IMC Technology Opens Up New Fields of Application

Injection Moulding Compounders. The combination of injection moulding with continuous plastification offers processing advantages – particularly where it is important to achieve high throughputs, to manufacture products with high filler contents or to solve complex plastification and compounding problems. As a result, injection moulding compounds are venturing more and more into new application fields.

The plastification capacities of injection moulding machines have been considerably increased in recent years. Nevertheless, the traditional single-screw, discontinuously operating plastification system reaches its limits in certain applications. At high screw speeds, the machine and material come under very high mechanical loads. High shot weights can only be achieved with large metering strokes of the screw. This reduces the effective screw length and also, to a comparable extent, the melt homogeneity. To improve the production of reinforced large-volume parts, Krauss-Maffei Kunststofftechnik GmbH has developed a system that combines the advantages of injection moulding and extrusion. The injection moulding compounder was first presented at K 2001. Its characteristic feature is the twin-screw extruder is directly integrated into the injection moulding concept (photo: Krauss-Maffei)

Fig. 1. In the injection moulding compounder, the twin-screw extruder is directly integrated into the injection moulding concept (photo: Krauss-Maffei)

Translated from Kunststoffe 8/2005, pp. 34–37
extruder, which is directly integrated into the injection moulding concept [1] (Fig. 1).

The continuous plastification process significantly increases the throughput. In addition, the injection moulding compounder has a significant advantage over a traditional injection moulding machine. With the IMC (injection moulding compounder), the processor can compound his own material himself, i.e. introduce fibres, fillers or masterbatches, into the process directly during processing. Since the material purchasing represents the largest cost block in the injection moulding of a part, the use of an injection moulding compounder increases cost efficiency [1]. Compared with pre-mixed compounds, the purchasing of individual components is much more cost effective.

**Increased Output with a New Clamping Unit**

In 2004, Krauss-Maffei further increased the efficiency of the IMC systems by equipping them with the two-platen clamping unit of the new MX range of large machines. The new clamping unit achieves very short clamping times with precise positioning. Even with large mould weights, the generously dimensioned platen support and guidance provide extreme platen parallelism. The one-part movable mould platen, with its special geometry, introduces the clamping forces into the mould in a particularly uniform way.

In the past four years, Krauss-Maffei has sold 25 IMC systems. Under production conditions, the injection moulding compounder permits a particularly homogenous melt quality, which allows lower injection pressures and thus enables the production of large parts with relatively small clamping forces. The injection moulding compounder shortens cycle times and reduces energy consumption. Thanks to these advantages, IMC technology is entering new fields of application. The main focuses are the incorporation of fillers into a polymer matrix, the production of fibre-reinforced parts and the production and processing of blends.

**Homogeneous Plastification Event with High Filler Contents**

The injection moulding compounder is used, e.g. for admixing fillers that cannot be easily handled in the standard injection moulding process because of their abrasive properties. A specific application is the production of counterweights for washing machines (Fig. 2). These parts prevent excessive vibrations from occurring in the spin cycle, and must therefore be as heavy as possible. Until now the counterweights were made of concrete. With the IMC technology, these parts can now be made of highly filled polyolefins. The high weight of 13 kg is achieved by admixing up to 90 % iron oxide to the matrix material. The abrasive effect of the filler is reduced to a minimum because, in the IMC process, the iron oxide is only introduced into the plastic melt at the end of the melting process. Changing over the counterweights to filled thermoplastics offers some advantages. The mechanical properties are much better than with concrete parts. No dust emissions are produced during processing of the thermoplastic counterweights. In addition, the filled thermoplastics are easier to fix in place and can be recycled.

Another example of incorporating high filler proportions into a thermoplastic matrix with the IMC is provided by the automotive industry. Here, the riding comfort is enhanced by noise-damping components (Fig. 3). Large-area insulating elements are mounted between the engine compartment and the passenger compartment. Fillers such as barium sulphate increase the noise-damping effect of the material. The injection moulding compounder particularly demonstrates its suitability with the high filler proportions of up to 80 % that are required in these applications. The homogeneity of the melt permits a good filling behaviour even with complex parts. Besides saving on compounding costs, the processor has the advantage that he can adapt the formulation to requirements of the customer.

A third example of incorporating fillers is bipolar plates for fuel cells. These parts serve to produce electrical contacts between adjacent individual cells. They distribute the reaction gases on the electrode surfaces and ensure the removal of the reaction products. The bipolar plates moreover conduct the heat of reaction to a cooling circuit. As material, PPS or LCP, for example, is used containing up to 80 % graphite.

