

# TechNews

Sumitomo (SHI) Demag

## BMC stuffing device poly-stuffer for thermoset processing

Sumitomo (SHI) Demag is a competent partner in the BMC systems engineering. Siemens makes targeted investments in BMC injection moulding.

*With a view to manufacturing its housing components, which are used in the area of electrical installation, Siemens started to set up its own BMC manufacturing facility at its Regensburg plant shortly before the turn of the millennium. Initially, the first choice was Fahr-Bucher, generally considered the leading brand in the area of mechanical engineering involving thermosetting plastics. In connection with the capacity expansions to be realised in 2006 and 2011, Siemens had found a perfect alternative to the original supplier, who had become insolvent by then, in Sumitomo (SHI) Demag Plastics Machinery GmbH, Schwaig. From material charging all the way to the injection nozzle, Sumitomo (SHI) Demag was able to offer the same technology, which meant that the processes that had become established by then could be transferred directly to the new installations.*



The Siemens plant in Regensburg expanded its production capacity further in 2011 with the addition of two BMC machines based on the Systec range.

Photos: Rahner Reports

Production at the Siemens site in Regensburg, which also houses the international headquarters of Siemens' Low Voltage Division, focuses on residual-current-operated circuit breakers and miniature circuit breakers. These wiring devices safeguard human life, prevent electrical fires and protect electrical cables against damage by overloading or by short-circuits both in buildings as well as in industrial applications such as machine switchgear cabinets. The highest safety standards in production ensure that the circuit breaking is performed with great reliability.

The internal components of the circuit breakers consist mainly of stamped and bent metal parts made from steel or copper as well as plastic parts made from PBT, PC or PES. These elements are fitted into a housing body made from heat-resistant and dimensionally stable thermosetting or thermoplastic resin to form a perfectly coordinated safety system. "We buy in some of the components required for our products," reports plant manager Stephan Schlauß, and he goes on to say: "In the area of plastics processing, the proportion of in-house manufacture is around 50 per cent. We source comparatively more thermoplastic injection moulded parts than thermoset parts externally. After all, there are only a few companies around that specialise in the processing of thermosets."

### The more cost-effective alternative in spite of the required re-finishing

Herbert Schneeberger, who works as a production planner for the plastic parts manufacture at the Regensburg plant, explains where the cross-linked materials are used: "We predominantly use thermosetting materials for the lids and housing bodies of our miniature circuit breakers. In some cases we do use thermoplastics as well. But these must be thermally stable, which makes the materials that much more expensive. We therefore frequently favour thermosets, even if there is a certain amount of re-finishing required."

Besides the processing of free-flowing thermoset bulk compounds, the people from Regensburg have made a point of investing in BMC (Bulk Moulding Compound) technology and are now getting through some 800 tonnes of these unsaturated polyester resins heavily filled with fibreglass and aluminium hydroxide. "We appreciate the great advantage of the dimensional stability that the BMCs offer. Our material supplier satisfies the requirements we determined in the course of product development through customised bulk moulding compounds. Since the material does not absorb water, the items retain their dimensional stability permanently and don't undergo any changes in their mechanical and electrical properties either. All in all, the bulk moulding compounds impress through their good price-performance ratio," explains Herbert Schneeberger.

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### Smooth transition to Demag machines

According to Siemens, excellent dimensional stability was one of the crucial arguments for becoming involved with BMC technology back in 1998. And when there was a need to expand capacity for the first time in 2006, Siemens had to part company with the existing machine builder, since it had stopped manufacturing machines, and needed to search for a new partner. "What was of particular importance to us was that the feed mechanism to convey the paste-like material had to be of similar construction to the system we were familiar with," reports production planner Herbert Schneeberger. "We found out about the Demag machines from one of our suppliers, who was very happy with them, and we decided to go with them as well." In the end, the vendor, then still trading under the name of Demag Plastics Group, delivered a system to Siemens that was "one-to-one compatible," according to Herbert Schneeberger. It was thus possible to adapt not only the familiar stuffer technology for BMC injection but also the geometry and dimensions of the BMC feed screw and the nozzle geometry of the injection nozzle to the previous concept. "In the end, we had the same conditions as with the existing machines from the top feeding of the material all the way to the injection nozzle. That was of great benefit to us because it allowed us to transfer the previously tried and tested processes and processing parameters to the new 2,000 kN machine directly and without any great adaptation effort," said the production planner.

