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Thermo Scientific Process 16 Twin-screw Extruder

Enhanced flexibility for your material development

ThermoFisher SCIENTIFIC

Introduction

Twin-screw extrusion is the standard for mixing and compounding in polymer processing and has expanded into other applications for new material development. The extruder offers a high level of process flexibility, more control of process parameters, and can produce a wider range of products. Being a continuous mixing process where a base matrix and multiple additives are transformed into a new compound, extrusion has benefits for multiple products beyond traditional polymer processing such as:

Packaging - Producing bio-based, recycled or compostable packaging materials to save natural resources

Food - Development of meat analogues from plant proteins, alternative proteins and up-cycling of food-by-products

Pharmaceuticals - Developing new medications with better drug availability for patients

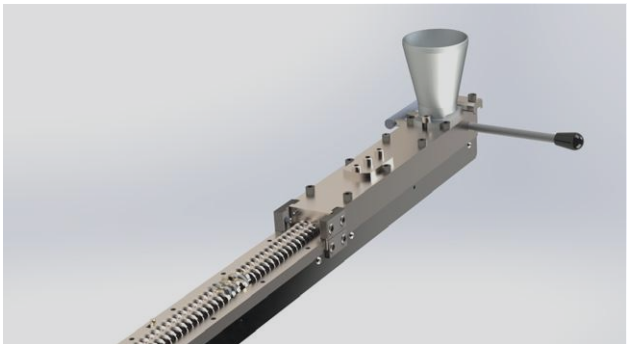
Every day products - Increase the utility of multi-touch surfaces by adding antibacterial properties.

The Thermo Scientific™ Process 16 Twin-screw extruder opens up many possibilities for your R&D and manufacturing environment, promoting fast and reliable material development in the polymer, food, or pharma industries. The Process 16 Extruder is a highly modular, flexible extrusion system with a wide range of options and accessories to exactly meet your processing requirements.

Flexibility of twin-screw configurations

The flexibility of the Process 16 twin-screw extruder results from a set of clever features. The segmented screw design e.g. can be reduced in length allowing to control the residence time inside the extruder or to adapt to low material availability. Also, the barrel design and available feeding options give the user the necessary flexibility to create processing solutions even for the most demanding materials.

Fully segmented screw
The process length of a fully segmented screw can be adapted from 40 L/D down to 15 L/D. A Process 16 extruder system can be individually configured to exactly match the process requirements with a wide range of conveying, mixing, and extrusion elements. Segmented screw configurations offer a solution for feeding and mixing of challenging materials such as fibers, nano materials, or shear sensitive additives.



Horizontal split barrel
The horizontal split barrel has a removable top that can be opened for easy cleaning and process inspection. It also offers six barrel-ports on the top that can be utilized for solid and liquid feeding, as well as inserting analytical tools (e.g. NIR probe) or for venting. The fully ported design and modular screw delivers ultimate process flexibility.

Side feeding
Side feeding can increase the amount of low-density fillers, such as wood fibers, that can be incorporated into a base polymer. With the Process 16 Twin-screw Extruder, the user can choose between 4 different locations on the barrel to place the side feed and has the option to run 2 simultaneously. Since the side feed connection is placed at the back of the barrel, setup is simple, quick and does not interfere with access to the extruder during operation.

The benefits of free volume vs. high specific torque in the laboratory

Getting more productive ...

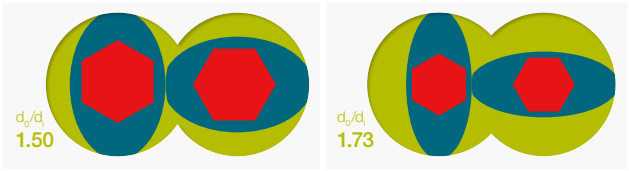
Increasing extruder output is an option to provide a cost-effective commercial extrusion process. Within a commercial manufacturing setup this can typically be achieved by increasing the specific torque [Nm/cm^3] of the extruder.

Increasing the specific torque with a fixed screw diameter will decrease the available free volume. With the increase of specific torque, the shaft needs to become more solid to transmit the higher torque, therefore maximizing torque and maximizing free volume are inversely related process parameters.

> “What doesn’t enter the extruder cannot be processed!”

