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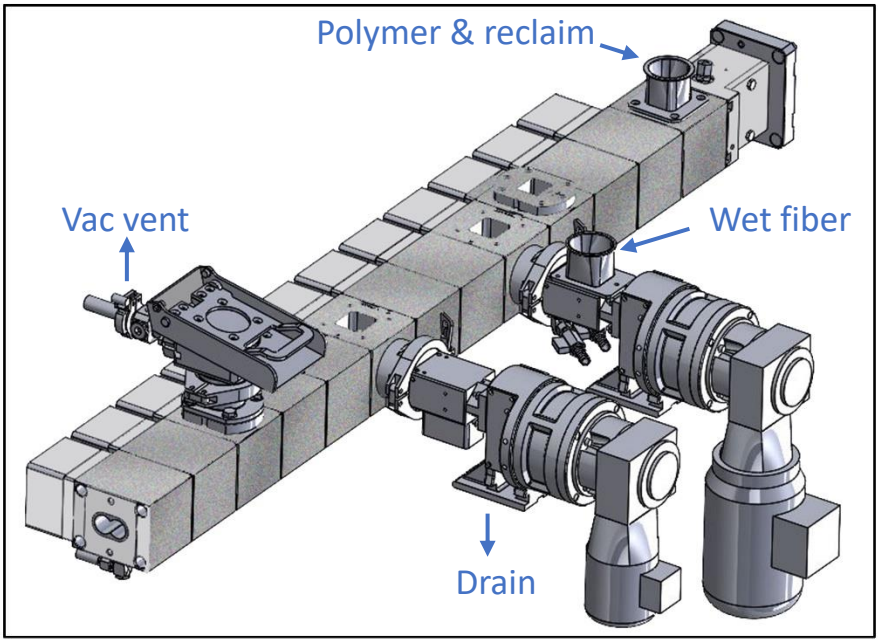
A comparison of twin screw extrusion technologies to process natural fiber composite compounds

Co-rotating, intermeshing twin screw extruders (TSEs) are widely used for processing and compounding natural fiber plastic composites. In addition to mixing the fibers, polymers and additives, the management of moisture inherent with natural fibers also plays an important role. The following provides an overview of the available TSE technologies for this application:

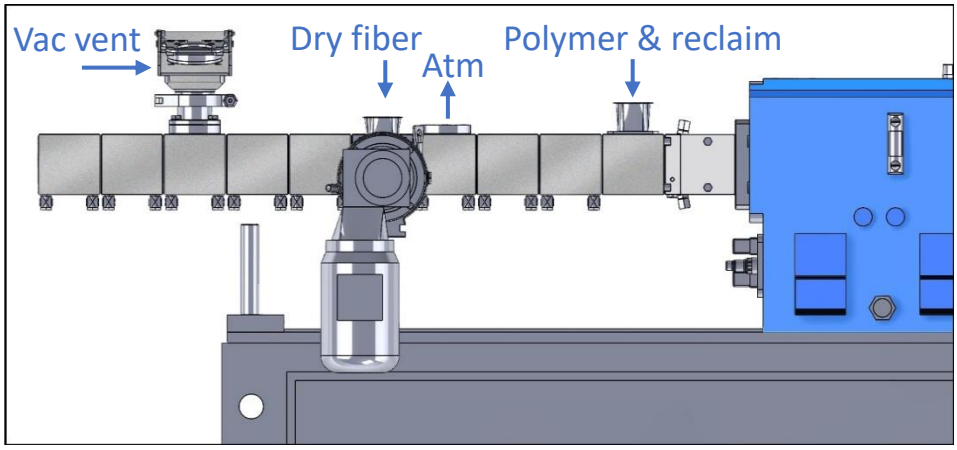
1. Wet fibers & split feed
2. Dry fibers & split feed
3. Dry fibers & pre-Mix
4. Wet fiber 1st & split feed- Don't do it!

Wet fibers & split feed: This process is performed by a co-rotating intermeshing twin screw extruder. The polymer (pellets, powder, flake, or reclaim) and additives are metered into the main feed throat and the undried natural fiber (typically 8-15% moisture) are introduced by a side stuffer into the process melt stream. The TSE process section integrates multi-stage venting, and vent stuffers (twin screw augers with drain or vacuum) are specified where high moisture removal occurs. Mixing elements simultaneously mix and provide a melt seal for vacuum vents. The advantages of this process include the elimination of pre-drying the fibers and excellent retention of fiber structure.



