PARALOID™ K-125 ER Acrylic Processing Aid

The Industry Standard for High Efficiency, Recommended for Building and Selected Packaging Applications

Description

With its unique combination of features, PARALOID™ K-125 ER has established itself as the industry standard for building and construction markets.

PARALOID K-125 ER is a particularly effective processing aid, thanks to its high molecular weight. Composed of long polymer chains, this all-acrylic processing aid increases the interaction between PVC grains, promoting faster fusion. After fusion, PARALOID K-125 ER's long polymer chains bind the shorter PVC choirs together, increasing the melt elasticity. PARALOID K-125 ER is also extremely cost-effective, requiring only very low addition levels for high-quality results.

This combination of features makes PARALOID K-125 ER attractive for a number of applications.

- With its excellent fusion qualities, it is widely used in injection-moulding, especially as PARALOID™ K-125 ER also reduces the risk of gate blush and improves surface finish.
- The processing aid's capacity to improve melt elasticity makes it suitable for many PVC foam applications.
- The cost factor makes PARALOID™ K-125 ER the ideal choice for high volume manufacturing, notably in the building and construction industry.
- In the packaging industry, fusion and melt elasticity are valuable features, offering excellent wall-thickness control and good thermoforming capabilities.

The following tests will demonstrate these qualities, drawing particular attention to the high performance obtained with low levels of addition.

The PARALOID K-125 ER production process has obtained the ISO 9002 quality assurance certification.

Building

Due to its versatility, vinyl is the leading plastic material used in the building sector. The precise and exacting performance standards of the industry require finely tuned compounds, and a vital component in this sophisticated technology is PARALOID™ K-125 ER.

Performance in Processing

PARALOID™ K-125 ER facilitates the processing of rigid vinyl and helps achieve a high standard of finish in even the most complex mouldings and profiles. The high molecular weight of PARALOID K-125 ER promotes faster fusion, increases melt strength, and improves melt homogeneity of the compounds.

Brabender Rheology:
Fusion Characteristics

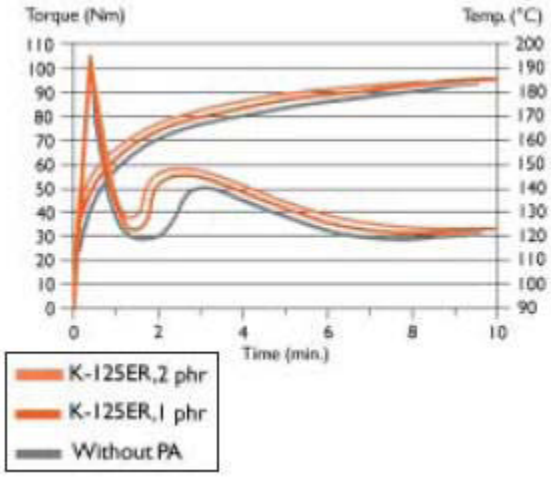
Pb Stabilised Vinyl Formulation	
S-PVC K57	100
Di-basic Pb phosphite	3.0
Neutral Pb stearate	0.35
Calcium stearate	0.60

Ester of montanic acid partially saponified with calcium	0.25
Stearic acid	0.50
$CaCO_3$	2.0
TiO_2	3.0
PARALOID™ KM-334	3.0
PARALOID K-125 ER	as indicated

Brabender conditions:

- Bowl: W50
- Charge weight: 57g
- Temperature set: 160°C
- Rotor speed: 40 rpm

As shown in the graph and table below, the use of PARALOID™ K-125 ER processing aid greatly reduces fusion time.



Brabender Rheology Test

	Without P A	K-125 ER, 1 phr	K-125 ER, 2 phr
Fusion time(s)	150	92	78
Fusion torque (Nm)	51	59	60
Fusion temperature (°C)	168	165	164
Equilibrium torque (Nm)	34	34	34

Melt Strength and Melt Homogeneity

Pb Stabilised Vinyl Celuka Formulation Without Blowing Agent

S-PVC K57	100
Di-basic Pb phosphite	3.00
Neutral Pb stearate	0.35
Ca stearate	0.60
Polyethylene wax	0.02
Stearic acid	0.20
$CaCO_3$	2.00
TiO_2	3.00
PARALOID K-125 ER	as indicated

Extrusion conditions: extruder Göttfert type 015

- Screw diameter: 30 mm
- Screw speed: 10 rpm
- Temperature set (°C):
  - Cylinder 160, 170, 175
  - Die head 180, 180

The addition of PARALOID™ K-125 ER significantly improves the elongational properties of the melt. The increased stress at break translates into reduced melt fracture and improved surface finish.