**Manufacturer**

Krauss-Maffei Kunststofftechnik GmbH
Krauss-Maffei-Straße 2
D-80997 Munich
Germany
Phone +49 (0) 89/88 99-0
Fax +49 (0) 89/88 99-3092
www.krauss-maffei.de
Institute for Plastics Technology (IKT), Stuttgart/Germany, investigated the use of injection moulding compounders for the production of bipolar plates. It was found that much reduced separation and orientation effects occur than with standard injection moulding processes with pre-compounded material. The gentle compounding of the material leads to a favourable distribution of the particle sizes. This improves both the electrical and thermal conductivity of the plates. Good material processes can of course also be achieved by pressing. However, the injection moulding compounder has the advantage in this comparison that it can produce bipolar plates with complex geometries without secondary finishing.

**Gentle Processing of Fibres**

In the profile and plate extrusion, wood has developed in recent years from a filler to a property-determining material component. The IMC transfers this development to the injection moulding field. The injection moulding compounder incorporates the wood fibres gently into the thermoplastic matrix. Low processing temperatures and precise control of the extrusion process prevent the thermally sensitive fibres from degrading during processing. The parts produced have such a high surface quality that they can even be used for applications with high optical requirements – such as chair shells. Other fields of application are transport boxes (Fig. 4), disposable pallets or covering plates in building construction.

IMC technology is also successfully used for incorporating glass fibres into thermoplastic parts for automotive applications. The best known application of this is the glass fibre-reinforced PP front-end carriers for the Citroën C3, Peugeot 307, Audi A3, VW Bora and VW Golf V (Fig. 5). The starting materials are unreinforced thermoplastics, which are added to the material hopper. The glass fibres – as rovings or cut fibres – are added at the end of the melting phase in the extruder. This makes the material costs much lower than when processing ready compounds, in particular of long glass fibre pellets. IMC technology also offers clear processing advantages. The fibres are less mechanically stressed than in the injection moulding machine. In the part, fibres with lengths of 1–5 mm are therefore found on average in the part. Fibre-reinforced frontends produced by the injection moulding compounder (Fig. 6) show outstanding fracture behaviour in highly dynamic loading tests. Other fields of application for injection moulding compounders in automotive engineering, such as door modules and instrument panels, are currently being tested.

The high throughput of the injection moulding compounder is an important aspect in the production of transport pallets (Fig. 7). The pallets each consist of an upper and a lower part and are produced by means of a stack mould. The shot weight reaches up to 48 kg. The melting capacity is up to 2500 kg/h. Even with these large amounts of material, the continuous extrusion process achieves a high melt quality. Where recyclates are used for pallet production, the IMC has another advantage. With a degassing stage, volatile components can be removed from the material during extrusion. Some manufacturers also reinforce the pallets with glass fibres to reduce de-
flection in the warehouse bay. Then, the metal inserts used until now are no longer necessary.

**Producing Blends**

Another field of application for IMC is mixing different polymers (blends), which are then processed directly subsequently. In a research project with the IKT, parts were successfully produced from a PP/PA blend. Here, the grafting reaction, the functionalisation of PP+PA, and incorporation of long fibres take place in a single stage. With the IMC, there is no sign of the separation that takes place with the injection moulding of finished compounds. Positive results were also obtained with the mixing of PC with ABS. That applies to the melt homogeneity as well as to the greater flexibility in processing and lower material costs.

**Summary**

The typical applications show how varied the applications of IMC technology can be. The advantages of the injection moulding compounder are always particularly useful when production involves high filler contents, high throughput rates or complex plastification tasks. IMC technology will open up further fields of application here in future. Several research institutes are involved in the continuous further development of the injection moulding compounding. They include the Institute of Plastics Technology, Stuttgart/Germany, the Fraunhofer Institute for Mechanics of Materials, Halle/Germany, and Neue Materialien Bayreuth GmbH. At Krauss-Maffei’s Munich injection moulding pilot plant, a new IMC system with a clamping force of 32,000 kN is available for tests under near-production conditions.

**REFERENCES**


**THE AUTHORS**

**DIPL.-ING. MATTHIAS SIEVERDING**, born in 1970, is head of injection moulding applications technology at Krauss Maffei Kunststofftechnik GmbH, Munich/Germany.

**DR.-ING. ERWIN BÜRKLE**, born in 1942, is head of preliminary development at Krauss-Maffei Kunststofftechnik GmbH, Munich.

**DIPL.-ING. RAINER ZIMMET**, born in 1944, is head of the development group on IMC injection moulding compounders at Krauss-Maffei Kunststofftechnik GmbH, Munich.