Selecting the appropriate antioxidant for PVC cable

Cable_2014, Cologne

Perstorp contributes to a better more sustainable world by delivering innovative chemical solutions

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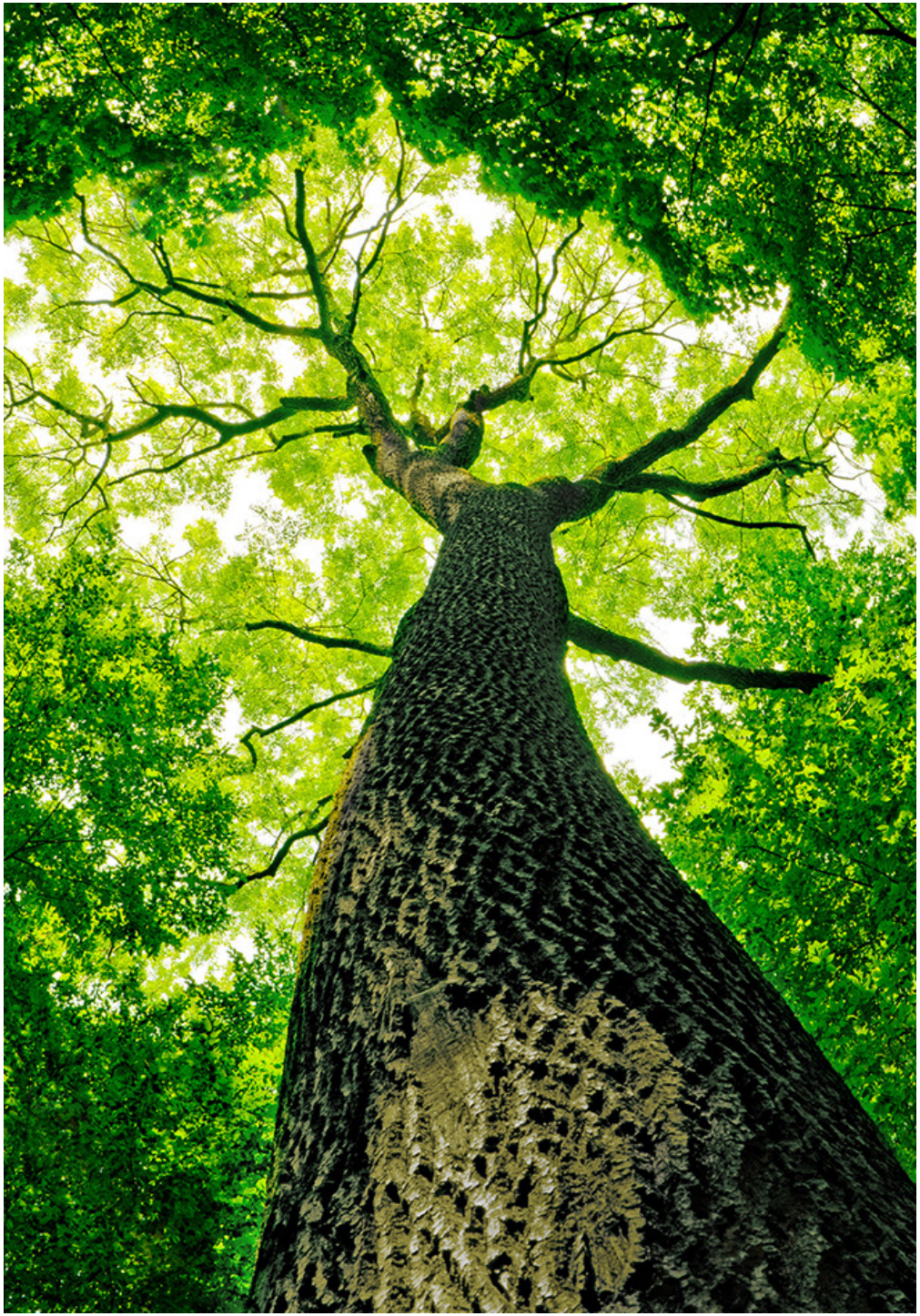
WINNING FORMULAS

