Energy and Sustainability Topics – Benchmarking energy use in plastics processing

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Introduction

Benchmarking is the process of assessing and setting targets for improvement and achievement. It is a proven method of improving performance in many areas of business and works particularly well in energy management.

Benchmarking is about setting targets to save money and improve performance. It is a driver for cost reduction.

To start the benchmarking process, it is necessary to estimate what the industry is doing globally and how a company compares with these global achievements. This is a chance to see where you come in the energy stakes for your industry.

1. The management structure

- Set the energy management structure...
- use the structure to set the targets…
- use the structure to implement projects to achieve the targets...

2. Targets

- Benchmarking is all about the targets to save money.
- Benchmarking is a driver for cost reduction.

3. What can we measure?

- Quickly...
- Easily...
- Accurately...

To save money.

4. The totals

Energy Used = Base Load + Production volume x SEC

5. Strategies:

- Reduce Base Load to reduce fixed costs.
- Reduce SEC to reduce variable costs.

6. Measurements:

- Site Load and SEC
- Machine Load and SEC

Use the ½ hour demand data to find the base load. Demand data is available from supplier for every main meter and also possible from sub-meters.

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Part 1: Injection moulding

1. Overall site values

For overall site values, the information on polymer purchases and electricity bills should be readily available. These can be used to calculate a first estimate of overall performance (the site SEC).

The site SEC will be higher than the weighted average of the individual machine results due to the effects of heating, lighting and other 'non-productive energy use'.

Use the 'Site Energy Use Calculator' to get an estimate of overall performance.

Plot Site SEC on the graph to get indication of the overall site performance. If the SEC is above the line there are potential savings to be achieved from energy use reduction.

If the results are close to the line, then performance is only average and there is no reason for complacency. If the results are below the line, then energy performance is good but savings can still be made by good management.

2. Individual machines

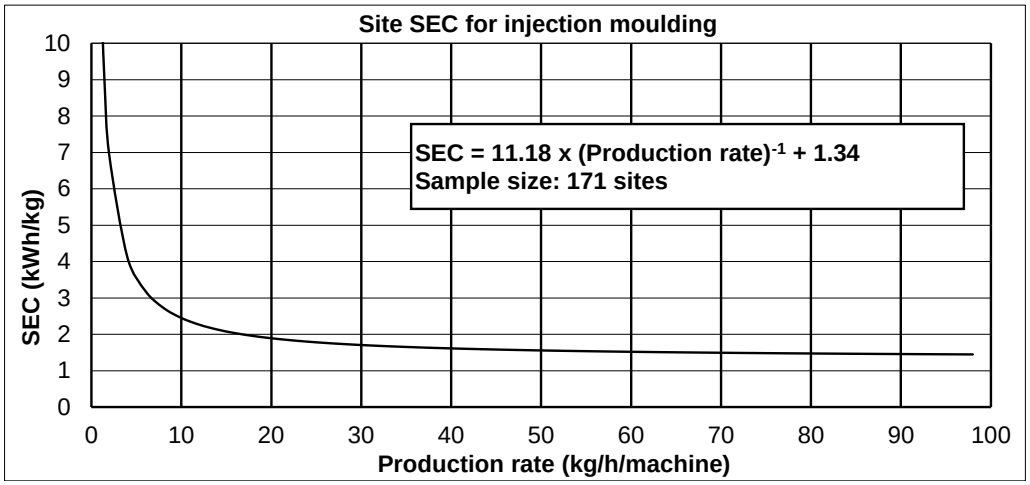
A hand-held clamp meter (costing between £50 and £100) can give current measurements while a machine is in production. The load of an injection moulding machine fluctuates considerably during each cycle and an accurate view of the average load needs some judgement by the operator. The machine movements and energy load follow a regular pattern but the barrel heaters are switched by their individual controllers and can cause some irregularity. The heater load will fluctuate as individual heaters are switched by their thermostats but an average can be observed over 10-15 minutes.