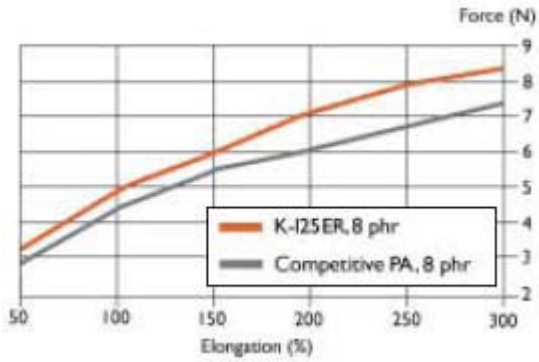
The Rheotens test, which measures elongation and stress of polymer melts, characterises melt elastic properties directly from the extruder, and predicts the performance of compounds in the molten state (see Standards and Formulations).

Extrusion and Rheotens Test

	Without P A	K-125 ER, 4 phr	K-125 ER, 8 phr
Elongation (%)	387	450	650
Die swell	1.30	1.50	1.55
Stress at break (N/mm2)	12.34	15.99	29.68

Die swell is measured as the ratio of the diameter of the extrudate to the diameter of the die.

In addition, the graph below compares the melt strength of PARALOID™ K-125 ER to a competitive processing aid.

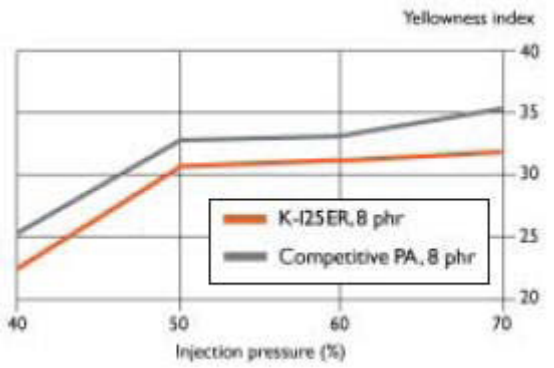


Injection-Moulding Applications

Typical problems encountered in injection-moulding applications include shear burning, gate blush, and low gloss. In most cases, the addition of PARALOID™ K-125 ER brings a significant improvement.

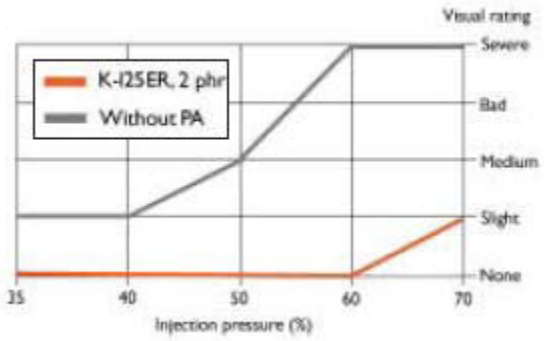
Shear Burning

In injection-moulding, as the injection pressure is increased, melt shear also increases. Under high shear conditions, yellowing and burning of the melt can occur. The addition of 2 phr of PARALOID™ K-125 ER delays the onset of this burning.



Gate Blush

The addition of PARALOID™ K-125 ER significantly improves the appearance of the injection moulded part.

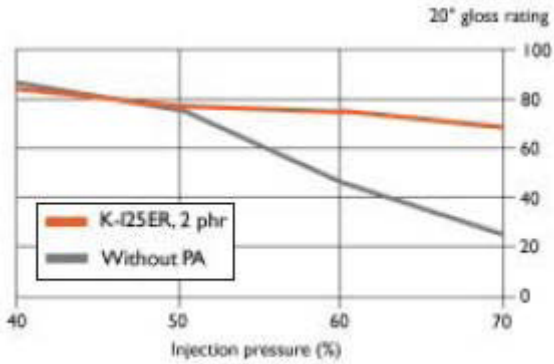


Gloss

The graph below shows that the addition of PARALOID™ K-125 ER provides high gloss, even under high injection pressure.

Sn Stabilised Vinyl Formulation	
S-PVC K51	100
Methyl Sn stabiliser	2.00
Glycerol mono stearate	2.00
Polar polyethylene wax	0.20
PARALOID K-125 ER	as indicated

Gloss was measured at an angle of 20° perpendicular to the flow direction.



Foam Applications

To ensure good control of cell structure for successful production of foam PVC, a high melt strength is required. The high molecular weight of PARALOID™ K-125 ER makes it suitable for many foam applications.

