IGS GeboJagema

Green Moulds

Enabling sustainable injection moulding

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From Precision to Perfection

Green Injection Moulds

The efforts to combat climate change will have a huge impact on the world economy over the next decade and beyond. Greenhouse gas emissions must be reduced dramatically. The EU is aiming at a reduction of 55% by 2030, compared to 1990 levels.* Similar goals are being set both by countries and companies in the rest of the world.

To achieve reductions of this magnitude, all sectors and industries must investigate ways to do more with less. This applies to all companies involved in injection moulding as well. Traditionally, the critical factors for moulds have been accuracy, cycle time, reliability and maintenance-friendliness. But as the world takes steps towards a carbon neutral economy, we expect that energy usage will become increasingly important.

* Regulation (EU) 2021/1119: European Climate Law, article 4(1)

By its nature, injection moulding is an energy-intensive process. Moulds are also typically used 24/7, 365 days a year. This means a mould manufacturer can make a large impact by delivering more energy efficient injection moulds. That thought inspired our team to initiate an in-depth investigation into sustainable injection moulding. **The objective: to discover whether energy consumption could be reduced by 20%, while retaining product quality and cycle time.**

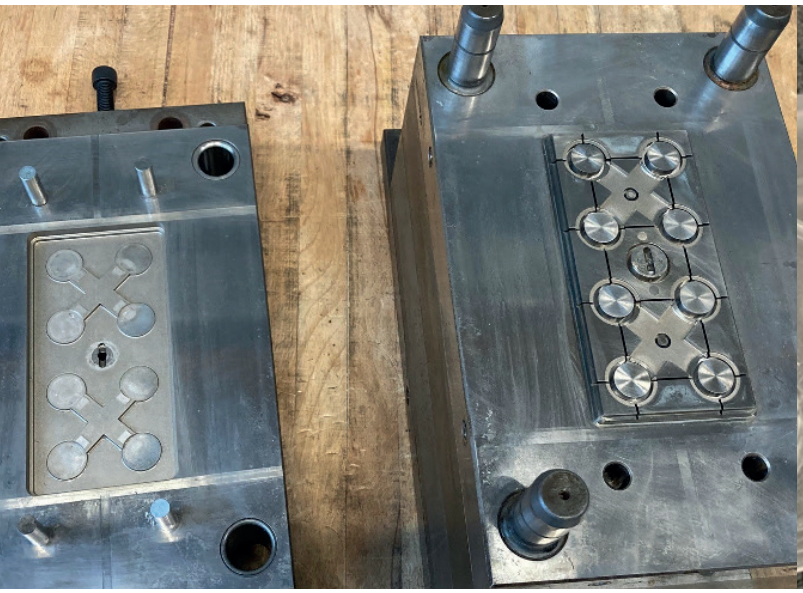
This whitepaper will share the innovative solutions we found that can dramatically increase energy efficiency in your production process. Our 'green moulds' will not only reduce greenhouse gas emissions associated with energy usage, but will also improve your mould's Total Cost of Ownership.

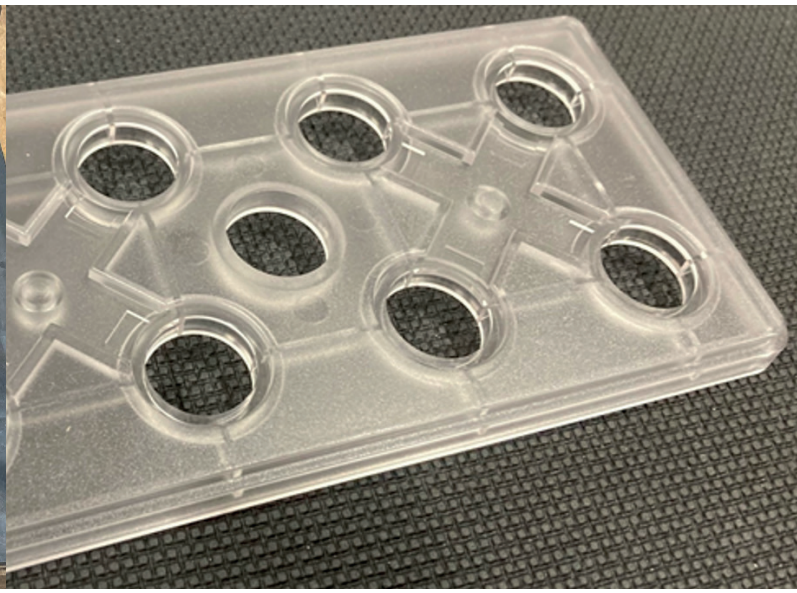
The sustainability of quality

For IGS GeboJagema, delivering the highest possible quality has always been and continues to be the top priority in our factory. It is a non-negotiable for our clients, the majority of which are based in the healthcare and ophthalmic industries. But in addition to being a crucial requirement for our clients, quality is also the cornerstone of sustainable production. Production lines with minimal downtime are the most energy efficient. And moulds with the highest possible yield minimise defects and waste. As such, quality was a hard requirement in our research. Quality is the sustainable choice.

