Baerlocher Additives for PVC

Extrusion and Injection Moulding

BÆRLOCHER

we add character to plastics

The Baerlocher Group of Companies is one of the world's leading suppliers of additives for the plastics industry with a strong focus on PVC. Baerlocher has extensive technology and market knowledge drawn from more than 190 years of company history.

Additives play a crucial role in determining processing properties as well as product quality and character. Baerlocher offers a broad range of additives for polymers suitable for various industries.

Baerlocher is your global partner for Ca-based solutions and metal soaps.

By developing and supplying innovative additives, Baerlocher enables the plastics industry worldwide to manufacture high-quality and sustainable products.

www.baerlocher.com

Sixteen production sites in Germany, United Kingdom, Italy, France, San Marino, Turkey, the United States, China, Malaysia, Korea, India, Brazil, Peru and Argentina as well as a worldwide sales network make the Baerlocher group of companies a strong partner. This global presence and 1150 employees worldwide make sure that we are always close to the customer. Future-oriented, we are continuously investing in research and development. Our innovative power results from the creativity of our in-house scientists and technical experts. Baerlocher has R&D facilities all over the world.

Sustainable development, safe and environmentally friendly production processes as well as protection of people and the environment are key corporate goals. Our quality management system with ISO 9001 certification, our environmental management system with ISO 14001 certification and our energy saving management system ISO 50001 certification encourage all employees to act responsibly in order to achieve joint success with our customers.

Baerlocher products

BAEROPAN
BAEROSTAB
BAEROPOL
BAEROLUB
BAEROPHOB
BAEROCID
BAEROCIN
CEASIT
ZINCUM

BÆRLOCHER

BAERLOCHER

Baerlocher worldwide

Headquarters
Germany **Baerlocher GmbH** Unterschleissheim

Production Sites	Products		
Germany **Baerlocher GmbH** Lingen	· Ca-based stabilizers · Stearates · BAEROPOL	· Fatty Acids · Glycerine	· Hydrophobic agents
Italy **Baerlocher Italy S.p.A.** Lodi	· Sn stabilizers · Liquid Mixed Metal stabilizers	· Lubricants · Stearates · Fatty Acids	· Glycerine · Fatty Acid Derivatives
United Kingdom **Baerlocher UK Ltd.** Bury	· Ca-based stabilizers		
France **Baerlocher France SAS** Marseille	· Waxes · Lubricants	· Solid Sn-based one-packs	
Turkey **Baerlocher Kimya SaN. Ve Tic. Ltd. Şti,** Akhisar	· Ca-based stabilizers one-packs · Pb one-packs		
Malaysia **Baerlocher (M) Sdn Bhd** Seremban	· Ca-based stabilizers · Pb one-packs	· Stearates · BAEROPOL	
India **Baerlocher India Additives Pvt. Ltd.**, Dewas	· Ca-based stabilizers · Pb stabilizers and one-packs	· Liquid Mixed Metal stabilizers	
China **Baerlocher Plastic Additives (Jiangsu), LTD**, Changzou	· Ca-based stabilizers · Pb one-packs		
USA **Baerlocher Production USA LLC,** Cincinnati	· Ca-based stabilizers · Liquid Mixed Metal stabilizers	· Stearates · BAEROPOL	
USA **Baerlocher USA LLC** Dover	· Ca-based stabilizers · Liquid Mixed Metal stabilizers	· Stearates · BAEROPOL	

Joint Ventures	Products		
Brazil **Baerlocher do Brasil SA** Americana	· Ca-based stabilizers · Pb one-packs	· Liquid Mixed Metal stabilizers · Stearates	· BAEROPOL · Fatty Acids
Argentina **Lestar Quimica SA** Junín	· Ca-based stabilizers · Pb one-packs · ESBO	· Phosphites · Stearates · BAEROPOL	
Peru **Compania Quimica SA** Lima	· Ca-based stabilizers · Pb stabilizers and one-packs	· Liquid Mixed Metal stabilizers · Plasticizer	
Italy **SO.G.I.S. S.p.A.** Cremona	· Stearates · Fatty Acids	· Glycerine · Esters	· Fatty Acid Derivatives
Republica San Marino **TITANSTUC SA** Faetano	· Ca-based stabilizers		
Korea **DOOBON, Fine Chemical Co., LTD,** Chungchong	· BAEROPOL		

