

TWIN SCREW REPORT

A technical review of compounding, devolatilization, reactive processing, foaming and direct extrusion via twin screw extruders



Leistritz manufactures High Speed, Energy Input (HSEI) twin screw extruders for compounding, reactive processing, devolatilization, foaming and direct extrusion, and offers a wide range of technical services

The following is included in this e-tech-newsletter:

- Featured HSEI TSE model co-rotating twin screw extruder: ZSE-87 MaXX
- New Nano-16 model with patent pending micro-plunger feeder processes 20 to 100 gram samples
- Leistritz to host Pharmaceutical Extrusion Seminar, June 18-19, 2008
- FREE technical paper: Twin Screw Extrusion Advances for Compounding, Devolatilization, and Direct Extrusion
- Upcoming exhibit/presentation schedule

ZSE-87 MaXX co-rotating intermeshing HSEI twin screw extruder integrates latest designs

The Leistritz ZSE MaXX series includes 8 sizes from the ZSE-27 to the ZSE-135 models. All ZSE MaXX extruders utilize an asymmetrical splined shaft for the highest torque transmission in the industry, 30% more free volume, and 30% more cooling via doubling the cooling connections and modifying the cooling bore design.



ZSE-87 MaXX HSEI twin screw extruder with (2) side stuffers and 1000 HP motor

The following specifications apply to the ZSE-87 MaXX:

- Screw diameter 90 mm
- OD/ID ratio 1.66
- Maximum torque 11,400 Nm
- Maximum screw speed 1000
- Typical throughput rates 2000 to 12,000 lbs/hr

New Nano-16 twin screw extruder with micro-plunger feeder for use in the pharmaceutical and plastics industries

The Nano-16 twin screw extruder, integrated with a new micro-plunger (patent pending) feeder, simulates the continuous extrusion process for 20 and 100 gram batches. Applications include compounding, devolatilization and reactive extrusion. The Nano-16 utilizes a segmented screws/barrels, a stainless steel process section, and state-of-the-art control/data acquisition.