The baseline test

Our team started its research by performing a baseline test. For this test, an Engel E-motion 110 was used: a fully electric, high-end machine. We selected an injection mould used to manufacture polycarbonate sample pallets. The resin data sheets indicated a processing temperature of 280 – 300 °C and a mould temperature of 80 – 90 °C.

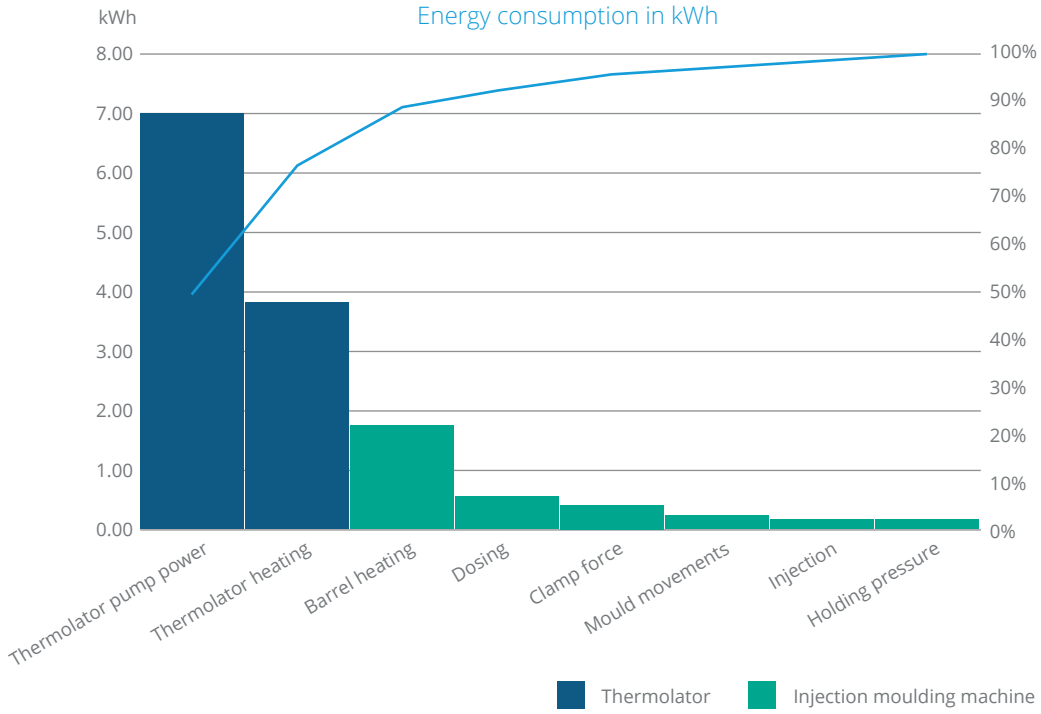




The baseline test showed the following energy consumption.

Peripheral equipment	10.80 kWh
Injection moulding machine	3.39 kWh
Total consumption	14.12 kWh

The baseline test also served to determine which factors had the largest impact on energy consumption. It revealed that the top three factors make up over 90% of total energy consumption, with the thermolator pump alone accounting for 50%.



Based on these findings, our team calculated the key figures for this injection mould.

Total consumption

365 days x 24 hours x 95% uptime = 8,322 production hours
8,322 production hours x 14.12 kWh = **117,507 kWh/year**

Annual costs

117,507 kWh x €0.1323[1] = **€15,546/year**

CO2 emissions

117,507 kWh x 0.53339kg CO_2 [2] = **62,677 kg CO_2/year**

Considering the goal of reducing energy consumption by 20%, the following savings would be realised.

CO_2 savings
12,535 kg

Cost reduction
€3,109

1 Based on input from current energy provider of IGS GeboJagema in December 2021.
2 Greenhouse Gas Protocol, GHG Emissions Calculation Tool, retrieved on 15-03-2022 from: https://ghgprotocol.org/ghg-emissions-calculation-tool

Optimisation tests

Using the data from the baseline test, our team identified three areas of optimisation as the most promising.