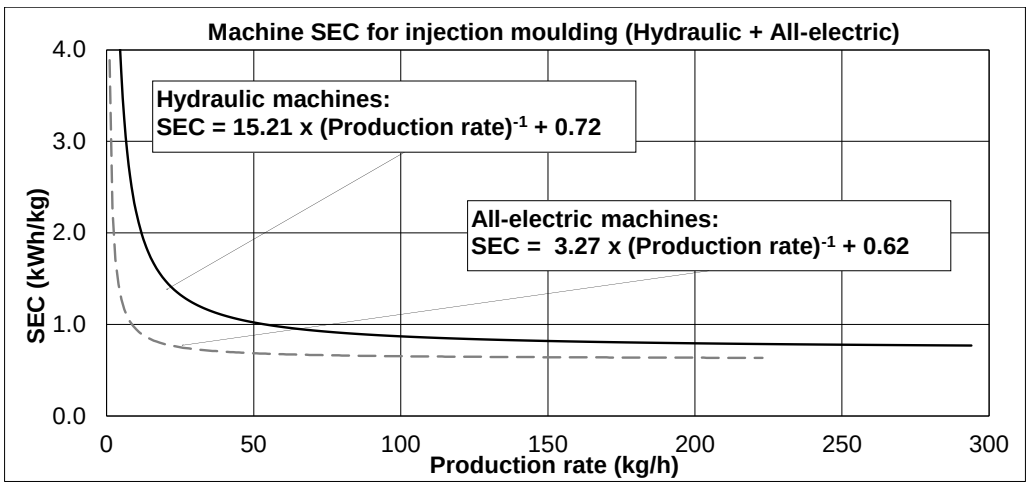
Typically, a machine is fed by a single supply into the control cabinet and is then split to the various parts – hydraulics, extruder and to the ancillary units for that machine (hopper, granulator, conveyor, etc). Measurements of the separate drives is usually possible from the control cabinet. Measurement of the whole machine may be more convenient from the sub-station distribution board. Making measurements at this point will account for all the downstream ancillaries. Comparison of the energy use of the hydraulics and extruder alone can be confusing because of the effect of the ancillaries. The extruder use is largely determined by the shot weight and cycle time of the machine and in most cases the extruder is not fully utilised. Similarly, the hydraulic system energy use is variable with time but relatively constant for a given machine. Compressed air and cooling water are large energy users and the use allocation can only be estimated. It is possible to calculate a theoretical use but it is more useful to locate and reduce leakage.

If you use this benchmarking guide to calculate your own results then please send the results (site SEC, production rate and any machine specific SEC data) to Tangram Technology and we will incorporate your results into the graph. This will keep the graphs up to date and benefit everybody.

All data will be treated confidentially and not used except to update the graphs.

Site energy use calculator – Injection moulding			
No. of hours/shift	❶	No. of shifts/day	❷
Days worked/week	❸	Weeks worked/year	❹
➲ Hours worked /year = ❶ x ❷ x ❸ x ❹ =			A
Total site annual electricity cost (£)			❺
Total site annual electricity use (kWh)			❻
Total site annual polymer usage (metric tonnes)			❼
No. of machines on site			❽
➲ Calculated average kW/machine = ❻ ÷ (❽x A) x 0.01 =			B
➲ Calculated kg/hour/machine = ❼ ÷ (❽ x A) =			C
➲ Site Specific Energy Consumption (SEC) = ❻ ÷ ❼ =			D
Plot D on the vertical axis and C on the horizontal axis of the site SEC graph.			





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Part 2: Extrusion

1. Overall site values

For overall site values, the information on polymer purchases and electricity bills should be readily available. These can be used to calculate a first estimate of overall performance (the site SEC).

The site SEC will be higher than the weighted average of the individual machine results due to the effects of heating, lighting and other 'non-productive energy use'.

Use the 'Site Energy Use Calculator' to get an estimate of overall performance.

Plot Site SEC on the graph to get indication of the overall site performance. If the SEC is above the line there are potential savings to be achieved from energy use reduction.

If the results are close to the line, then performance is only average and there is no reason for complacency. If the results are below the line, then energy performance is good but savings can still be made by good management.

2. Individual machines

A hand-held clamp meter (costing between £50 and £100) can give current measurements for each of the three live conductors while a machine is in production. The load of extruders and blow-moulders is a relatively steady one, motor power does not change rapidly and, although heaters are frequently switching, it is possible to obtain a sensible approximation that is adequate for an initial assessment. The load will be similar across the three phases and measurement of a single phase is adequate. The heater load will fluctuate as individual heaters /fans are switched by the thermostats but an average can be observed over 10-15 minutes. Repeat the test on each phase will ensure that no unforeseen variance is present.

Typically, a machine is fed by a single supply into the control cabinet and is then split to the various parts – hydraulics, extruder and to the ancillary units for that machine (hopper, granulator, conveyor, etc). Measurements of the separate drives is usually possible from the control cabinet. Measurement of the whole machine may be more convenient from the sub-station distribution board. Making measurements at this point will account for all the downstream ancillaries. Comparison of the extruder alone can be confusing because of the effect of the ancillaries. The extruder has to be set to match the machine's ability to make products. This is primarily determined by the ability to cool the moulding and in most cases the extruder is not fully utilised. Compressed air and cooling water are large energy users and the usage allocation can only be estimated. It is possible to calculate a theoretical air volume but, in most cases, a more useful method is to search for and reduce leakage.