... needs the right strategy

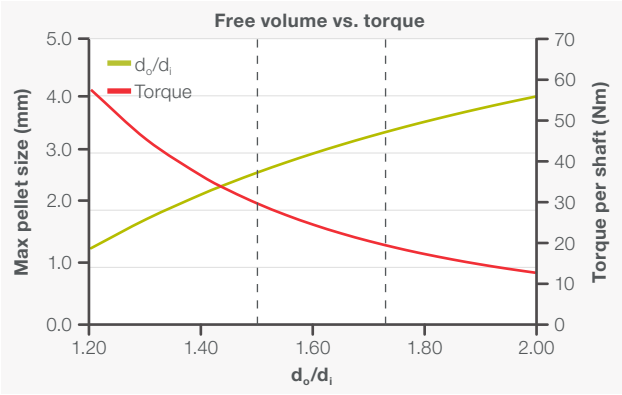
Free volume is related to the ratio of the outer and inner screw diameters (d_o/d_i). The image below depicts the difference in free volume for a constant screw diameter when (d_o/d_i) is changed. The comparatively small change from 1.50 to 1.73 shows a significant increase in available space between the twin-screws (green area) were the material must travel in order to be processed.



Change of (d_o/d_i) with a fixed screw diameter.

The trade-off in volume may not be a big problem with large screw diameters within production scale extruders. The absolute free volume within a high-torque extruder e.g. 60 mm screw-diameter is still enough to accommodate pellets, fibers or low-bulk density materials. However, with screw sizes typically used in the laboratory or a pilot plant (e.g. 11, 16, or 24 mm screw diameter), increasing the specific torque directly reduces free volume and may prevent materials from entering the extruder.

To ensure all material enters the extruder in a laboratory and pilot plant environment, the Process 16 extruder uses a high-free volume approach (d_o/d_i = 1.73) with appropriate specific torque to generate the necessary throughput. The image below shows the relation between (d_o/d_i) and free volume here expressed as a pellet size in mm.



Relation of (d_o/d_i), torque and free volume.

This allows low-density materials and larger pellets or flakes to be processed easily and completely. A high-volume screw design can also help to process shear sensitive material such as the embedding of hollow glass beads into a polymer matrix. Experience within our demo centers around the world have proven that with lab-scale extruders the higher volume gives you more output than higher torque.

Process 16 Twin-screw Extruder is the ultimate tool for material development

Intuitive and convenient operation

The Process 16 extruder and all connected feeders are controlled via the integrated and clearly structured touch-screen HMI (Human Machine Interface). When a feeder is connected to the extruder it is automatically recognized and depict as an icon on the touchscreen. All relevant setup and control parameters are accessible from the extruder HMI and no additional control-box is required. Simply click on the feeder icon and go from here.

The HMI screen allows fast toggling between separate overview, setup and parameter screens that helps the user to see all relevant information at a glance. A consistent user guidance simplifies handling, lowers the learning curve and minimizes operator errors. This helps the extruder expert to be more effective and the novice to extrusion get up and running faster with a new technology.

All attached feeders are controlled via one HMI.

Streamlining the operation

The compact stainless-steel monocoque housing enables fast and thorough cleaning to minimize downtime between experiments. It also reduces the number of visible cables and hoses and thus minimizes the risk of damage.

Technical data	
Barrel diameter	16 mm
Barrel length	40 L/D
Barrel/screw material	• 440C* - Process 16 Extruder • X15TN - Process 16 Hygienic Extruder
Diameter ratio Do/Di	1.73
Screw speed	10 - 1000 rpm
Torque max.	36 Nm
Pressure max.	100 bar
Temperature	350°C (450°C as option**)
Barrel zones	8 zones. 7 x 5 L/D electrical heated (optional water cooled)
Dimensions (L x W x H)	1230 x 690 x 1120 mm
Weight	180 kg
Power	3 x 400V 25A

* CPM option available
** not available with Process 16 Hygienic Extruder

Flexible access

Easy access to the “inside of the barrel” when the process is stopped enables the optimization for an extrusion process. The horizontally split barrel has a removable top and easily facilitates this process insight. It helps to gain a deeper process understanding and at the same time makes cleaning easier.