Pb Stabilised Vinyl Formulation	
S-PVC K58	100
Di-basic Pb phosphite	3.00
Neutral Pb stearate	0.35
Calcium stearate	0.60
Stearic acid	0.50
$CaCO_3$	4.00
TiO_2	2.00
PARALOID K-125 ER	as indicated

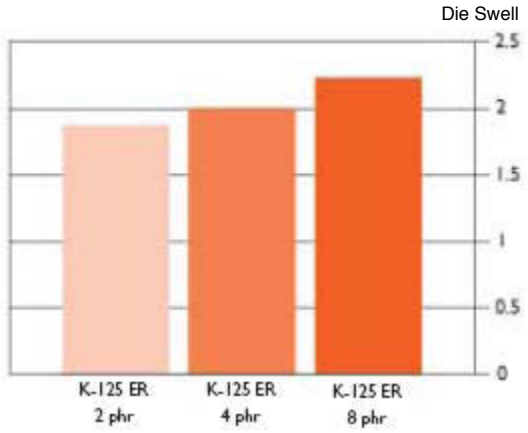
Die Swell

Die swell is measured as the ratio of the diameter of the extrudate to the diameter of the die.

Extrusion conditions: extruder Göttfert type 015

- Screw diameter: 30 mm
- Screw speed: 10 rpm
- Temperature set (°C):
  - Cylinder 160, 170, 175
  - Die head 180, 180

To retain the gas produced by the decomposing blowing agent within the PVC melt, high melt elasticity is required. Die swell is a measurement of melt elasticity.

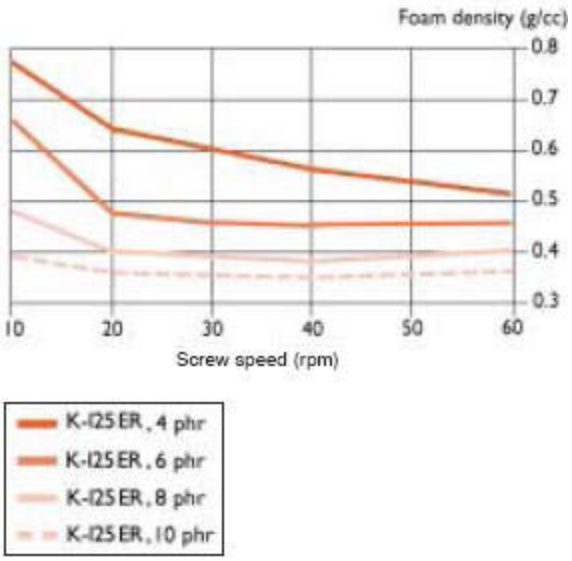


Density

Extrusion conditions: extruder Göttfert type 015

- Screw diameter: 30 mm
- Screw speed: as indicated
- Temperature set (°C):
  - Cylinder 160, 170, 175
  - Die head 180, 180

Density of the foam product depends on the ability of the melt to retain the gas. As the addition level of processing aid is increased, melt strength improves, more gas is retained and lower density foam is produced. Under standard manufacturing conditions, formulations with high addition levels of PARALOID™ K-125 ER give a wider processing window and a more consistent product.



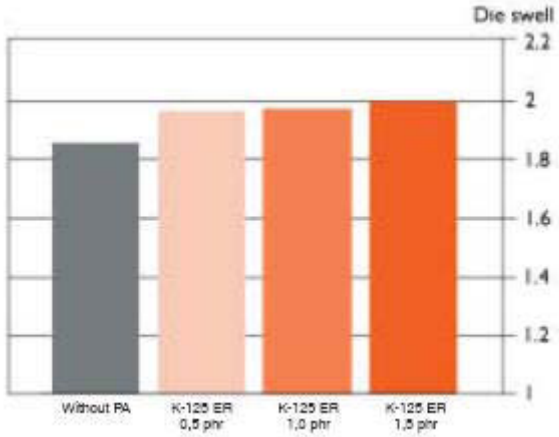
Extrusion Applications

A precise control of dimensions is a critical factor in the extrusion process.

Dimensional Control

The use of PARALOID™ K-125 ER increases die swell, even at very low addition levels, allowing users to control the wall thickness consistency.

Die swell is measured as the ratio of the diameter of the extrudate to the diameter of the die.



Wall Thickness Variations

	Without PA	PARALOID K-120N ER 0.4phr	PARALOID K-120N ER 0.8phr	PARALOID K-125 ER 0.3phr	PARALOID K-125 ER 0.4phr
Wall thickness variation (%)	8.5	6.72	2.62	3.93	3.80
Wall thickness range "E" (%)	15.32	12.25	5.11	7.57	5.97
Variation from nominal thickness (%)	12.38	8.41	3.42	2.42	7.83

Packaging

PARALOID™ K-125 ER is an excellent cost-effective choice for selected packaging applications, in particular cosmetic bottles and deep-draw thermoformed containers.

