.[8]

BELTING OUT SAVINGS

Bradken Foundry in Ipswich gradually replaced 11 of its drive belts with moulded V notch belts. These provided maximum tension control, less slippage, drive uniformity and long life with minimum heat build up or stretching. The ongoing energy saving from replacing these belts is 34.4 MWh per year or approximately $3,440.

Multiple speed motors or multiple smaller motors

When a variable speed drive is too expensive, or the motor is so oversized that the variable speed controller would operate at very low speeds, reducing the useful life of motors and other equipment, consider one of the following:

- using a multi-speed motor that can operate at a number of different speeds, or
- installing several smaller motors with controls that switch on only enough motors to meet the demand.

Well maintained motors will increase efficiency.

Computer software improves drive efficiency

Computer software has been developed which can provide better control of the drive of the motors. The software provides a quicker response from the drive to the system and component requirements improving the efficiency of the whole system.[9] Most major process control companies should have access to this type of software.

Maintain motors

Proper maintenance of motors can improve performance. Regular maintenance tasks include:[10]

- cleaning motors of dirt and grease, particularly fans on fan-cooled motors
- checking for excessive vibration which may be a sign of motor misalignment
- checking for connections or wires that might be loose or damaged
- checking motor bearings.

7 Sustainability Victoria, Resource Smart Business- AC Variable Speed Drives www.seav.vic.gov.au/manufacturing/sustainable_manufacturing/resource.asp?action=show_resource&resourcetype=2&resourceid=31

8 Foundry Management and Technology, 2007, Lost Foam Foundries Find Energy Savings Opportunities, US Department of Energy and Cast Metals Coalition www.foundrymag.com/feature/feature/67804/lost_foam_foundries_find_energysaving_opportunities

9 Katherine Crichton, 1 January 2009, Motor efficiency evolution, Manufacturers' Monthly, www.manmonthly.com.au/Article/Motor-efficiency-evolution/201781.aspx

10 US Department of Energy, 2001, 5.7.1 High Efficiency Motors.

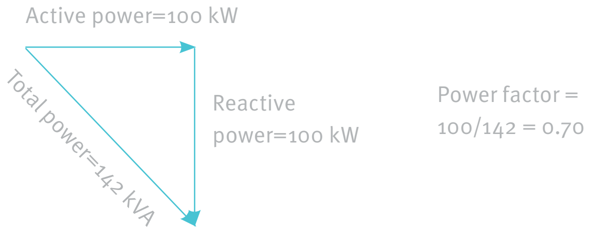
Power factor correction

Induction motors, magnetic ballasts and transformers require two types of power:

- **Active power –** produces work or heat and is expressed in kilowatts (kW)
- **Reactive power –** generates magnetic fields and is expressed as kilovolts-amps reactive (kVARs)

Total power is the vector sum of these two powers and is measured in kilovolts-amps (kVA).

Power factor is the ratio of active power to total power and is expressed as a number between zero and one (perfect score). The figure below demonstrates this graphically using an example.



This indicates that only 70 per cent of the current provided by the electrical utility is being used to produce useful work.

Plants that operate with a low power factor require the power company to feed much more power into the distribution system to operate the plant's equipment and appliances. Power companies in other states of Australia usually charge an additional fee to foundries with poor power factors (e.g. 0.6) to capture costs not reflected by the electrical (kWh) meter. While Queensland power charges are currently based only on active power consumption, this is likely to change in the future.

Poor power factors cause extra current flows, increase the chances of cables overheating, reduces equipment reliability, increases supply costs and results in additional greenhouse gas emissions.

Power suppliers or consultants can assist in power factor correction options which include:

- power factor correction capacitors designed to provide reactive current
- automatic power correction equipment or banks of capacitors that are switched on and off-line depending on the power factor
- replace oversized motors that are lightly loaded, or idling, with smaller motors
- installing high power factor lighting and electronic equipment.

