Press release

Faster specimen production!

The Brabender® SpeciMold® speeds up plastic formula development

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A new inline injection moulding machine for the quick, energy-saving production of samples can help compound designers, additive manufacturers and plastics development laboratories accelerate the development of plastic formulas – and at the same time determine genuine material properties that are closer to real-world conditions. The unit introduced by Brabender® GmbH & Co. KG under the name SpeciMold was developed by the polymer analysis specialists based in Duisburg, Germany in conjunction with UMSICHT (Fraunhofer Institute for Environmental, Safety and Energy Technology) in nearby Oberhausen. It fits seamlessly into existing laboratory systems and solves various compound development challenges in one fell swoop, especially with regard to residual moisture problems or dealing effectively with small material quantities.*

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Over the last few decades, polymer materials have become an ever more important part of our everyday lives. As part of this, users have continuously pushed previously applicable performance limits ever further – either through noteworthy material or process-related technical developments such as in the case of bimodal polyolefins, or through more creative compounding. Polyamides are one such example. Thanks to a high glass fibre content and special stabilisation systems — among other things — they display heat ageing resistance up to temperatures well over 200°C. Just a few years ago, this would have been regarded as revolutionary.

Success stories like this should not, however, mask the fact that those working with plastics of this nature constantly find themselves in uncharted territory when it comes to application technology. It is very important for formula development to thoroughly test the new compounds no matter the quantity.

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Compound development has become a time-critical task

It is critical for the alter success, of the injection molding handling process, that the results from the laboratory testing are monitored and understood with careful detail. This would prevent misinterpretations of the data sheet, thusly, avoiding out-of-spec products. Hence, for example, the addition of liquid or solid formula components in the laboratory extruder should be as close to real-world applications as possible. Special attention must be paid to the injection moulding process with all its parameters – the most important being, for example, control temperature/temperature profile and forming pressure.

Time plays a critical role in successful material development. In order to be able to obtain products with a custom characteristics profile and to really exhaust the potential of polymer materials, plastics suppliers and/or compound designers ideally need to be involved in the development process at an increasingly earlier stage. In doing so, they are however also faced with the task of being required to adapt to the enormously accelerated innovation cycles in, for example, the automotive industry: The decision as to whether or not to use a particular material generally occurs very early in the process. Plastics suppliers therefore need to be in a position to present their clients with a dependable solution quickly, despite the fact that material development is constantly becoming more complex.

Inline specimens – direct from the polymer flow, without granulation

By solving this apparent conflict, an innovative inline injection moulding system can assist developers when it comes to manufacturing samples: The SpeciMold, jointly developed by Brabender® GmbH & Co. Duisburg, Germany, together with the renowned Fraunhofer Institute for Environmental, Safety and Energy Technology (UMSICHT), Oberhausen, Germany. Brabender brings its decades of experience in the fields of extrusion technology and test instrument development in the polymer industry to this highly innovative device **(Fig. 1).**

In a ‘classic’ workflow, the material sample is granulated in the laboratory extruder and then sent to the injection moulder, which then creates the resulting sample – a time-consuming process. However, the SpeciMold creates injection-moulded specimens for a multitude of common laboratory tests directly from the polymer sample destined for granulation – quickly and inline, i.e. directly from the extruded polymer flow.

Additionally: Samples produced by the SpeciMold — e.g. dumbbell samples — more closely resemble the end product in terms of core physical characteristics than those manufactured in the conventional material development workflow using granulate that has already been melted **(Fig. 2).** The unit not only spares the developer the time-consuming task of sending the granulate to the injection moulder, but also spares the material itself the disadvantage of having to be melted again before inspection (see below).

The Brabender SpeciMold's advantages at a glance:

- ✓ *Inline* reference samples – direct from the extruded polymer flow, saving time
- ✓ Granulate manufacture is not interrupted
- ✓ No need for time-consuming sending of granulate to the injection moulder
- ✓ Tailored for processing the tiniest quantities of compounds
- ✓ No need for renewed melting – therefore physical characteristics that are extremely close to practice
- ✓ Many sources of errors, such as from hydrolysis, are eliminated
- ✓ Suitable for a wide range of polymer materials – even recycled materials

Compounding process is not interrupted

The SpeciMold's working principle is exponentially simple. The device is fitted between the (twin-screw) extruder and the die head or the laboratory unit's downstream equipment. In the case of the latter, it is of course irrelevant whether the down stream equipment consists of a conveyor belt with an air knife or a water bath.

