# Energy and Sustainability Topics – Energy management in rubber processing

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# Energy and Sustainability Topics – Energy management in rubber processing

## Contents:


Part 1: Reducing energy costs – the first steps 2

1. The vital questions ..... 2
2. Where are you using energy? ..... 2
3. When are you using energy? ..... 2
4. Why are you using energy? ..... 3
5. How much energy are you using? ..... 3

Part 2: The rewards 4

1. Raising energy awareness ..... 4
2. The initial site energy survey ..... 4
3. How do you carry out a site survey? ..... 5
4. Turning a survey into savings ..... 6

Part 3: Compounding 7

1. Materials preheat ..... 7
2. Control of additions ..... 7
3. Control and maintenance ..... 8

Part 4: Moulding 9

1. Process design ..... 9
2. Insulation ..... 9
3. Controls ..... 9
4. Low pressure curing ..... 10
5. Steam use ..... 10
6. Hydraulic systems ..... 10

Part 5: Extrusion 12

1. The extruder ..... 12
2. The ancillaries ..... 13
3. Management ..... 13

Part 6: Motors and drives 14

1. The motor management policy ..... 14
2. Motor sizing ..... 14
3. High efficiency motors ..... 14
4. Variable speed drives ..... 15

Part 7: Compressed air 16

1. It is not free! ..... 16
2. Minimise demand ..... 16
3. Optimise the supply ..... 17
4. Next steps ..... 18

Part 8: Buildings 19

1. Building audit tips ..... 19
2. Lighting ..... 20

# Energy and Sustainability Topics – Energy management in rubber processing

## Part 1: Reducing energy costs – the first steps

Industry generally treats the cost of energy as ‘somebody else’s problem’ (to be ignored) and regards the cost of energy as an overhead and a fixed cost. In reality, the cost of energy is everybody’s problem and it is a variable and a controllable cost.

Most rubber processors could easily reduce energy costs (without major investment) and increase profits through good energy management practice. This document aims to show how to reduce energy use and increase profits in rubber processing.

## Energy is a variable and a controllable cost

### 1. The vital questions

Before starting to reduce energy costs it is necessary to understand where, when, why and how much energy is being used. This information provides the benchmarks and signposts for improvement.

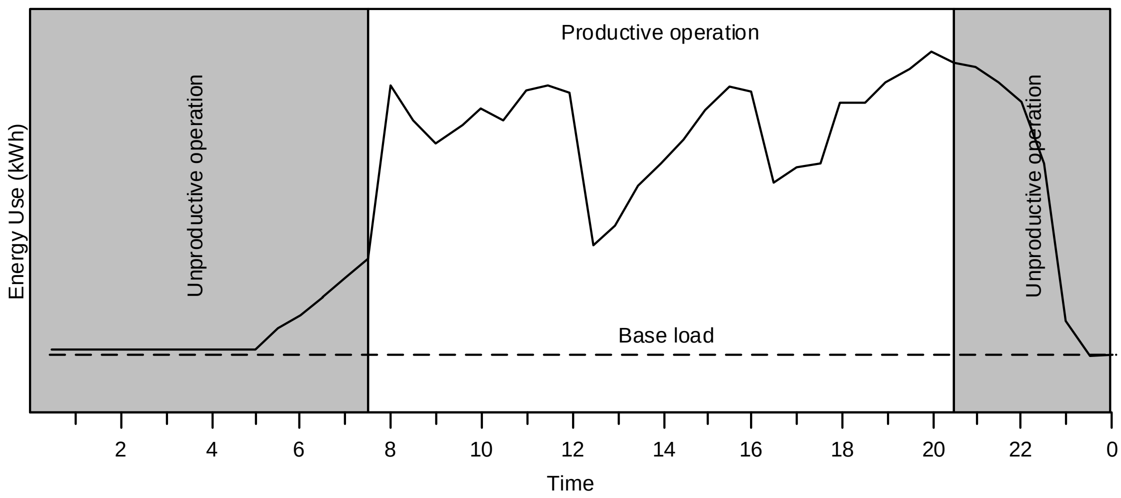
### 2. Where are you using energy?

The main electrical energy users in rubber processing are motors and drives, heaters, cooling systems and lighting systems. A simple site energy distribution map will reveal where energy is being used, and if only a single meter is being used for the whole site, then it can be very cost-effective to install sub-meters to obtain further information on the areas of high energy use. Sub-metering allows the calculation of the cost of energy for each operation and the identification of areas of high energy usage – key factors in reducing energy costs.

A first step is to produce an energy map of the site to locate areas for monitoring and improvement targeting.

### 3. When are you using energy?

The time of day that energy is used is also important and total demand plotted versus time gives invaluable information on how to reduce energy costs. Data for demand versus time plots are normally available free from the electricity supply company. Look for unusual peak variations and energy use when there is no production.




**Typical site energy use over time**

A demand graph also helps to find the ‘base load’ – the load used for heating, lighting, compressors and pumps when there is no production at all. The base load is a prime target for energy saving.

- **Tip:** Another way to find the base load is to record the meter readings (in kWh) and production volumes (in kg) at the end of each shift. Plot the amount of rubber processed against the energy consumption. From the graph, the energy use at zero production gives an idea of the base load.
- **Tip:** Reducing the base load is a sure way to make savings.

