The Westland Corporation

PROCESSOR

The Big Squeeze

Dave Larson
President


Dave Larson

Even though quite different in function, the compression ratio is a very important factor in both the performance of a car and the design of a screw.

When it is time for a “fill-up”, the choice of either the regular, mid-grade or premium gas should be based upon the compression ratio of the engine.

Compression can be defined as squeezing something to reduce its size or volume. The octane rating of gasoline indicates how much the fuel can be compressed before it spontaneously ignites.

That knocking or pinging sound coming from under the hood could be due to the gas igniting by compression versus a spark from the spark plug. That condition necessitates the compatibility of the octane of the fuel and the engine compression.

A high compression ratio equates to a higher horsepower rating on an engine. These “high-performance” engines require a higher octane fuel to perform as designed.

In regards to a plasticating screw, the proper compression ratio should be based on the resin being processed.

The high-tech resins being used in today’s world were designed to melt in a specific way. A screw designed to be compatible with that process will provide the opportunity for a better end product.

An incorrect compression ratio can create too much shear and/or affect the heat uniformity of the melt. However, processing with a custom designed screw can make the difference in the resin “performing as designed”.

That knocking sound could be the gas igniting by compression versus a spark from the spark plug.

Be sure to read the article inside this newsletter which explains screw compression ratio in detail.

Westland’s process and design engineers work hard to learn about the behaviors of the resins in the market today. This knowledge is used to design screws that will optimize the process for our customers.

In today’s market it is no secret that the “big squeeze” is on to optimize production by increasing output and decreasing reject rates. Westland can help. Call us today to discover the difference a “high-performance” screw can make in your processing.

DO YOU KNOW ...

A dart board is made of what compressed material?

There have been several variations of dart boards over the years. Among the first ones were simple wooden dart boards usually made of elm. Since they were prone to splitting, each had to be soaked overnight in water. As the wood swelled, the dart holes would close. The company Nodor was the first to produce a dart board made of bristles compressed to form a smooth surface. The sisal (Agave sisalana) plant is the bristle most used in producing these boards. It has a natural self healing property which results in longer use. The bristle dart boards are still used today in many prestigious tournaments.

As published by the American Darts Organization, do you know the maximum legal weight of steel-point darts used in competition?

Answer Inside

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MADE IN THE USA
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Brad Stoskopf (center), Sr. Design Engineer at Westland, shown receiving an appreciation award from Bob Susnik, Professor (left) and Paul Herring, Asst. Professor (right) of Pittsburg State University, Engineering Technology Dept.

WESTLAND RECOGNIZED

Pittsburg State University Plastics Engineering Technology

The Plastics Engineering Technology Program at Pittsburg State University, in Pittsburg, Kansas, recently celebrated their 40th Anniversary. Brad Stoskopf, Westland's Senior Design Engineer and an alumnus of Pittsburg State, attended the recent celebration.

The Plastics Engineering Technology program at Pittsburg State University has a four-year curriculum which culminates in a Bachelor of Science Degree in Engineering Technology.

This degree prepares professionals for careers in the plastics manufacturing, design and materials industries. It teaches current technologies including plastics processing (injection molding, blow molding, extrusion and thermoforming), materials design and selection, part and mold design, composite materials and processing.

Practical, hands-on, laboratory experience and real-world internships are a key element of the program.

The coursework is designed to prepare graduates for the plastics industry where the use of their knowledge and skills of plastic materials, processes and related technology will help create the best possible quality products at the most economical cost.

Westland Corporation received a Plaque of Appreciation for being a Partner in Education. We are very proud to be a part of the industry support for this exceptional program.

COMPRESSION RATIO

How It Affects Resins and Processing

Westland is often asked about compression ratio in a screw and how it can affect a process. An incorrect compression ratio can result in processing issues as well as poor melt quality. The different resins found in the market today require a screw designed with a compression ratio that aids in the proper melting of the material. Following are answers to common questions about compression ratios that will help explain this important design feature on a screw.

