HMW Processing Aid PVC Foam Regulator

Melt Strength and Melt Elasticity are Two critical elements that are critical in the development of an effective rigid cellular foam PVC formula.

When the balance between these two properties are optimized it allows the development of a cell structure that provides for the best physical properties at a given density.

The characteristics of the HMW Acrylic Process aid plays a fundamental role in achieving this balance at the most efficient load level and the ability to measure these properties will enable an effective selection to be made

Develop a methodology for measuring melt strength capability imparted by a HMW Acrylic Process Aid into a Rigid Cellular foam formulation.

Demonstrate an ability to use this technique to identify the correct acrylic process aid loading to match that provided by an alternate process aid at a given loading

SolutionProvider

Melt Strength Formulations

Ingredient (phr)	#1	#2	#3	#4	#5	#6	#7
	DL-530	DL-638	DL-658	DL-688	K-445	PA-40	DL-688
PVC (K-58)	100.00	100.00	100.00	100.00	100.00	100.00	100.00
19% Methyl Tin Stabilizer	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Calcium Stearate	0.50	0.50	0.50	0.50	0.50	0.50	0.50
OPE Wax	0.10	0.10	0.10	0.10	0.10	0.10	0.10
165 Wax	0.30	0.30	0.30	0.30	0.30	0.30	0.30
1875 Wax	0.60	0.60	0.60	0.60	0.60	0.60	0.60
CBA(Foam agent)	0.60	0.60	0.60	0.60	0.60	0.60	0.60
CaCo3	10.00	10.00	10.00	10.00	10.00	10.00	10.00
TiO2 (Rutile)	4.00	4.00	4.00	4.00	4.00	4.00	4.00
P-311 (Lubricating P.Aid)	2.00	2.00	2.00	2.00	2.00	2.00	2.00
DL-530	5.00	-	-	-	-	-	-
DL-638	-	**5.00**	-	-	-	-	-
DL-658	-	-	**5.00**	-	-	-	-
DL-688	-	-	-	**5.00**	-	-	**3.50**
K-445	-	-	-	-	**5.00**	-	-
PA-40	-	-	-	-	-	**5.00**	-

Equipment & Process Conditions

Equipment Type	Single Screw Extruder
Screw Diameter	30mm
L/D Ratio	25:1
Die Diameter	5mm
Barrel Zone 1	165 C
Barrel Zone 2	170 C
Barrel Zone 3	185 C
Barrel Zone 4	175 C
Barrel Zone 5	170 C
Motor Speed (rpm)	5.0
Motor Amps	4.4-4.6
Haul Off Speed (m/min)	4.4

Expansion Capabilities

- Foamed Die Swell Ratio = Diameter of Extrusion Bar with Blowing Agent / Extrusion Die Diameter x 100

Data Table

Material	*Foamed Die Swell Ratio% With 0.6phr CBA(Foam agent)*
#1 DL-530 5.00phr	*127.6*
#1 DL-638 5.00phr	*126.6*
#1 P-DL-658 5.00phr	*128.2*
#1 DL-688 5.00phr	*126.6*
#1 K-445 5.00phr	*133.0*
#1 PA-40 5.00phr	*132.6*
#1 DL-688 3.50phr	*128.4*

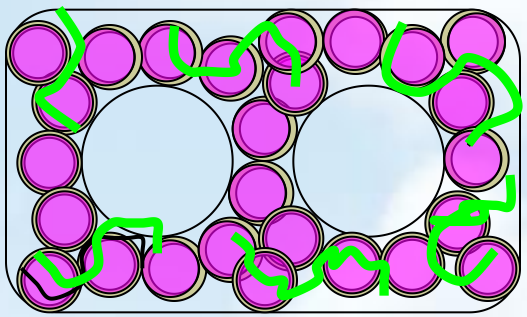
Melt Strength

- **Measurement Methodology**
  - Method A: - A torque meter is added between the die and the puller and the torque is balanced the value is recorded at a fixed speed
  - Method B:- A torque meter is added between the die and the puller and the torque is balanced the puller speed is increased until the foam rod breaks and the highest value is recorded
  - **Note – melt strength is presented as torque value / cross sectional area of foamed bar**
- **Results**