## 4. Why are you using energy?

Ideally, energy should be used only to produce good product and the most important energy benchmark is the energy used to process good product (in kWh/kg). This is the specific energy consumption (SEC) and is found from the slope of the graph produced to find the base load. It can be compared to the industry averages to provide targets for energy reduction.

Is energy being used to keep machines idling when they could be turned off? Are heaters running that are not being used? Are compressors running just to pump air out of leaks? Finding out why you are using energy will reveal a wide range of possible steps for reducing energy use.

## 5. How much energy are you using?

Electricity charges are based on a combination of factors (see Key Tips) and an initial survey will reveal areas for potential savings. Sometimes actions as simple as changing the tariff can reduce costs at no cost! 'Peak demand lopping' can be very effective to reduce short peaks in the maximum demand.

**Key tips for reducing the cost of electricity**

**Maximum Power Requirement (MPR)** is the maximum current a site can draw at the supply voltage. Reduce the cost by:

- Staggering start-ups.
- Matching the MPR to the requirements.
- Getting the MPR right for new premises to avoid costly charges.
- Negotiating an annually based MD instead of an MPR charge.

**Maximum Demand (MD)** is the current drawn at the supply voltage averaged over half an hour. Reduce the cost by:

- Staggering start-ups.
- Giving machinery time to stabilise before starting up new processes.

**Power Factor (PF)** is a measure of the phase shift created by machinery. Lightly loaded machinery tends to have a high phase shift, and a low power factor. Improve the power factor by running electric motors efficiently to get power factors close to 1.

**Load Factor** is a measure of the hours per day that the user draws from the supply. Reduce the cost by:

- Running for greater than a single shift.
- Carrying out some operations outside the main shift pattern e.g., regrinding.

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## Part 2: The rewards

Energy efficiency measures can improve your profits significantly for minimum effort and costs. For a rubber company with an annual turnover of £10 million per year and a net profit of 10%, i.e., a profit of £1 million. The average electricity bill will be approximately £250,000 (between 1% and 3% of turnover). Simple no-cost or low-cost energy reduction practices can reduce this by a minimum of 10% (and possibly up to 20%) and increase profits by at least 2%. This is the equivalent of adding sales of £200,000 to turnover and is a worthwhile investment by any standards.

### 1. Raising energy awareness

**Low-cost energy efficiency measures can improve profits significantly**

The cost savings possible from energy efficiency will only be achieved if there is management commitment to actually carry out the work necessary and save money. This is best ensured by having an energy policy that is as much a part of the overall company operations as the quality policy. The energy policy should ideally be part of a broader company environmental policy and, at the very least, should be formally adopted with top-level management commitment. The policy should be the responsibility of a designated Energy Manager who has clear responsibility for energy matters. There needs to be regular communication with major users who are held accountable for their energy usage, which should be monitored and targeted. The quantified savings from the implemented energy policy should be promoted within the company and used to create a favourable climate for investment treatment of other energy saving programmes.

Energy efficiency is a competitive advantage in any market and an initial site survey is the start of gaining the advantage for your company.

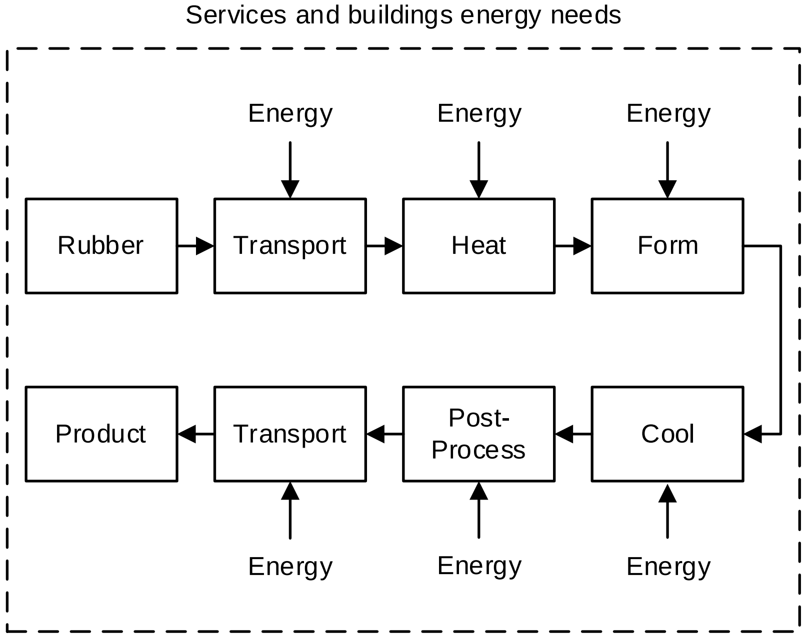
### 2. The initial site energy survey

**An initial site survey is a key starting point for energy saving**

The objective of the initial energy survey is to gain an overview of the general site energy use. It is a walk around the site with 'an energy manager's hat on'. This will identify some rapid no-cost or low-cost improvements that can be made to save money.

The survey should be carried out as soon as possible – if energy is being wasted now, it is costing money now.

Use the diagram below as a guide during your walk-around to look for areas of high or unnecessary energy use.




**The main areas of energy use in rubber processing**

## 3. How do you carry out a site survey?

Take an unannounced walk around the site at around mid-shift. If there is no night shift it can also be worthwhile to take a walk around the factory when there is no production.