- **What is compression ratio in a screw and how does it affect the melting process of resins being processed?**

Compression ratio is the difference between the volumetric area of the feed channel and the volumetric area of the meter channel of the screw. In calculating volumetric compression ratio, the radii and flight angles must be taken into consideration. The compression ratio is calculated by dividing the feed area by the meter area. A much simpler approach used by many people is to measure the feed flight channel depth(1) and the meter flight channel depth, dividing the feed depth by the meter depth.

When focusing on the compression ratio, it is important to determine what the meter flight channel depth needs to be to accommodate the resin being processed. This can generally be found in the resin data sheets. Figure 1 (on the next page) shows two 50mm 3:1 compression ratio screws that will perform drastically different. This illustrates why, when specifying a compression ratio, the meter flight depth must be taken into account.

- **Why are different compression ratios needed for different resins?**

An important goal in processing is to maintain a consistent pack in the screw channels to achieve an isothermal, homogenous melt quality and consistent screw recovery. The screw compression ratio determines how the heat (energy) is put into the resin being processed. Different compression ratios are required for different resins due to the way the resins accept heat.

High crystalline resins (PP, HDPE, PA, etc) are typically not shear sensitive and accept a larger amount of shear heat. They transition from solid to a melt at a much faster rate. Greater shear heat is needed with high crystalline resins to achieve the isotheral and homogeneous melt quality.

Amorphous resins (ABS, PC, Acrylic, etc) accept heat at a slower rate and typically are more shear sensitive. This requires lower internal forces (ie: compression ratio) in the screw so there is not too much shear heat imparted to the resin.

Another consideration for compression ratio is the bulk density of the resin at a granulated state versus a molten compressed state.

Most amorphous resins without fillers have approximately a 50% reduction (rule of thumb) in volumetric area from a solid granulated state to a compressed molten state.

High crystalline resins (PP, HDPE, PA, etc) without fillers typically have a 66% volumetric let down ratio (rule of thumb). This is one of the reasons screws for amorphous resins will have close to a 2:1 compression ratio and screws for high crystalline resins will have

close to a 3:1 compression ratio. The crystalline level and viscosity[2] of the resin will determine if a higher or lower compression ratio is required.

- **How will compression ratio affect the resins being processed?**

Too much compression will add shear heat to the resin. This could cause heat overrides, degradation of the resin and higher melt temperatures. When processing resins that have fillers such as glass fiber or calcium carbonate, it is important to reduce the compression ratio so that the fillers are not fractured or destroyed.

Too low of compression ratio will not force the air and gasses out of the resin which can lead to bubbles and splay. It is also difficult to achieve a good isothermal uniform melt when the compression ratio is too low.

- **How can several different resins be processed with the same compression ratio screw?**

In an ideal world, every screw would be designed for the specific resin being processed. However, this is not the case in many injection molding facilities. With this in mind, a thorough understanding of the screw in the machine must be known so that the proper adjustments to the process can be made to accommodate the different resins encountered.

When processing both highly crystalline resins as well as amorphous resins, Westland recommends a lower compression ratio (low shear) screw. The reasoning behind this recommendation is as follows:

- When processing a resin that requires greater shear with a screw that does not produce a lot of shear, adjustments can be made to the machine that will create shear, such as:

  Lowering the heater band settings;
  Increasing back pressure; and/or
  Increasing screw RPM.

