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FEATURE

Longer fibers, increased strength

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When it comes to the cost-effective production of high-strength lightweight parts in large volumes, the length of the structural reinforcing fibers is of key importance. The rule of thumb here is: the longer the fibers incorporated in the plastics, the greater the resilience of the final products. The fiber length and content cannot be influenced in the case of ready-to-use fiber-filled granulate mixes. Things are different with innovative fiber direct compounding (FDC). Here, a side feeder can be used to incorporate fiber strands of variable length in the liquid plastic melt. This allows the mechanical properties of the parts to be improved. Moreover, it also offers significant cost advantages in comparison with fiber-reinforced standard granulate.

The use of fiber-filled plastics in lightweight construction is just one of several alternatives when optimum component properties are to be achieved and when every gram of weight counts. The focus here is on reducing weight without compromising on load-bearing capacity, rigidity or other design functions. Lightweight construction can relate both to the structure of an individual part and to a complete unit. Thus, for example, the use of honeycomb structures as they occur in nature has been a familiar feature in aircraft construction and in the automotive industry for many years. The trend toward electric mobility has caused this topic to gain considerable attention. Lighter batteries with greater efficiency and an increased range can only be achieved through consistent lightweight construction.

Fiber direct compounding (FDC)

If one considers the high demands placed on fiber-reinforced parts in automotive construction, for example, then it becomes clear that the individual adjustment of plastics and fiber lengths to the specific component properties is desirable. The technical solution for the processing of different fiber lengths that Arburg provides in the context of innovative fiber direct compounding (FDC) comprises a servo-electric side feeder with integrated cutting device, an adapted cylinder and a special screw geometry. The continuous fibers from inexpensive glass fiber rovings are cut into lengths before being added directly into the liquid melt (Fig. 1). Fibers up to 50 mm in length can be cut in theory, however a maximum length of 33.6 mm has proven itself in practice.

Advantages of glass-fiber reinforced plastics

The most important advantage in using fiber-reinforced plastics is their great mechanical load-bearing capacity, which is not temperature-dependent. However, a noticeable effect on strength and toughness is only achieved with fibers exceeding a length of 2 mm. Distortion, creep and energy absorption are similar to those of metals, however with the benefits of thermoplastics. While conventional granulate mixes have fiber lengths between 0.3 and a maximum of 6 mm, the side feeder from Arburg enables fiber lengths of between 15 and 50 mm to be incorporated in the plastic melt. In addition to the fiber length, the fiber content and material combination (and therefore the part properties) can be individually influenced.

Greater part strength

In essence, the principle of the side feeder on the injection unit is very simple. The fibers are fed directly from a roving, cut to the required length by means of a cutter and added to the liquid melt. The screw of the injection unit has two sections. Firstly the plastic granulate is melted, then the cut fibers are fed to the front of the injection units and homogenized with the plastic through the movement of the screw.

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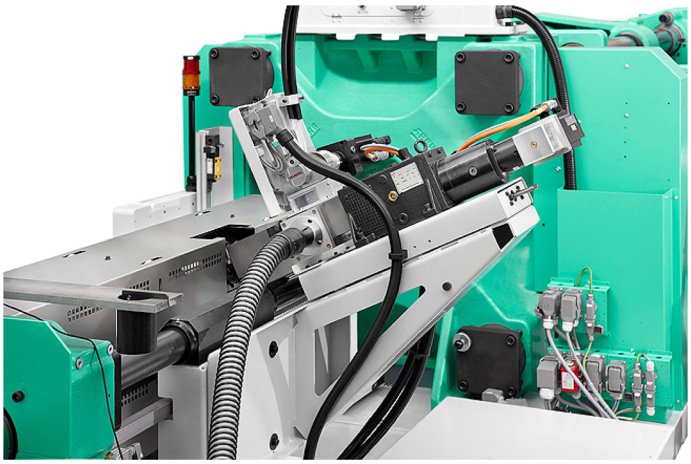

FIG. 1
During fiber direct compounding (FDC), the fibers are fed directly into the liquid melt by means of a side feeder on the injection unit.