### The questions to ask (and answer)

- Which areas have the largest electrical load? Look for the largest machines, they are most likely to have the largest motors and create the largest load, when they are used.
- Is the thermal insulation, if present, on all the machines in good condition? If there is no insulation then why not?
- Are there any good reasons why machines need to be kept idling to be ready for the next production run, or when not in production? These include conveyors, water pumps, vacuum pumps, motors, granulators, fans, and machine heaters etc.
- Why are the motors the size they are and would a smaller motor be more efficient?
- Is the airflow from fans being throttled back with dampers and could variable speed drives be used instead?
- Are there leaks for water, air or steam?
- Where can you hear steam and compressed air leaks? The hissing noise you hear from leaks is costing real money. If there is no production being carried out then why is the compressed air system still running?
- Is compressed air being used for expensive applications where other cheaper methods can be used, e.g., cleaning or drying?
- Does the compressed air pressure need to be so high, or the vacuum so low?
- Is the lighting dirty or broken?
- What are the good, simple maintenance measures that can be adopted to reduce energy use?
- Are 'accepted' practices wasting energy?
- Can they be modified at no cost at all?

- Are there clear setting instructions for all machines and are they implemented when a machine is set up?

## 4. Turning a survey into savings

A site energy survey is only worthwhile if action is taken as a result of the findings. Use the survey to estimate the excess energy usage of the site and arrange for an electrician to measure the factory electrical load and calculate the costs involved. Use the survey to identify operating practices that cost money and need to be changed. The results of the survey should be distributed with full recommendations and costs for carrying them out.

# Energy and Sustainability Topics – Energy management in rubber processing

## Part 3: Compounding

Energy is a large cost to compounders but there is a range of simple activities that can reduce energy use and costs dramatically.

## 1. Materials preheat

Energy saving for pre-heat systems focuses mainly on warm rooms. These are likely to need more careful management than the more compact and probably well-insulated autoclaves.

### Insulation

Savings of up to 50% can often be achieved by good insulation of walls and ceilings and draught-proofing of the door.

### Bale spacing

Spacing out the bales and arranging successive layers at right angles can increase the surface area by more than 100%. Spacing out reduces the capacity but increases the heating rate and this decreases the need for large volumes. Savings can then be made by reducing the warm room size (using insulating panels) and reducing the standing loss.

- **Tip:** The important thing is the throughput of the warm room, not the volume capacity.

### Reducing stratification

Warm air stratifies in any room and temperature differences of up to 15°C between the floor and the ceiling can result. Using fans to move the air will substantially reduce heat losses.

- **Tip:** Thermostats should be properly maintained and able to achieve control with a minimum dead band.
- **Tip:** To prevent heat loss, preheated bales should be repacked into a close-fitting mass when removed from preheating.

### Heat recovery

Transferring waste heat from other site operations, e.g., flash steam, heat from air compressor cooling operations and heat from mixer/mill cooling, to the warm room will reduce heating costs.

- **Tip:** This will involve piping costs and will only be economical for factories operating on a three-shift basis.
- **Tip:** Microwave preheating eliminates standing losses but has a high capital cost and will only be economical if the site is already using it for other processes and has spare capacity.
- **Tip:** Use waste heat to preheat extender oil and reduce the viscosity before pumping. If extender oil is a large proportion of batch volume, it may be better to cool the oil so that it acts as part of the process cooling system. This can be useful where high batch temperatures result in multi-stage operations and the extra cooling can enable a switch to single-stage operation.

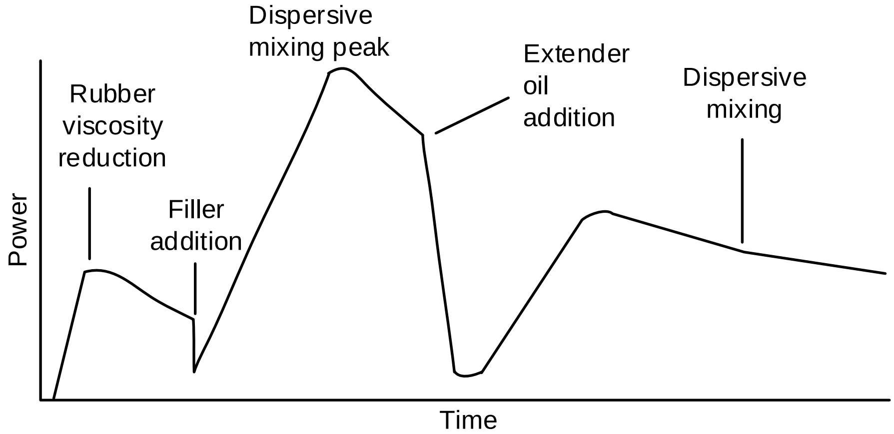
## 2. Control of additions

Controlling additions is the key to good compounding and accurate weighing systems will quickly pay for themselves through improvements in product quality and consistency and in energy savings through a reduced need to rework off-specification material.

Using detailed energy (kWh) and power (kW) recordings of production allows much closer control of batch conditions and also the optimisation of additions timing. Incorporating this information into batch controls also contributes to product quality and consistency. The savings from optimised energy usage can give payback periods of less than one year.

- **Tip:** The same information allows batch comparison and can be used for preventive maintenance systems by monitoring changes in machine performance in terms of kWh/kg batch (on-load).