Additives for the extrusion and injection moulding of rigid PVC

Extruded or injection moulded PVC products have excellent technical properties that meet the most demanding economic and ecological requirements. Applications are: window frames, shutters, cable ducting, skirting, siding, gutters, potable water pipes, compact sewer pipes, foam core pipes, corrugated land drainage pipes etc..
Baerlocher PVC additives allow products of high quality to be made efficiently, imparting to the finished products specific performance characteristics, such as high mechnical stability and longevity.
Baerlocher develops tailor-made products to suit the needs of each customer and manufacture them at one of the worldwide production sites. Special emphasis is always placed on customer focus and consistent quality. We offer a full range of stabilizers, from proven Lead stabilizers to current Calcium-based stabilizers. All stabilizer types are available in various supply forms ranging from powders to one-packs in granule or pastille form.

Baerlocher PVC Additives

- **high-performance**
- **quality-controlled**
- **future-oriented**
- **cost-efficient**

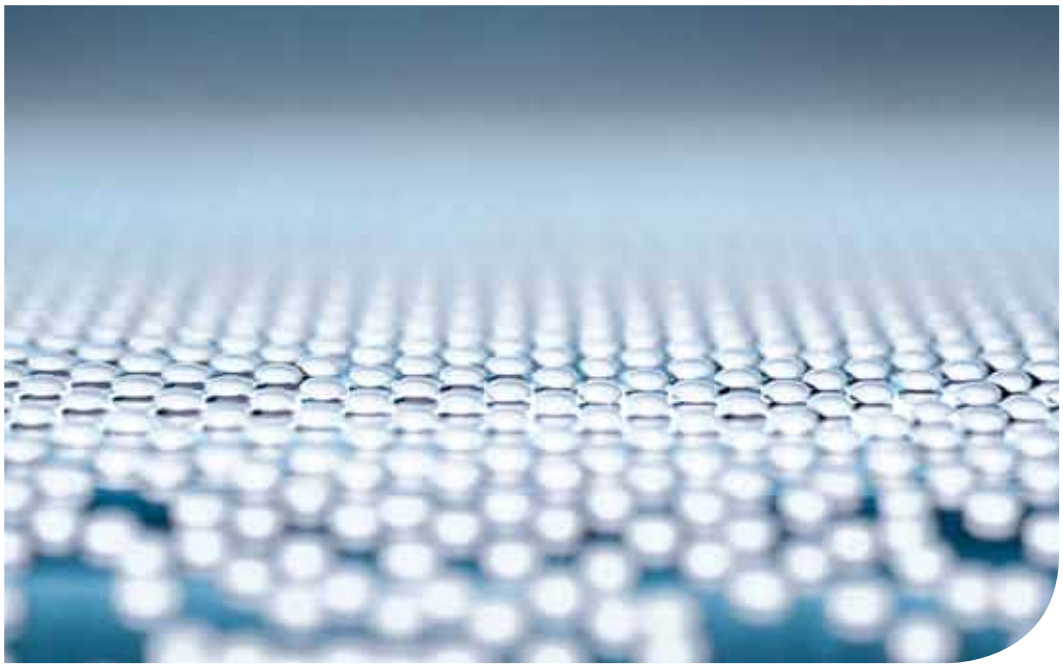
Contents

Window profiles

From Lead to Calcium-based stabilizers

Although the demand for Ca-based stabilizers is vastly growing, Lead stabilizers are still used because of their large processing latitude and outstanding heat stability.
Baerlocher has continuously developed Ca-based systems to produce stabilizers which are not just equivalent but in some respects even superior to Lead formulations.
The product development for Ca-based systems also involves the choice of sustainable raw material sources and the compliance of all raw materials with current and future chemical legislations.
The latest-generation Ca-based stabilizers offer good performance at considerably lower addition levels than Lead stabilizers or previous Ca-based systems. In addition, the 2% lower density of a Ca-based stabilized dryblend is a key consideration in the comparison of overall dryblend costs.

