The „Renaissance" of RRIM Technology – a new trend

More flexibility through combination

Polyurethane RRIM technology gives users a great scope for design versatility in creating parts and components. FiberFlex technology adds even further to this flexibility because here the filler content can actually be changed from one shot to the next. Such a FiberFlex production system has been running at KVG in Geilenkirchen since October 2001. The company manufactures vehicle bumpers and side skirts.

Hans-Dieter Jansen, Managing Director at KVG GmbH / Geilenkirchen / Germany, is impressed with the high-precision drive system and flexible variation of glass-fibres in the moulded part (photos: Hennecke)

Dipl.-Ing. Dipl.-Wirt. Ing. Thomas Kirsten, Marketing / Communication Manager, Hennecke GmbH, Sankt Augustin, Germany
Jürgen Oelkers, Regional Sales Manager, Hennecke GmbH, Sankt Augustin, Germany

Flexibility is the key factor to success for manufacturers of moulded parts for the automotive industry. Intense competition among suppliers is one reason, the vast and ever growing diversity of vehicle models with a simultaneous reduction in production volumes of the individual types is another.

While thermoplastic injection moulding has proven to be cost-effective in large-scale production, the ongoing trend towards a growing model diversity has revived a strong interest in RRIM technology. Productivity will definitely be increased, if this technology is turned into

Reprint from PLASTVERARBEITER 2/2003, pages 18-21, Hüthig GmbH & Co. KG, Heidelberg

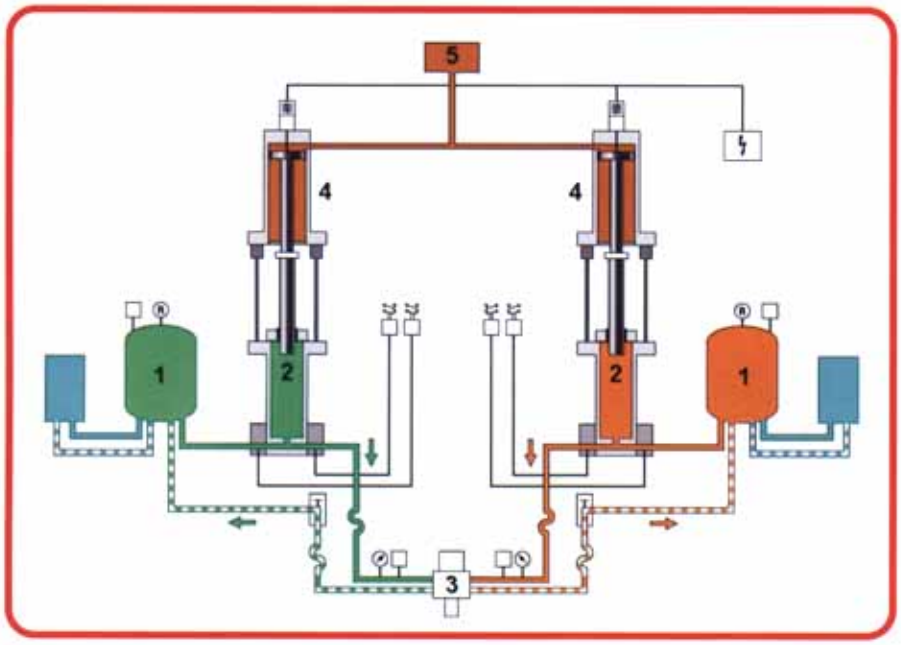
a flexible process by facilitating a variation of the filler-material. This new approach has already been realised at the plastics manufacturer Kunststoff-Verarbeitungs GmbH (KVG) / Geilenkirchen near Aachen.
Polyurethane RIM technology (RIM = Reaction Injection Moulding) was developed by Bayer AG/Leverkusen in the late 60s. Like classic injection moulding, the RIM process uses a cavity mould for shaping the plastic material. A multi-component PU reaction mixture is injected into the mould cavity where it cures into a moulded part.
The fields of application of this process can be expanded by adding fillers or reinforcing materials such as short-glass or mineral fibres (wollastonite). The name of this extended technology is RRIM (Reinforced RIM).
RRIM can in fact be used for manufacturing any number of the most diverse parts in an economically efficient way. In comparison to thermoplastic injection moulding, designers have much more creative leeway in developing three-dimensional large-surface parts because the available PU systems have a very good flowability during mould filling. RRIM is frequently used for making exterior vehicle body components, such as front and rear bumper shields, side skirts (side member claddings) and side panelling.