Table of Contents



Perstorp in brief

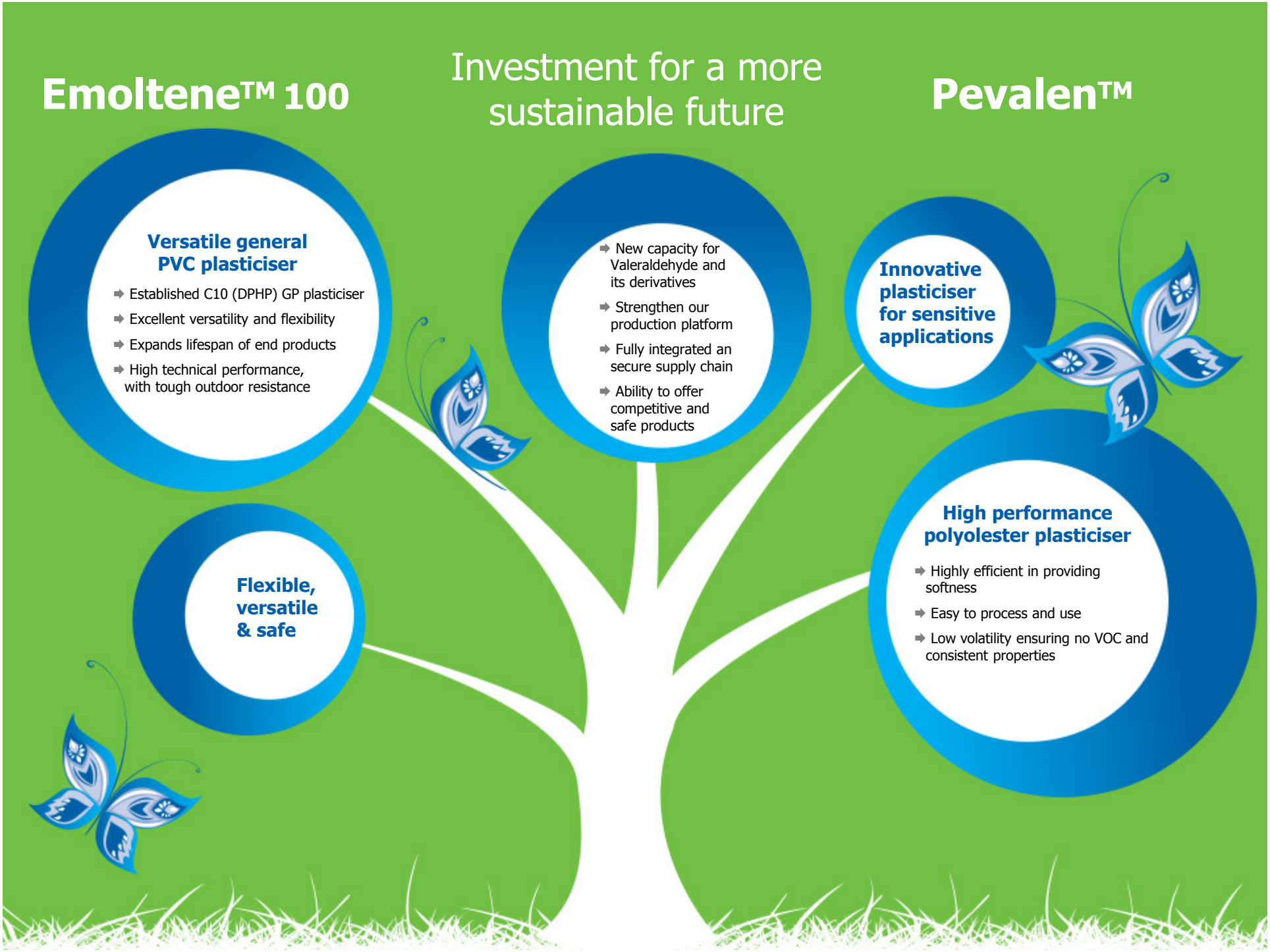
- World leader in several sectors of the specialty chemicals market
- Pioneer in formalin chemistry, plastics and surface materials
- Perstorp was formed in 1881, over 130 years of winning formulas
- Since December 2005 controlled by PAI partners, a leading European private equity company
- Annual turnover of more than 10 billion SEK in 2012
- About 1,500 employees in 22 countries
- Production plants in Europe, Asia and North America
- Sales offices in all major markets

