The Westland Corporation

PROCESSOR

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WHAT DOES A "WADITW" COST?

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There is an old saying that the only thing constant is change.

Change has been a constant companion in the plastics industry over the past several decades. The introduction of new resins allow more and more products to be produced. The need to keep up with today's technology is imperative to staying profitable.

What are the melt characteristics of your resin? What should you look for in a screw design? What materials will be the most wear resistant in your process? Do you have the correct heat profile designated? There are so many variables that can affect your process and your bottom line.

Education is key to captializing on change. That is why Westland Corporation places such a high value on learning, both inside and outside our company.

We believe educating our customers on the value of good screw design is vital to their success and ours. We work with resin suppliers and original equipment manufacturers daily to ensure the performance of our top quality components.

We also routinely provide training to our customers on screw and barrel technology. Our Cylinder and Screw Handbook is published as a tool for the end user of our products. It is also utilized by several universities in their plastics technology departments.

Westland is committed to education. Often times, with education comes change.

However, one of the biggest obstacles to much needed change is WADITW, which is an acronym for "We've Always Done It That Way".

WADITWs may be controlling much of what is going on in your company, without your even realizing it. These WADITWs could very well be costing you time and money.

Recently Westland presented a screw design display to The Nypro University. You can read about it inside this issue. Doug Thorpe, of Nypro, stated "the display will be used to better demonstrate how screw design (which is often taken for granted) greatly affects processing".

Is screw design a WADITW for you? Are you processing with the same general purpose design because you've always done it that way? How much is it costing your company in time and profit?

Why not call us today. Our experienced processing engineers can help you break the WADITW chains as you travel on your path to increased knowledge and profits!

DO YOU KNOW ... what happened to Einstein's brain?

Albert Einstein died April 18, 1955 at Princeton Hospital in New Jersey. His body was cremated, except for his brain, which was removed by Dr. Thomas Harvey during an autopsy the morning of Einstein's death. Harvey cut the brain into 240 pieces and gave several pieces to different researchers. Do you know where the remaining pieces are now?

(answer inside)

Dan Johnson, Jim Johnson & Dave Larson

Jim Johnson Receives 20 Year Award

Jim Johnson was recently honored for 20 years of service at Westland Corporation. He started in shipping and is currently a Senior CNC Programmer/Operator. His experience and attention to detail means quality components for our customers. He especially enjoys the challenge of working on a variety of screw designs and diameters. Jim is the main operator of Westland's new screw milling machine and is another reason why we can state with confidence, "Our People Make The Difference".

Doug Thorpe, The Nypro University, with Scott O'Gara, Spectrum Machinery

Westland Screw Design Display Presented

Scott O'Gara, Westland's sales representative with Spectrum Machinery, recently presented a screw design display to Doug Thorpe of The Nypro University. This display will be used in their new "hands-on" Learning Center located in Clinton, Massachusetts.

Approximately 100 people go through this instruction every year in an effort to standardize the very best practices of injection molding. The display will be used to better demonstrate how screw design (which is often taken for granted) greatly affects processing. Westland is proud to provide this learning tool as a demonstration of our commitment to education in the field.

SCREW GEOMETRY

Proper Screw Design Is Critical To Successful Results

A properly designed screw can improve cycle time, melt quality, color mixing and profits. Knowledge of the resin to be processed and an understanding of screw geometry are crucial to proper screw design.

RESINS

Resin crystallinity, viscosity and additives all have an effect on design.

Resin Crystallinity

The crystallinity of a resin influences the manner in which it changes from a solid to a melt. The differences in melting characteristics between highly crystalline and less crystalline (amorphous) resins include their resistance to deformation as heat is applied, their sensitivity to thermal conductivity and their sensitivity to shear, regardless of the source.

Amorphous resins soften gradually and have no defined melting point. In contrast, the more highly crystalline materials remain in a relatively solid state until the temperature reaches their melting point, at which time they quickly change to melt.

Even though all plastics are poor conductors of heat, amorphous materials are especially slow to absorb heat and increases in temperature. They tend to degrade when rapidly exposed to higher temperatures rather than melt more quickly.

Due to these characteristics, amorphous materials are considered to be more shear sensitive and do not tolerate high shear rates.

Amorphous materials should be gradually changed from solid to melt, necessitating screws designed with a longer transition zone and deeper channel depths utilizing lower compression ratios. (See Design Variables) This design helps protect the resin from burning or degrading.

The higher crystalline materials can be processed more effectively by screws with shorter transition zones, more shallow channel depths and higher compression ratios.

Resin Viscosity

Viscosity, or the resistance of a melt to flow, is expressed as the Melt Index of a resin. A high melt index value corresponds to a low melt viscosity, and vice versa. The higher the melt index, the more shallow the channel depths of the screw. More viscous materials require deeper channel depths.

Resin Additives

All reinforcements and fillers affect screw geometry as many additives increase the viscosity of the melt and require screws with deeper channel depths and somewhat lower compression ratios. The screw design is especially important with the use of fibers to prevent their breakage which would lessen their effectiveness.

DESIGN VARIABLES

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. These variables are briefly described below, focusing on how they affect the resin. (See FIGURE A on next page.)

L/D Ratio

The L/D ratio is the ratio of the flighted length of the screw to its outside diameter. The larger the ratio (longer flighted length) the more shear heat can be uniformly generated in the plastic without degradation. A larger ratio also provides opportunity for mixing, resulting in a better homogeneity of the melt.