After introducing melt products of Lead stabilizers some time ago, Baerlocher's efforts have lead to the first melt products of Ca-based stabilizer for PVC profile applications. The pastilles, formed by a melt process, are well approved for their various advantages.
The production process of the so called TX products ensures highly homogeneous one-packs which can even include processing aid. The pastilles are not prone to abrasion during transport and conveyance, thus there are virtually no fines. The good flowability of the TX products facilitates dosage and handling of the stabilizers. Moreover, the pastilles possess superior silo storage ability. Baerlocher TX products are tailor-made for each customer and serve in white as well as coloured profile applications.



Weathering resistance

Weathering resistance is a key requirement of profiles, especially window profiles. Over the last decades, Lead-stabilized window profiles have proven their outstanding durability under different climatic conditions. They maintain their mechanical properties, such as impact strength or dimensional stability, even when exposed to strong temperature changes, alternate periods of humid and dry weather and solar radiation. Ca-based stabilizers exhibit better colour hold than traditional Lead systems both in artificial and natural weathering.

Example 1

Components	[phr]	[phr]
S-PVC, k-value 66	100.0	100.0
Impact modifier	6.0	6.0
Filler	8.0	8.0
Titanium dioxide	3.5	3.5
Pb stabilizer	5.0	–
Ca-based stabilizer	–	3.7

Processing aid is included in stabilizers

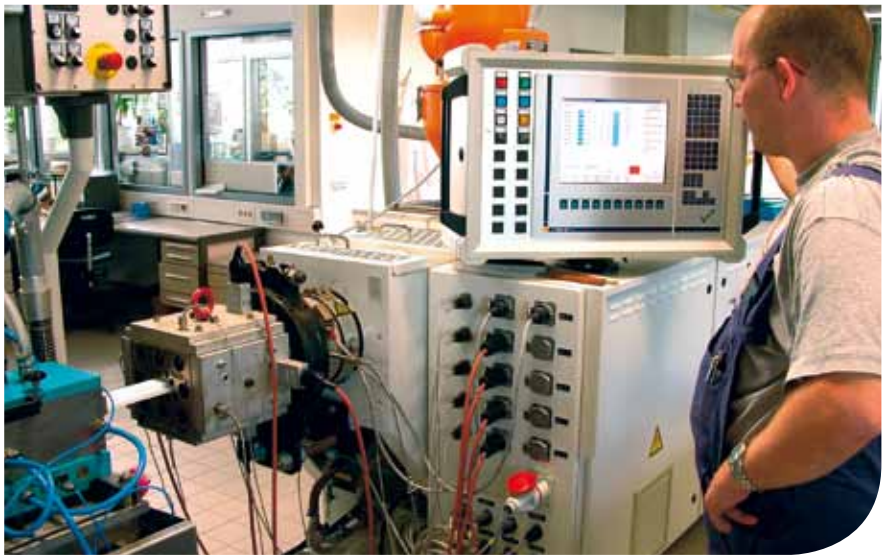
Xenon test

Stabilizer									
Pb									
Ca-based									
hours:	0	500	1000	1500	2000	2500	3000	3500	4000

The Xenon test illustrates the outstanding weathering resistance of PVC window profiles. The use of Ca-based stabilizers delays "chalking" in comparison with Lead stabilization.

(Colour deviations may occur due to printing variations)

Xenon test aparatus



Modern technical equipment enables Baerlocher to develop customised recipes. The picture shows a twin screw profile extruder in Baerlocher's laboratory.

Processing properties

Baerlocher has further improved the modern Ca-based formulations in terms of dosage, which now is below 4 phr in most cases. Generally the processing aid is included in the one-packs. Ca-based Stabilizers provide good early colour and excellent colour hold under mechanical and thermal stress. It is thus possible to produce profiles of consistently high quality even with a variety of machinery and tools. When processed with suitable lubricant systems, Ca-based stabilized profiles compare equally with Lead-stabilized profiles in terms of surface gloss.

