"PUSHTRUSION℠" DIRECT IN-LINE COMPOUNDING

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Abstract

Pushtrusion℠ is a new technology that combines continuous fiber reinforcement with molten polymer, creating fiber reinforced compounds during the molding process. The continuous reinforcing fibers are cut to specified lengths to create short fiber compounds, long fiber compounds, or even continuous fiber reinforced materials. The technology can be used with many part forming processes, including injection molding, compression and transfer molding, extrusion, and filament winding. The process was developed and patented by Woodshed Technologies, Inc. The process is licensed to end-users. PlastiComp, LLC, acquired the technology, including patents and trademarks, from Woodshed in May 2005. Equipment is manufactured to use existing molding machines (retro-fit), or for new molding machines with compounding technology integrated by licensed OEM machine manufacturers.

Introduction

Cost reduction is a dominant industry "driver" or requirement. Since raw material cost is typically the largest cost component of plastic part manufacturing, reduction of material cost can be the most effective cost reduction activity for a plastic part producer. Direct compounding (in-line compounding) is a process that creates the plastic compound during the molding process. This is a fundamental industry change that eliminates the compounding step in the traditional market value chain. Direct compounding has already been established as a successful technique for compression molding, especially for large volume, large size parts. For injection molding, direct compounding has not yet been well established as a successful technology. Competitive in-line compounding processes are expensive, complex, and require substantial floor space. Our new compounding technology is a simple process requiring little additional floor space, low maintenance, and it can be added to existing molding equipment. This technology provides a unique route to market for injection molders to incorporate cost reduction into their business strategy.

Direct Compounding for Injection Molding

In the direct in-line compounding process, thermoplastic resin pellets are fed into the hopper of the polymer injection unit. The injector unit is a typical injection barrel capable of melting resin and homogeneously mixing and injecting the melt into the process at high rates and pressures. Continuous glass fibers are pulled from the supply creel and into the process die by the high-pressure flow of molten resin. The entrainment die is designed to meter glass fiber and molten resin, keeping the glass fiber percentage within close tolerances. The glass fiber strand and molten resin mixture is pushed from the viscous entrainment die at 100-200 meters per minute. This process starts and stops instantaneously, as dictated by the material in-feed requirements of the injection press barrel. An in-line chopper cuts the glass fiber imbedded in the molten thermoplastic resin as it exits the viscous entrainment die. The chopper's cutting chamber is heated to maintain the cut mixture in the molten state and this cut mixture is directed through a nozzle positioned directly above the injection press screw. Glass fiber cut lengths of 3 – 50 mm through several inches are possible. The "Pushtrusion Process" is capable of controlling glass fiber percentages within a narrow range. A total variation of less than 1% by weight is typical.

A single input signal from the injection press is required for the system to operate. When the injection press screw is turning, the system is delivering molten material. The system stops delivering material when the injection press screw stops turning.

Four significant process advantages occur when chopped glass fiber and molten resin are fed into the injection press barrel.

- Advantage #1: Conventional pultruded pellets in lengths of 25 mm or longer are difficult to feed. The mixture from the process is pliable, allowing very long fiber lengths to be processed without experiencing feeding problems. Cut lengths of 50 millimeters and longer would be possible if the injection press were large enough to handle them.
- Advantage #2: The resin has already been melted, allowing for gentle mixing and maximizing retained fiber length of any given chop length.
- Advantage #3: The screw and barrel wear associated with melting resin and glass fiber pellets is eliminated.
- Advantage #4: The resin has undergone a single melt history, minimizing degradation and improving physical properties.

This direct in-line compounding system is compact in comparison with other in-line compounding systems. The fiber/resin mixing die has no moving parts and, therefore, functions on the basis of viscous entrainment. The integral, variable speed cutter is a unique and patented hot strand cutter. The process speed through the entrainment die is typically in excess of 200 meters per minute. Mechanical systems have been developed with either hydraulic or electric drives.

Pellets or Direct In-Line Compounding

The industry debate over which technique - precompounded pellets or in-line compounding - is misguided, as both have merit and utility. The customer will usually select the route that best fits their business strategy. The option to go either in-line or precompounded, simply adds to the options for business success in a highly competitive industry environment.

Another side of this debate is the issue of formulation competency. Several molders already are formulating successfully. A new option now available is to use the in-line compounding process with formulation technology provided by PlastiComp and its partners.

PlastiComp has completed various studies to evaluate different grades of polymers and alternative fibers. Studies with both co-polymer and homopolymer polypropylene suggest that different applications can benefit from selection of the proper PP for each application. Additional studies with chemical coupling systems suggest that mechanical properties can be enhanced with the direct in-line process, when comparing results to precompounded pellets.

Conclusion

A unique process for in-line compounding has been developed that provides value to customers by reducing molded part cost and can be retrofit to existing molding equipment, or purchased integral with new molding machines. The process offers simple and practical solutions for today's competitive market environment.

References

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About the Author

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Previously (1984 - 1999), Steve was President and CEO of Celstran, the long fiber compounds subsidiary of Ticona.