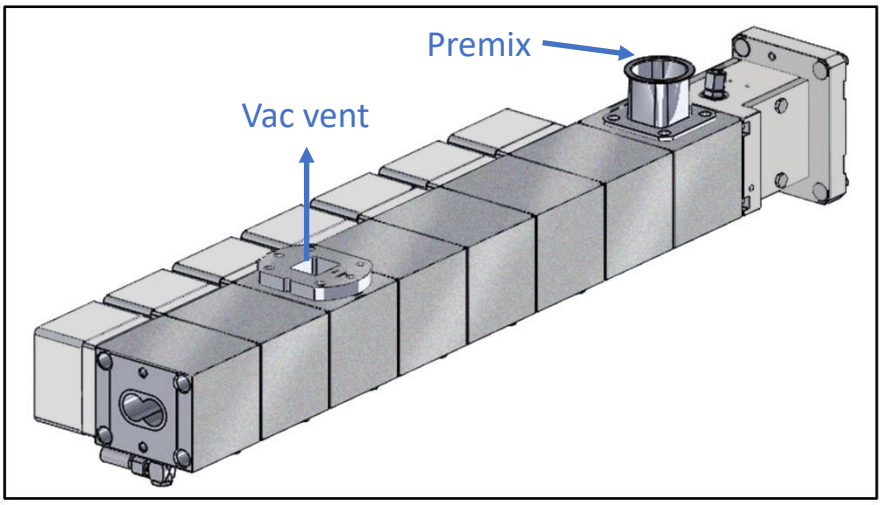
Example pellets/reclaim in main feed port+ wet fibers & split feed

Dry fiber & split feed: This process is also performed by a co-rotating intermeshing twin screw extruder. Polymer and additives are metered into the main feed throat and dried fiber (typically 3% +/- moisture) is introduced by a side stuffer into the process melt stream, just like any other filler material. The L/D ratio is specified to minimize the thermal exposure of the natural fiber, and a vacuum vent removes residual moisture. This process configuration results in high throughput rates and minimal fiber attrition.



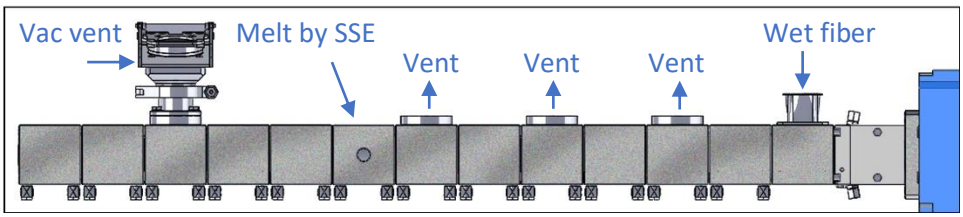
Example pellets/reclaim in main feed port+ wet fibers & split feed

Dry fiber & pre-mix: This process can be performed by either a co-rotating or counterrotating intermeshing twin screw extruder. The polymer and additives are metered into the main feed throat. The polymer component is typically in powder form to minimize particle segregation during the metering step to the TSE, and also helps facilitate a gentle melting effect. Due to the low bulk density and potentially poor flow characteristics of the pre-mix, a crammer assist feed mechanism sometimes may be required to facilitate feeding. A short L/D ratio (approx. 30/1 or less) is specified and a vacuum vent typically removes residual moisture. The main advantage of this process is simplicity. Interestingly, this TSE configuration has been in commercial operation since early 1970's.



Example dried fibers and powder pre-mix

Wet fiber 1st & split seed: An alternative process that has been attempted is a method where undried fibers are metered into the main TSE feed throat and super-heated to facilitate water removal prior to introduction of the plastic/additives downstream via a side stuffer or single screw extruder. This process has proven to be unviable in a production setting due unstable and inconsistent process, equipment wear and maintenance issues. The bottom line in our opinion is- do not do it!



Example wet fibers and downstream polymer melt feed

Pelletization vs direct extrusion: Pellets can be produced for natural fiber composite formulation. Water quenching, for either strand cut or hot face pelletization, helps rapidly cool and size pellets, but often causes the pellet to pick-up moisture. An in-line continuous dryer can help eliminate this issue, or alternatively a die face pelletizer where the molten strands are cut at the die face by high speed knives. The pellets are then conveyed to a vibratory cooler/separator. The optimum pelletizing system is highly formulation dependent, and therefore testing is recommended to determine what works best.

Combining TSE compounding/devolatilizing with direct sheet or profile extrusion is also possible. If tight product tolerances are required, a gear pump or single screw front-end attachment is used to provide a consistent and elevated front-end pressure to the die. The downstream equipment is then the same as if mated to a single screw extruder. Some advantages associated with the direct extrusion process include: avoidance of moisture pick-up, saving conversion costs associated with pelletizing, and better properties since the natural fibers having one less heat and shear history. (less fiber attrition)

Don't hesitate to contact Leistritz Extrusion to prepare a quotation, schedule a test in our USA process development laboratory, or to discuss twin screw technologies in general.

We look forward to working with you in the future!

Team @ Leistritz Extrusion