Perstorp in the PVC industry

- Perstorp is a fully integrated plasticiser producer based on the west coast of Sweden since 1980's
- Perstorp exited the DOP business in 2012
- Storage facilities in UK, Belgium, Germany and Portugal to serve Europe
- Focus on European market and sustainable growth
- Member of ECPI, VinylPlus and founding member of PlasticiserPlus

Perstorp believes in plasticisers

- Perstorp is making its largest investment in history
- Based on our own technology and backwardly integrated in raw materials
- It will be on stream in Q1 2015
- Two plasticizers in the product tree, Emoltene™ 100 and Pevalen™
- This investment will increase the production by 150 000 MT


Emoltene™ 100
Investment for a more sustainable future
Pevalen™
Versatile general PVC plasticiser
Established C10 (DPHP) GP plasticiser
Excellent versatility and flexibility
Expands lifespan of end products
High technical performance, with tough outdoor resistance
New capacity for Valeraldehyde and its derivatives
Strengthen our production platform
Fully integrated an secure supply chain
Ability to offer competitive and safe products
Innovative plasticiser for sensitive applications
Flexible, versatile & safe
High performance polyolester plasticiser
Highly efficient in providing softness
Easy to process and use
Low volatility ensuring no VOC and consistent properties

Emoltene™ 100 and Pevalen™ focus on different markets

Emoltene™ 100 - Durable applications

- Wire and cables
- Films & sheets e.g. roofing membranes, pool and pond liners
- Coated fabrics; e.g. tarpaulins
- Automotive interiors

Pevalen™ - Sensitive applications

- Coated fabrics; e.g. table cloths, protective clothing
- Films & sheets; e.g. office materials, furniture foils
- Flooring; e.g. public buildings, hospitals, domestic
- Plastisols; e.g. wall paper, toys
- Moulded parts; e.g. grips, hoses

Three key segments where Emoltene™ 100 is favorable for use

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CABLES & WIRES

- Low volatility and high UV resistance with C10 plasticiser
- Well accepted for PVC cables at all major users