The unit is divided into a SpeciMold block, with piston and die head, as well as a mould that opens and closes via a knee lever mechanism **(Fig. 3 and 4).** The function of the SpeciMold Block is to constantly divide the polymer flow into two parts. As the main flow continues through a die head, and is handled further in the down stream line and then the bypass flow fills a cavity within a preset time period. As soon as this volume has been completely filled, the molten compound collected there is injected into a mold, forming a sample.

With this, the regular process goes uninterrupted. The user obtains a reference probe, which depending on the mould is either in the form of a dumbbell or a filling screw, thus saving an enormous amount of time **(Fig. 5).** The operator can therefore draw valid conclusions as to whether the (new) polymer material possesses the properties requested by the customer in a more timely manner than was previously the case. Since the reproducibility can be easily shown, the user gains a competitive advantage.

Sources of errors easily identified and eliminated

Compared to the 'classic' workflow, significant process-related disadvantages are reduced. For example, those relating to polymer degradation as a result of excessive thermal stress. Detrimental effects on fibre length resulting from unexpected shearing effects (such as from unsuitable extrusion parameters) could also previously present analysts with a challenge. With the SpeciMold, these undesired changes are no longer an issue, as the granulated sample compound for manufacturing the samples do not need to be melted again. The samples correspond exactly to the material used in production.

A further advantage, which particularly applies to laboratory units used for the creation of polymer samples is: No large production systems need to be blocked in order to provide the quantities of materials that the SpeciMold is tailored for use with. Whereas manufacturing samples in the classic procedure requires larger quantities of compounds, just a few kilograms are required for smaller laboratory units.

The SpeciMold is suitable for an extremely wide range of modern polymer materials.
These include commodity, engineering, high-temperature resistant thermoplastics and thermoplastic elastomers. Also, and a number of synthetic rubbers for the production of technical rubber items also benefit from this innovative new unit. Additives and fillers that are usual in the field of injection moulding can also be used without restriction – in every respect, the SpeciMold behaves just like the processor's injection moulding system.

The SpeciMold in use: Everyday life for the injection moulder

Despite all its advantages, the SpeciMold does not present experienced users with an array of new challenges. In principle, it is 'merely' a small injection moulding system… with a twist. The difference from the usual injection moulding systems lies principally in the 'switch' that causes a small side flow to be diverted from the material flow in order to fill the mould.

Operating the SpeciMold – The main points

- ✓ No complex training required
- ✓ PLC-controlled – no readjustment for personnel with practical experience
- ✓ Software helps with adjustment of the main and bypass flows
- ✓ Process management that is close to real-world conditions – with holding pressure phase, decompression and cooling phase
- ✓ The injection process is precisely documented
- ✓ Parameter sets can easily be stored and read
- ✓ Fast mould changes – extruder does not need to be stopped
- ✓ Can be integrated into Brabender environments, as well as third-party equipment

Before the usual fill study is carried out, the Operator can simply determine the volume of this material bypass flow that is continuously channelled off from the main flow by the extruder. In essence, the following two points must be observed:

- The first is to ensure that the main flow, which will ultimately be fed to the granulator, does not break off – after all, it exerts a certain tensile load on the line.
- Secondly, the diverted quantity is immediately deposited at the rate at which the SpeciMold creates its injection-moulded products.

A compromise needs to be found that will enable suitably quick filling of the cavity – ultimately, the polymer must not linger there for too long. As a general rule, the quantity diverted by the switch – the compound bypass flow – can be set so low that the main flow's diameter only decreases insignificantly, and the granulator's work is not affected. Of course, no complex calculations are required on the part of the user. It is enough to merely specify an interval in which the specimens should be created. The software takes care of the rest. If the main flow breaks off, simply set a longer interval.

Entire procedure is controlled electronically

If the chamber is filled with a sufficient quantity of the material, it is injected into the mould in a fully automated process. For example, a classic pressure switchover can serve as the 'trigger'. Just as in the classic injection moulding workflow, a holding pressure phase, decompression and cooling phase can be chosen.