Screw Profile

The standard metering screw has three zones: 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 that is necessary to form parts.

The length of each zone has an impact on how a resin reaches a melt condition. A longer feed zone creates

a greater potential throughput. A longer transition zone results in less shear heat and more time to compress and melt the resin. A shorter meter zone allows less time to assure an isothermal (uniform) melt quality.

Channel Depths

The channel depth in the meter zone of the screw is determined by the resin to be processed. The feed and transition zone channel depths are dependent upon the selected compression ratio and screw profile. The channel depths influence the degree of shear heat developed by the screw. For example, a shallow screw channel increases exposure of the plastic to the heated barrel, and increases the shear heat imparted to the resin. A deep screw channel would have just the opposite effect, reducing the shear heat.

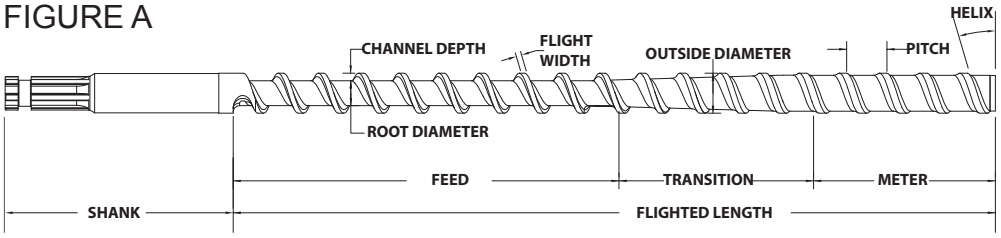
Compression Ratio

The ratio of the channel volume in the feed zone to the channel volume in the meter zone is referred to as the compression ratio. The higher the compression ratio, the greater the resulting shear heat imparted to the resin, the heat uniformity of the melt and the potential for creating stresses in some resins.

Helix Angle

The helix angle is the angle of the screw flight relative to a plane perpendicular to the screw axis. Although the helix angle is not commonly altered from the standard square pitch (pitch is the same as the diameter), such a change can have a major impact on processing. A change to a smaller helix angle (resulting in more flight turns per diameter), increases the axial melting length of the screw and conveys stiffer materials with greater ease using less torque.

FIGURE A



TYPICAL SCREW GEOMETRY

The chart below illustrates the typical values of a general purpose 50mm (2") injection molding screw with a 20:1 L/D Ratio compared to the variations that are used on custom designed screws.

VARIABLES	GENERAL PURPOSE	TYPICAL VARIATIONS
Channel Depths		
Feed	.310"	.230" to .340"
Meter	.125"	.070" to .195"
Compression Ratio	2.5:1	1.2:1 to 4.5:1
Profile		
Feed	9 Turns	6 - 14 Turns
Transition	7 Turns	4 - 10 Turns
Meter	4 Turns	1 - 6 Turns

On a 50mm Injection Screw w/ 20:1 L/D Ratio

VARIABLES FOR COMMON RESINS

Following are descriptions of screw designs for polypropylene, polycarbonate and nylon.

Polypropylene, a higher crystalline resin**,** can be processed successfully with most general purpose type screws having a L/D Ratio between 18:1 - 24:1. The screw profile needs to have 40-50% of the flighted area in the feed section and 25-30% in the transition and meter sections. The compression ratio on a screw processing **polypropylene** will generally range from 2.7:1 to 3.3:1 with the meter channel depth measuring between 3.5% and 6% of the screw diameter.

When reinforcements are added to **polypropylene**, Westland recommends lengthening the transition section of the profile to 35%-40% of the flighted area.

Polycarbonate, an amorphous resin, is best processed with a screw that develops less shear than most general purpose screws. Longer L/D ratios ranging between 20:1 to 24:1 are desired. If **polycarbonate** is compressed too quickly, it will tear the resin, breaking up or fracturing the polymer chains and compromising the integrity of the resin.

The screw profile should be in the range of 30-35% feed, 45-55% transition and 20-25% meter. The compression ratio will range between 2.0:1 – 2.4:1, with a meter channel depth of 5% to 7% of the diameter of the screw. (Continued on page 4)

Answer to "Do You Know ..."
Dr. Harvey lived several places over the years, including Wichita, Kansas, always taking the brain with him. The Pittsburgh Post-Gazette newspaper reported in an article dated April 2005 that Harvey had delivered the remaining parts of Einstein's brain to the pathology dept at Princeton.

To read that article, go to:
http://www.post-gazette.com/pg/05107/488975.stm

CONTINUED FROM PAGE 3:

Nylon is another high crystalline resin. Commonly referred to as PA (Polyamide), it requires a screw with a L/D ratio of 18:1 to 24:1. A common screw profile would be 40-45% of the flights in the feed section, 30-35% in the transition section and 25-30% in the meter section. A compression ratio between 2.7:1 and 2.9:1 is ideal, with the meter channel depth being 3.5% to 5% of the diameter.

A screw processing **glass filled nylon** would require a lower compression ratio and deeper flight depth to prevent fracturing the glass fibers. This will also reduce wear on the screw and barrel.

Screws with a short L/D ratio can present a challenge when designing for a specific resin. However, the helix angle can be reduced to allow for more flights in the different screw profile sections producing optimum results.

The good news is you don't have to remember all this when you buy a screw from Westland. We develop the best design for your process, at no additional cost. We are anxious to prove our capabilities. Call us today!

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