Performance in Processing

Brabender Rheology:
Fusion Characteristics

Ca/Zn Stabilised Vinyl Formulation	
S-PVC K57	100
Calcium hydroxy stearate	0.30
Zn octoate	0.078
Epoxidised soya bean oil	5.75
Stearoyl benzoyl methane	0.20
Glycerine tri-ester	1.50
Ester of montanic acid	0.75
Polar PE wax	0.15
PARALOID BTA 736-S	6.00
PARALOID Processing Aid	as indicated

Extrusion conditions:

- Bowl: W50
- Charge weight: 48 g
- Temperature set 160°C:
- Rotor speed: 40 rpm

In the table below the test results clearly show the higher efficiency of PARALOID™ K-125 ER. Even at a significantly lower concentration, PARALOID K-125 ER gives faster fusion characteristics compared to those of a lower molecular weight processing aid.

Brabender Rheology Test

	K-125 ER 0.2 phr	**K-125 ER 0.5 phr**	**K-120N ER 0.2 phr**	**K-120N ER 0.5 phr**
Fusion time(s)	36	30	73	69
Fusion torque (Nm)	33	34	32	32
Fusion temperature (°C)	111	108	116	117
Equilibrium torque (Nm)	24	23	24	25

Dispersion Test

Test rating 0-12 where:

- 0 = gel free excellent dispersion
- 12 = sandpaper / high gel content

Extrusion conditions:

- Blowing extruder: Bekum BA 0 7
- Cylinder temperature (°C): 150, 160, 170
- Die head temperature (°C): 180, 180
- Screw speed: 80 rpm

As shown below, PARALOID™ K-125 ER processing aid helps dispersion of compounding additives, and does not contribute to gel formation under typical manufacturing conditions. The low gel content means that the modified PVC can be vacuum formed to deep draws without developing tears or others imperfections.

Inflated Parison Test

	Without P A	K-125 ER 2.0 phr	K-120N ER 2.0 phr
Dispersion rating (0-12)	0.1	1	7

Sn Stabilised Vinyl Formulation

S-PVC K58	100
Octyl-Sn mercaptide stabiliser	1.50
Glycerol mono oleate	0.50
Epoxidised soya bean oil	0.25
Polyethylene wax	0.25
Di-octyl phthalate	5.00
PARALOID™ Processing Aid	as indicated

Optical Properties

Because PARALOID™ processing aids are fully compatible with PVC, they do not affect the optical properties.

	Without P A	K-125 ER 0.2 phr	K-125 ER 0.5 phr
LT (%)	87	85	86
Haze (%)	13.2	14.3	12.7

Bottle Applications

PARALOID™ K-125 ER is used for cosmetics bottles where a good balance of optical, low-weight and processing properties are desired.

Parison Extrusion Test

Ca/Zn Stabilised Vinyl Formulation

S-PVC K57	100
Calcium hydroxy stearate	0.30
Zn octoate	0.078
Epoxidised soya bean oil	5.75
Stearoyl benzoyl methane	0.20
Glycerine tri ester	1.50
Ester of montanic acid	0.75
Polar PE wax	0.15
PARALOID BTA 736-S	6.00
PARALOID K-125 ER	as indicated

As shown below the addition of PARALOID™ K-125 ER increases both relative die swell and total weight, giving more consistent wall thickness.

	Without P A	K-125 ER 0.2 phr	K-125 ER 0.5 phr
Total weight (g)	105.0	106.9	110.6

Flow time(s)	22.5	25.0	25.5
Relative die swell	1.00	1.04	1.09

Relative die swell is calculated as the ratio of parison weight with processing aid to parison weight without processing aid (see Standards and Formulations)

Film Applications

Rheotens Melt Elongation Test

Sn Stabilised Vinyl Formulation	
S-PVC K6O	100
Di-n-octyl Sn stabiliser	1.20
Ester of montanic acid partially saponified with calcium	0.20
Ester of montanic acid with ethylene glycol	0.10
Blue toner	0.01
PARALOID™ K-125 ER	as indicated

Extrusion conditions: extruder Göttfert type 015

- Screw diameter: 30 mm
- Screw speed: 10 rpm
- Temperature set (°C):
  - Cylinder 160, 170, 175
  - Die head 180, 180

As shown below PARALOID K-125 ER improves the elongational properties of the melt, producing a film that is easily thermoformed, giving deeper draws without tearing.