A demonstration part illustrates the proportion of longer fibers that can be incorporated through FDC: when a conventional long-fiber granulate is used, around 30 percent of the fibers are longer than 2 mm. With FDC and 16 mm fibers this percentage increases to around 50 percent.

Long fibers bring clear advantages

Fiber direct compounding offers clear advantages in comparison with long-fiber granulates: There is far less damage to the fibers during melt preparation, the strength of the components increases significantly and their properties can be influenced in a more targeted way through the individual adjustment of fiber length, fiber content and material combinations. Finally, FDC also offers immense cost benefits when the much less expensive base materials are used separately. During long fiber direct injection molding, long-fiber rovings and a bonding agent are required in addition to a standard commercial PP LGF 30 (Fig. 2). The cost benefit in series production is significant.

FIG. 2
Cost-effective and flexible: The fibers are supplied as rovings and are cut to the correct length during fiber direct compounding process.

Feeding and cutting integrated in control unit

The FDC process can be fully integrated in the Selogica control unit with dedicated symbols. The symbols can be flexibly placed at different points in the cycle sequence. A plausibility check is used to establish whether the sub-sequences are integrated in a rational way. This process is thus also incorporated in quality monitoring of the machine control system.

The flexibility of the process is also evident in daily use. Thus, for example, it is possible to use a wide variety of materials because many commonly used plastics can be reinforced with fibers in the manner described above. The enclosed structure of the side feeder enables injection molding by means of the thermoplastic cylinder modules of various Allrounder injection molding machines and rapid changeovers. The basic investment also remains modest when the system is used on standard injection molding machines with a clamping force of 275 tons or more. It is also possible to automate FDC. For example, a robotic system can be used to insert additional organic sheets into the mold, significantly enhancing the load-bearing capacity of the lightweight parts.

Combination of FDC with composite sheets

The continuous fibers, whether in woven or non-woven form, enhance the mechanical characteristics, such as strength and rigidity. The benefits of the multi-material design are exploited through the combination of the FDC process with thermoplastic composite sheets: the thermoplastic composite sheets provide extra strength. Highly resilient composite parts are produced that can replace metal in some cases.

An example for such a high-strength, lightweight composite component used in the automotive industry is a pedal for the automotive industry (Fig. 3). In order to increase the rigidity of the component, two additional organic sheet sections of different thicknesses are inserted into a single-cavity mold and further functional and reinforcing elements are subsequently molded on.

Fast and efficient: the process sequence

Firstly the organic sheets are gently heated by means of a heating plate in the gripper of the central six-axis robotic system before

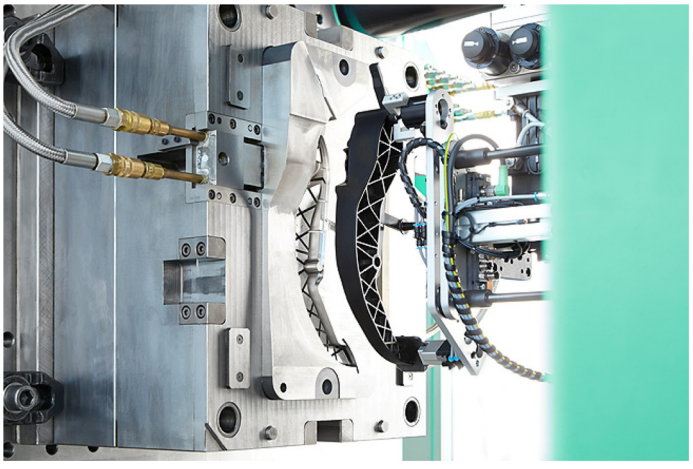

FIG. 3
Fiber direct compounding process can be used to produce a pedal and other reinforced lightweight parts for the automotive industry, for example.

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