Highly Precise and Fully Automated

Compression Moulding. In the area of compression moulding and technology, the innovations presented at K were to be found in the details. Thus, presses are becoming ever more precise and the processes have now evolved from the development stage to series application.

The company **Dieffenbacher** GmbH & Co. KG presented a plant for the so-called LFT-D-ILC process, which compounds continuous strand-reinforced thermoplastics in line by the direct method. First, the polymer is melted and blended with additives in a twin-screw compounding extruder. In a second compounding extruder, the fibres are incorporated, wetted, dispersed and the polymer melt is then homogenised. The advantage of this approach is that the two extruders can be optimised for the sub-tasks. This leads to improved homogeneity of the polymer melt, especially if, in addition to the rovings which are usually fed to and processed in the extruder to continuous fibres, chopped fibres are introduced into the compounding extruder.

Back-compression-moulded Parts with Excellent Surface

At the Dieffenbacher stand, back-compression-moulded parts were also exhibited that the company has developed in collaboration with the **Fraunhofer ICT** and **BASF** AG. The goal of this development is to produce a surface that satisfies the requirements of automotive outer-skin applications.

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The highly promising results again confirm how fruitful close cooperation can be between institutes and machine manufacturers. It will be very interesting to see if this process makes it to series production.

Already in production is the fully automatic plant for the SMC compression process, which was also presented by Dieffenbacher (Fig. 1). This concept does away completely with manual steps. From unrolling and cutting the blanks to size, stripping the protective film from the SMC and inserting the cut-to-size package, all links in the process chain are automated. As a result, for example, variations in dwell times of the SMC material with removed protective film can be virtually ruled out. Robots also remove and deflash the parts. Process fluctuations that stem from the necessary irregularities of manual operation are reduced in this way.

The trend towards automated production was also to be seen in the production of parts from unreinforced thermosets. **L. Terenzio** S.r.l. and **Viebahn Pressen Systeme** GmbH presented production cells for toilet seats in which the cycle time has been substantially reduced by means of automation. Users can gain a further time advantage by pretreating the free-flowing thermoset moulding compounds. Terenzio has opted to dry the granules, whereas Viebahn prefers to pre-heat them. **Maschinenfabrik Lauffer** GmbH & Co. KG also showcased a production cell featuring a precision screw feeder and preheating of the granules to up to 100 °C.

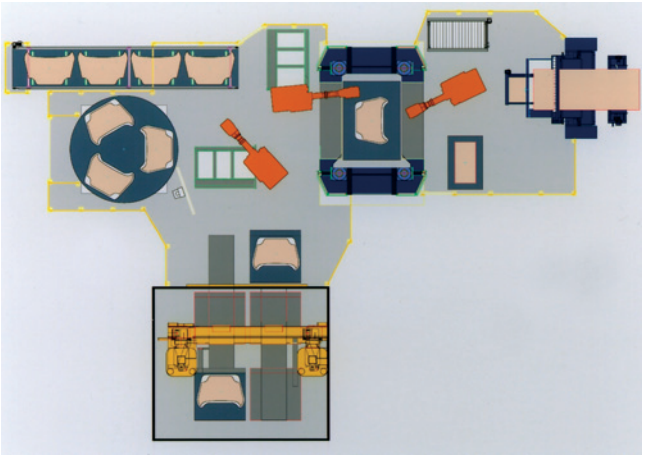

Fig. 1. Fully automated SMC process chain (source: Dieffenbacher)

Excellent Solution

Quadrant Plastic Composite AG presented, among other things, parts made from a blended nonwoven of polypropylene and glassfibres, so-called Symalite, that is laminated between two films. During processing, the increase in volume of the fibres during heating – so-called loft – increases the thickness of the material. The material is then compression moulded at a low clamping force. Here, a semi finished property, that was formerly regarded as a hindrance, is being selectively used to reduce the density. Various parts applications for this material have already received awards, e. g. the underbody of the BMW 5 series was honoured with the Innovation prize of the AVK-TV Arbeitsgemeinschaft Verstärkte Kunststoffe – Technische Vereinigung e. V. (Fig. 2).