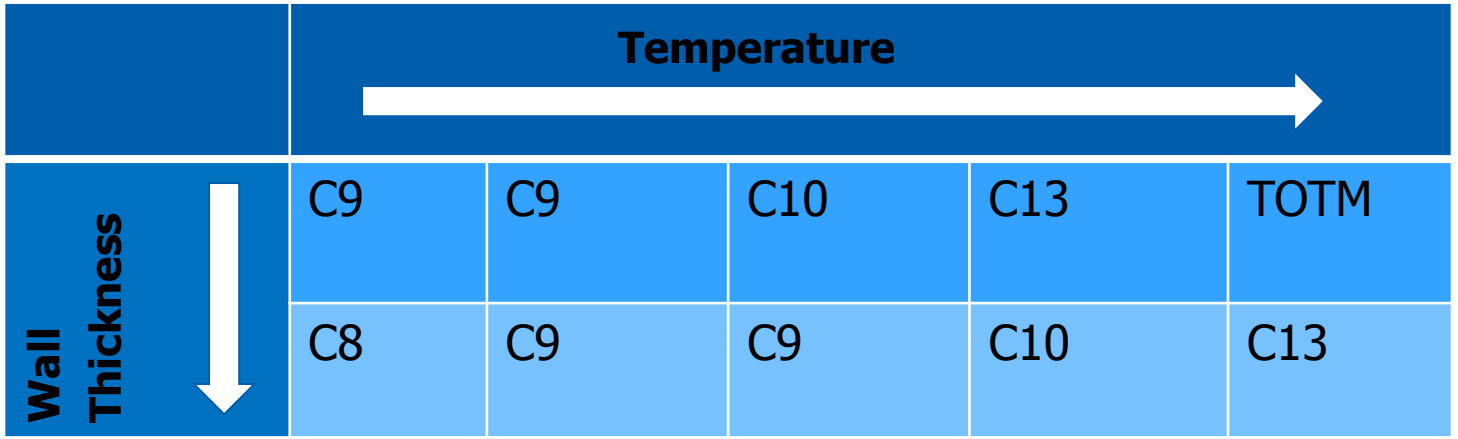
AUTOMOTIVE INTERIOR

- Low volatility/migration of C10 plasticisers secures long life span required
- Plasticized PVC not easy substituted for this industry due to the advantage PVC has vs. other polymers

FILM AND SHEETS

- Low volatility of C10 plasticisers secures long life span required
- Plasticized PVC good UV stability and outdoor resistance

plasticiser Selection Cable Insulation



- The C10, Emoltene 100, covers wide cable classifications
- Volatiltiy affects the choice of plasticiser
- Wall thickness affects diffusion (volatility)

Antioxidant

Why use antioxidants?

- PVC cable compounds operating at elevated temperatures
- Antioxidants are added to the polymer formulation to prevent cable degradation
- Extended product lifetime using antioxidants
- Preserve mechanical and electrical properties
- Plasticiser can be supplied using dissolved antioxidant
  - This aids dispersion of the antioxidant in the compound

Antioxidant

Selection

- The selection of long-term thermal stabilizers includes
  - Phenolic
  - Aminic
  - Thioesters
  - Metal deactivators
  - Antiozonants

Antioxidant performance

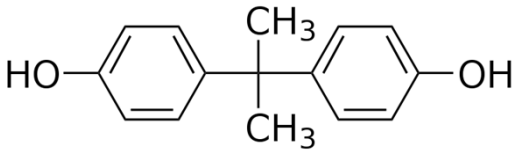
Important to test in application

- Range of concentrations in specific formulation
- Different sources of raw materials might affect antioxidant performance
- Various antioxidants interact differently with the other ingredients
- Different responses to different test conditions

Antioxidant

Traditional

- BPA
  - Bisphenol A



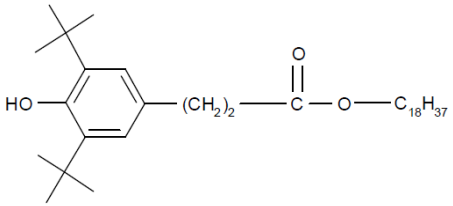
Performance – pros and cons

- BPA
  - – Pressure on usage due to its classification
  - + Very efficient antioxidant