Supply forms

Baeropan	MC	R	TX	Dosage [phr]	
51021 FP	•	•	•	approx. 5.0	Pb stabilizer
90705 FP	•	•	•	approx. 3.7	Ca-based stabilizer

MC = powder; R = granules; TX = pastilles

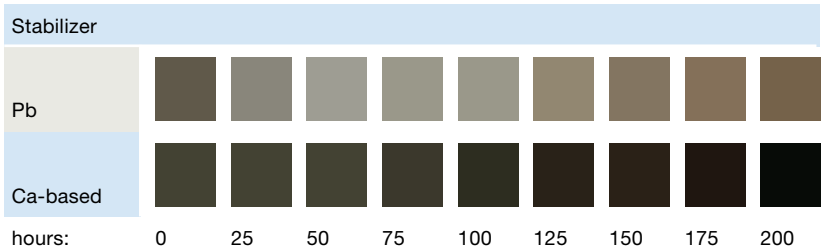
Weathering stability

Baerlocher stabilizers for technical profiles are used in outdoor weatherable shutters and building profiles as well as in the extrusion of cable ducting and furniture profiles. The improved protective effect provided by Ca-based stabilizers is very clearly visible in dark-pigmented profiles. While dark-pigmented Lead-stabilized profiles gradually fade under the influence of weathering, Calcium/Zinc-stabilized profiles maintain their original colour much longer.

Example 2

Components	[phr]	[phr]
PVC	100.0	100.0
Filler	10.0	10.0
Pigment	1.7	1.7
Pb stabilizer	4.1	–
Ca-based stabilizer	–	3.2

Sun test



The SUN weathering test clearly demonstrates that pigmented Ca-based stabilized profiles have better colour hold than Lead stabilized profiles.

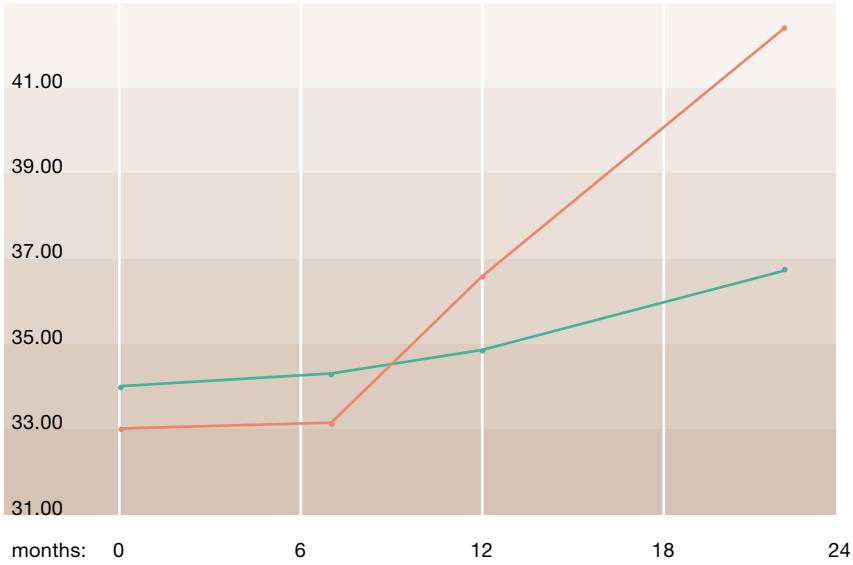
(Colour deviations may occur due to printing variations)

Baerlocher one-packs facilitate manufacturing of high quality profiles for various applications, e.g. roller shutter with different sizes and geometries.

Natural weathering of Ca-based and Lead-stabilized profiles

Brown profile

brightness [L-value]

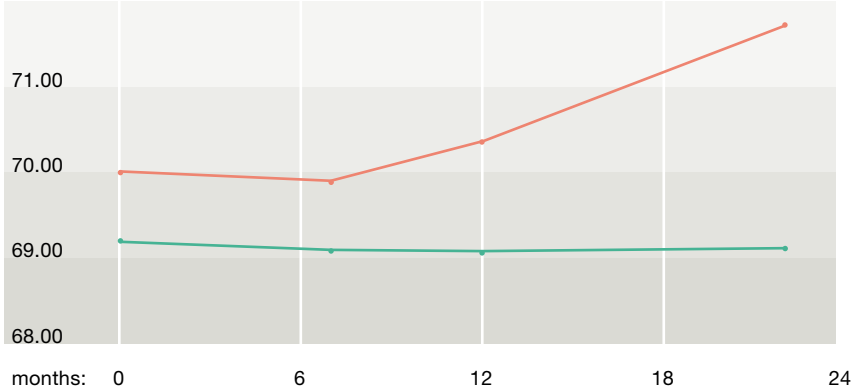


Ca-based system

Pb system

Grey profile

brightness [L-value]



Ca-based system

Pb system

Calcium/Zinc-stabilized systems show better colour hold during natural weathering in Central Europe. Chalking starts significantly later.