1 Use of a more optimised thermolator pump
2 Thermal insulation of the mould
3 Optimising all other process parameters for energy efficiency

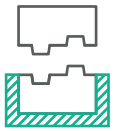
Optimised thermolator pump

With the thermolator pump making up 50% of energy consumption, it was the prime target for optimisation. From a purely technical point of view, it makes sense to use a pump with more than enough power to ensure optimal product quality. However, when taking sustainability into consideration, one must guarantee optimal product quality, while maximising energy efficiency.

In the baseline test, two HB-Therm pumps were used, which used 7 kWh and resulted in a water flow rate of 72 litres per minute. Based on several measurements, the team decided to replace the pumps with a single Regloplas 90S. While this reduced water flow rate to 26.3 litres per minute, there was no effect on product quality or cycle time. The optimised pump used only 0.5 kWh, leading to an impressive 45% reduction in total energy usage. Moreover, the Regloplas pump is significantly less expensive than the two HB-Therm pump, meaning that this optimisation lowers the total cost of ownership both by saving energy and by reducing upfront costs.

Thermolator pump energy usage reduction

-45%



Thermal insulation

Heat is a major factor in the energy required for injection moulding. This was confirmed in our baseline test, which showed that the heating of the thermolator and the barrel made up 40% of energy consumption. Our team took several actions to make the heating process more efficient. They placed isolation plates between the bed plates, which reduced total energy consumption by 13.3%. They also wrapped isolating material around the mould, which led to a further reduction of 10.8%. By reducing heat radiation, these thermal insulation measures increased energy efficiency by a total of 24.1%.

Thermal insulation energy usage reduction

-24%

Process optimisation

Finally, the team performed an in-depth investigation of the process parameters. This is a standard part of our validation procedure. For every mould, our validation engineers identify the ideal process settings using an advanced version of Pro-Op, which IGS GeboJagema has further developed in-house.

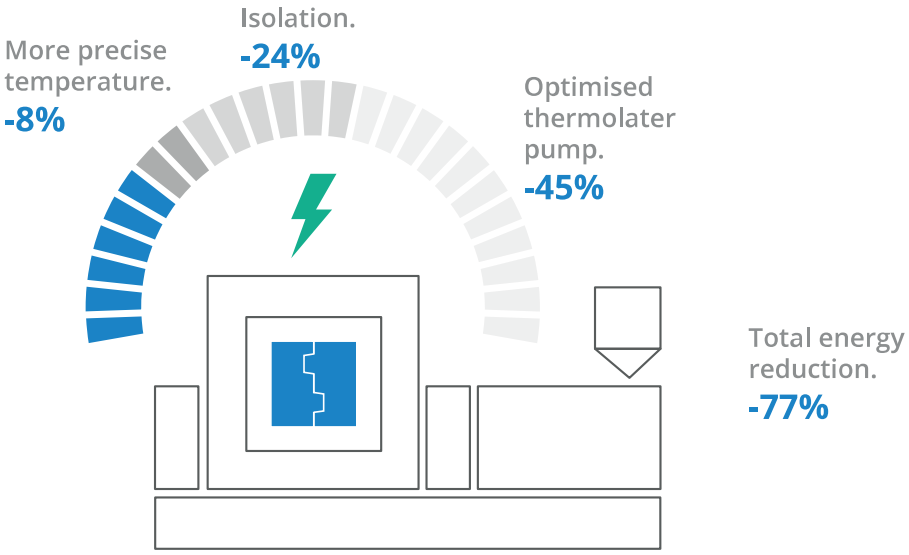
For this research, our engineers used Pro-Op to measure how each process parameter affected energy consumption. The test showed that most process parameters had little to no impact, with the exception of mould temperature. Plastic suppliers provide a material data sheet that defines a temperature window for their product. Usually this window is 20 degrees Celsius. For the baseline test, the temperature was set in the middle of that window, but the team determined that they could lower the temperature without affecting cycle time or product quality. This reduced energy consumption by another 8%.

Thermal insulation energy usage reduction

-8%

Results

Our goal for this research project was to improve energy efficiency by 20%. With the combination of the measures described above, our team far exceeded this target. In total the difference between the baseline test and the optimized test was an impressive 77%. While such dramatic results cannot be expected for all moulds, this research proves that large reductions can be achieved.