	K-125 ER 0.2 phr	**K-125 ER 0.5 phr**	**K-125 ER 1.5 phr**
Elongation	500	620	640
Stress at break (n/mm2)	7.3	8.8	10.1

Standards and Formulations

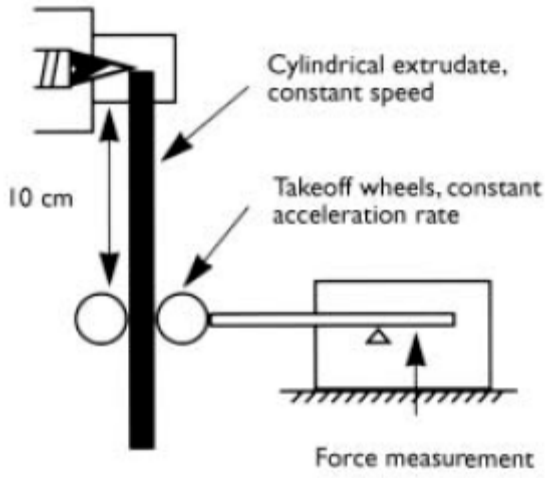
Test Standard Descriptions

Test	**Standard**
Optical	ASTM-D1003-61

Rheotens Extensiometer

The Rheotens Extensiometer is an instrument designed to measure elongation and stress of polymer melts. It is comprised of an extrusion gear assembly, a programmer, and a chart recorder.

The programmer is used to control the speed and acceleration of two cogged wheels in the extrusion gear assembly. The operator first sets the speed and acceleration, typically to the same linear speed as the extrudate. The polymer melt strand is passed between the two cogged wheels, and the speed is increased until the melt breaks. The force and velocity are recorded, to determine elongation and stress.



Parison Extrusion Test

In this test, the parison is extruded vertically from the die to the floor. The hot parison is then squeezed between two vertical plates and allowed to cool. The cold parison is removed from between the plates and cut carefully into 10 cm segments. Each segment is weighed and plotted against the parison length. The segment weights are plotted back to the zero length to give the weight/cm of the first part of the peson exiting the die.

The relative die swell is calculated as the ratio of the zero-length weight of the parison with processing aid to the zero-length weight of the parison without processing aid.

Formulations

Window Profiles	
S-PVC K68	100
PARALOID™ KM-370	7.00
PARALOID K-125 ER	0.50
Di-basic Pb phosphite	4.00
Neutral Pb stearate	0.50
Calcium stearate	0.50
Dicarboxylic acid ester	0.60
Fatty acid ester	0.40
Paraffin wax (MP 95°C)	0.05
TiO_2	4.00
$CaCO_3$	4.00

General Purpose Injection-Moulding	
S-PVC K57	100
PARALOID™ K-125 ER	2.00
Tri-basic Pb sulphate	3.85
Di-basic Pb stearate	0.25
Neutral Pb stearate	0.15
Calcium stearate	0.75
Montanic acid	0.20
Ester of montanic acid	0.40
Paraffin wax (MP 95°)	0.05
Paraffin wax (MP 55°C)	0.10
$CaCO_3$	3.00

Inward Foaming	
S-PVC K57	100
PARALOID™ K-125 ER	8.00
Di-basic Pb phosphite	3.00
Neutral Pb stearate	0.50
Calcium stearate	0.40
12 hydroxy stearic acid	0.40
Dicarboxylic acid ester	0.50
Polar polyethylene wax	0.20
$CaCO_3$	3.00

Toiletries	
S-PVC K57	100
PARALOID™ BTA 736-S	7.00
PARALOID K-125 ER	0.80
PARALOID K-175 ER	0.60
Methyl Sn stabiliser	1.20
Tri glycerol ester of hydroxy saturated fatty acid	1.00
High molecular weight complex fatty acid ester with calcium	0.40
Polar polyethylene wax (oxidised)	0.25

Sodium bicarbonate	1.60
Azo di carbonamide	0.20
TiO_2	3.00

Blue toner	0.006
Violet toner	0.012

Film Calenderette

S-PVC K57	100
PARALOID™ BTA 736-S	6.00
Di-n-octyl Sn mercaptide stabiliser	1.50
PARALOID K-l25 ER	1.20
PARALOID K-l75 ER	0.60
Tri glycerol ester of hydroxy saturated fatty acid	0.60
Epoxidised soya bean oil (ESBO)	0.80
Polar polyethylene wax (oxidised)	0.10
High molecular weight complex fatty acid ester with calcium	0.70
Blue toner	0.01
Violet toner	0.02