Supply forms

Baeropan	MC	R	TX	Dosage [phr]	
50870 P	•	•	•	approx. 4.1	Pb stabilizer
90704 P	•	•	•	approx. 3.2	Ca-based stabilizer

MC = powder; R = granules; TX = pastilles

Additives for the extrusion of PVC pipes and injection moulding of PVC fittings

Lead stabilizers

Pipe extrusion – compact pipes

The Baeropan 300 series comprises Baerlocher's range of standard Lead-based stabilizer one-packs for a diverse range of applications. Their balance of internal/external lubricants provides an excellent processing window and allows polymer processors very narrow wall thickness tolerances. Stabilizer one-packs for potable water pipes are available. For actual legislative status please contact one of Baerlocher's representatives.

Supply forms

Baeropan	MC	R	SMS	TX	Dosage [phr]	Applications
4617 R	•	–	•	•	1.8 – 2.3	High filled soil and sewer pipes
318	•	–	•	•	2.0 – 2.5	Soil and sewer pipes, pressure pipes
355	–	–	•	•	1.8 – 2.4	Soil and sewer pipes, pressure pipes
330 L	•	–	•	•	1.9 – 2.2	Light-resistant compact pipes
320 C	•	•	–	–	7.0 – 8.0	C-PVC pipes
340 D	–	–	•	•	2.5 – 3.5	Corrugated pipes, land drainage pipes

MC = powder; R = granules; SMS = flakes; TX = pastilles

Pipe extrusion – foam core pipes

Lead-based stabilizer systems are also available for foam-core pipes. These are produced by the so-called co-extrusion process, in which two or three extruders are combined in such a way as to extrude thin solid inner and outer walls onto a cellular core layer. This technique can save up to 20 % raw material, depending on pipe diameter, filler content and technical requirements. Moreover, as the materials for the cellular core and the compact skins are fed into separate extruders, it is possible to use recyclate as well as different pigments and filler loadings for the individual layers. The wide range of processing systems currently in use usually requires custom-formulated recipes, for which the following has been found to be an excellent starting point:

Supply forms

Baeropan	MC	R	SMS	TX	Dosage [phr]	Application
3670 RS	–	–	•	•	2.2 – 2.7	Compact skin, cellular core

MC = powder; R = granules; SMS = flakes; TX = pastilles

Baerlocher recommends to add 1.0 – 3.0 phr of processing aid (M_W low/medium) to achieve a foam core with an even cell structure.

Example

Compact skin	[phr]
S-PVC, k-value 68	100.0
Filler	10.0 – 15.0
Baeropan TX 3670 RS	2.5

Cellular core	[phr]
S-PVC, k-value 57	100.0
Filler	10.0 – 15.0
Baeropan TX 3670 RS	2.5
Processing Aid (M_W low/medium)	2.0
Blowing agent	as required

Non-dusting stabilizer one-packs in granule form provide excellent processability.

PVC injection moulding

Due to improved injection moulding technology, rigid PVC injection moulding has been gaining in importance in recent years. Key considerations in the choice of a suitable stabilizer system are the processing machinery used and the requirements the final product must meet. We recommend to add 1.0 phr of an adequate acrylic processing aid if PVC with a k-value higher than 57 is used.