The entire process is controlled by a PLC controller. The majority of injection moulding specialists will already be familiar with its user interface. And of course, the usual injection moulding parameters determined by a fill study can easily be stored and quickly accessed at a later point in time, as seen with other "state-of-the-art" injection moulding systems — yet another example of Brabender's commitment to provide the user with a tool that can be used universally.

Conclusion

With the SpeciMold, Brabender GmbH & Co. KG meets material developers' current requirements in many respects: Inline manufacturing of reference pieces not only saves time and energy; it also brings quality inspection to an entirely new level, and makes material development considerably easier. The SpeciMold is therefore an ideal addition to all businesses – from formula developers and research institutes who work as closely to real-world conditions as possible and additive manufacturers right up to compound designers – who all need to be able to analyse the highly specialised polymer formulations in the shortest time possible, or provide proof of product consistency for their clients' quality assurance purposes.

Even though the SpeciMold has been tailored for optimum results with proven Brabender laboratory equipment for material developers, and is offered as an entire package with granulator, extruder and downstream equipment, it can also be easily adapted for use with other suppliers' laboratory systems and units, thus supplementing them with an innovative quality assurance and analysis tool. The Brabender SpeciMold therefore helps the developers of tailor-made polymer materials to effectively adapt them to ever-shortening innovation cycles and the stricter quality requirements of ever more demanding customers. Most notably, the SpeciMold will help you save time, energy and money!

Info boxes:

FAQ: Recycling

Brabender's new SpeciMold inline injection moulding system not only solves problems relating to compounding the very latest high-performance polymers: It also helps when the use of recycled materials is planned. The industry is seeing increased acceptance among environmentally conscious end users, but can also provide plastics processors with assistance when it comes to reducing their material costs and planning their processes so that they are more economical.

The use of polymer materials during their 'second life' does however raise certain questions: Due to their product lives, used plastics have very particular and individual 'histories' (for example resulting from high thermal stress or from use in the open air, i.e. under UV light), as well as from crushing and melting in the preparation stage. These naturally have effects on their properties (as a blend or in composites). And this is not only with respect to the stiffness of materials filled with glass fibre, which has a correlation to the average fibre length: Every time sensitive polymers are melted, their properties degrade further. Even wood plastic composites (WPC) are known to react to high thermal stress with particular sensitivity.

With the SpeciMold, how recycled materials actually behave in the injection mould can be quickly and reproducibly established right in the materials laboratory, without them being negatively affected further by additional melting before manufacture of the specimen.

FAQ: Residual moisture

The SpeciMold addresses residual moisture which is an important, yet ofter neglected aspect of polymer processing.. It is well known that some polymers (for example 'biopolymers', but also polyester or polyamides) will experience hydrolytic decomposition upon contact with water. This results in dramatic changes to their properties. Even with plastics that are less susceptible to hydrolysis, such as polyolefines, water can also lead to the incorrect interpretation of measurement data during the material development stage. One of the reasons for this is that water adsorbed from the granulate is a compound 'component' that is not taken into account, which therefore distorts the formulation. Furthermore, even additives in the material can be disintegrated, which can negatively alter their effects.

All of these problems can be mitigated by the use of suitable analysis instruments, such as Brabender Messtechnik GmbH & Co. KG's AQUATRAC, as well as sufficient drying. Pre-drying, however, consumes a lot of energy. But with the SpeciMold, this is no longer necessary, because the material used for manufacturing the sample is separated and processed immediately after passing through the extruder, before it has the opportunity to adsorb water from the laboratory environment.

FAQ: Compatibility

As the newest member of the Brabender family, the SpeciMold is of course optimally tailored for use with other system components from the Brabender lineup – both in terms of throughput as well as connection. Examples of ideal partners when it comes to efficient plastics analysis are the Brabender *Plasti-Corder Lab-Station* and Brabender *Plastograph EC* plus torque rheometers with appropriate measurement extruder attachments. The ideal compact extruders for the Brabender 'dream team' are the *Lab-Compounder KETSE 20/40* twin-screw extruder and the two single screw extruders *KE 19* and *KE 30*.