Test Method	Method A Tension Value (N)	Method A Melt Strength (Kpa)	Method B Tension Value (N)	Method B Melt Strength (Kpa)
#1 DL-530 5.00phr	1.308	1.665	40.938	52.120
#1 DL-638 5.00phr	1.958	3.400	62.015	108.100
#1 DL-658 5.00phr	1.696	2.938	52.587	91.103
#1 DL-688 5.00phr	2.085	3.688	66.275	117.265
#1 K-445 5.00phr	1.173	1.496	33.792	43.099
#1 PA-40 5.00phr	1.335	2.219	41.249	68.59
#1 DL-688 3.50phr	1.473	2.696	42.69	78.135

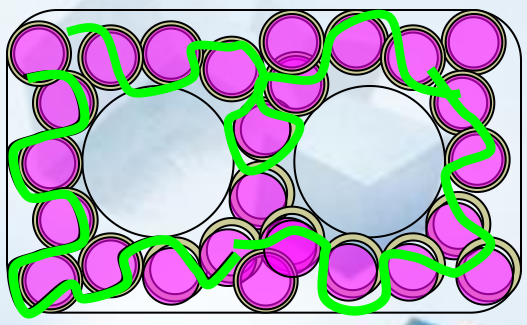
The influence of molecular weight on shear

Low Mw



VS

High Mw



Addition of higher Mw processing aid generates shear

Higher shear generates heat

Shear heat causes fusion with lower external energy input

Fusion causes continuous matrix of polymer

Continuous polymer matrix develops good physical properties

Better PVC products performance

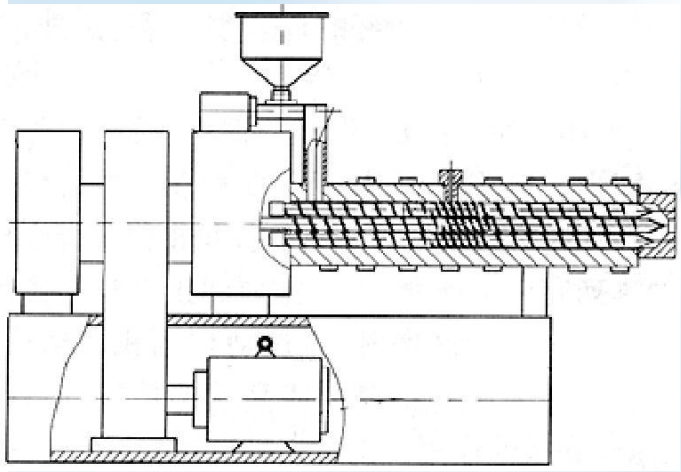
The advantages of Donglin processing aid

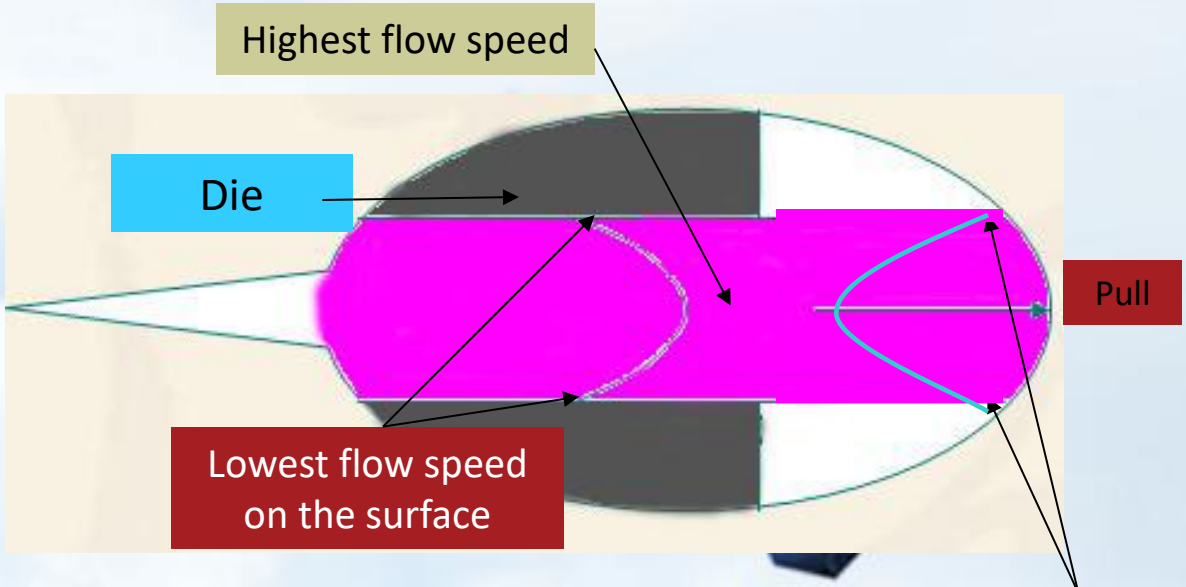
Donglin processing aid has the highest molecular weight in the world.