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Site energy use calculator – Extrusion			
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Days worked/week	❸	Weeks worked/year	❹
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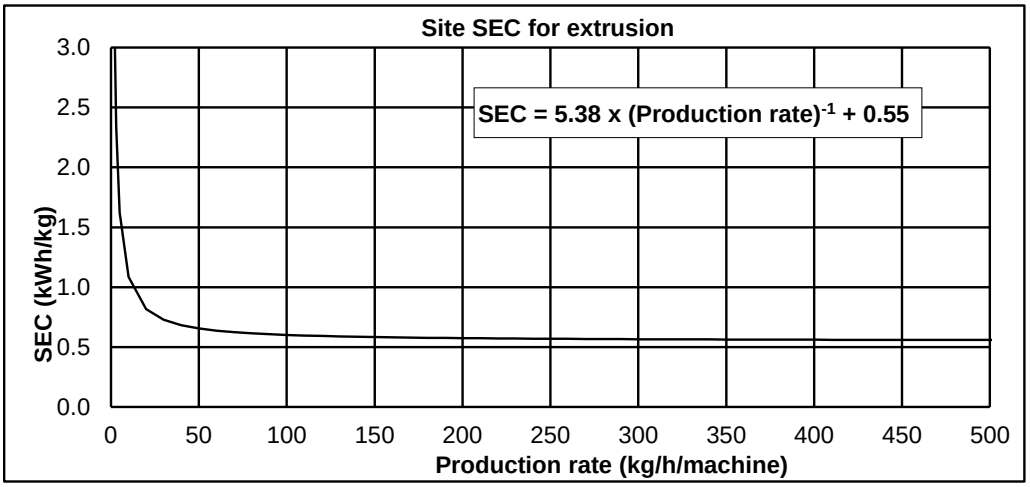

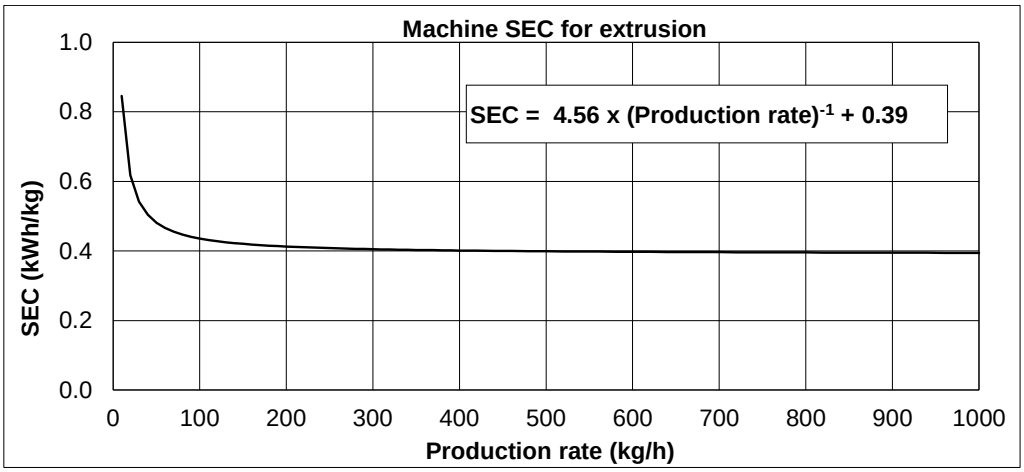

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Part 3: Extrusion blow moulding

1. Overall site values

For overall site values, the information on polymer purchases and electricity bills should be readily available. These can be used to calculate a first estimate of overall performance (the site SEC).

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Use the 'Site Energy Use Calculator' to get an estimate of overall performance.

Plot Site SEC on the graph to get indication of the overall site performance. If the SEC is above the line there are potential savings to be achieved from energy use reduction.

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2. Individual machines

A hand-held clamp meter (costing between £50 and £100) can give current measurements for each of the three live conductors while a machine is in production. The load of extruders and blow-moulders is a relatively steady one, motor power does not change rapidly and, although heaters are frequently switching, it is possible to obtain a sensible approximation that is adequate for an initial assessment. The load will be similar across the three phases and measurement of a single phase is adequate. The heater load will fluctuate as individual heaters /fans are switched by the thermostats but an average can be observed over 10 -15 minutes. Repeat the test on each phase will ensure that no unforeseen variance is present.

Typically, a machine is fed by a single supply into the control cabinet and is then split to the various parts – hydraulics, extruder and to the ancillary units for that machine (hopper, granulator, conveyor, etc). Measurements of the separate drives is usually possible from the control cabinet. Measurement of the whole machine may be more convenient from the sub-station distribution board. Making measurements at this point will take account of all the downstream ancillaries. Comparison of the extruder alone can be confusing because of the effect of the ancillaries. The extruder has to be set to match the machine's ability to make containers. This is primarily determined by the ability to cool the moulding and in most cases the extruder is not fully utilised. Compressed air and cooling water are large energy users and the usage allocation can only be estimated. It is possible to calculate a theoretical air volume but, in most cases, a more useful method is to search for and reduce leakage.

Injection blow moulding

Benchmarking for injection blow moulding is more difficult because of the small number of data points available. As a general rule injection blow moulding is far to the right-hand end of the curve shown for extrusion blow moulding. The data points still fit the calculated equation and can be used but the small data set makes them less reliable.

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Site energy use calculator – Extrusion blow moulding			
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Days worked/week	❸	Weeks worked/year	❹
➲ Hours worked /year = ❶ x ❷ x ❸ x ❹ =			A
Total site annual electricity cost (£)			❺
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No. of machines on site			❽
➲ Calculated average kW/machine = ❻ ÷ (❽ x A) x 0.01 =			B
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➲ Site Specific Energy Consumption (SEC) = ❻ ÷ ❼ =			D
Plot D on the vertical axis and C on the horizontal axis of the site SEC graph.