- **Tip:** Reliable measuring systems are essential to allow project energy savings to be verified to justify further investment. The capital costs of better monitoring systems can often be justified on the grounds of energy saving alone. In many instances, switching off equipment when it is not in use for significant periods (as during shift changes and meal breaks) can be highlighted as an easy method of saving energy.
- **Tip:** Better measurement on mills, related to throughput and separated into on and off-load kWh, will reveal other opportunities for savings and short payback investment.




**Power-versus-time profile for conventional single stage mixing cycle**

## 3. Control and maintenance

Energy for motors in mixing, pumps, dust extraction etc is a major cost and using variable speed drives and motor controllers/soft starts can significantly reduce energy use in internal mixing and milling. Worksheet 6 deals exclusively with motors and drives but some areas for improved control are:

- Water cooling pumps and cooling tower fans both use significant amounts of energy. Using good and flexible control systems to vary flow rates and keep cooling water supply temperatures constant not only reduces energy use but also improves product consistency and quality.
- Festoon coolers need high volumes of air crossing the rubber sheet. Designs using counter current flow and minimum airflows are best but the main savings come from ensuring that fans are switched off when not in use.
- **Tip:** Use a photocell at the inlet to the festoon cooler to sense when product is no longer entering the box. Use this to activate a timer to shut down the fans as the sheet passes through the cooler.
- **Tip:** For dust extraction systems, minimise the volume of air extracted at the point of use by employing high velocity/low volume collection systems.
- **Tip:** Cooling water distribution should be as clean as possible to prevent the formation and deposition of rust and scale on cooling surfaces.
- **Tip:** Insulate extender oil systems and use either steam or fossil fuel-based heating systems rather than electricity.

# Energy and Sustainability Topics – Energy management in rubber processing

## Part 4: Moulding

The theoretical SEC required to mould rubber is 0.1 kWh/kg but actual results range from 0.3 kWh/kg to 2 kWh/kg. These are efficiencies of only 5% and 33% respectively and most of this energy is used to heat the machinery and the surroundings.

### 1. Process design

Process design based on energy efficiency can produce plant at a capital cost of not much more than for inefficient plant – if energy efficiency is included at the start of process. In addition, it can provide savings in maintenance, improved reliability, throughput and product quality.

**Failing to control energy costs will affect your wallet**

### 2. Insulation

Heat loss is a major source of inefficiency but it can be reduced by good insulation. Surfaces such as injection press barrels, autoclave doors and flanges can be easily insulated.

- **Tip:** Insulating a press platen from the body is difficult because of the large pressures but strong insulating materials are available and they greatly reduce the heat loss from platen to back-plate. A 2-3 year payback period can be expected.

Insulation saves the most money in plant with large exposed areas operating long hours at high temperatures. Savings include lower maximum demands for electrically heated plant and smaller steam supply requirements for steam plant. Safety and comfort for operators are improved, heat-up times are shorter, and temperature distribution is more even, reducing ventilation or air-conditioning costs.

- **Tip:** Insulating electrically heated presses saves electricity, which costs three to five times more per unit than gas, oil or coal.

### 3. Controls

The energy needed to heat a compound increases with the cure temperature (the heat losses also increase) but the cure rate acceleration more than compensates for the increased rate of heat loss.

- **Tip:** Curing at the highest possible temperature reduces the time over which curing plant losses occur and minimises the curing SEC. High cure temperatures and rates also maximise the machine throughput.

Once the shortest cure cycle consistent with product quality has been found, the SEC can be reduced by:

- accurate temperature control.
- accurate cure period timing.
- accurate cure pressure control.

Cure temperatures, pressures or times above or below the optimum cause excess energy use, reduced throughput or increased scrap, all of which increase costs and the SEC.

#### Cure temperature control

In many electrically heated presses, simple thermostats do not provide accurate temperature control. This is best achieved using Proportional Integral and Derivative (PID) control systems that quickly reach set point with low overshoot and final offset to reduce the heat loss and energy cost and provide consistency for reduced cure times.

#### Cure time control

Curing plant can take a long time to warm up before the working shift can begin and may be left to run for longer than necessary. In small factories, simple timers can make dramatic savings at low cost but these must be reprogrammed when there is a change in plant usage. In larger factories, an Energy Management System (EMS) can produce savings and better control of plant.

- **Tip:** Computerised cure prediction and machine control give quick determination of settings for curing plant and good cure cycle control.

### Cure pressure control

The minimum moulding pressure consistent with product quality should be used to save pumping energy and to reduce flash and rubber wastage.

- **Tip:** New curing plants using central computer control have achieved 50% energy savings.

## 4. Low pressure curing

Electrical heating methods convert 100% of the electricity supplied into heat, but transfer to the rubber is slow because of the very low thermal conductivity of rubber. The transfer of energy to rubber can be improved with appropriate conversion techniques such as electromagnetic radiation, conduction or convection in liquid or gas curing media.

Processes for low pressure curing are:

- microwave heating.
- infrared heating.
- induction heating.
- high power density resistance heating for electric ovens.

## 5. Steam use

Efficiently generated and well controlled steam is a far cheaper heat source than electricity, especially where good utilisation gives high boiler and distribution system efficiencies. As with compressed air it is best to 'minimise the demand before optimising the supply'. This means:

- minimising the curing heat required.
- minimising heat losses from the process plant.
- maximising the heat transfer efficiency by prevention and removal of scale, corrosion, air ingress and condensate flooding of heat exchangers.
- maximising the amount of condensate recovered and minimising temperature and pressure losses.
- **Tip:** At sites where steam usage has decreased, the system is often too large for the demand. This gives very high standing losses, maintenance and manning costs. It can be economic to decentralise the steam supply using local gas or electric boilers.
- **Tip:** Very low efficiency may indicate a need for system improvements or decentralisation of heat supply.