Supply forms

Baeropan	MC	R	SMS	TX	Dosage [phr]
2028 SP	●	●	●	●	3.5 – 4.5
2305 SP	●	●	–	–	4.0

MC = powder; R = granules; SMS = flakes; TX = pastilles

Calcium-based stabilizers

In the recent past, alternative stabilizer systems have been gaining the edge over traditional Lead stabilizer systems. This is essentially due to initiatives forcing a reduction in the usage and gradual phase-out of lead compounds. Having undertaken carefully targeted research and development, Baerlocher is today able to offer a wide range of calcium-based alternative stabilizer systems. The choice of raw materials is in accordance with sustainable development including the consideration of legal regulations.
The Calcium-based stabilizers widely used today incorporate zinc compounds such as zinc stearate as co-stabilizers. However, there are also zinc-free products – so called Calcium-organic – in which organic molecules act as co-stabilizers.

Baerlocher considers Calcium-based stabilizers for rigid PVC processing a viable alternative to traditional Lead systems. Logically consistent development work has produced a full range of Calcium-based stabilizers for application in pipes and fittings. The good processing properties of Calcium-based stabilized PVC formulations as well as the excellent performance characteristics of the finished products have proven successfully in many applications.
Calcium-based stabilizers contain co-stabilizers in order to enhance heat stability, colour hold and weathering properties. Especially in terms of light and weathering resistance Calcium-based stabilizers offer advantages over Lead stabilizers. Chalking, for example, occurs significantly later with Calcium-based stabilized products.
For many applications Calcium-based stabilizers are also available in pellet or flake form which are characterised by easy handling and dustfreeness. Furthermore pellet or flake form enable easy access to coloured stabilizer systems.

Pipe extrusion – compact pipes

Calcium-based stabilizers are used to produce soil and sewer pipes, pressure pipes, corrugated land drainage pipes or cable ducting. It is usually possible to switch from Lead stabilization to Calcium-based stabilization without making changes to processing machinery such as extrusion screws or tools. Stabilizer one-packs for potable water pipes are available. For actual legislative status please contact one of Baerlocher's representatives. Pipes extruded with Calcium-based stabilizers display similarly good mechanical properties compared to traditional Lead-stabilized pipes.

Supply forms

Baeropan	MC	R	SMS	TX	Zn-free	Dosage [phr]	Applications
9419 R	•	–	•	•	–	2.0 – 2.4	High filled soil and sewer pipes
9421 R	•	•	–	–	–	2.0 – 2.5	Soil and sewer pipes, pressure pipes
9422 R	•	–	•	•	–	2.0 – 2.4	Soil and sewer pipes, pressure pipes
9423 R	•	•	–	–	–	2.1 – 2.6	Corrugated land and drainage pipes
9933 R	–	–	•	•	•	2.0 – 2.5	Soil and sewer pipes, pressure pipes
9934 R	–	•	–	–	•	2.0 – 2.5	Soil and sewer pipes, pressure pipes
80059 R	•	•	–	–	•	2.0 – 2.5	Soil and sewer pipes, pressure pipes
80060 RR	•	•	–	–	•	2.2 – 2.6	Corrugated land drainage pipes

MC = powder; R = granules; SMS = flakes; TX = pastilles

Baeropan one-packs allow pipe extrusion even under harsh conditions

Pipe extrusion – foam core pipes

Foam core pipes are produced by the co-extrusion process, whereby thin solid inner and outer walls are extruded onto a cellular core layer. This technique saves at least 20 % raw material in comparison with compact pipes. Moreover, the foam core can incorporate recyclate.

Calcium-based stabilizers are an alternative to Lead stabilizers, achieving similarly good mechanical properties for foam core pipes. Baerlocher recommends to add 1.0 – 3.0 phr of an acrylic processing aid (M_W low/medium) to achieve a homogenous foam structure.

Supply forms

Baeropan	MC	R	SMS	TX	Zn-free	Dosage [phr]	Applications
9424 RS	•	–	•	•	–	3.0 – 4.0	Compact skin, cellular core layer
80061 RS	•	•	–	–	•	3.0 – 4.0	Compact skin, cellular core layer
80066 RS	–	•	•	–	•	3.0 – 4.0	Compact skin, cellular core layer

MC = powder; R = granules; SMS = flakes; TX = pastilles

Standard recipes

Compact skin	[phr]
S-PVC, k-value 68	100.0
Filler	10.0 – 15.0
Baeropan TX 9424 RS	3.8

Cellular core	[phr]
S-PVC, k-value 57	100.0
Filler	10,0 – 15.0
Baeropan TX 9424 RS	3.2
Processing Aid (M_W low/medium)	2.0
Blowing agent	as required

PVC injection moulding

The development of Calcium-based stabilizers for injection-moulded fittings has followed along the same lines as developments for pipe extrusion. Recipes for fittings have a very diverse range of applications. Covered are pressure pipe fittings for potable water pipes and fittings for non-pressure pipes. The use of multi cavity moulds puts additional requirements on the formulations. Calcium-based stabilized fittings have similar mechanical and technical properties compared to old fashioned stabilized fittings.