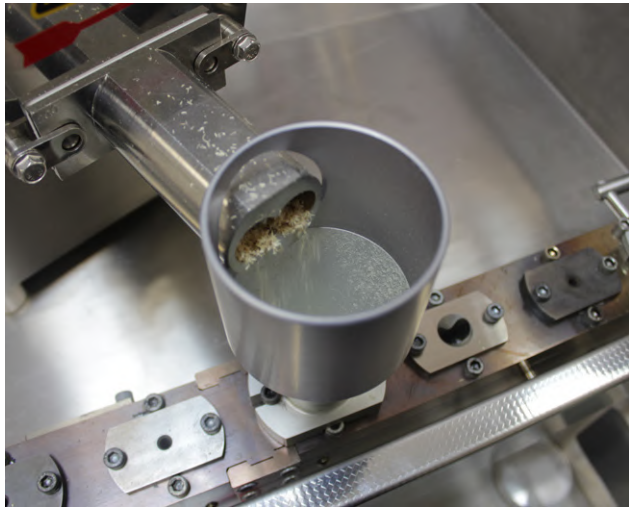
Flexible feeding

Metering solid and liquid materials into the extruder can be achieved via the six-barrel ports on the top of the extruder or via one of the four side feeding positions that are located on the back of the barrel. To accommodate for different flow behaviors of solids (e.g. powder, pellets, fibers) and liquids, the user can choose from 10 different feeder models. Up to 5 feeders (3 top feeders and 2 side feeders) can be operated simultanesouly along the fully ported barrel. This range of solid and liquid feeders offers infinite options to introduce materials into the extruder.

Flexible barrel setup

The 40 L/D barrel is segmented in 5 L/D sections. Each segment can be individually heated or cooled, giving you an unmatched precision in applying different temperature profiles to your process. If a process requires a small amount of raw materials or if there is concern that a material may degrade due to a long residence time, a screw length reduction kit is available. Simply cover the unnecessary segments of the screw with blind sleeves and begin feeding the material into a barrel port located closest to the extruder die. The reduction can be done in 5 L/D increments and the blind sleeves ensure that no metal-to-metal contact occurs in the “dry” area of the extruder.

Barrel with top half removed.



Secondary feeding of wood-fibers from the top.

Segmentation of barrel to match process requirements.

Developing future materials

Modern twin-screw extruders can enlarge their applications beyond the compounding of polymer materials. Being a continuous and very efficient mixer with precise temperature control, a modern extruder can also be used for wet extrusion, as used in the food industry, or for granulation processes. The Process 16 extruder offers all the necessary options as the base instrument can be selected according to the main utilization and additional application kits can be retrofitted to existing units.

Applications

The Process 16 extruder supports applications beyond the compounding of polymers such as food, pharmaceuticals and healthcare products. Wet and melt granulation can be used for agglomeration of materials after an intensive mixing with precise temperature controls. Application kits and options are available that expand the application versatility.

Polymer or Food

For chemically demanding or abrasive materials, steel and coating options for the screw and barrel are available. Corrosive ingredients or reactive extrusion is possible with the Process 16 extruder.

The Process 16 extruder is also available in a hygienic model which includes stainless steel / pharma-grade steel product-contact-parts. The hygienic model is recommended when developing materials such as HMMA (high-moisture meat analogues) and TVP (texturized vegetable protein) applications.

Feeders

You may require one feeding device for your first extrusion project. When future projects require multiple feeding solutions the Process 16 extruder accommodates up to five feeding solutions “out of the box”. It is not necessary to retrofit your extruder to allow more feeding capacity. Just add the accessories whenever they are required. Feeder controls are integrated with the Process 16 extruder as it leaves our factory. Start with one feeder and add up more as needed.

Up- and downstream equipment

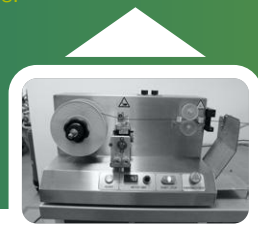
The extruder is the heart of an extrusion process, but it needs a comprehensive range of up- and downstream options to make it a truly complete processing solution.

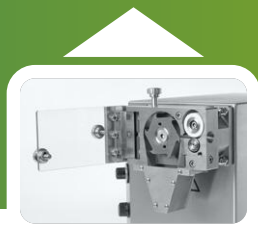


Volumetric and gravimetric solid feeders assure uniform metering of material into the process. Liquid feeders are available with a heating option for food or granulation processes. We offer a wide range of feeding instruments to accommodate flow behavior of different materials.



Dies at the end of a process help to form the material leaving the extruder. Polymers can be shaped as strands, films, sheets or co-extrudate. Dedicated granulations screws are used to form agglomerated powders for further processing.





Take-off devices such as conveyor belt, water-bath, strand-pelletizers, face-cut pelletizers, 3 roll sheet take-off or spooler for 3D filaments are examples to complete a specific process requirement.

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Benefit from global application support

Demonstration run in a laboratory (Karlsruhe).

With decades of application know-how in our worldwide demonstration labs, we can assist you in realizing your specific application needs and goals. Talk to our experts today and learn what options are available. Experience the complete Process 16 extrusion line in our demo centers in Europe, USA and Asia.

Find out more at **thermofisher.com/extruder**

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