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Expanding the market for long fiber technology

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Significant progress in processing long fiber reinforced plastics and advances in materials technology are providing new opportunities in the composites industry. *Reinforced Plastics* reviews some recent developments.

The potential market for composites based on long fiber technology is increasing as a result of new developments at a number of leading machinery manufacturers. Arburg, in cooperation with SKZ German Plastics Center, for example, has developed a fiber direct compounding (FDC) process for high strength lightweight construction. In FDC, fibers up to 50 mm long are added directly to the liquid melt. Arburg says that this enables lightweight molded parts with thinner wall thicknesses to be produced with the same strength, or metals to be replaced with plastics. The longer the fibers in the component, the better the mechanical properties. Until now, direct processing of longer glass fibers failed due to limitations during material preparation and dosage, as well as the granulate form. The FDC process developed by Arburg and SKZ enables the inline feeding of longer glass fibers, opening up new ways of reinforcing plastics (Figure 1).

According to Arburg, FDC offers several advantages in comparison with long fiber granulates. These include: targeted influence on component properties due to individual adjustment of fiber length, fiber content and material combinations; reduced destruction of fibers during melt preparation; increased strength through the use of longer fibers in the component; and use of less expensive base materials.

The cutting and inline feeding of fibers into the liquid melt requires specialized technology (Figure 2). A servo-electric side feeder on the injection unit cuts continuous fiber strands into 15–50 mm lengths (with an optimal maximum length of 33.6 mm) and adds them directly to the liquid melt. There is a special cylinder module for the size 2100 injection two-stage screw, which homogenizes the fed-in fibers and prepared melt, and the SELOGICA machine control system makes for simple programming and detailed quality control.

The company adds that cost-effective production at reduced unit costs was the main concern during process development. This includes a large material variety, with individual reinforcement of all common plastics with glass fibers, as well as other fiber types such as carbon. Investment costs are low as the process can be used on standard injection molding machines with clamping forces of 2,500 kN and higher. Fast reconfiguration is possible with universal application on various ALLROUNDERs thanks to the enclosed construction of the side feeder. Arburg adds that it offers maximum flexibility – conventional injection molding via a thermoplastic cylinder module is possible at any time. Highly resilient lightweight parts can be produced with automation through a robotic system for combination with organic sheets (Figure 3).

Continuous pultrusion

KraussMaffei and partners including Thomas Technik, Fraunhofer IGCV, Huntsman, Evonik and Covestro, have collaborated to develop a continuous pultrusion system – iPul – with a production speed of up to 3 m/min (Figure 4). In pultrusion, continuous fibers – usually glass, carbon or aramid – are impregnated with a reactive plastic matrix and formed to the desired profile in a heated mold. Grippers pull the cured profile continuously and feed it to a cutting unit. The new iPul system encompasses the entire sequence. The process encapsulates the impregnation of the fibers, which currently mainly takes place in open vessels, in an injection box that permits the use of fast reacting systems, such as epoxy, polyurethane and polyamide 6. The company says that this increases production speed from the current 0.5–1.5 m/min to approximately 3 m/min. This production efficiency approaches that of PVC extrusion, which opens new markets for this technology.

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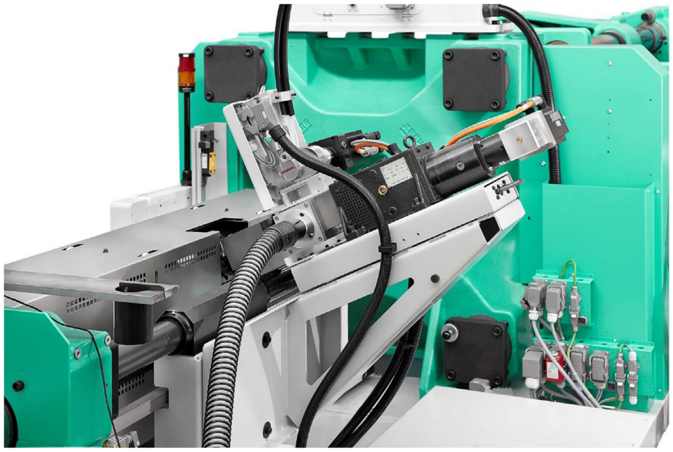

FIGURE 1
During the FDC process, fibers are fed directly into the liquid melt by means of a side feeder on the injection unit.