Maximum precision with each metering stroke

Characteristics of the RRIM process, such as
– use of abrasive fillers and reinforcing materials,
– high inner mould pressure due to long flow distances and thin walls of the components,
– some high shot weights carried out within very short metering times
as well as the automotive industry's extremely exacting standards in terms of parts quality call for a particularly high-grade processing technology.
The Rimdomat made my Hennecke GmbH / Sankt Augustin /Germany is a type of machine that is widely used for RRIM applications. It is the Rimdomat's design principle that makes it suitable for processing both unfilled and highly filled abrasive PU systems, even at high viscosities. The RIMDOMAT machine uses so-called plunger-piston metering cylinders adapted to delivering the necessary shot weights in a single metering stroke with ultimate precision. It is used mainly in applications where high shot weights have to be injected within a few tenths of a second (high-speed systems) and the output cannot be readjusted because of the short shot time.
The application range of this machine type includes the manufacture of thin-walled automobile body components reinforced with glass or mineral fibres, melamine-containing seat cushions or interior automotive insulating elements and the processing of pulverized recyclates.
While most piston-type metering units available on the market today have hydraulic servo-drives with valve control and control loops, the Rimdomat's two metering pistons each have a linear amplifier drive.
The machine control generates a pulse sequence, is converted by a stepper motor and through the linear amplifier into a piston actuating movement – and this takes place with utmost precise and reproducible accuracy. Each individual pulse corresponds to a defined mini-step of the metering piston. The pulse frequency, which may range up to 10 kHz depending on the machine type, determines the piston speed and thus, the output. The number of pulses defines the output.
This design means that there is no more need for remeasuring and readjusting the piston speed by means of machine control as is necessary on hydraulic servo-drives. Another advantage of linear amplifier drives is that they are virtually independent of any back-pressure so that mixing errors at the start and end of mixing cannot occur.

Vehicle body parts made with the RRIM method

But it is not only the metering machine that has to meet special requirements for RRIM processes, the mixheads too must be of special design. Hennecke for example tends to equip its machines with a 4-component MN-type mixhead, which is „armoured". This means that all critical wear parts are in fact hardened for applications with abrasive fillers or reinforcing materials.
The mixhead works on the four-jet principle to ensure an optimum mixing quality even at high output rates. It means that polyol and isocyanate are each split in half and fed to two injec-



Functional diagram showing the main Rimdomat modules: 1 Temperature-controlled work tank, 2 Metering cylinder, 3 Mixhead, 4 Hydraulic drive system with linear amplifier control, 5 Hydraulic unit

tors, which are positioned opposite each other. It is of course also possible to connect four different components to the mixhead.

Another decisive impact on the end-product's quality is the performance and optimum functioning of the RRIM's machine peripheral equipment.

The manufacture of a RRIM part starts with the preparation of a batch, i.e. a polyol filler mix is initially premixed at a preparation station and then fed to the processing operation. Maintaining the exact mixing ratio and ensuring a homogeneous distribution are not the only factors for proper batch preparation. Another is that some fillers, such as glass fibres for example, have to be processed without polluting the environment and without causing damages to health.

An automatic filler preparation process is better than the manual preparation of the polyol-filler batch, which can entail both health hazards and problems with keeping the formulation accuracy. The automatic preparation involves a mixing tank being applied with vacuum and the fillers thus being sucked into the liquid from the bottom of the tank. This procedure ensures that the fillers are properly spread within the polyol. An electronic scale, which is fitted with a formulation computer, controls and monitors the mixing process inside the mixing tank that operates with a special type of stirrer. When the mix is ready it is pumped into the work tank. This is necessary to bridge the batch preparation time, which may take up to 60 minutes.

All of the MN 20–4 high-pressure mixhead's elements that are subject to wear are hardened for use of abrasive fillers or reinforcing materials in RIM/RRIM applications.

Polyol filler mix with a high air content

A gas-loading unit, such as Hennecke's AEROMAT, is usually used for loading the polyol component with gas (air or nitrogen). The purpose of it is to enhance the flowability of the polyol filler mix and to obtain a fished moulded part with an optimum surface. In RIM or RRIM applications, the gas-loading factor is up to 70 % with a tank pressure of about 9 bar. To obtain such high air contents in the polyol filler mix while also ensuring ultra-fine dispersion and then to keep these stable and accurate, all of the individual modules, i.e. gas-loading unit, tank plus stirrer, piping, and this metering machine with its mixhead, not only have to be of top quality but also need to interact smoothly throughout the processing operation.