When a further expansion of the production capacity became necessary in 2011, it was therefore a matter of course that Siemens would once more turn to Sumitomo (SHI) Demag. The new machines are based on the hydraulic Systec range and operate with a closing force of 1,600 kN. "For one, we were changing a product, which had previously been moulded from free-flow thermosets, to BMC injection moulding. Secondly, we also needed the new machines to make up for downtimes of the older machines for servicing," Herbert Schneeberger explained the reasons for the new investment. On the two Systec 160 machines, lids and housings for miniature circuit breakers are produced in three shifts on up to six days a week using six-cavity injection moulds. Each machine is equipped with a handling unit, which remove the items from the mould and deposit them on a conveyor belt. From there the lids and housings are transported directly into a continuous blasting line, where the flash is removed by blasting with PA granulate beads.

### Flash formation provides the benchmark for mould quality

"We keep the formation of flash down by our finely adjusted process. We inject into the closed mould, build up a vacuum and then vent at the end of the injection process by just briefly removing the locking force, after which we reapply the locking force and effectively pack the mould through the hold pres-

sure," production planner Herbert Schneeberger describes the process details, and he goes on to say: "This minimises flash thickness. The thinner the flash, the less the effort and cost involved in re-finishing. Mould quality is a decisive factor in this. "For this reason, we construct virtually all the moulds required for thermoset processing ourselves, investing appropriately in their care and maintenance," stresses Herbert Schneeberger. When constructing moulds for new items, Siemens integrates sensors to measure the pressure inside the moulds. Knowledge about the process gained from the resulting pressure curves can then be transferred to subsequent moulds constructed for the same item. "As soon as we know which settings we should adhere to, we can do without the interior pressure sensors in further moulds without affecting part quality," says the production planner. In the area of BMC processing, Siemens is benefitting from its control over the entire value chain. From development to design and construction of the moulds to injection moulding and assembly, the items undergo all production steps right there in the Regensburg plant.



Herbert Schneeberger, production planner for the plastic parts manufacture in the Siemens Regensburg plant: "Using the tool technologies available today we are able to minimise the production of flash. This has a considerable effect on the amount of deflashing required."

### BMC features: stuffing, cooling, venting and extraction

The processing of BMC materials actually differs substantially from the injection moulding of thermoplastic materials in various aspects. The special material feed unit for the compound, which is supplied in bales and similar to sauerkraut in consistency, is just one of the idiosyncrasies of a BMC injection moulding machine. The hydraulically driven Poly 100 screw stuffers, which are constructed by Sumitomo (SHI) Demag, introduce the putty-type material into the feed and injection screw. The 100 l reservoir is easily accessible to operating personnel once a lid has been opened. At Siemens, an operator replenishes the reservoir manually with around three BMC bales per batch,

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weighing approximately 36 kg. There is no need to interrupt the injection moulding process while this is being done. Optical sensors monitor the quantity of material remaining. As soon as the injection moulding machine requests material for the metering process, the stuffing screw begins to turn. This builds up a defined stuffing pressure ahead of the screw, which is measured by a sensor and controlled via the rotational speed of the screw. During this process, the polyester bulk moulding compound is routed via a swivelling feed arm into the cooled cylinder of the BMC feed screw via a filling shaft located on the side. In order to ensure that the cross-linking does not take place until the material is in the mould, the temperature of both the cylinder area and the nozzle area needs to be maintained at around 35 to 40 °C. The injection moulds themselves are heated to a temperature of around 160 to 170 °C with cartridge heaters or heating coils. The BMC does not become free-flowing until it meets the hot mould surface; it then spreads out in the mould, reacts and hardens right there in the tool. Due to the relatively short hardening times of the BMC resin, cycle times are under half a minute.