The potential impact of green moulding

Most injection moulds are used 24/7 and 365 days a year. Depending on the product, IGS GeboJagema's moulds are active for many years. Considering these factors, the potential impact of a more energy-efficient mould is very significant. Depending on its type and size, an injection mould can use between 135,000 and 240,000 kWh per year (assuming an uptime of 95%). To put that into perspective, that is the same amount as 49 to 86 Dutch households.[3] It translates to 72 to 126 tonnes of CO2 emissions a year.[4]

Energy use

49 to **86** Dutch households = **72** to **126** tonnes of CO_2 emissions a year

Annual figures at 95% uptime

Autoinjector A – Part #01 (16.4 kWh)

Energy consumption: 136,398 kWh *(49 households)*
Costs € 18,045
Emissions: 72,753kg CO2

Insulin pen – Part #02 (26.3 kWh)

Energy consumption: 218,869 kWh per year *(79 households)*
Costs € 28,956
Emissions: 116,750kg CO2

Dry powder inhaler – Part #03 (28.49 kWh)

Energy consumption: 237,094 kWh per year *(86 households)*
Costs € 31,367
Emissions : 126,500kg CO2

1 kWh: €0.1323 [5]
Average household consumption: 2,760 kWh [6]
Carbon emissions per kWh: 0.53339 CO2 [7]

3 Assuming 2,760 kWh per household. Central Bureau for Statistics, Energieverbruik particuliere woningen. Retrieved on 15-03-2022 from https://opendata.cbs.nl/statline/#/CBS/nl/dataset/81528NED/table?ts=1643029279362
4 Assuming 0.53339 CO2 per kWh. Greenhouse Gas Protocol, GHG Emissions Calculation Tool, retrieved on 15-03-2022 from https://ghgprotocol.org/ghg-emissions-calculation-tool
5 IGS GeboJagema energy supplier December 2021
6 Central Bureau for Statistics
7 Greenhouse Gas Protocol

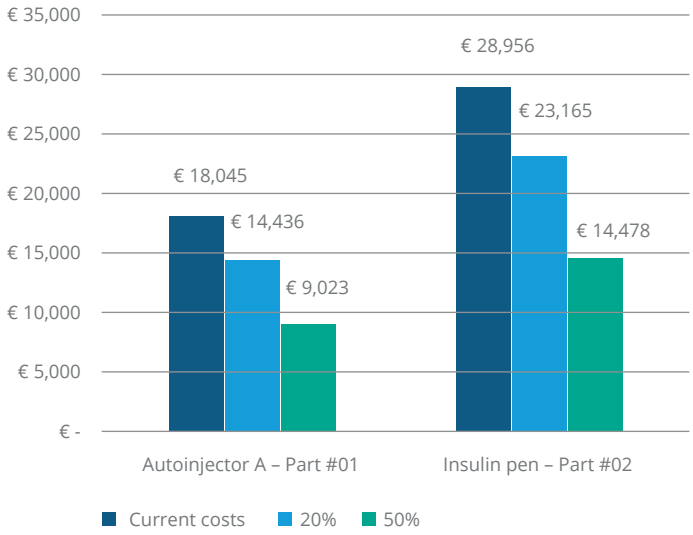
In our test, we achieved an energy reduction of 77%. Of course, it would be imprudent to assume that equally dramatic results can be achieved with all moulds. Taking a more conservative estimate of a 20 to 50% reduction, a single green mould could save the energy usage equivalent of between 10 and 43 households. With hundreds of moulds being produced at the IGS factory every year, the energy saved by delivering more energy-efficient moulds would be the equivalent of thousands of households.

Energy savings

10 to **43**
Dutch households

The impact on the Total Cost of Ownership should also be considered. Assuming a mould is used for four years and the targeted 20% increase in efficiency is reached, an energy-optimised mould would reduce the Total Cost of Ownership between € 14,000 and € 25,000.

Current annual costs compared to costs with 20% or 50% efficiency increase



Finally, our team found that the insulation of moulds offered a number of additional benefits. The time required to heat up the mould from 23 °C to 90 °C was reduced by 61%, from 38 minutes to 15 minutes. The chance of burn injuries is reduced, because hot parts are no longer directly exposed to personnel. And lastly, the mould's lifetime is increased, because the mould expands more evenly and temperature differences in the mould are prevented. This reduces stress on guidings and interlocks.

Time required to heat up the mould

-61%

Green moulds: a new standard

Green moulds are not only better for the environment, but also significantly reduce the Total Cost of Ownership for our clients. This makes them the perfect choice for organisations that want to reduce their dependence on energy prices, realise sustainable ambitions, or simply want to improve their Total Cost of Ownership.

IGS GeboJagema has already put the results of this research into practice. For example, it has developed a method to minimise energy consumption of its moulds, which will be a standard part of the validation stage going forward. Moreover, our first thermally insulated mould has already gone into production.

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