Flexible from shot to shot

Glass fibres are the most commonly used filler material. The actual fibre content in the moulded part depends on the required product properties. Typical filler levels are between 16 and 22 parts by weight, but higher and lower proportions are also feasible.

The manufactured thin-walled and therefore light-weight moulded parts display a special combination of properties, for example:

– high thermostability,
– low-temperature impact resistance,
– good elasticity and high flexural modulus,
– good dimensional stability,
– low thermal coefficient of linear expansion.

There is however a problem that frequently occurs under actual production conditions. If the ambient production conditions should alter, such as the air humidity, the shrink behaviour of the moulded part might also change during the production process. This would then need to be compensated by adjusting the glass-fibre content. As a result, the original batch with its predefined glass content can no longer be used. In other words, it is necessary to mix a new batch with correspondingly adapted glass percentage.

FiberFlex technology eliminates this problem because here changes in the moulded part's shrink behaviour can be

corrected by altering the glass content directly in the next shot. So there is no need for mixing a new polyol glass-fibre batch.
The process utilises an extra, i.e. second, unfilled or only slightly filled polyol in addition to the polyol glass-fibre mix already mentioned. An additional metering piston feeds this second polyol to the mixhead. The glass content can be altered from one shot to the next by varying the ratio between these two components with the stochiometric mixing ratio remaining the same.
Different filler percentages in the moulded parts can be realised in the same way, i.e. a single batch can be processed at different foaming stations, so that there is no need for mixing a specific polyol filler batch for each individual part. PU moulded parts with different filler contents, such as fenders, bumpers or side skirts, can now be made in parallel on one and the same production line. And that will increase both flexibility and productivity.
Though the FiberFlex principle may sound simple and despite the fact that its operation is very easy and user-friendly, the technology itself is in fact by no means „simple". A highly sophisticated state-of-the-art control system is needed to ensure that all machine modules interact with each other in an optimum way. Only specialists with the right know-how are able to handle the process operation.
FiberFlex was initially developed together by Hennecke GmbH and Wayand GmbH of Idar-Oberstein/Germany, where the first FiberFlex production line was installed with four foaming stations. Now, there are a number of other companies benefiting from this new technology. One of them is German plastics processor Kunststoff-Verarbeitungs GmbH (KVG) of Geilenkirchen near Aachen/Germany. A Rimdomat-FiberFlex system for the manufacture of vehicle bumpers and side skirts has been successfully in operation here since October 2001.
„The high-precision drive system as well as the variable glass-fibre contents in the moulded parts were the determining factors in our investment decision", Hans-Dieter Jansen, General Manager at KVG said.
A FiberFlex assembly unit specifically consists of:
– an extra metering piston for the second polyol component, which is either not at all or only slightly filled,
– an extension of each foaming station by the required control and supply units,
– for the second polyol a 500 litre work tank, which is insulated, temperature-controlled and automatically refilled by a pump,
– a machine control extension, i.e. its hardware and software.
Rimdomat production lines that have been supplied in the past can now also be retrofitted with FibreFlex.
Given an ever growing vehicle model diversity with production volumes of each individual type actually shrinking at the same time, suppliers of vehicle body parts are finding themselves under more and more pressure to manufacture with greater flexibility and higher economic efficiency. The parts and components they produce are subject to ever more stringent requirements in terms of mechanical properties, dimensional accuracy and surface quality. This trend necessitates the use of innovative and efficient manufacturing systems.

Rimdomat-FiberFlex production line in operation at KVG GmbH since October 2001.

Hennecke

Hennecke GmbH, a subsidary of Bayer AG, is located in Sankt Augustin near Bonn.
After manufacturing the first PUR processing machines in the early 50s Hennecke has today a workforce of 650 employees worldwide and manufacturing facilities in Germany, the USA and Japan. Hennecke ranks among the leading suppliers of polyurethane technology.
Its activities are split into five product groups: metering machines for a variety of applications, production lines for slabstock, sandwich panels, diverse applications in the automotive sector and for insulating refrigerated appliances.

Hennecke
Polyurethane Technology

A Bayer Company

Hennecke GmbH
Polyurethane Technology
D-53754 Sankt Augustin
Telefon: +49 (0) 22 41/3 39-0
Fax: +49 (0) 22 41/3 39-9 74
E-Mail: vw.marketing@hennecke.com
Internet: http://www.hennecke.com