Cost efficiency improvement

- Lower dosage
- Higher potential filler addition level
- Excellent PVC products performance

Influence of Processing aid on gloss





The biggest traction force on the melt surface.

The surface is easily to fracture during pulling

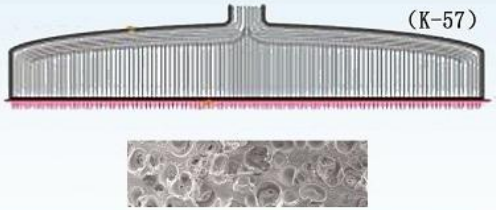
Bad gloss

Processing aid → Enhance the melt strength → Avoid surface fracture of melt during pulling → Good gloss

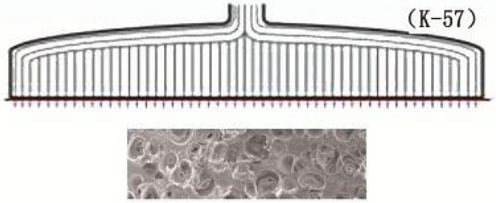
Our Products For Foaming Application

SolutionProvider

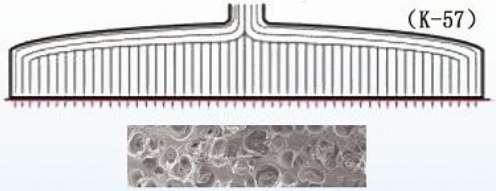
DL-530 (3-8mm)

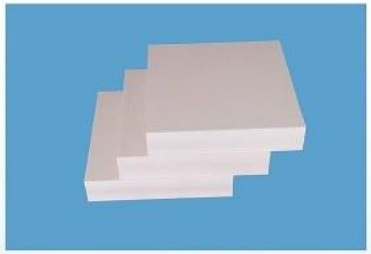


DL-638 (8-12mm)

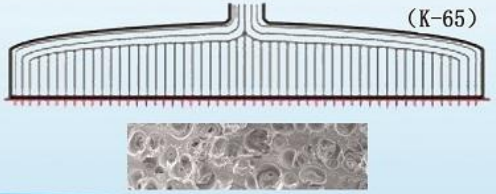


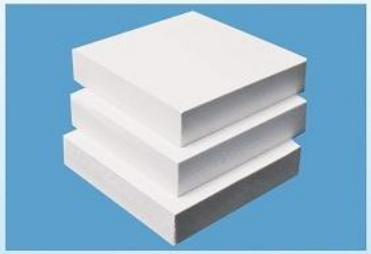
DL-688 (12-18mm)





DL-698 (>18mm)





Different thickness of foam sheet have different die lip gap, the different requirment melt pressure and flowdity request different type of foam regulator.