Antioxidant

Alternative

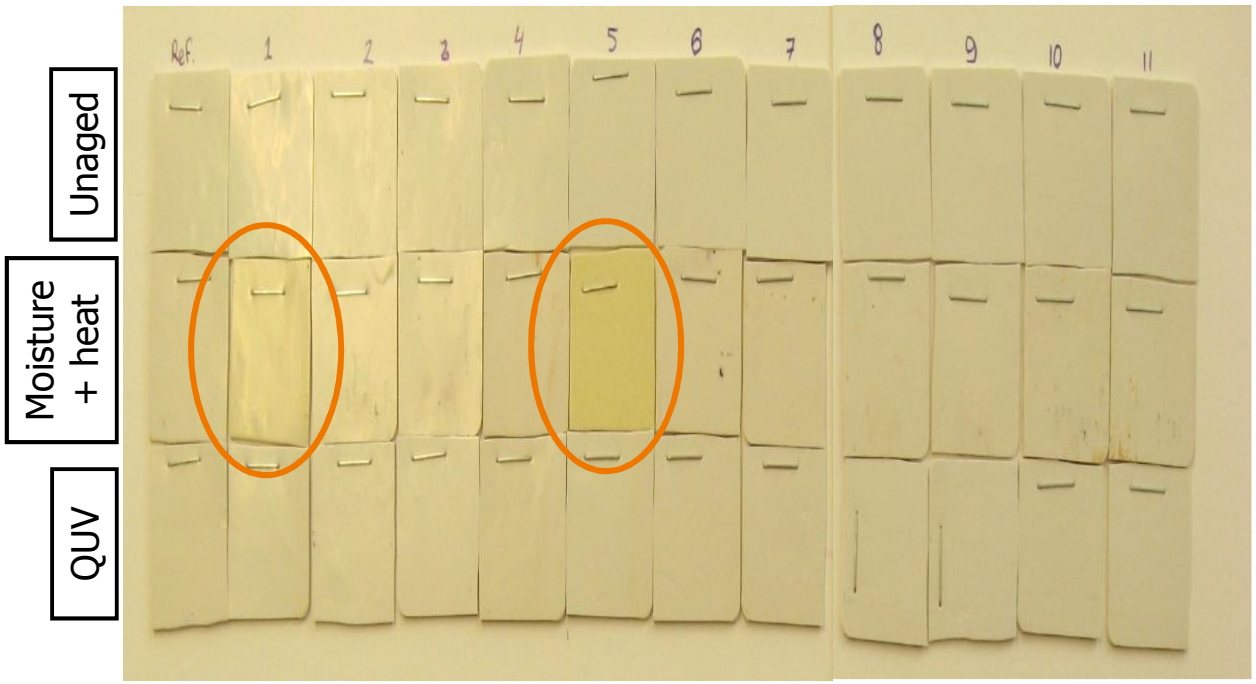
- Irganox® 1076
  - Sterically hindered phenolic structure
  - Octadecyl-3-(3,5-di-tert.butyl-4-hydroxyphenyl)-propionate



Performance – pros and cons

- Irganox® 1076
  - \+ In general good properties
  - – Compatility issues with antioxidants in the stabiliser package

Compatibilty



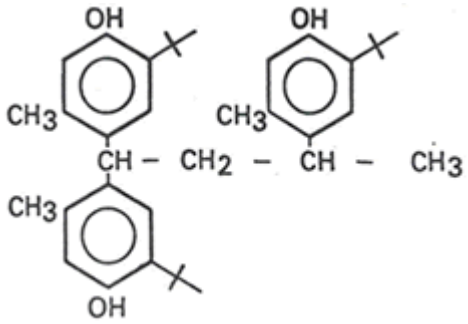
- Reference (1st) column based on BPA
- Each column represents formulation with different combinations of antioxidants and stabiliser package
- Each row represents one testing condition

Conclusion: Irganox® 1076 works well in general but might have compatilibility issues in certain formulations

Antioxidant

Alternative

- Topanol® CA-SF
  - High molecular weight phenolic antioxidant
  - 1,1,3-Tris(2-methyl-4-hydroxy-5-t-butylphenyl)butane