Supply forms

Baeropan	MC	R	SMS	TX	Zn-free	Dosage [phr]	Applications
9425 SP	•	•	–	–	–	4.5 – 6.0	Injection moulding
9937 SP	•	–	•	•	–	4.5 – 5.0	Injection moulding
80062 SP	•	•	–	–	•	5.0 – 7.0	Injection moulding
80067 SP	•	•	–	–	•	5.0 – 6.0	Injection moulding

MC = powder; R = granules; SMS = flakes; TX = pastilles

Classification of lubricants

Depending on their way of action, one distinguishes between internal and external lubricants, with continuous transition. Internal lubricants often exhibit a certain external lubrication and vice versa. Lubricants having both effects are called “combined”.

Internal lubricants reduce friction occuring between the molecular chains of PVC, thus lowering the melt viscosity. They are polar, highly compatible with PVC, give excellent transparency even in high dosages and do not tend to exudate which could impair the weldability, printability and bonding properties.

External lubricants mainly reduce wall adhesion between PVC and metal surfaces. Most of them are non-polar substances, such as paraffins or polyethylene. The external lubrication is influenced by the length of the hydrocarbon chain, the branching or the functional groups. In high dosages “over-lubrication” can lead to haziness and exudation. External lubricants increase the fusion time.

Overview of lubricants:

Baerolub	Chemical name	Length of chain	Polar moiety	Lubrication
L-OH	Fatty alcohol	C_{14-18}	-OH	Internal
L-TP	Dicarboxylic ester	C_{14-18}	-COO-	
L-PL	Fatty acid glycerol ester	C_{14-18}	-COO-	
L-MS	Fatty acid glycerol ester	C_{14-18}	-COO-	
Ceasit SW	Metal soap	C_{14-18}	-COO-Ca	
L-CD	Fatty acid glycerol ester	C_{16-18}	-COO- and -OH	
GTS	Fatty acid glycerol ester	C_{16-18}	-COO-	
L-PM	Fatty acid ester	C_{16-18}	-COO-	
L-PK	Fatty acid ester	C_{14-18}	-COO-	
A 275	Ester wax	C_{6-18}	-COO-	
43 C	Ester wax	C_{6-18}	-COO-	
LS 100	Ester wax	C_{14-18}	-COO-	
L-AK	Fatty acid amide	C_{14-18}	-CO-NH-CO-	
Zincum SW/F	Metal soap	C_{18}	-COO-Zn	
FTO	Hydroxy fatty acids	C_{14-18}	-COOH and -OH	
FTA	Fatty acid	$> C_{14-18}$	-COOH	
L-KM	Paraffin wax	$> C_{20}$	Non-polar	
L-KO	Paraffin wax	$> C_{20}$	Non-polar	
RK 6	Polyethylene wax	$\approx C_{100}$	Non-polar	External

Parameters influenced by lubricants

Performance of lubricants

Properties	Mainly internal lubricants	Mainly external lubricants
Release PVC-metal	low	high
Inner friction	will be reduced	will be reduced
Fusion time	almost no influence	will be prolonged
Torque	will be decreased	will be decreased
Transparency	no negative influence	can lead to haziness
Surface gloss	will be improved	will be improved
Exudation	does not occur	can lead to exudation
Printability Adhesion Weldability	no negative influence	could worsen
Pigment and filler dispersion	will be improved	no influence
Melt viscosity	is reduced	is reduced