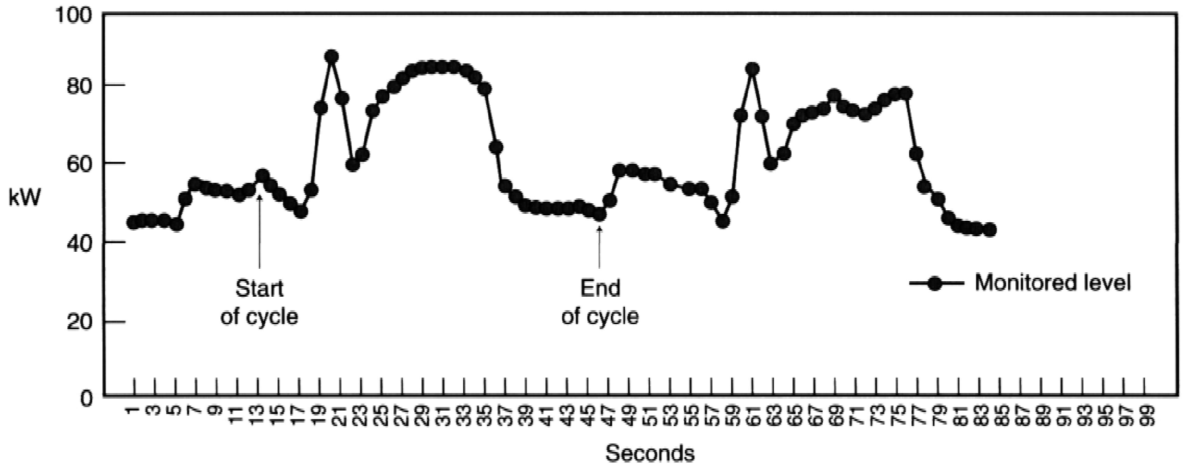
## 6. Hydraulic systems

Hydraulic plant can consume as much as 50% of the energy used, especially when systems are operated at flows, pressures and loads significantly different from their design capacity.

- **Tip:** Staggering of cure cycles will reduce the maximum fluid demand and the size or number of pumps required.
- **Tip:** Use accumulators to smooth intermittent demand from presses and allow the use of smaller pumps.

# Energy and Sustainability Topics – Energy management in rubber processing

- **Tip:** A hydraulic network with oversized, undersized or redundant pipes will waste energy.
- **Tip:** Use booster pumps if 'spot' pressures higher than the system pressure are needed. This is cheaper than running a high-pressure system and using reducing valves.
- **Tip:** Servo electric drives can be used as substitutes for hydraulic systems to reduce energy costs and plant complexity and improve performance.
- **Tip:** Using throttling or by-pass valves to control pressure is very inefficient. In new installations, savings can be made by replacing control valves with pressure-controlled pump motors.
- **Tip:** Heat transfer from the press to the hydraulic system often means that cooling systems are needed. Improved platen to back-plate insulation will reduce heat transfer and the cooling load.




**Instantaneous energy use of a hydraulic moulding machine**

# Energy and Sustainability Topics – Energy management in rubber processing

## Part 5: Extrusion

Extrusion is not only a final forming process for a product but is also an intermediate process for other processing techniques such as moulding. The efficient operation of extrusion screws is therefore essential to much of the rubber processing industry. The process is highly dependent on electricity and most of the energy used is directly related to machine operation. For profile extrusion, the energy used to drive the extruder itself is 50% of the total and the remaining energy is used for items such as ancillaries and utilities.

Industry surveys show that a typical company should be able to reduce energy usage by 10% without major capital outlay.

**Extrusion is a key forming process and is integral to many other processes**

## 1. The extruder

The initial cost of energy-efficient extruders may be higher but they will give rapid returns on the extra investment. Options such as high efficiency AC motors and variable speed drives (VSD) have good payback periods for both new purchases and when replacing motors and drives.

Whatever the age of the machine, it is essential to get the right extruder for the job, and the screw diameter and design should be checked to make sure they are right for the product.

- **Tip:** Using large extruders for small profiles is wasteful.
- **Tip:** Total efficiency (including energy efficiency) is optimised at the design stage.
- **Tip:** Set the extruder to run at its most efficient speed (usually maximum design speed) and control the screw speed to give an extrusion rate as close to the maximum as possible and still produce good product.

Motors run most efficiently close to their design output – a large motor at part load is less efficient than a small one at full load.

- **Tip:** Size and control the electric motor to match the torque needed by the screw.

Optimising the extruder speed maximises the heat from mechanical work and minimises the amount of electrical energy needed. Provided the downstream equipment does not limit the output, the energy consumption can decrease by nearly 50% by doubling the rotational speed of the extruder.

Accurate temperature control is needed for good extrusion – excess temperatures are wasted energy. The polymer needs to be kept close to the optimum processing temperature.

- **Tip:** Barrel insulation has a payback period of less than one year and also reduces Health and Safety issues and air current fluctuations.
- **Tip:** Check the controls to make sure that the heating and cooling are working efficiently together.
- **Tip:** 'Stand-by' operation can use significant amounts of energy in utilities through barrel heaters, cooling water, calibration vacuum and lights.
- **Tip:** Find the minimum stand-by settings and set an operator routine to always leave machines in this condition.
- **Tip:** Can you turn off barrel heaters and cooling fans between runs?
- **Tip:** Can you turn off cooling water on idle machines?

