The Westland Corporation

PROCESSOR

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Can Design Change History?

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Dave Larson

Design is important. No matter what the product, its design dictates function and end results.

Can design change history? Just consider the Presidential Election of 2000. The design of the "butterfly ballot" in Palm Beach County, Florida may have changed history.

There will always be the question of whether it was actually the design or voter instruction and education that contributed to this incident. Whatever the case, something wasn't right.

Design is making things right.
Ralph Kaplan

"Design is making things right." -- Ralph Kaplan.

Good design does make things right.

There were design issues in the beginning of the flight data recorders, commonly referred to as the black box, which are now required on large commercial aircraft and some smaller commercial, corporate, and private aircraft. The drive to mandate these devises started in the 1940s, however there were many delays.

The technology needed to match the design requirements for a unit that could survive an aircraft crash and the resulting fire exposure did not exist until 1958.

Good design is based on good technology.

Do your processing requirements demand better technology than a standard general purpose design?

The technology is there and Westland knows how to implement it.

We have the engineering expertise and processing experience to design and manufacture the right screw for your application. If you are processing a number of different resins, we can design a screw optimized to allow all the materials to be processed with reasonable success.

There is no additional charge for our special design services.

Let Westland's process engineers and years of experience go to work on evaluating your process and offering recommendations on screw design to increase your productivity.

Can your screw design change history? Perhaps not on a global basis, but a specially designed screw can contribute to historic improvements in your process and your profits.

DO YOU KNOW?

This year marks the 50th anniversary of the '55 Chevrolet. Everything about this car was new, including the introduction of the legendary small-block Chevy V8 engine. Versions were rated from 162 brake horsepower (bhp) to 180 with the optional 4-barrel, dual-exhaust "powerpack." The car's design broke new styling ground, set new sales records, and changed the look of the American automobile.

Do you know how this famous line of cars became known as Chevrolet?

Answer inside.

SCREW DESIGN

Basic Screw Design Variables and Their Effect On Processing

In order to select the proper screw design for a particular resin (or resins), a basic understanding of screw design variables and their effect on processing is essential.

Excluding the use of multiple flights (as used in barrier screws) and mixing sections, there are five variables that may be utilized in the design of a metering screw that have a bearing on how a solid resin becomes a melt.

Design Variables

A standard metering screw that is a single-flighted, single stage design without a mixing section, may be altered in its design by changing one or more of the following features:

L/D Ratio
Profile
Channel Depths
Compression Ratio
Helix Angle

The drawing below illustrates the different aspects of these screw design variables.

L/D Ratio

The L/D Ratio is the ratio of the working flighted length of the screw (distance from the front edge of the feed opening to the forward end of the screw flights when the screw is in the forward position) to its outside diameter. As a practical matter, however, the industry uses the total flighted length of the screw in making the calculation.

Most injection screws use a 20:1 L/D ratio. The L/D ratio for blow molding machines typically ranges from 20:1 to 24:1 and extruders generally range from 24:1 to 30:1 with some much larger.

Effect of L/D Ratio

The larger the ratio (longer the flighted surface):

■ the more shear heat can be uniformly generated in the plastic without degradation;

■ the greater the opportunity for mixing, resulting in a better homogeneity of the melt; and

■ the greater the opportunity to control conductive and shear heat, permitting potentially faster cycles.

Screw Profile

The screw profile is generally described as the length (in diameters) of each of the three sections of the screw as follows:

■ the feed zone, where the plastic first enters the screw and is conveyed along a constant root diameter;

■ the transition zone, where the plastic is conveyed, compressed and melted along a root diameter that increases with a constant taper; and

■ the meter zone, where the melting of the plastic is completed and the melt is conveyed forward along a constant root diameter reaching a temperature and viscosity to form parts.

A typical 20:1 L/D general purpose screw design features a 10-5-5 profile indicating that 50% of the flighted length (10 diameters) is dedicated to the feed section and 25% (5 diameters) is assigned to both the transition and meter sections.

Effect of Screw Profile

The length of each section has an impact on how a resin reaches a melt condition, as follows:

■ a longer feed section creates a greater potential throughput;

■ a longer transition means less shear heat and more time to compress and melt the resin, and the converse is also true;

■ a longer meter section develops more pumping pressure vital to extrusion; and

■ a shorter meter means less time to assure an isothermal melt quality.

Generally, amorphous polymers, which soften gradually when heated, require a long transition and lower compression ratio to avoid overheating and degrading the material.

Crystalline polymers, which remain relatively solid to their melting point, favor a longer feed section, shorter transition and higher compression ratio to insure pre-heating and total melting.

Channel Depths

The channel depth in the meter section is determined by the polymer to be processed. The channel depth in the feed and transition sections are dependent upon the selected compression ratio and screw profile.

Effect of Channel Depth

A shallow screw channel:

■ increases the exposure of plastic to the heated cylinder wall;

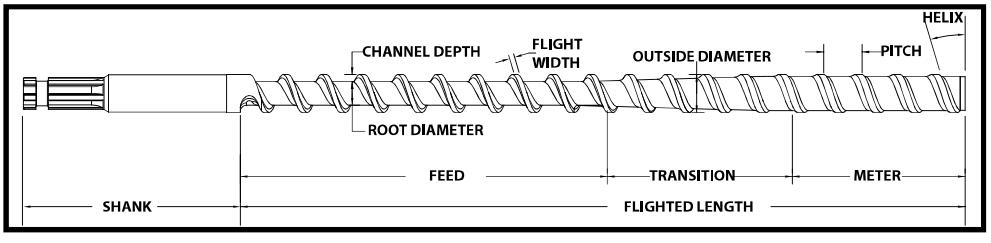
■ increases the shear rate (plastic sheared between cylinder and screw);

■ generates heat; and

■ reduces throughput.

