TECHNICAL SERVICE REPORT Number 55

Extruding Rigid PVC Cubes Into Vertical Blind Profiles

INTRODUCTION

Rigid PVC (Vinyl) vertical blinds are used extensively in homes and offices as the material of choice for interior window treatments. That is because vinyl offers unique opportunities for the consumer to purchase window treatments in a wide variety of colors and decorative surface finsihes to complement the interior decor of the dwelling.

Meeting all the aesthetic and mechanical requirements of vertical blind profiles, to insure the marketability of their design, involves the entire extrusion process; the best extruder and screw combination can be defeated by a poor die design. Thus, this bulletin is intended to summarize the current, commonly accepted techniques, which when combined, will successfully produce PVC vertical blinds.

Our Technical Service Report #13 entitled *Extruding Cubes of Rigid Geon Vinyls into Profiles* is a generic guide to successfully extrude rigid vinyl and contains additional valuable information on materials of construction for extruder barrels, screws, and dies which are not included here.

EXTRUDER

Either 2-1/2" or 3-1/2" extruders are the machines of choice to extrude rigid PVC vertical blind profiles. The recommended MINIMUM linear rates and corresponding output in pounds per hour rate are:

Size	fpm	lb/hr
2-1/2"	40	160
3-1/2"	55	225

These figures are based on a Specific Gravity of 1.50 and a vane 3-1/2" wide, 0.030" thick. The actual output will vary depending on the S.G., color, screw design, die design, and setup conditions. The reasoning behind a MINIMUM rate is discussed later in this bulletin.

The high screw speeds required to attain the above output rates demand adequate barrel cooling. High-capacity air blowers or circulating coolants are essential to maintain barrel temperature settings. Fluctuations in barrel zone settings will result in variations in output rate which will translate into dimensional variations. A continuous override in any or all barrel zones is indicative of inadequate cooling capacity and will result in loss of control of the extrusion process.

The correct barrel and die temperature setpoints are those which result in the above output rates at a melt temperature between 360°F-370°F using Geon 87600 vinyl compound. If the actual melt temperature is below 360°F, then the profile will likely be brittle; there may be signs of pinholes resulting from inadequate fusion of the PVC; and there will likely be longitudinal bands of alternating high and low gloss, commonly called shine lines. The shine-line problem tends to appear when Geon 87600 is extruded at less than 40 fpm on a 2-1/2" extruder, implying a minimum screw speed is required to generate the correct melt temperature; hence, the above-recommended MINIMUM linear rates. Above 370°F, the surface will begin to show signs of roughness or orange peel.

It should be noted that not all Geon vinyl vertical blind compounds can be run at these rates and temperatures. Compounds introduced for this application before Geon 87600 have maximum linear rates well below the above-stated figures. Any attempt to run these compounds at rates attainable with Geon 87600 will usually result in severe surface roughness.

Horsepower requirements are the same as for other rigid PVC extrusion compounds, i.e., 40 HP and 75 HP for a 2-1/2" and 3-1/2" extruder, respectively.

SCREW

Several different screw designs can be used successfully. The following 24:1 metering screw works very well:

Size	Feed	Number of Flights of Depth Transition	Metering
2-1/2"	5 @ 0.500"	7	12 @ 0.210"
3-1/2"	5 @ 0.625"	7	12 @ 0.260"

Typical placement of 4 rows of pins on a 3-1/2" screw is at 3, 6, 9, and 12 flights from the screw tip. Use 27 pins at 5/32" diameter of 304SS on a 36-hole index. Do not interrupt the screw flight.

If the screw length is greater than 24:1, then the extra flights should be located in the transition portion of the screw. Extra feed flights will result in more pumping capacity. Extra metering flights will result in higher shearing and melting. But the two must be balanced. Thus, locating extra flights in the transition section maintains the balance.

The Davis Standard Company has recommended both their BM and Spiral Maddox screws for extrusion of vertical blind profiles. The BM design is a combination Barrier screw and Maddox tip which has been specifically designed for rigid PVC. The Spiral Maddox differs only in that the Maddox section parallels the screw channel as opposed to paralleling the screw shank in the BM design.

Both of these designs are capable of supplying a well-mixed melt to the die. For a given screw RPM, both designs have slightly higher output with a melt of about 5°F-7°F hotter than the above metering screw. Thus, the screw speed needs to be lowered very slightly to maintain the desired melt temperature. The resulting reduction in output is negligible, and the benefits of improved mixing from both designs can be attained.

The BM design is not self-cleaning, i.e., at the end of a run, the screw must be pulled to expose the Maddox section in order to remove any compound in the channels if the extruder is to be shut down for an extended period. Repeatedly failing to do so can result in HCl etching of the barrel. The Spiral Maddox is reported to be self-cleaning.

One screw design to avoid is a constant taper. By its very nature, there is no section of the screw where the melt temperature can equilibriate within the channel. Thus, a melt of varying temperature within the screw channel is fed to the die. This makes die balancing very difficult in a thin-wall profile.

Screw cooling, either in the form of an air lance or a recirculating heat exchange fluid, can help control the melt temperature and avoid burning at the screw tip. However, it is not essential.

BREAKER PLATE AND SCREEN PACK

Both the entrance and exit sides of the breaker plate should be chamfered to avoid stagnation and burning at high extrusion rates. Screen packs should be no greater than 1 x 20 and 1 X 40 mesh and should be stainless steel.

DIE

High extrusion rates virtually demand some form of streamlined die. The prevalent design is best described as a modified coat hanger, i.e., the type used for sheet extrusion. As opposed to a flat plate design, the "coat hanger" forces material to the edges by restricting melt flow down the center so as to attain a uniform flow rate across the die land. This results in less distortion of the profile due to induced stresses when it is hung in a sunny window.

Draw-down is minimized, again to avoid built-in stresses. Typically, a 3-1/2" vane will be best extruded from about a 4" die opening. A larger draw-down can result in pronounced shrinkage of the vane when it warms up in a window.

The optimum land length is about 10:1, but as rates are increased, this might have to be lowered slightly to reduce drag and shear heating in the die.

COOLING

Extruded profiles must be cooled uniformly, top and bottom, so that the surface temperature is below 100°F at the saw. Uniform cooling is required to minimize bending or bowing of the profiles when they are hung in a sunny window. Bowing results from the difference in expansion caused by a different surface temperature on the side facing the window and that facing inside the room. If there is uneven cooling of these surfaces during extrusion, the thermal expansion in a window will be aggravated.

If profiles are cut to very long lengths, there may be some provision for the thermal contraction that will take place as profiles cool further to room temperature. This correction to the length can be made using a typical Coefficient of Expansion (and Contraction) for rigid PVC which is $3.5 \times 10E^{-5}$ in/in/deg F.

Somwhere prior to the saw blade but after most of the cooling has been accomplished, a surface antistat must be applied to the profiles. This is to prevent dirt pickup and clinging of the vanes due to a surface static charge when they are installed over air ducts.

Cutting is usually a high-speed sharp guillotine blade. High-speed saws usually don't travel fast enough to keep up with the linear rate of extrusion.

Please contact The Geon Company Technical Service Department for help in any aspect of extruding rigid PVC vertical blind profiles.

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