Wickert Maschinenbau GmbH demonstrated the high-precision press for reducing optical moulded parts that had already been announced (see ***Kunststoffe*** 10/2004, p. 151). This is a precise example of how an improvement in sensors can lead to major advances in the field of press construction as well. The machine (Fig. 3) has a maximum compression force of 1000 kN that can be controlled with an accuracy of 70 N. The traversing speed of the embossing stroke is 0.001 to 0.5 mm/s, while opening and closing of the compression chamber occur at a rate of ▶

500–1000 mm/s. As is usual with these types of presses, the embossing chamber can be evacuated.

Press with Toggle Clamping Mechanism

Also a topic at K was the collaborative venture between **Coperion Werner and Pfleiderer** GmbH & Co. KG and **Müller Weingarten** AG, which had already been announced at the seventh international meeting of the Arbeitsgemeinschaft Verstärkte Kunststoffe – Technische Vereinigung e. V, held in Baden-Baden/Germany on 28 and 29 September. By way of innovation in the field of compression technology, a press featuring a toggle clamping mechanism was unveiled (Fig. 4). In this design, the press ram is connected to a toggle system that consists of two front and two rear powerful toggle packages that are opposed to each other. This creates a large surface area for introducing the force into the ram.

The ram is driven by servo motors that act on the toggle. This drive enables the ram force and speed to be controlled in line with process requirements. Moreover, the toggle also meets the strict requirements on closed-loop control of parallelism. A similar machine design has been widely used for years in Müller Weingarten's die-casting machines. Thus, the adjusting mechanism for altering the mould height via a vertical displacement of the upper tie bar on the four columns is well proven in practice.

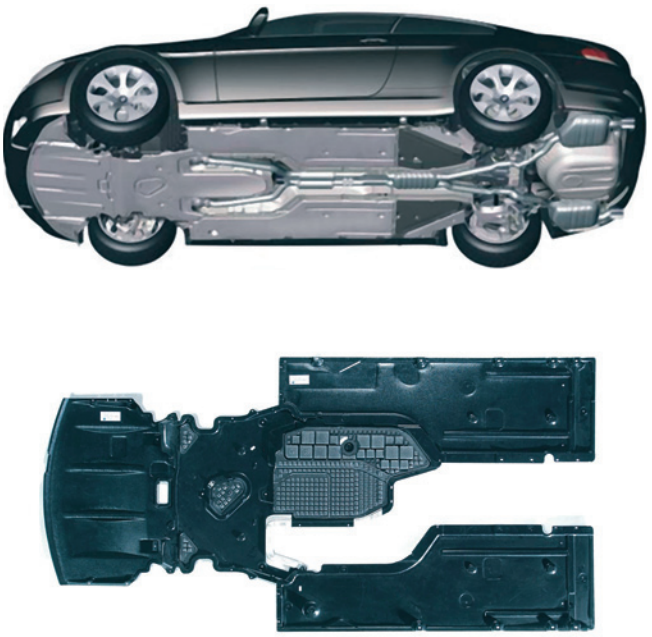

Fig. 2. Underbody trim for BMW; bottom: interior view with absorber (photo: Quadrant)

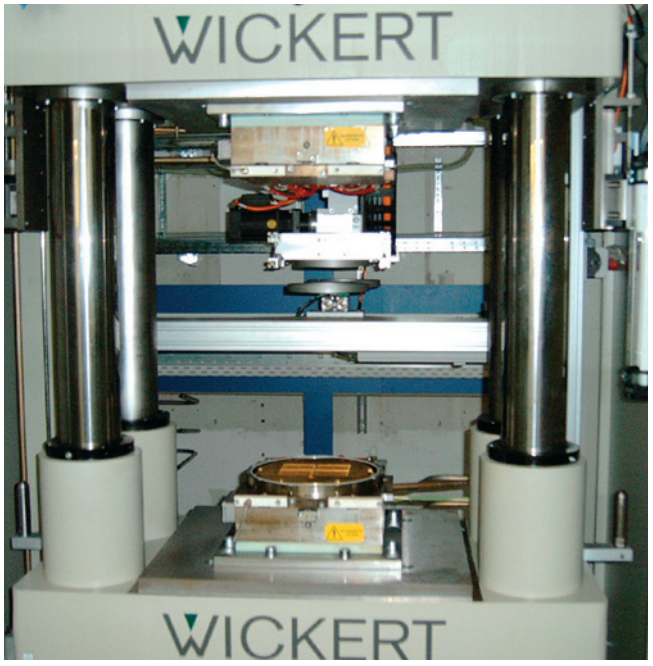

Fig. 3. Embossing chamber of what the manufacturer claims to be the "most exact 100-tonnes hot embossing press in the world" (photo: Wickert)

The expected advantages over conventional hydraulic presses accrue from the translation ratio in the toggle system, by which, in the upper ram position, rapid traversing of the ram is possible and, in the lower ram position, high forces can be generated with low energy input. When electromechanical drives are used, the drawbacks of hydraulic drives, such as less efficiency and maintenance of the hydraulic oil, are eliminated.

