Top tips for saving energy

Energy management is one of the most overlooked areas of cost reduction in injection moulding plants, despite the fact that there are many ways that moulders can start to reduce their power consumption.

On average, energy represents around 6% of most processors' total expenditure and yet very few spend anything like that amount of time or effort trying to control this rapidly rising cost. Most processors have little understanding of the easy ways to reduce energy costs, and they regard the costs as fixed and uncontrollable. In reality, energy costs are both variable and controllable. Reducing energy consumption has two fundamental benefits:

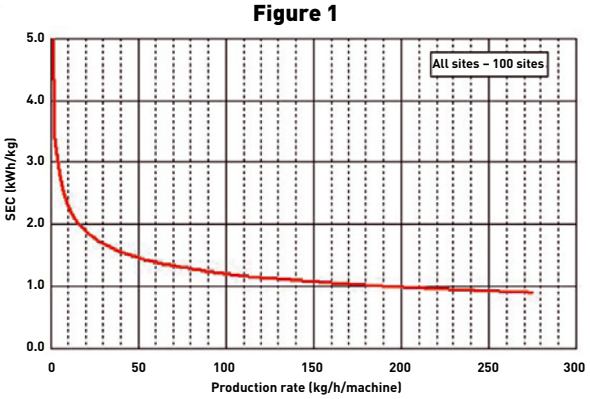
- It reduces costs. In many cases the cost of energy can be reduced by more than 30% which is a significant boost to the bottom line and insurance against rising energy costs.
- It reduces the carbon footprint of the business – a significant boost to the sustainability agenda and always a good thing.

How are you doing externally?

Before starting to try to reduce costs it is useful to gain an understanding of where you stand in the world of costs. This can be quickly done both across the plant and at individual machine level by using the graphs included here.

For a site assessment, find the total amount of material processed (through the nozzles) at the site - don't worry about the type of material processed, it really isn't important. Then calculate total amount of energy used in the year and calculate the site's Specific

Figure 1



Energy management expert **Dr Robin Kent** shows how to benchmark your injection moulding plant against the rest of industry, and gives practical tips on how to reduce energy consumption and boost profits

Energy Consumption (SEC) in kWh/kg for the year. Calculate the production rate in kg/h/machine using the production volume and the number of machines, and then plot the production rate versus the site SEC as shown in Figure 1.

If the site result is above the red line, then the site is using more energy (in kWh/kg) than the average site. If the site result is below the red line then the site is using less energy (in kWh/kg) than the average site. It is important to note that being below the red line means that you are better than average – not 'world class' and certainly not 'best in class'. Being average will only keep you alive for so long in a very competitive market.

- **Tip:** Benchmark your site today.

For the machine assessment, measure the energy use of the machine (in kWh) and calculate the machine's SEC in kWh/kg. Calculate the machine's production rate in kg/h and plot the production rate versus the machine SEC as shown in Figure 2. Be sure to use the correct curve depending on the type of machine you are assessing (once again don't worry about the type of material processed - it really isn't important).

If the machine result is above the relevant line, then it is using more energy (in kWh/kg) than the average for that type of machine. If the machine result data is below the relevant line then the machine is using less energy (in kWh/kg) than the average machine. As with the site analysis, the line is only the average, and running machines at 'average' energy efficiency is not a recipe for continued success.

- **Tip:** Benchmark your machines and tooling as soon as possible.

How are you doing internally?

This may sound like a question that your doctor would ask, but in this case the question relates not to your physical health but to the health of your business. All injection moulding sites will have a Performance Characteristic Line (PCL) that is a distinct 'fingerprint' for the site and effectively describes how the site is running and can be used for internal monthly or weekly assessments of how efficient the operation is. The PCL is easy to create:

- Find out the energy used in each month or week.
- Find out the amount of material processed in the same month or week.