(Continued on back page)

TYPICAL COMPRESSION RATIOS

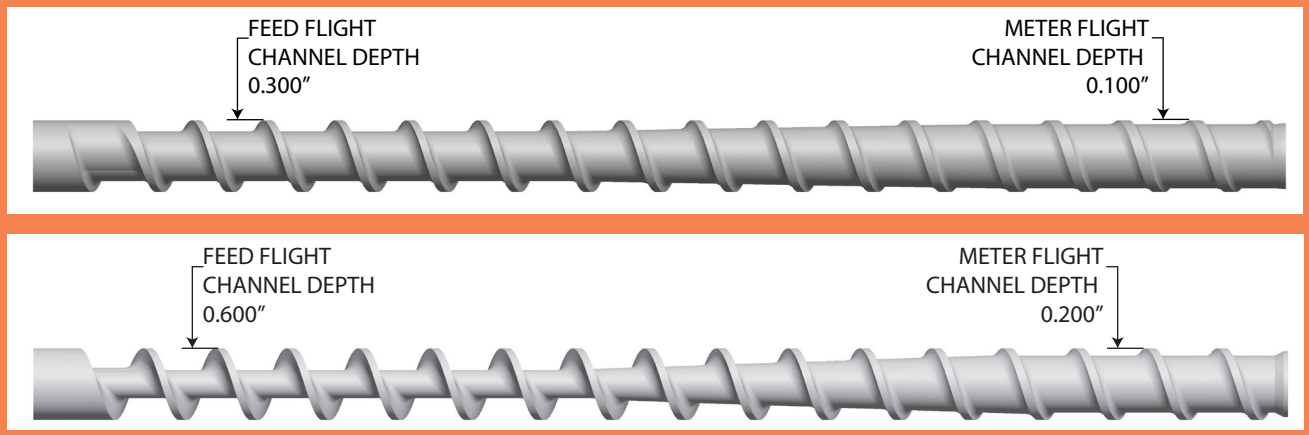
For a 20:1 L/D 50mm (2”) Injection Screw

	ABS	PC	PS	PP	PA
Feed Flight Channel Depth	.330”	.305”	.310”	.320”	.317”
Meter Flight Channel Depth	.157”	.140”	.125”	.106”	.104”
Compression Ratio	2.1:1	2.2:1	2.5:1	3.0:1	3.0:1

Answer to Do You Know: Darts used in tournament play shall not exceed an overall maximum length of 30.5cm (12in.), nor weigh more than 50gm (1.765 oz) per dart ... as reported on the American Darts Association website: http://www.cyberdarts.com/ado/adorules.html#10

FIGURE 1

BOTH OF THE SCREWS ILLUSTRATED BELOW ARE 50MM, 3:1 COMPRESSION RATIO SCREWS
The Difference Is Found In The Meter Flight Channel Depth



(Continued from page 3)

- When processing with a screw that has a high compression ratio (high shear), there is not a good way to reduce the shear produced by the screw. Therefore, when processing an amorphous resin, there could be issues with heat overrides and burning.

In summary, as another rule of thumb, a low viscosity, thinner resin requires shallow channel depths and/or a higher compression ratio. These are typically high crystalline resins. The thicker resins, which feature a high viscosity, will typically require deeper channel depths and a lower compression ratio. And remember, when it comes to screw design, shear can always be added to the process but it is very difficult to take it out of a process if it is designed into the screw.

Westland's approach to screw design is based on using the very best design for the resins to be processed. Our design engineers routinely select the proper screw design variables to enhance melt quality, minimize cycle time, improve part quality and reduce rejects. Why not call us today and put our engineering expertise to work on your applications?

(1) A definition of channel depths is provided in Volume 2, Issue 3 of the Westland Processor Newsletter. To access visit www.westlandusa.com. The link to previous Processor Newsletters can be found under the Processing Resources option at the top of the page.
(2) Further information on viscosity of resins can be found in Volume 5, Issue 2 of the Westland Processor Newsletter, which can be accessed as stated above.

Use Scheduled Plant Shut Downs To Your Advantage

Scheduled summer shut-downs are an excellent time to send Westland your worn screws and cylinders.

Ship them with your instructions for evaluation and/or printing to:

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1735 S. Maize Rd.
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CALL US FOR MORE INFORMATION:
800-247-1144

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