But at the same time, the SpeciMold is an explicitly autonomous unit, and is therefore not strictly limited to use in a purely Brabender environment: It can be adapted for use with other manufacturers' systems at any time. The customer can either order the required adaptors, threaded rings and retainer nuts from Brabender GmbH & Co. KG, or, if they have their own workshop, can produce them themselves: In this instance, Brabender will supply them with all the detailed information required.

The only resulting restrictions are in relation to the throughput, which in the case of the SpeciMold is tailored to laboratory requirements. As a plasticising unit, single or twin-screw extruders with a diameter of 11 to 27 millimetres can be fitted. However, in everyday practice, this restriction is not relevant, as users with higher throughput requirements, for example injection moulders, generally no longer develop their formulas themselves, but outsource them, and therefore rely on materials that have already been specified.

And of course, the Brabender SpeciMold is not just restricted to being used between twin-screw extruders and downstream equipment. For example, it is also possible to operate the unit with a film die for manufacturing foils, to bring quality assurance in this area to a new level.

Dumbbell specimens in the blink of an eye

By adapting the SpeciMold to users' requirements, Brabender demonstrates a considerable eye for detail in many respects. For example, the cassette moulds for creating the specimens can be switched quickly on the fly, without the need to stop the extruder. You then merely need to select a different filling programme that was previously adjusted to fit the new mould. In this manner, dumbbells and other types of samples can be created in the specified quantity from one and the same batch – which is especially time-saving.

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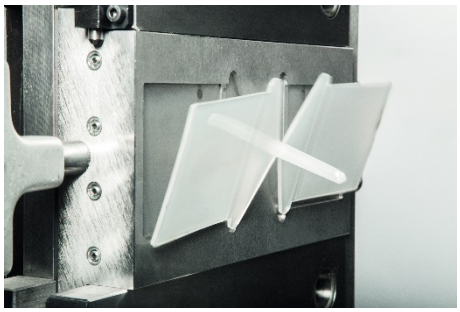
Fig. 1: SpeciMold

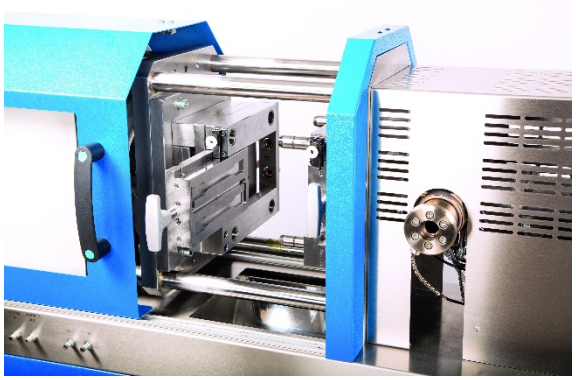
Time-saving machine from Duisburg, Germany: The SpeciMold, Brabender's innovative inline injection moulding machine, can help significantly speed up development processes in the polymer industry.

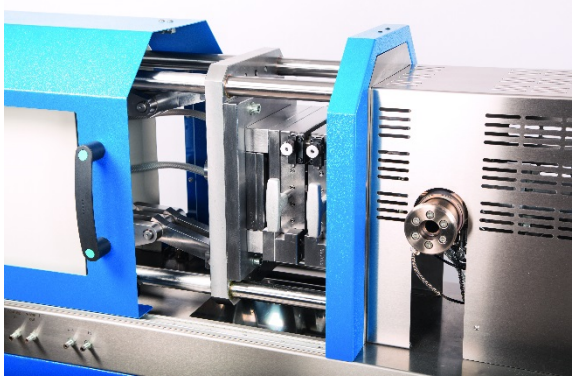
Fig. 2: Specimens/Injection mould



The Brabender SpeciMold produces samples during the ongoing compounding process. For example, small plates in accordance with ISO 294-3 (2002), dumbbell specimens in accordance with DIN EN ISO 3167 or flow spirals.

Fig. 3 and 4: Knee lever mechanism





The mould is opened and closed via a knee lever mechanism.

Fig. 5: Mould types

Interchangeable mould types: At the moment, Brabender already provides moulds for dumbbell specimens, small plates and flow spirals. The range is constantly being expanded.