Nano-16 twin screw extruder with micro-plunger feeder

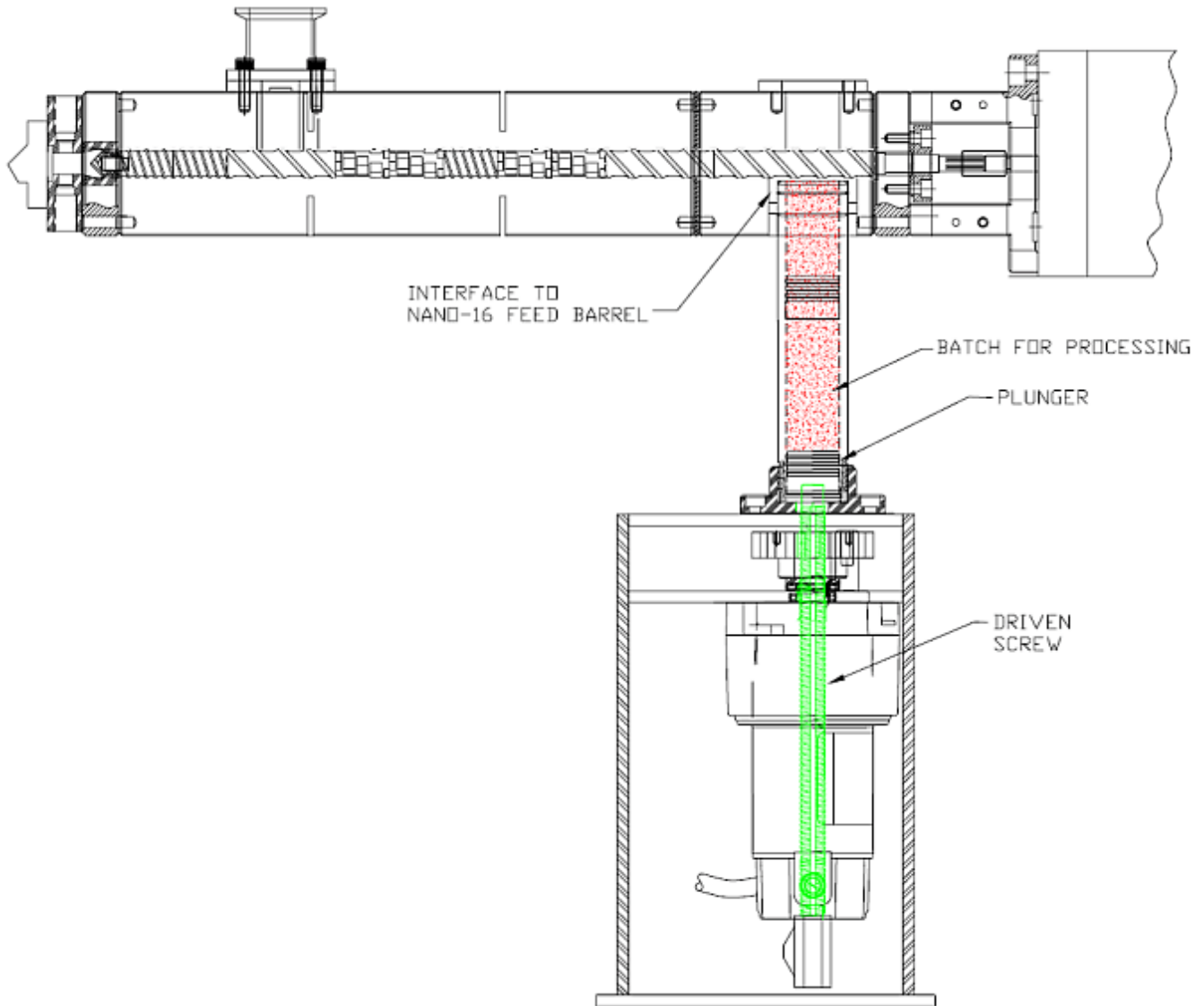
Free volume is an important parameter for a twin screw extruder, and is directly related to the OD/ID ratio. The OD/ID ratio is defined by dividing the outer diameter (OD) by the inner diameter (ID) of each screw. The 1.18/1 OD/ID ratio of the Nano-16 results in a free volume of 0.9 cc/diameter- the lowest free volume available for a twin screw extruder that is scaleable to production class machinery.



Nano-16 screw design with 1.2mm flight depth

Twin screw extruders are starve fed, with the output rate determined by the feeder(s) that meter materials into the process section. The extruder screw RPM is independent and used to optimize compounding efficiencies. Previously, there has not been a feed mechanism available to effectively meter very small batches to a twin screw extruder.

The solution is the new micro-plunger feeder (patent pending). The micro-plunger feeder is a piston that slides within a stainless steel tube that is filled with a 20 to 100 cc batch. After being mated to the bottom of the feed barrel, the piston is pushed upwards by a driven screw for precision feeding at extremely low rates. Since the micro-plunger feeder is a positive displacement device it can meter materials in virtually any form, such as powders, granules, micro-pellets, pastes, water-based slurries, etc.



Schematic of micro-plunger feeder mated to Nano-16 barrel from underneath

The Nano-16 replicates the unit operations and the shear imparting mechanisms of larger scale twin screw extrusion equipment. The combination of a small free volume and precision low-rate feeding makes the Nano-16 the only extrusion device that can produce results that are scalable to a production scale extrusion process.

Leistritz to host Pharmaceutical Extrusion Seminar June 18-19, 2008

The annual Leistritz Pharmaceutical Extrusion Seminar provides an in-depth review of twin screw extrusion theory as applied to the pharmaceutical industry. A unique facet of the program is that classroom sessions are combined with "hands-on" twin screw extrusion demonstrations. A partial list of topics is as follows:

- High speed, energy input (HSEI) twin screw extruder theory and design
- Comparison to low speed, late fusion (LSLF) twin screw extruders
- Screw design and processing techniques for a GMP environment
- Dispersive and/or distributive mixing of active pharmaceutical ingredients (API)
- Devolatilization/solvent extraction via extrusion
- Advantages of the continuous extrusion as compared to batch processes
- Staging of unit operations in an extruder to manufacture dosage forms
- Upstream considerations for feeding, material handling and containment
- Scale-up of the extrusion process from laboratory to production
- Downstream systems for pelletization, films/laminates and shapes
- Material considerations, applications and advances
- Process analytical technology (PAT) for improved process control
- Cleaning and maintenance of extrusion equipment in a GMP environment
- Equipment and process validation
- Control issues pertaining to CFR 21 part 11 compliance
- New technologies, i.e. foaming and co-extrusion