Energy use can be used as a diagnostic tool to identify deterioration of the machine condition and the need for maintenance.

- **Tip:** Increasing maintenance involves effort and cost but gives significant energy savings.

## 2. The ancillaries

The main opportunities for energy saving in ancillaries are in minimising the demand for utilities, such as compressed air. The electric motor drives are generally small so replacement with efficient motors is only likely to be cost-effective when motors fail. Specifying energy-efficient features at the design stage will give rapid paybacks on any additional costs.

The first step is to get the extruder right – if the extruder is at the optimum conditions the need for downstream cooling and calibration will be minimised. For utilities, the approach should be to ‘minimise the demand and then optimise the supply’.

- **Tip:** The cure time in continuous curing processes is regulated by the speed of the haul-off. To achieve the optimum cure cycle, with varying products and cure conditions, the speed needs to be accurately controlled.
- **Tip:** Find the maximum acceptable extrudate temperature after cooling and set the maximum cooling water temperature to achieve this.
- **Tip:** Check that cooling water is treated, chilled and distributed efficiently.
- **Tip:** Check that compressed air is not supplied to idle machines.
- **Tip:** Check that compressed air is generated and distributed efficiently at the minimum pressure needed.
- **Tip:** Check that any vacuum supplied is the minimum needed and that it is generated and distributed efficiently and is switched off when not needed.
- **Tip:** If replacing electric motors, then match the size to the actual demand and fit energy-efficient motors.

## 3. Management

‘Tweaking’ of machines by setters and operators causes more lost time and energy than any other cause.

- **Tip:** Get the machines set correctly, record the settings and do not change them unless absolutely necessary.

Energy efficiency will save you money – start an energy management programme today and reap the benefits of improved profits by cost-effective investment and management.

# Energy and Sustainability Topics – Energy management in rubber processing

## Part 6: Motors and drives

Approximately two-thirds of the energy costs in rubber processing are the result of electric motor use. Yet motors are often overlooked when considering energy use. The motors in the main processing equipment such as compounders, moulders and extruders are obvious but the majority of motors are 'hidden' in other equipment such as compressors, pumps and fans. When the energy cost of running a motor for 1000 hours can exceed the purchase cost and when the 'whole life' costs are often over 100 times the purchase cost then failing to take action with all the motors in a factory is expensive!

**The energy cost of a motor exceeds the purchase cost in just 1000 hours of use**

## 1. The motor management policy

The greater importance of running costs over the initial purchase price means that companies need to change the way they look at motors. Decisions need to be made on the 'whole life' cost where all purchase, maintenance, repair and operating costs are considered. The energy efficiency improvements available with the development of VSD and high efficiency motors (HEM) mean that, in order to reduce costs, companies must develop and implement a motor management policy for the purchase and operation of motors. This policy should include guidelines on:

- repair and replacement based on lifetime costing
- the specification of HEM for all new purchases

When new motors are required, the benefits of opting for HEM are obvious. However, the failure of an existing motor needs a decision on whether the motor should be repaired or replaced. Repairing a failed motor may appear to be a cost-effective action but repair can reduce energy efficiency by up to 1% and may not be the most economical long-term action. A motor management policy can provide the rules for making the best financial decision.

## 2. Motor sizing

Motors are most efficient when their load equals, or is slightly greater than, the rated capacity. Motors can be overloaded for short periods provided that there is a later lower load to allow cooling. If machines larger than needed are purchased or used then the motor will not reach the design load and will never run at optimum efficiency. Oversized motors are inefficient and equipment needs to be carefully matched with demand. Even 'steady' loads from extruders, fans, compressors and pumps will fluctuate slightly and the basic operating load rarely matches a standard motor.

The demand graph (below) shows the instantaneous energy demand during a typical moulding cycle and illustrates the wide variations in load demand from a typical moulding machine.

- **Tip:** It is strongly recommended that expert advice on motor sizing is sought to reduce costs.
- **Tip:** Where motors can be accurately predicted to run at less than 33% of the rated output it is possible to reconfigure the motor from Delta to Star connection. This simple low-cost action can produce savings of up to 10%.
- **Tip:** VSD will allow motors to run at the required speed to save energy.

## 3. High efficiency motors

The cost premium for HEM is now very small and easily offset by the energy cost savings that result from their use. HEM achieve efficiency levels of up to 5% more than conventional motors and have a peak efficiency at 75% of load, thus reducing both energy costs and oversizing problems. A 5% efficiency gain may not sound much, but a £500 motor uses approximately £50,000 in energy over a ten-year life and a 5% saving is £2,500 – this is equivalent to five free motors.

## 4. Variable speed drives

The speed of an ac motor is fixed by the number of poles and the supply frequency. As a result, the hydraulic pumps in many processing machines are driven at a constant speed, even though the demand varies considerably during the cycle. The flow demand changes from the hydraulic pump are controlled by a relief valve and recirculation of the hydraulic fluid. Another way of meeting the varying demands is to fit a VSD to the motor. A VSD allows the speed of an ac motor to be varied and the pump output can be matched to the variable demand. The energy demand graph shown would have considerably fewer peaks and troughs if a VSD were to be used on the machine. The application of VSD can significantly reduce energy costs.