Product range of lubricants

Type	Baerolub	Chemical composition	Physical form	Melting (°C)	Lubrication
Solid fatty esters	L-MS	Glycerol partial ester of saturated fatty acids (glyceryl monostearate ca. 40%)	Powder	56 – 62	Internal
	L-CD	Glycerol ester of saturated fatty acids (Castor oil, hydrogenated)	Powder	84 – 88	Internal
	GTS	Glycerol ester of saturated fatty acids	Powder	50 – 54	Combined
	L-TP	Fatty alcohol phtalate	Powder	46 – 50	Internal
	L-PM	Fatty ester wax	Powder	52 – 55	Combined
	A 275	Fatty acid complex ester and fatty acid Calcium soap	Powder Pellets	125 – 135	Combined
	43 C	Fatty acid complex ester	Powder Pellets	59 – 65	Combined
	LS 100	Fatty acid complex ester	Powder Pellets	58 – 65	Combined
Liquid fatty esters	L-PL	Glycerol partial ester of unsaturated fatty acids (glyceryl mono/dioleate)	Liquid	liquid at roomtemp.	Internal
	L-PK	Fatty acid ester	Liquid	liquid at room temp.	Combined
Solid hydro-carbons	L-KO	Synthetic paraffin wax	Powder	100 – 105	External
	L-KM	Paraffin wax	Powder	54 – 56	External
	RK 6	Polyethylene wax	Powder	102 – 110	External
Solid fatty acids, alcohol, and amide	FTA	Fatty acids mixture	Powder	54 – 60	External
	FTO	Hydroxy fatty acids mixture	Powder	70 – 80	External
	L-OH	Fatty alcohols mixture	Powder	52 – 54	Internal
	L-AK	Amide wax (N,N'-ethylene distearamide)	Powder	138 – 144	External
Metal soaps	Ceasit SW	Calcium stearate	Powder	approx. 160	Internal
	Zincum SW/F	Zinc stearate	Powder	approx. 120	External

Applications								Food contact (release date Aug. 2007)
Extrusion		Injection moulding		Calender		Hollow articles	Plastisols	
Rigid	Flexible	Rigid	Flexible	Rigid	Flexible			
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Food contact: * = listed in Commission with directive 2002 (as amended)
** = in accordance with certain national regulations, details on request
– – = no agreement
++ = under evaluation

Please ask Baerlocher for the actual food contact status.

Research and development

We continuously improve the processing properties and performance characteristics of our stabilizers by way of comprehensive research and development using state-of-the-art equipment. We coordinate our activities closely with our customers in order to offer them tailor-made products to suit their needs.

Together with our customers, suppliers and other companies in the PVC industry we take an integrated approach to our innovative development goals in order to achieve the best possible solutions for our customers.

Innovative research and development empowers Baerlocher to supply high-performance stabilizer systems.

Certificates

ISO 9001: Quality Management System

ISO 14001: Environmental Management System

Nomenclature of Baerlocher One-Packs

Baeropan	Baeropan is the name for our stabilizer/lubricant one-packs that contain all necessary additives. Each Baeropan is characterised by a specific product code consisting of the elements shown below.
E	The prefix indicates the physical form of the product (see examples on page 26). MC = Powder E or R = Granules SMS = Flakes TX = Pastilles
50248	The main recipe number is assigned in continuous order according to the specific development for a customer.
FP	The suffix explains the primary field of application for our product. For instance: FP = Window Profiles R = Pipes P = Technical Profiles RS = Foam Core Pipe SP = Injection Moulding
/1	A number appended to the product code shows that a minor change has been made on the main recipe.

Supply forms and packaging

Supply forms

MC
Powder

E or R
Granules

SMS
Flakes

TX
Pastilles

Packaging

we add character to plastics



Reach out for the Future: **www.baerlocher.com**

Please download the following brochures from our webpage:

Baerlocher Additives for PVC

- Cables and Wires
- Calendered Films and Sheets
- Extrusion and Injection Moulding
- Lubricants
- Organotin Stabilizers
- Plastisol
- Sheets and Foamed Profiles

Baerlocher Special Additives

- Metallic Stearates
- Hydrophobic Agents for Building Materials

Baerlocher GmbH
Freisinger Str. 1
85716 Unterschleissheim
Germany
phone: +49/ 89 14 37 30
fax: +49/ 89 14 37 33 12
info@baerlocher.com
www.baerlocher.com

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