Plotting a scatter chart of this data should result in a graph similar to Figure 3. The red line in the example is the PCL or 'line of best fit' for the data and in the example has the equation:

kWh = 1.5751 x Production volume + 152,440

- **Tip:** The number in front of the Production volume (1.5751 kWh/kg) is the 'process load' – this is the amount of energy needed to process 1 kg of material. For injection moulding this should be between 0.9 and 1.6 kWh/kg).
- **Tip:** The constant (152,449 kWh) is the 'base load' – this is the amount of energy you will use when ready to run but producing no product. It should be between 20 and 40% of the total load.
- **Tip:** The R2 value is the correlation coefficient and should be greater than 0.7 to show that the data is reliable.

The equation for the PCL tells you how much energy (in kWh) the site should use for any given production

Left: Why burn money? Dr Robin Kent has lots of tips for reducing the energy consumption in injection moulding plants

Below:
Figure 1: SEC versus production rate for injection moulding sites

Figure 2: SEC versus production rate for injection moulding machines

Figure 3: Performance Characteristic Line for a site (example)

Figure 2

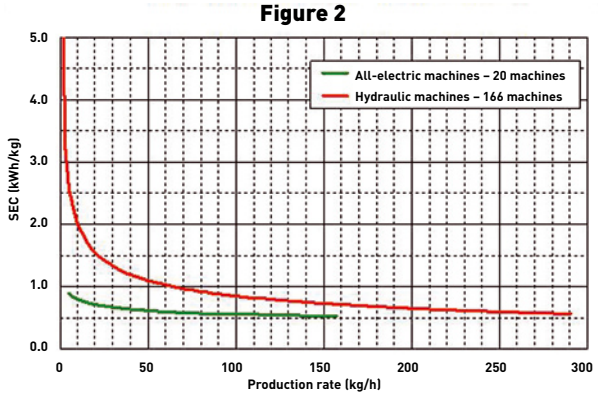
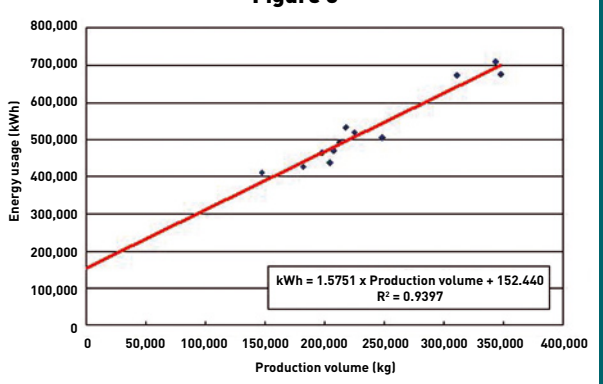
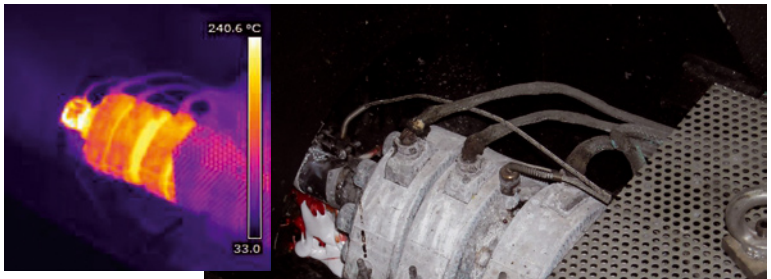


Figure 3





A guarded but uninsulated IMM barrel leaks energy

volume (in kg) in a month. If the production volume is 250,000 kg then the amount of energy used should be:

kWh = 1.5751 x 200,000 + 152,440 = 467,460 kWh

If the site uses more than this then it is exceeding its internal benchmark and wasting energy compared to its previous performance. If the site uses less than this then it is better than its internal benchmark.

The PCL can be used to track performance improvements (using deviations and cumulative sum or CUSUM analysis) and to look at yearly improvements. It can also be used for budgeting purposes - simply convert the sales forecast into production volume and the monthly energy bill can be assessed for the future.