"Hands-on" demonstrations at Leistritz process laboratory will include:

- Co-rotating and counterrotating twin screw extruders
- Devolatilization via hot melt extrusion
- Downstream addition of shear sensitive API
- Direct sheet/film extrusion with gear pump front end
- Foam extrusion via gas injection
- Micro-pelletization

In addition to the Leistritz staff, outside speakers will include:

- Pete Palmer, Wolock & Lott
- Tony Listro, Foster Corp.
- Hibre Terefe, ExxPharma LCC
- Greg Troup, Merck
- Mark Hall, Dow Chemical
- Nasser Nyamweya, Evonik
- Bob Bessemer, Conair
- Michael Crowley, PharmaForm
- Sharon Nowak, K-Tron

Place: Classroom sessions are held at the Holiday Inn Select in Clinton, NJ, and extrusion demonstrations at the nearby Leistritz Process Laboratory. Transportation to/from the demonstrations is provided.

Cost: Early registration, if received by April 18, 2008 is \$820; after this date \$920

Hotel: Holiday Inn Select, 111 Route 173, Clinton, NJ 08809, Phone: (908) 735-5111

To register for this program contact Sarah Scovens at 908/685-2333 or e-mail sscovens@alec-usa.com.

Mark your calendars: Leistritz will host the next Twin Screw Extrusion Workshop for plastics applications December 3-4, 2008.

Free technical paper: Twin Screw Extrusion Advances for Compounding, Devolatilization, and Direct Extrusion

**Prepared for
Plastic Extrusion Asia Conference
March 17-18, 2008, Bangkok, Thailand
Charlie Martin, Leistritz**

Abstract: High speed, energy input (HSEI) twin screw extruders (TSE) are recognized as the manufacturing methodology of choice to perform compounding, devolatilization and reactive extrusion of a wide range of polymer formulations. The final product is often a pellet to facilitate accurate/consistent feeding into an injection molding machine or single screw extruder. There is also a trend to combine compounding with direct extrusion of a sheet, film, filament/fiber or profile.

Design enhancements relating to increased torque, higher volume and better cooling for HSEI twin screw extruders are detailed with comparative test results for LDPE, HDPE and PLA. Test results indicate that volume, torque or temperature limited processes will benefit from the 1.66/1 OD/ID ratio of the Leistritz ZSE MaXX series, as compared to previous 1.55/1 OD/ID designs. A few examples of applications where this technology is particularly beneficial include:

- Compounding of engineering composites, including high filler levels
 - Foam extrusion with chemical and physical blowing agents
 - Direct extrusion of film/sheet/profiles/filaments
 - Processing of shear sensitive materials, such as bioplastics
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Industry events where Leistritz will participate

- Plastic Extrusion Asia: 3/17-18/2008, Bangkok, Thailand; presentation by Charlie Martin entitled Twin Screw Extrusion- Advances for Compounding, Devolatilization and Direct Extrusion
 - MassPlastics: 3/26-27/2008, Leominster, MA; 10 ft. exhibit
 - Plastimagen: 4/8-11/2008: Mexico City; 3 meter exhibit
 - ANTEC: 5/5-8/2008, Milwaukee, WI; 20 ft. exhibit, presentation by Bill Thiele, The Evolution of Twin Screw Extruders, presentation by Charlie Martin, Twin Screw Extruder Designs for Bioplastics
 - Color RETEC: 9/21-23/2008, Dearborn, MI; tabletop display
 - Coextrusion Topcon: 10/20-21/2008, Cincinnati, OH; tabletop display
 - American Association of Pharmaceutical Scientists (AAPS) Annual Meeting; 11/16-20/08, Atlanta, GA; 20 ft. exhibit
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