Other VSD benefits are:

- reduced demand on the hydraulic system means that the hydraulic oil runs at a lower temperature and requires less cooling – an additional cost saving measure
- reduced noise
- lower maintenance costs
- better all-round performance.

VSD can also be applied to fans, water pumps and air compressors where the load varies considerably. For constant loads, the use of a correctly sized motor is the best option.

Despite this, the varying loads and the difficulty of matching the output to the need will inevitably lead to some energy losses.

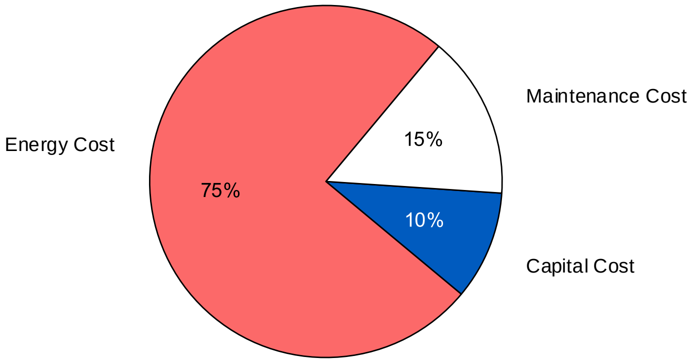
## Part 7: Compressed air

### 1. It is not free!

Compressed air is a convenient and often essential utility, but it is very expensive to produce. In fact, most of the energy used to compress air is turned into heat and then lost. At the point of use, compressed air costs more than ten times the equivalent quantity of electrical power, i.e., an equivalent cost of around £1/kWh. At this price, it should never be wasted and only be used when necessary.

Air also needs to be treated to remove moisture, oil and dirt and the higher the quality required, the greater the energy consumed by the treatment system.

The chart below shows the cost of compressor ownership over ten years. At a site operating 24/7, a 100-kW motor will have an energy cost of ≈ 90,000/year, assuming the cost of electricity to be ≈ 10p/kWh. At these cost levels, an energy-efficient system is highly cost-effective, even if it costs slightly more to install.




**Whole life costs for compressors (10-year life cycle)**

The cost of compressed air makes it an expensive resource and the way to achieve the best savings is to minimise the demand and then to optimise the supply. Savings up to 30% can be made by inexpensive good housekeeping measures such as making end-users aware of the cost of generating compressed air and enlisting their help in reporting leaks.

**Compressed air is an expensive resource. Minimise the demand and then optimise the supply.**

### 2. Minimise demand

#### Reduce leakage

A significant amount of energy is wasted through leakage. Typically, leak rates are up to 40%, i.e., 40% of the generating power is wasted in feeding leaks. A 3 mm diameter hole in a system at 7-bar will leak about 11 litres/sec and cost around £2,000 per year. In a system with numerous leaks, this cost will multiply rapidly!

Simple leak surveys and maintenance can produce dramatic cost reductions, and in some cases, leak reporting and repair have enabled companies to shut down some compressors for all or most of their operating time.

- **Tip:** Simple and repeated walk-around surveys, with leaks tagged and repaired as soon as possible, will significantly reduce leakage rates.
- **Tip:** Isolate redundant pipework, this is often a source of leakage.
- **Tip:** Measure losses due to leakage and target reductions.

### Reduce use

Compressed air is often misused because everyone assumes it's cheap. Check every application to see whether it is essential or simply convenient.

- **Tip:** Stop the use of compressed air for ventilation or cooling – fans are cheaper and more effective.
- **Tip:** Fit high efficiency air nozzles – payback can be as short as four months.
- **Tip:** Consider the use of electric tools instead of compressed air tools.
- **Tip:** Do not use compressed air for conveying granules or products.

## 3. Optimise the supply

### Reduce generation costs

The higher the compressed air pressure, the more expensive it is to provide the air. Twice the pressure means four times the energy cost. The real needs may be lower than you are supplying. In some cases, the machine rating is for a 7-bar supply but pressure reducers are fitted inside the machine. What are your real needs?

- **Tip:** Check that compressed air is not being generated at a higher pressure than required.
- **Tip:** Switch off compressors during non-productive hours. They are often only feeding leaks or creating them.
- **Tip:** Check that compressors are not idling when not needed – they can draw up to 40% of full power when idling.
- **Tip:** Position air inlets outside if possible – it is easier to compress cold air.
- **Tip:** If there is a machine or area that requires compressed air longer than the rest, consider zoning or a dedicated compressor so that others can be switched off.
- **Tip:** Investigate electronic sequencing to minimise compressors going on and off-load.
- **Tip:** Maintain the system – missing a maintenance check increases costs.

### Improve distribution

The longer the compressed air pipeline, the higher the pressure loss over the pipeline and the greater the cost of the system.

- **Tip:** Make sure that pipework is not undersized, this causes resistance to airflow and pressure drops.
- **Tip:** Use a ring main arrangement in each building – air can converge from two directions. This reduces the pressure drop and makes changes to the system easier.
- **Tip:** Avoid sharp corners and elbows in pipework, these cause turbulence and hence pressure drops.