Because shear rate increases as the screw channel depth becomes more shallow and/or as screw RPM increases, shear or heat sensitive materials are generally processed using a deeper screw channel and slower screw RPM.

Accordingly, amorphous polymers are typically processed with a somewhat deeper meter depth, whereas crystalline polymers use more shallow flight depth in the meter section.



Change in Screw Design Equals Decreased Scrap Rate

Westland recently worked with a customer processing TPO with colorant and flame retardant using a general purpose design screw. Their process was overworking the material, resulting in the additives coming to the surface, plating the tooling, and compromising part quality with splay, burns and surface blemishes.

After careful study, our design engineers modified their screw design by changing the compression ratio, channel depths and profile in order to accommodate the resin.

These design improvements resulted in this customer reducing their scrap rate from 12% to less than 1%.

Additionally, this helped control the tool plating issue and down time for cleaning was greatly reduced.

How would your process be improved with a screw designed for your particular application? To learn more call:

Westland Corporation
800-247-1144
www.westlandusa.com

Can Your Process Be Improved?

Put Westland's years of processing and screw design experience to work for you. **Complete a Process Inquiry Sheet** found on our website under the forms heading. You can also call us to have one faxed to you.

Fill in as much as possible and return to Westland. One of our sales engineers will contact you with our recommendations.

Compression Ratio

The ratio of the feed zone channel depth to the meter zone channel depth is referred to as the compression ratio. The compression ratio for most thermoplastic materials typically ranges from 1.5:1 to 4.5:1. Most injection screws classified as general purpose have a compression ratio of 2.5:1 to 3.0:1. Thermoset screws typically have a 1.0:1 ratio.

Although there are many factors which influence the selection of a compression ratio, the molecular structure of the polymer is a major determinant.

Lower compression ratios (1.5:1 to 2.5:1) generally are desirable for processing amorphous polymers and higher compression ratios (3.0:1 to 5.0:1) are recommended for crystalline polymers.

Compression Ratio Effect

The higher the compression ratio, the greater the:

- shear heat imparted to the resin;
- heat uniformity of the melt;
- potential for creating stresses in some resins; and
- energy consumption.

Helix Angle

The helix angle is the angle of a screw flight relative to a plane perpendicular to the screw axis. Although the helix angle is not commonly altered from the standard square pitch, such a change can have a significant impact on processing.

In years past, changes in the helix angle were more common in two stage screws and special mixing screws than in metering screws. However, due to the intricate composition of materials developed in the past 10 years, science has shown increased benefits of a reduced helix angle on shorter L/D screws, resulting in a more homogeneous melt quality.

(Continued on page 4)

Do You Know: Louis Chevrolet, a well known racing driver and talented mechanic, partnered with William C. Durant to start the Chevrolet Motor Car Company in Detroit, Michigan in the early 1900's.

ADDING THE THIRD DIMENSION

It's A 3-D World

Two-dimensional drafting was developed as a means to convey three dimensional information.

A decade ago there was debate with respect to the advantages of manual drafting versus those of CAD (computer-assisted design). The cost of remaining in the 2-D world today is that it is inherently less efficient than 3-D modeling.

Westland's continued mission to be an industry leader in screw design technology is evidenced by our utilization of Pro/E 3-Dimensional software in our design engineering department.

The advantages for our customers are wide-ranging. The most obvious is drawing consistency, which is more easily managed through the use of common part models.

The 3-D models allow Westland designers to directly visualize how changes in the screw design might affect its performance. Design updates can also be validated through the use of structural and thermal analysis.

Volume analysis is used to enhance the accuracy of machine thru-put calculations.

Once designed, CNC programs can be generated directly from the engineering model.

The drawing at the bottom of page two was produced on a 3-D CAD system. That same screw is pictured here utilizing the 3-D modeling software.

Westland is excited about this opportunity to push the limits of performance in designing the right screw for your application.

Winners of the annual Westland Employee Golf Tournament were (from left to right) Shawn Graves, Welder; Dan Johnson, Vice President; Lucas Peterson, Shipper; and Vinton Brown, CNC Lathe.

Watching the activites at our recent employee picnic are (from left to right) Randy Wise, Sales Manager; Chuck Hogarth; Gina Hook; Cindy Hogarth, Inside Sales Engineer; and Wayne Hook, Director of Engineering and Sales.

The Annual Westland Employee Horseshoe Tournament was won by (from left to right) Tom Kramer, Barrel Supervisor; and Loren Tedder, Machinist.

Entertainment at this year's picnic was provided by Ashton Jackson at left, standing by Debbie Larson, Dave Larson and Dan Johnson. Ashton is the granddaughter of Tom Howell, Westland's Day Shift Supervisor.

Ashton has already won several national awards for her singing, including the Galaxy of Stars Overall Winner in 2004. Everyone at the picnic agreed, this 11 year old certainly has a promising future. Thanks Ashton!

SCREW DESIGN

(Continued from Page 3)

Effect of Helix Angle

A change to a smaller helix angle, meaning more flight turns per diameter:

- reduces the axial melting length;
- conveys stiffer materials with greater ease and less torque; and
- reduces the rate at which material is conveyed.

Westland Corporation works with our customers to select the proper, most efficient screw design for their particular application(s). This added benefit is provided at no additional charge.

Call one of our sales engineers today to discuss how a specially designed screw can improve your bottom line.

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