K-RESIN®
Styrene-Butadiene Copolymers

Plastics Technical Center Report #414

Davis-Standard Screw Design for K-Resin® SB Copolymer Sheet

INTRODUCTION. Since many K-Resin styrene-butadiene copolymer blends are processed on HIPS sheet extrusion equipment, problems sometimes occur because of improper screw design. Over the years, several equipment manufacturers have developed successful screw designs for K-Resin sheet. However, most of these manufacturers have declined to build screws for installation in competitor's sheet extruders. This has made it difficult for some processors to purchase a screw designed specifically for K-Resin sheet.

Some time ago, Davis-Standard agreed to work with the Plastics Technical Center to develop an "optimum" screw design for extruding K-Resin/GPPS blends. They also agreed to supply this screw to all sheet extruders, regardless of equipment brand. Since simple two-stage screw designs were well understood by the industry, developmental focus was on various barrier designs.

EQUIPMENT. Three developmental screws were evaluated on the PTC sheet line consisting of a 3.5 in, 32:1 L/D NRM extruder with a 125 hp drive motor. K-Resin/GPPS blend sheet was extruded through a 40 in wide EDI die, and cooled on an NRM sheet train. The first developmental screw (L1363) was designed to run with the vent open. The other two screws (L3329 and 3980) were built for best performance, without consideration of vent placement.

PROCEDURE. Sheet was extruded from 100% K-Resin and 60/40 blends of K-Resin/GPPS at 30, 60, and 90 rpm. Extrusions parameters were recorded as shown in Table 1. Two of the most critical performance measurements, screw output and stock temperature vs. screw speed, are shown in Figures 1 and 2. Sheet was then thermoformed into deli-containers on our roll-fed thermoformer to review wall distribution and part clarity. After the best of the three screw designs was identified, additional experiments with regrind were performed.

RESULTS. As seen in Table 1, the L1363 screw was lower in output. This screw, though, made sheet with excellent clarity and lower stock temperature. The barrier section on this screw was fairly short to ensure a match-up with the extruder vent.

The second screw, L3329, had a longer barrier section and a deeper undercut on the screw's barrier flight. The result was excellent throughput, excellent sheet and part clarity and stock temperatures in the moderate range. L3329 also performed well in our regrind study, with only a slight loss of output at the 100% regrind level.

The third screw, L3980, had an even deeper undercut on the screw's barrier flight. This resulted in exceptional throughput for a 3.5 in extruder at 90 rpm. However, we felt the resulting sheet had a grainy texture due to marginal mixing of the K-Resin and GPPS materials. As a result, L3329 was judged the best overall performer.

The data in Table 1 reveal the importance of proper barrel temperature control for this particular screw design. We increased throughput more than 7% by running the first two barrel zones cold and maintaining set temperatures with barrel cooling.

CONCLUSION. The L3329 screw performed very well in our tests concerning gel levels, melt temperature, sheet and part clarity and extruder output. Use of high levels of regrind had little effect on this design. The other two designs had limitations in either output or sheet quality.

Data generated in this study has been made available to Davis-Standard for use in future screw design considerations. They should be able to produce a suitable two-stage or barrier screw for K-Resin/GPPS sheet extrusion, and have agreed to do so for any make of equipment.

Figure 1

Output vs RPM

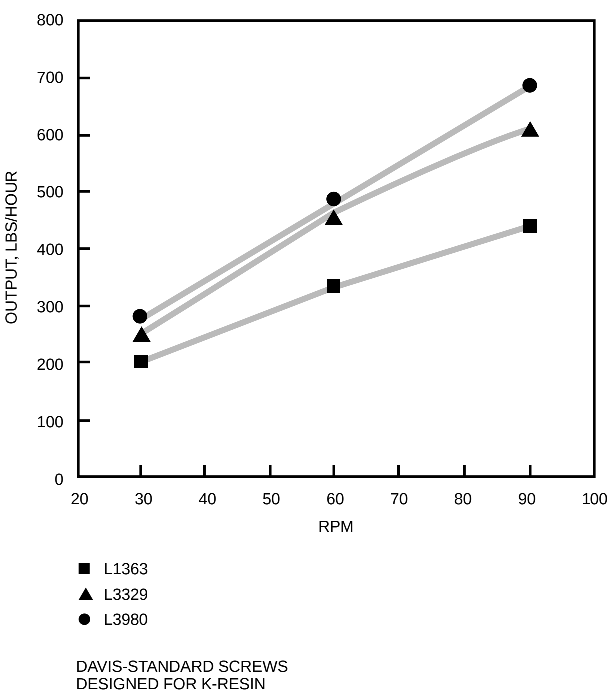

Figure 2

Screw Speed vs Melt Temperature

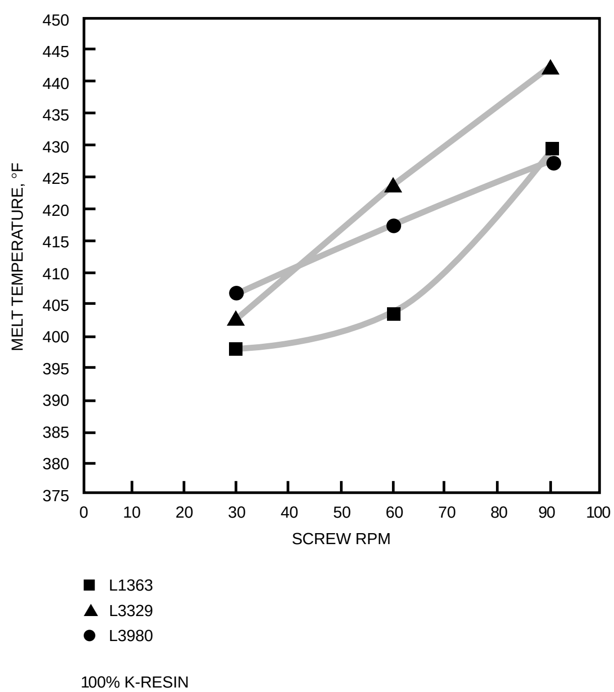

Table 1

Extrusions Parameters

		L1363			L3329			L3980		
	RPM	**30**	**60**	**90**	**30**	**60**	**90**	**30**	**60**	**90**
Barrel, °F	**Set**	**Melt Temperature in Barrel**								
Zone 1	320	275	307	337	276	307	332	282	298	313
Zone 2	340	348	368	388	349	368	391	351	369	384
Zone 3	380	376	378	386	377	383	396	378	385	390
Zone 4	380	–	–	–	–	–	–	–	–	–
Zone 5	380	394	397	398	402	412	426	398	406	414
Adaptor	380	–	–	–	–	–	–	–	–	–
Die	380	–	–	–	–	–	–	–	–	–
Melt Temperature, °F Instrument (End of Screw)		399	404	429	402	424	442	406	417	428
Hand Held Pyrometer (Die)		376	413	420	391	415	428	–	407	414
Output, lbs/hr (Barrel coolant off)		197	339	446	242	457	607	269	465	684
Output, lbs/hr (Barrel coolant on)		–	393	510	249	474	650	–	476	70
Motor Load Amps		55	60	65	70	75	75	70	80	85
Drive Power (A C Kilowatts)		30	35	60	10	50	60	20	50	65
Head Pressure, psi		1850	1975	2000	2000	2200	2400	2000	2200	2550

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