### Reduce treatment costs

- **Tip:** Treat the bulk of air to the minimum quality necessary, e.g., 40-micron filters are usually sufficient. Specifying 5 micron will increase filter purchase cost, replacement frequency and pressure drop.
- **Tip:** Test filters regularly to make sure pressure drop does not exceed 0.4 bar – if the pressure drop is higher than 0.4 bar, replace the filters, since the cost of power to overcome this drop is usually greater than the cost of a filter.
- **Tip:** Manual condensate traps are often left open and act as leaks. Consider fitting electronic traps to replace these.

## 4. Next steps

Compressed air is not free and you can save at least 30% of the costs of compressed air by simple management systems and maintenance.

# Energy and Sustainability Topics – Energy management in rubber processing

## Part 8: Buildings

Buildings-related energy use is often seen as secondary but it actually represents an average of 17% of the total energy costs. Buildings-related energy is an easy area in which to make energy savings because any changes do not impact on production. In most, cases a simple site survey can reduce costs considerably.

### Building energy costs are a significant percentage of the total energy costs.

For the rubber processing industry, recent years have seen vast improvements in factory buildings and working conditions. This upgrading of conditions has produced significant improvements in all-round site efficiency, and has resulted in a general reduction in the usage of energy. However, large opportunities still remain for energy savings in areas such as lighting, space heating and general hot water supplies.

Many processes generate excess heat and it is worth investigating if this can be used for other purposes, such as space heating on colder days.

**Building energy costs**

ECG018 ‘Energy Efficiency in Industrial Buildings and Sites’ presents the results of a survey conducted across all UK industry. The figures below give the average annual delivered energy use and cost. The main figures represent an average working day of 2.3 eight hour shifts and the figures in brackets give the values per eight-hour shift worked.

| | $kWh/m^2$ | $Ł/m^2$ | % total kWh | % total cost |
|---|---|---|---|---|
| Process | 532 (231) | 26.60 (11.56) | 61.0 | 82.9 |
| Buildings | 340 (148) | 5.48 (2.38) | 39.0 | 17.1 |

Of the building’s energy use, the space heating element was over 50%:

| | | | | |
|---|---|---|---|---|
| Space Heating | 288 (125) | 2.88 (1.25) | 33.0 | 9.0 |

The buildings energy use values from the sample ranged from 300 (130) to 550 (239) $kWh/m^2$. Calculate your annual buildings energy use per $m^2$ per shift, and compare it to the sample range above.

- **Tip:** Processes that involve any vaporising solvents will require ‘local exhaust ventilation’. Processes that only generate heat have options for general or local ventilation or preferably energy recycling through a heat exchanger.

## 1. Building audit tips

The starting point to reduce building energy use is an audit of the buildings and systems. The following tips can serve as a basis for the initial audit.

### Existing buildings

Improving the energy efficiency of existing buildings can be very cost-effective and easy to do.

- **Tip:** Reducing heating load is the top priority, so prevent unnecessary heat loss by making buildings as airtight as possible. Draught-proofing doors and windows is cheap but effective.

- **Tip:** Automatic fast-acting roller shutters save energy on external access doors used for forklifts and other mechanised access.
- **Tip:** High ceilings increase your heating costs. Investigate the use of false ceilings, or destratification fans to blow hot air from the roof space down to the working area.
- **Tip:** Restrict the areas to be heated by using partitions or local systems to control the key areas. Don't ventilate or heat the whole building space for a few small areas.
- **Tip:** Do not heat areas where you have windows or outside doors open.
- **Tip:** Do not heat lightly occupied stores or warehouses when you are only trying to prevent excessive dampness.
- **Tip:** Insulate supply pipes to radiators.
- **Tip:** Install tamper-proof thermostats and controllers to stop staff changing them. For larger sites, Building Energy Management Systems control energy costs without relying on staff.

Improving building energy efficiency also improves staff comfort and work output

### New buildings/refurbishment

New or refurbished buildings are an ideal opportunity to reduce long-term costs. Low energy buildings are not only cheaper to operate but are more comfortable for staff.

- **Tip:** Ensure building insulation and fabric meet the current best practice.
- **Tip:** Double glazing can both reduce heat loss and improve comfort. Modern low-e glass and systems are even more effective than standard double glazing.
- **Tip:** Condensing boilers are the best option for new or replacement small hot water systems.

## 2. Lighting

Although they may only be a relatively small part of the overall energy usage, lighting systems offer easily demonstrable opportunities to save energy. Pay attention to areas with:

- High or continuous lighting levels and no or low occupancy. Use occupancy sensors or time switches.
- Fluorescent tubes at high levels without reflectors. The use of reflectors increases light levels and the number of fittings can often be reduced.

In lighting, simple measures can save money easily and a well-designed lighting system can be a permanent energy-saving feature.

- **Tip:** Many major lamp manufacturers also offer advice and contract consultancy on lighting. Use any free help to save energy.
- **Tip:** Replacing old tungsten bulbs with LED lighting saves money in the long-term. Although they cost more, LED bulbs use only 10% of the energy of tungsten bulbs and last much longer. The reduced maintenance costs, especially for lights in high fitments, can easily fund the extra purchase costs.
- **Tip:** LEDs can also be used to replace T12 or T8 tubes in offices and to replace high pressure sodium or tungsten in warehouse/storage areas.
- **Tip:** Use natural daylight where possible and keep skylights clean to reduce the amount of artificial lighting needed.
- **Tip:** Research shows that lighting switched on in the morning will rarely be switched off until the evening – whatever the changes in daylight levels in the intervening period. Carry out a lighting audit to determine if lighting demands can be reduced.