FIGURE 2
The fibers are supplied as rovings and are cut to the correct length during the FDC process.

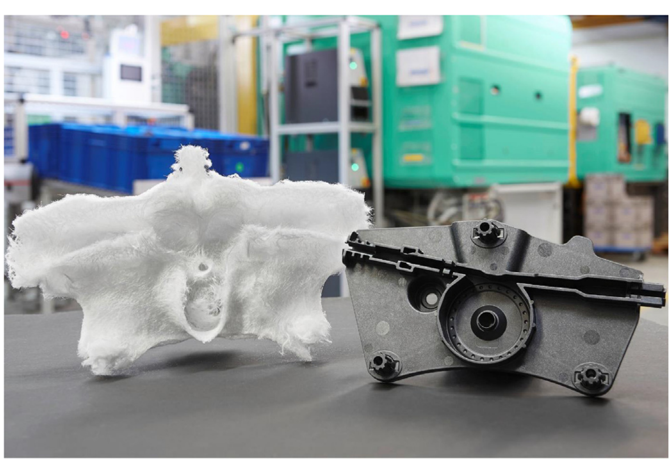

FIGURE 3
FDC ensures that long glass fibers are distributed homogeneously in the part, for example, an automotive housing before and after processing.

The company asserts that the new iPul system sets new standards. “It is the easiest way of producing profiles, there are hardly any turnkey offers, and it is a growth sector. In addition, we are knowledgeable about fibers, metering technology and even about extrusion,” says Nicolas Beyl, President of the Reaction Process Machinery business area of the KraussMaffei Group. Already shown at JEC in Paris, the new iPul complete system was demonstrated at a recent Competence Day (Figure 5), where around 220 visitors took the chance of experiencing it live. The event featured presentations by development partners and raw material manufacturers.

The iPul system has been developed over the past 18 months. The ‘i’ in iPul stands for injected, innovative, integrated and industrialized that are the core features of the system, according to Wolfgang Hinz and Daniel Lachhammer, pultrusion experts at KraussMaffei.

Customized pultrusion

ProTec Polymer Processing has introduced customized pultrusion lines for the production of high quality long fiber reinforced thermoplastics (LFT). The company says that these lines are capable of reliably processing difficult material combinations, such as carbon fibers and polypropylene (Figure 6). ProTec adds that its LFT technology is suitable for producing a wide range of materials comprising variable fiber reinforcement in a defined pellet length and using different polymers as the matrix. The lines are capable of producing LFT pellets with fiber contents of up to 65 weight percent at throughputs of up to 1,000 kg/h. Any conventional thermoplastics or even biopolymers such as polylactic acid (PLA) can be used as the matrix, while glass, steel, carbon or aramid fibers can be used as the reinforcing fibers.

In practice, LFT materials with fiber lengths of 7–25 mm are standard. When injection molded, LFT compounds with fiber reinforcement along the length of the pellets result in components which combine high strength and light weight with good surface quality – a particular requirement of the automotive industry. LFT pellets with a fiber length of approximately 12 mm are ideal for meeting this requirement.

The company adds that a high-performance twin screw compounding extruder is the focal point of the line, permitting highly flexible production of a broad range of individual polymer matrix formulations directly in the process. Recycled material and additional fillers can be included in the material formulation. The LFT line’s impregnation die, where the fiber strands are spread apart and coated with polymer melt, is designed in such a way that, even at recycled material contents of up to 10 percent in the melt, consistently high-quality impregnation of the fiber filaments is achieved. Various different creel racks required for unwinding glass and carbon fibers in the pultrusion line are also available. The turntables with the fiber bobbins rotate automatically in accordance with the bobbin diameter, so preventing fiber twisting during unwinding.

A central control system handles the LFT line and all its modules, with line speed, extruder throughput and pellet chopping length all being variably adjustable. Additional functions, located upstream or downstream depending on application, may also be integrated into the controller. These include drying,

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