A further advantage over the use of holding cylinders, which ensure parallelism between the ram and table plate in hydraulic presses, is that, in the parallel closed-loop control, all forces come from one side and the compressive force generated in the drive is fully available for the compression process. Additionally, the toggle concept offers control advantages of hydraulic systems where there are high demands on accuracy. One can then expect lower operating costs (power consumption, no costs for oil hydraulics) and less maintenance outlay as compared with hydraulically driven machines. The first machine from this type of press, a patent for which has been filed, is to be presented at the end of 2005.

Simulations Becoming Increasingly More Accurate

Progress has also been made in the simulation of the compression process. **M-Base Engineering + Software** GmbH, which has been continually developing the software program "Express" in collaboration with the IKV, presented a new version of this process-simulation program for the flow-compression process. Elongational viscosity flow effects and wall slippage effects can now be taken into account. Up until now, simulation programs only allowed for shear flow in the flow channel and assumed adhesion of the moulding compound to the mould wall.

However, studies at the IKV have shown that elongational viscosity flow effects and slippage at the mould wall influence the simulation. Modelling of these effects now leads to more accurate predictions of the compression force in many cases (Fig. 5). Since the calculation of the compressive force forms the basis of all other calculation stages, further stages of the simulation, such as calculating fibre orientation, are expected to im-

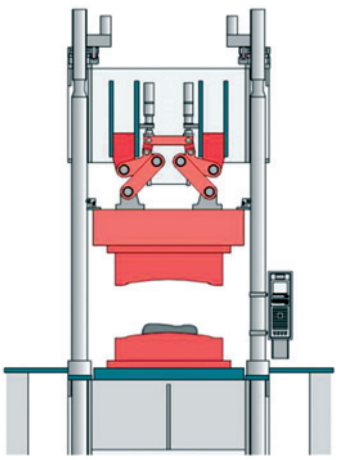

Fig. 4. Principle behind toggle press (source: Müller Weingarten)

prove. The Carreau parameters that are additionally needed to describe the elongational viscosity and the wall slippage factor of the compression moulding compounds can be determined with the aid of the squeeze flow rheometer developed at the IKV.

the quality of the material data and the assumed process parameters play an important role. Unfortunately, there is still is no material database in the field of continuous strand-reinforced compression moulding compounds. Since M-Base has vast experience in this area, the company will in future be building up a database for long fibre-reinforced compression moulding compounds. ■

Klaus Skrodolies

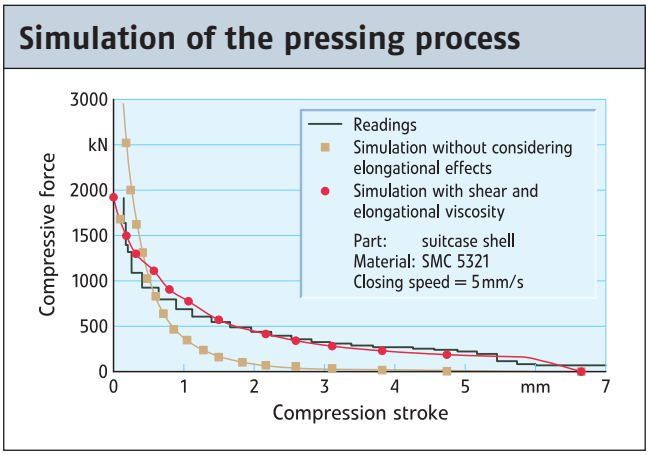

Fig. 5. Comparison of compressive forces in flow compression of SMC
(source: IKV)

A crucial factor in obtaining an exact simulation result is that the simulation be performed by a trained user who is familiar with both the simulation program and the compression process. In addition,