Therma DM500

PowerPlast s.r.l.
- ITALIA -

DWS

The first stage of industrialisation

Introduction

The ongoing industrial revolution is characterised by new words which point toward tomorrow trends.
Crowdfunding, start-up, maker, self-production, 3D printing, and Industry 4.0 are the terms ringing around the "middle ground" that exists between the universities and established industry.
Since the 1950s, plastic materials have completely changed production processes, making it possible for brands to create objects, accessories, and furnishings with increasingly targeted characteristics, thanks to the continuous development in polymers.
The leap from concept to industrial-scale production requires significant investment, not always obtained, which is the greatest obstacle for the brands of tomorrow.
Creating a mould, or cavity, into which plastic material is injected at high temperature and high pressure, traditionally meant investment of thousands of euros (typically between € 5,000 and €100,000) and long lead times (between 4 and 8 weeks).
Today, therefore, there is an increasing need to shrink timescales and costs to produce small batches, allowing start-ups and established brands to obtain finished items made of materials for the industrial production.

The Therma DM500 project:

Before proceeding with a mass production, it is necessary to consider the different technologies, times and costs.
Using DWS SLA technology and the resin developed specially for industrial applications, businesses can create moulds suitable for the use in injection moulding presses:

Technology	Producibility	Material	Tooling cost	Per-item cost	Tooling creation time	Item creation time
3D printing (FDM, SLS, SLA)	1	FDM filaments*, photosensitive resins* or polymeric powders	No cost - additive manufacturing process	HIGH	none	HIGH
Mechanical milling	1	Polymers available in sheet form	No cost, but there is a material cost	HIGH	none	LOW - MEDIUM
Silicone moulds	5 - 25	Thermosetting polymers in liquid form	LOW (€ 100 - 500)	MEDIUM	MEDIUM (1 - 2 weeks)	LOW - MEDIUM
Resin moulds DWS - Therma DM500	10 - 150	Thermoplastic polymers	LOW - MEDIUM (€ 400 - 2,000)	LOW	LOW (2-3 working days)	LOW
Pilot mould	100 - 5,000	Thermoplastic polymers	HIGH (€ 1,000 - 10,000)	LOW	HIGH (2-4 weeks)	LOW

*Additive technologies cannot entirely replicate polymer performance in an industrial process due to differences in materials, in the performance and consistency of the polymer.

Focus on DWS Therma DM500 resin

Time and cost drive every industrial process, and research by DWS and PowerPlast, industrial partner for the project, has been focused on these drivers.

Making inserts from resin makes it possible to:

- produce a small series, reducing mould building times
- use and test industrial polymers from the outset
- anticipate the time required for product certification according to the various standards (e.g. UL or CE)
- produce shapes with articulated geometry without affecting the mould building costs
- validate geometries and assemblies before making significant investment
- carry out all post-processing on the products with the industrial materials available.

The importance of polymeric materials

Industrial production involves exploiting the characteristics of hundreds of different polymers, depending on the applications for which they are used. It is important, from the preliminary project study onwards, to identify which type, and therefore which family of polymers one intends to use with DWS Therma DM500 inserts.
Certainly, some materials perform better than others on resin inserts, but the research by DWS and PowerPlast is constantly evolving.

Polymers currently recommended for moulding on Therma DM500 inserts are:

- Polypropylene (PP)
- Polyethylene (PE)
- Acrylonitrile butadiene styrene (ABS)
- Polypropylene + filler
- Polystyrene (PS)
- Polymethyl methacrylate (PMMA)
- Polyacetal (POM)
- Polyamide (PA6)

In general, all non-filled polymers with a melting temperature below 250 °C are potential candidates, however the material's fluidity is a factor to be considered as well, as it could require pressures too high for the inserts.

Filled materials can be used too, but this significantly shortens the useful life of the cavity, accelerating the formation of burrs and loss of accuracy on the finest details.