- **Tip:** Find the PCL to internally benchmark your site and to provide you with essential monitoring and targeting information.
- **Tip:** Find the PCL to allow accurate budgeting of energy usage into the future.

What can you do to reduce energy use?

Services: The golden rule for services is 'minimise the demand and then optimise the supply'. Whether it is motors, compressed air, cooling or drying, the primary aim is to minimise the demand (reduce motor sizes, reduce compressed air leaks or reduce parasitic heat gain) before attempting to optimise the supply of the service to the machine or cell.

For most injection moulders the services will use over 26% of the total energy, and controlling and reducing the energy used in services is an easy area for up to 50% energy-use reductions. This is around 13% of the total energy cost to the site.

- **Tip:** Remember the golden rule with services – Minimise the demand and then optimise the supply.

Idling machines: injection moulding machines use between 52% and 97.5% of the full moulding energy consumption energy when idling with no production. An idling machine is not 'free'; it is using energy and costing large amounts of money.

- **Tip:** Define an 'idling' mode for all machines - heaters reduced, hydraulics off and compressed air off.
- **Tip:** Stop supplying services (compressed air and cooling water) to idle machines.

At many sites it is not only the idling machine that is costing money. The machine may stop, but all the downstream equipment continues to use energy regardless of what it does.

- **Tip:** Design downstream equipment and handling systems to operate 'on–demand' only. Stop them operating when the moulding machine stops operating.

Barrel heating and insulation: Barrel heating is a major part of the cost of injection moulding but can easily be reduced by barrel insulation and this is a safe process for most materials. Barrel insulation is a proven method of reducing energy losses in plastics processing and producing a more stable process bringing quality and output improvements.

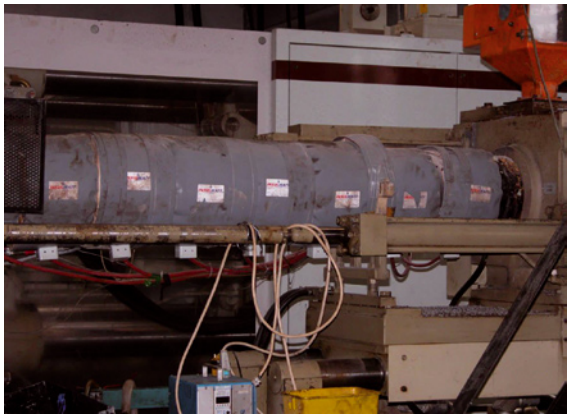
- **Tip:** Fit barrel insulation where it can be done without affecting the process.

Barrel insulation has many positives, but you do have to look after it and many sites do not use it with care or carry out the maintenance that is required.

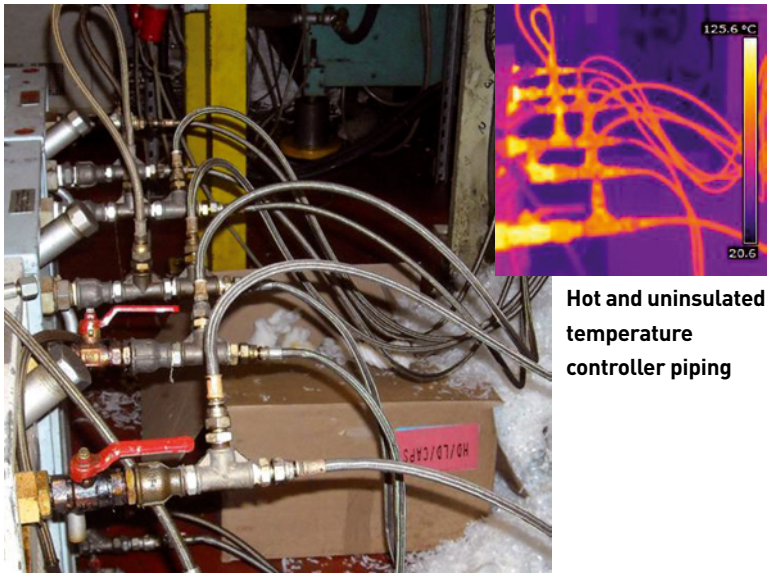
- **Tip:** Checks on insulation condition and fitting should be part of the set-up process.