In the tamper, the BMC material, which has the consistency of sauerkraut, is introduced into the plasticising unit with a stuffer screw and then fed to the actual feed and injection screw.

### Background to BMC machines

The Fahr-Bucher brand was considered the epitome of high-quality thermoset injection moulding machines up until the 90ies. In 1999, Krauss Maffei initially took over the BMC technology from the insolvent machine builder; four years later, hw.tech GmbH & Co. KG bought Fahr-Bucher Service GmbH from Krauss Maffei. After hw.tech went into insolvency in 2009, Sumitomo (SHI) Demag took over the well-known stuffer technology for BMC injection from hw.tech. Sumitomo (SHI) Demag developed the technology based on the Fahr-Bucher concepts further and integrated it into its injection moulding machines. The stuffer control unit, for instance, was integrated into the NC5 machine control system and allows the stuffer pressure to be controlled to provide constant material feed. In addition, the BMC machines from Sumitomo (SHI) Demag offer integrated electrical mould heating.

### Objective achieved: production with minimum amounts of styrene and dust

A further distinctive feature of plant engineering involving BMC is the presence of extraction facilities above the material charging and the mould area. The raw BMC material contains styrene, which acts as a component carrier on the one hand, facilitating dispersion and processing, and is incorporated in the cross-linking process as a copolymer on the other. To minimise pollution of the working environment by styrene being out-gassed, Siemens installed large extraction systems. "We extract both above the stuffer and above the mould, and we regularly measure the styrene content in the hall, which is always well under the limit," reports Herbert Schneeberger. The above-described evacuation and venting of the cavities and the associated extraction above the mould is also important because the cross-linking causes gaseous reaction products to be released. Also, other gases such as air contaminants or a volume of styrene gas in front of the material might prevent the cavity being packed out.

Siemens is thus achieving the high standards it aspires to both with respect to part quality and regarding the production facilities. The production planner condenses the complexity that this material group entails as follows: "To achieve consistently high quality is our greatest challenge. Because the interaction between man, machine and tool is even more delicate in the area of BMC than with thermoplastic materials."

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## Applications

- **Electrical modules** (electrical properties) power switches, overvoltage protection, magnetic coils etc.
- **Structural components** (mechanical properties) housing, connector, piston, safety helmets etc.
- **Moulded optical parts** (continuous service temperature) light housing, LED reflectors, outside cladding etc.
- **Automotive applications** (mechanics + temperature) brake pistons, pulleys, intake manifolds, turbocharger housings, valve covers, toothed belt wheels, throttle valves etc.
- **Sanitary facilities** (large components) washbasins, rinsing tanks, toilet lids etc.
- **Household products** (temperature contact) heat shields, impellers, stove borders, pot handles etc.

## Benefits of BMC/thermoset materials

- ✓ Lower shrinkage in combination with metal compared to thermoplastic materials
- ✓ Heat resistant
- ✓ Low pressure loss (near pressureless filling)
- ✓ Simple retaining of inserts (even pressure, no laminar flow during filling)
- ✓ Freedom of design for moulded parts (allows wall thicknesses of less than 0.5mm)
- ✓ Extremely accurate surface reproduction due to low viscosity (accuracy of surface reproduction for visible components)
- ✓ Allows strong adhesive bonds with thermoplastic materials
- ✓ Low shrinkage (precision parts)
- ✓ Excellent mechanical properties (adequate metal replacement)
- ✓ High chemical resistance
- ✓ Cost advantage (filler materials/not tied to oil price)
- ✓ Dimensional stability (freedom of design)
- ✓ Corrosion resistant
- ✓ Consistency of properties across a broad temperature range (-60 to 180°/220°C)
- ✓ Adjustable electrical properties (adjustable surface resistance and tracking resistance (CTI 600))
- ✓ Thermal expansivity within the range of aluminium
- ✓ Adjustable fire behaviour (low flue gas density, drip-free, halogen-free, free of heavy metals)
- ✓ Recyclable (particle recycling, cement production)
- ✓ Sound-absorbing (applications in engine compartments)