General mould design guidelines

A successful outcome depends not only on the product design, but also the design of the mould itself, in terms of materials, finishes, and whatever production process optimisation one wants to achieve. Using inserts made from DWS Therma DM500 resin is not vastly different from creating traditional inserts, but designers will need to consider certain aspects identified during PowerPlast's R&D process:

Design

- Insert fixing. Whether the insert is placed on a subframe or on the mould base directly, it is important to plan some size tolerance on the external edges, which will have to be retrieved manually in some cases.
- Draft angles. The consistency of the resin requires the walls to be angled a few more degrees than usual, as far as compatible with the object's design.
- Injection point. To avoid excessive thermal shock, the injection point should ideally be large and laminated, and its impact in the cavity should not be against overly thin walls.
- Injection point. It is advisable to avoid direct contact with the press injection point, by providing a bush in the injection area.

3D printing the insert

- We recommend positioning the models on the platform so that the working areas do not overlap, to avoid excessive wear at the shared points (see figures 1 & 2).
  This placement, together with our DWS-patented TTT (Tank Translation Technology) System, increases the tank's lifespan by avoiding excessive wear on a single area.

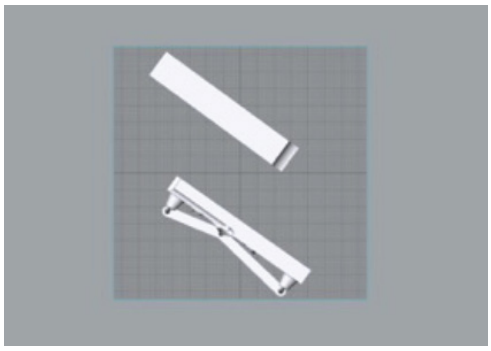


figure 1

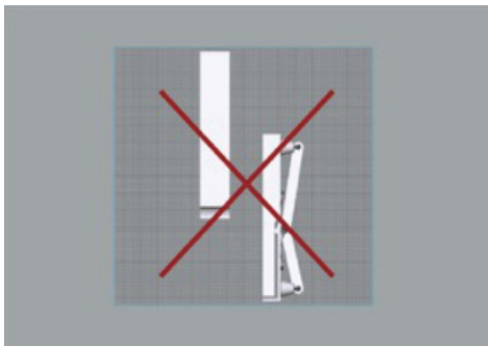


figure 2

- Use Nauta software to create supports with easy break points.
  We advise creating a support structure designed to make the washing procedures easier.
- Avoid positioning supports on the surface where injection occurs.
  If necessary, create thin supports with easy break points. Use an electric scalpel to remove them.
- Preparing the Therma DM500 material: warm the resin bottle to 35 °C, then shake the bottle well.
  Pour the resin into the tank. Before every print run, mix the resin using the spatula provided, being careful to remove and dissolve any filler settled on the bottom.
- How much resin to use: add a reserve of 500 grams to the model weight estimated by Nauta.
- Proceed with the printing using the default parameters supplied for Therma DM500.
- After the 3D printing, allow excess resin to drain off by placing the platform in a vertical position.
  Clean using a compressed air brush and ethyl alcohol, taking appropriate safety precautions.
  Take special care when cleaning any injection and cooling channels.
- Place the model in the UV device for a minimum 1-hour cycle.
- To improve its heat resistance, place the model in a temperature-controlled thermal oven, and heat to 120 °C at a rate of 1 degree per minute. Leave the model in the oven at a constant temperature of 120 °C for 30 to 60 minutes, depending on model thickness. Set the oven to cool down at 1 °C per minute.

Tooling

Making inserts through DWS Therma DM500 resin allows the production of dozens of parts in a few hours.
Depending on the injection press, insert type, and design, some critical areas of the mould may require a reworking:

- Extractors. Given their importance, it is advisable to design extraction holes slightly smaller (around 0.2 mm) in diameter in the STL file, so they can be finished by boring out.
- Fixing threads. If fixing with metric screws is involved, we recommend creating a classic 45-degree chamfered pilot hole at the top, and manually tapping it afterwards.