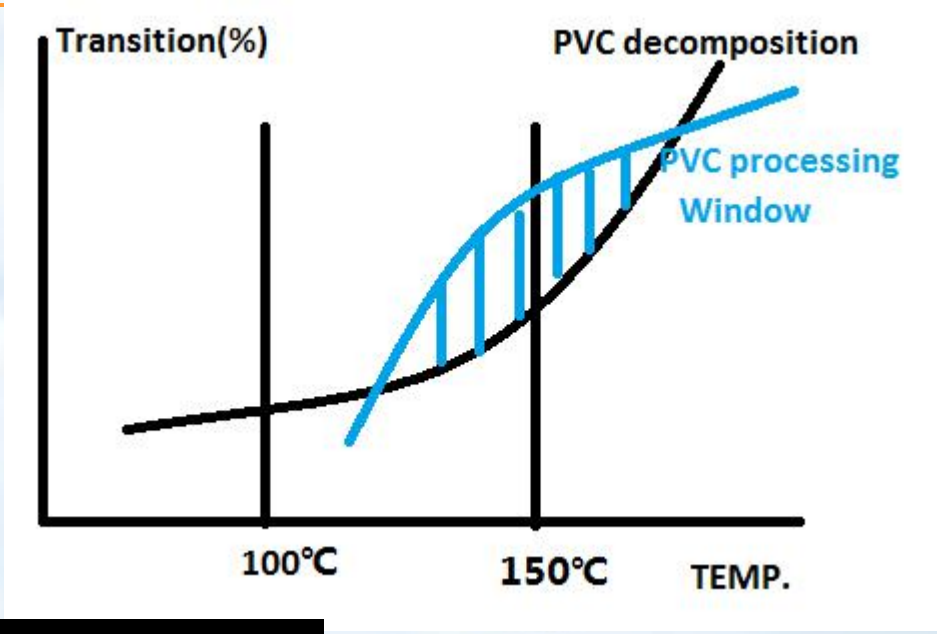
1- For Thin sheet (3-8mm)
High melt pressure, high melt flowdity request a little lower viscosity foam regulator

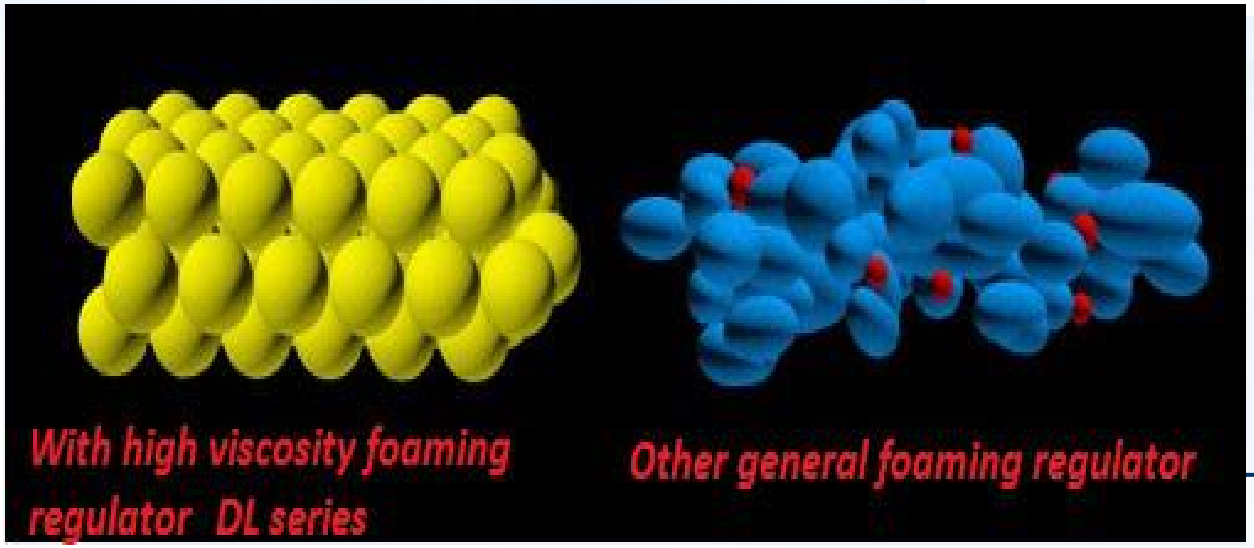
2- For Medium sheet(12-18mm)
Die lip gap open bigger hole, the melt pressure release more, it request high melt strength and a little lower flowdity, thus we select DL-688.

3- For thin sheet(above 18mm)
We should keep very high melt stength and lower melt speed

Donglin Chem

PVC processing under very narrow process window, we want to control the process temperature as lower as possible.
High molecular weight processing aid(foam regulator) assist us expand the process window and make the bubble under control with uniform cell structure





Think of Service, Think of Donglin Chem.

Thank you !