Fan and pump efficiency

Fans and pumps are driven by motors and are essential to many manufacturing sites. Improving efficiency of pumps and fans will not only save energy but will also reduce maintenance, extend the life of the equipment and reduce noise.

A unit of energy saved at the pump or fan saves 3.3 units at the motor.[11]

Avoid over sizing fans or pumps

Pumps and fans are often over sized due to uncertainty of the plant's requirements or to accommodate future expansion. Pumps are also often over sized to cater for gradual increases in pipe flow resistance due to roughness increases or scaling.

A pump that is over sized will have an operating head and/or flow rate far greater than the plant's requirements and will need constant throttling. Similarly, an over sized fan will waste energy unnecessarily.

Inlet and outlet conditions

The inlet and outlet conditions of fans and pumps can impact on the efficiency of the system. Pumps are often operate below their optimal design efficiency as dampers, throttling and pressure relief valves and by-pass systems restrict flow.

11 NSW Department of Energy, Utilities and Sustainability, Energy Saving Manual Section 12: Pumps and Fans **www.energysmart.com.au/sedatoolbox/esmo.asp**

The equipment manufacturer will have specified inlet and outlet conditions that lead to superior performance of the equipment.[12] Periodically check the inlet and outlet conditions to ensure they have not changed.

Some tips on fan efficiency:[13]

- Minimise the number of obstructions of the air flow in both the inlet and outlet by removing all restrictions where possible.
- Minimise dead air spots in the system where air cannot circulate.
- Size the inlets and outlets appropriately to minimise air recirculation.
- Chose the right shape and size impellor for the job.
- Operate fans at peak efficiency points.

Dirty equipment can reduce efficiency.

Well designed and minimised pipework

Friction losses can be reduced by reducing the number of bends and valves in pipework. It is also important to ensure the diameter of the pipework is not too small, thereby creating additional load on the pump, motor and fans. In some cases the type of material used in pipework can also reduce friction losses.

Trim impellers on oversized pumps

The impeller can be trimmed if a pump is continuously throttled to 10 per cent less than its design flow rate or the bypass valves are continually open indicating excess flow. Trimming involves machining the impeller to reduce its diameter, which reduces the amount of energy it imparts to the pumped fluid. Contact the service provider before undertaking trimming.

Keeping equipment clean

Prevent the build up of contamination or dirt in filters, strainers, coils, pipes or ducts as this can reduce the efficiency of the fan or pump. An unexpected or gradual increase in load on the system could be an indication of the build up of contamination.[14] Put in place an inspection and maintenance program based on the expected maximum load (as opposed to the nameplate load) to control this build up.

Operate pumps and fans only when required

The following are some initiatives that can reduce energy use when operating pumps and fans:

- If pumps or fans are only required during certain tasks, turning them off when not required will reduce energy use.
- Automatic controls, such as computer software, can be used to limit the operation of pumps and fans to only when needed.
- Similarly, using variable speed drive (as mentioned above) on the motor will minimise operation to meet the demand.

This series of fact sheets provides examples and suggestions to the modern foundry operator on how to achieve both economic and environmental benefits from eco-efficiency. Visit the project website www.ecoefficiency.com.au for more ideas and case studies.

12 Australian Department of Environment, Water Heritage and the Arts, Motor Solutions, System Optimisation, www.environment.gov.au/settlements/energyefficiency/motors/systems/sog5.html

13 COOLING TECHNOLOGIESGROUP OF NMB TECHNOLOGIES CORPORATION, Ways to Improve Cooling Efficiency When using Air moving Devices, 7/30/2007, USA, www-03.ibm.com/procurement/proweb.nsf/objectdocswebview/file12+-+jarrah+-+fifteen+ways+to+improve+cooling+efficiency/$file/12-+jarrah+-+15+ways+to+improve+cooling+efficiency.pdf

14 Australian Department of Environment, Water Heritage and the Arts, Motor Solutions, System Optimisation, www.environment.gov.au/settlements/energyefficiency/motors/systems/sog5.html

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