Injection moulding

Using inserts made of Therma DM500, it is important to check the correct functioning both of any extractors and of the mould closure by taking the following precautions:

- Run the first mouldings at low temperature and low speed, even without filling completely the cavity, to bring the insert slowly up to temperature.
- Once the moulding cycle is complete, it is important to allow the insert a cooling time to avoid sink marks.
- After the moulded item has been removed, compressed air can be applied to the cavity to reduce waiting times between the cycles.

REAL INDUSTRY EXAMPLES.

01

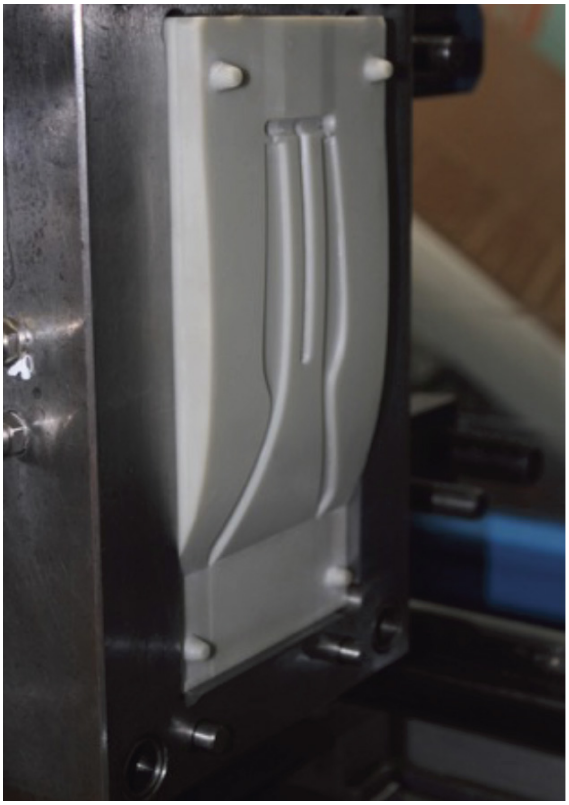
Spatula Project

Item	Material	Temperature	No. of cycles	Mould closure pressure	Injection pressures
Spatula	ABS	210/220 °C	25	80 bars	45/28 bars
Spatula	Polypropylene	190/200 °C	30	80 bars	41/24 bars
Spatula	Polythene	125/135 °C	30	80 bars	39/22 bars

	STEEL inserts	DM500 inserts
Production times	4 working days	File preparation, printing, and post-processing = 1.5 days (printing at night)
Cost of inserts	€ 850	1.5 kg of resin = € 450

02

Glasses Arms Project



Resin insert with single injection point and single sprue extractor.

Item	Material	Temperature	No. of cycles	Mould closure pressure	Injection pressures
Temples	ABS	210/220 °C	40	80 bars	42/26 bars
Temples	Polypropylene	190/200 °C	80 (2 colours)	80 bars	39/23 bars
Temples	Polythene	125/135 °C	80	80 bars	37/20 bars

	STEEL inserts	DM500 inserts
Production times	15 working days	File preparation, printing, and post-processing = 2 days (printing at night)
Cost of inserts	€ 3,500	2 kg of resin = € 590

03

Bicycle Support Project

Single-cavity resin insert with sprue extractor. The mould closure is shaped according to the shape of the item, and there are no burrs.

Item	Material	Temperature	No. of cycles	Mould closure pressure	Injection pressures
Bike support	Polypropylene	190/200 °C	200	85 bars	37/22 bars

	STEEL inserts	DM500 inserts
Production times	10 working days	File preparation, printing, and post-processing = 1.5 days (printing at night)
Cost of inserts	€ 2,250	0.5 kg of resin = € 150

Observations and developments

The development of DWS Therma DM500 resin enables us to bridge the gap between the worlds of prototyping and of industrial manufacturing, both in terms of cost benefits and production times.
It is also important to emphasise the improvement in terms of the development of new products, which right from the early stages, can make use of injection moulding technology to validate geometries and materials, and reduce the project's time to market.
The development of industrial resins by DWS continues in our quest to optimise the process. Together with PowerPlast, we are developing the know-how to enable our customers to benefit from polymers with advanced technical qualities.

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