All-electric machines: All-electric machines are an obvious choice for most processors when purchasing a new machine. The curves shown in Figure 2 show that at almost all production rates the all-electric machines use around 50% of the energy used by hydraulic machines.

Bear in mind that Figure 2 is not the result of testing by suppliers who want to sell you machines and may test under the best conditions; it is the results of real



Well-maintained conventional barrel insulation fitted to an injection moulding machine



Hot and uninsulated temperature controller piping

machines in the real world making real products and saving real money for their owners.

Choosing hydraulic machines when the application is suitable for an all-electric machine is simply throwing money away for the next 10 – 15 years.

- **Tip:** Always choose all-electric injection moulding machines if they meet the specifications. The initial cost may be slightly more, but the energy savings will give a rapid payback on the additional cost and generate profits long into the future.
- **Tip:** All-electric machines can deliver many other benefits such as improved control, reduced cycle times and reduced maintenance loads.

VSD machines: Some machine suppliers can supply machines with integral variable speed drives (VSD). Instead of letting the hydraulic pump run at a fixed speed irrespective of the needs of the process, these slow the hydraulic pump down when there is reduced need for fluid, automatically reducing the energy use of the machine.

On some machines it is possible (and economical) to retro-fit a VSD to the motor. This is a proven technique that can deliver energy-use reductions of up to 55%, but the machine must be suitable and the installation must be done with care to get the full benefits.

- **Tip:** Ask for performance-backed guarantees to be included in the purchase contract so that if the equipment does not save the predicted amount of energy then it can be returned at no cost.
- **Tip:** Retrofitted VSDs should not be confused with motor voltage regulators (MVR), this is a different technology.
- **Tip:** Investigate if it is possible to purchase an integral VSD for any new hydraulic moulding machines.

Mould temperature controllers (MTCs): Not all mould tools need cooling and MTCs are often used. Some sites use no MTCs and other sites producing similar parts use them extensively. The first issue with MTCs is that of indiscriminate use, i.e. they are here so why not turn them on?

- **Tip:** Just because they are there doesn't mean that you have to use them. Check if MTCs are really necessary and that they are performing a useful function. If they don't save you time/money, then turn them off!

MTCs rarely have any insulation on the piping to the tool. Heat losses or gains can be substantial whether heating or cooling the tool.

- **Tip:** Insulate MTC piping to reduce heat gains or losses.

Mould design: Energy management and efficiency in the design of moulds has not really been an issue in the past and many of the existing moulds are not designed to be energy efficient.

- **Tip:** Cool the part and not the mould.
- **Tip:** Get cooling channels close to the mould surface.
- **Tip:** Design products with thin walls to minimise materials usage and minimise energy use.

Summary

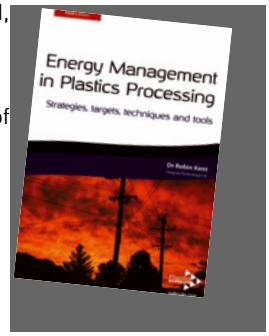
Reducing energy use in injection moulding by 30% may seem a daunting task but moulders have a huge number of opportunities to save energy and reduce costs. There are so many things that you can do that the real decision is in the choice of actions you take to maximise the payback for the efforts. There is no excuse for not starting to reduce your costs, and improving both your financial and environmental performance.

- PS: Keep the labour, get rid of the kWh!

More Information

Dr Robin Kent is the author of Energy Management in Plastics Processing. To find out more about the book, click here.

He is also running a one-day masterclass on Energy Management in Plastics Processing in Coventry in the UK on 3 June 2010. To request more details on this seminar, contact Matt Wherlock at AMI, mjw@amiplastics.com or click here to download the brochure..



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