Performance – pros and cons

- Topanol® CA-SF
  - \+ High efficiency
  - \+ No known issues

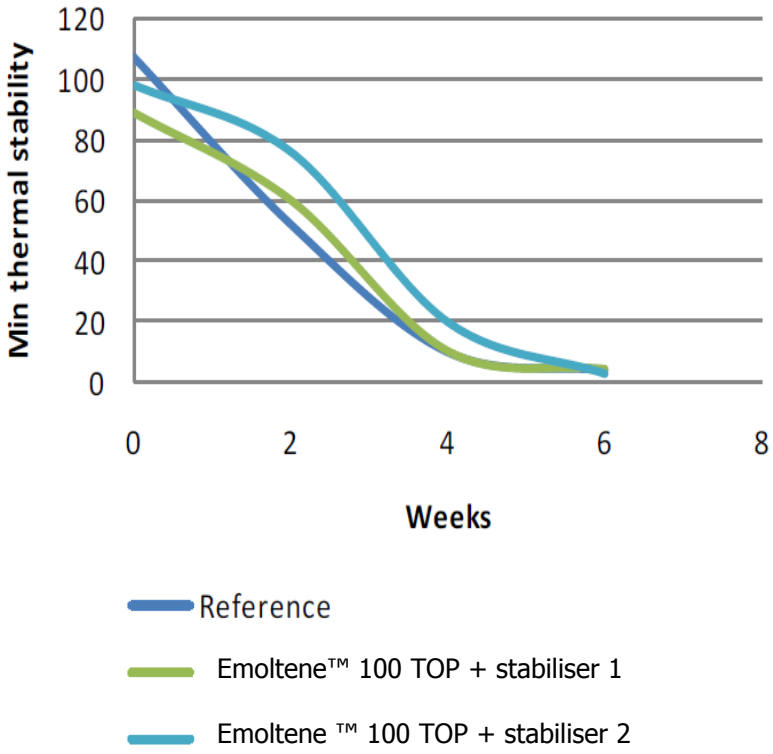
Thermostability

- Measured as dehydrochloronation

Stab 1 + AO	**Thermostability** (min)
0.25 % BPA	101
0.1 % Topanol® CA-SF	95
0.25 % Topanol® CA-SF	105
0.1 % Irganox ®1076	94
0.25 % Irganox® 1076	99

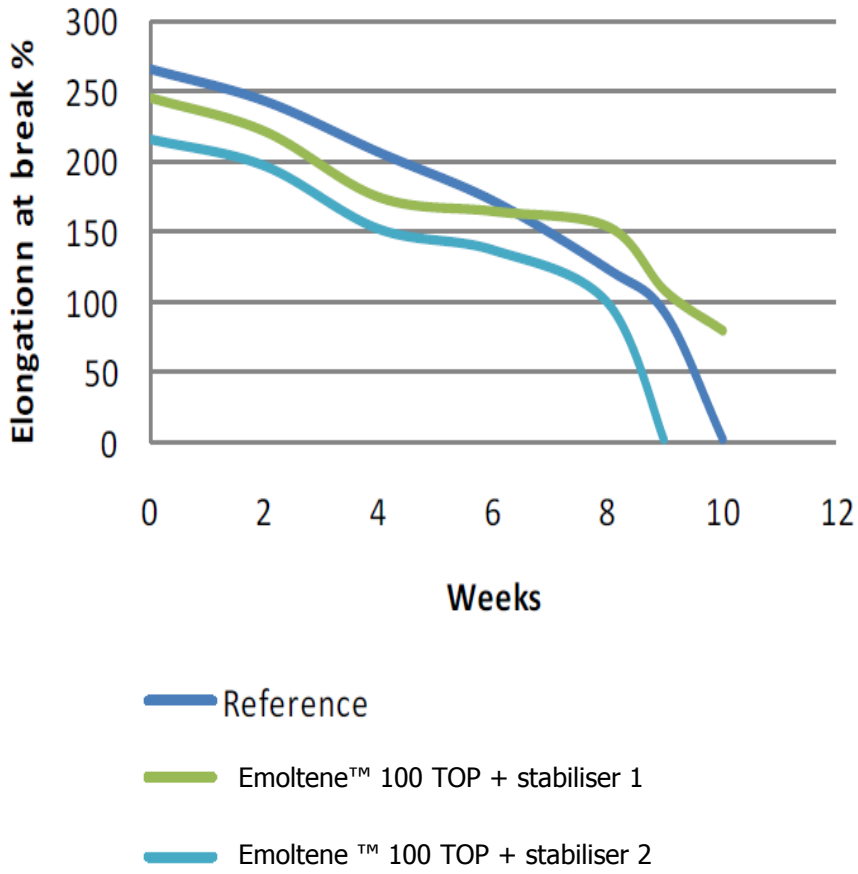
Thermal stability

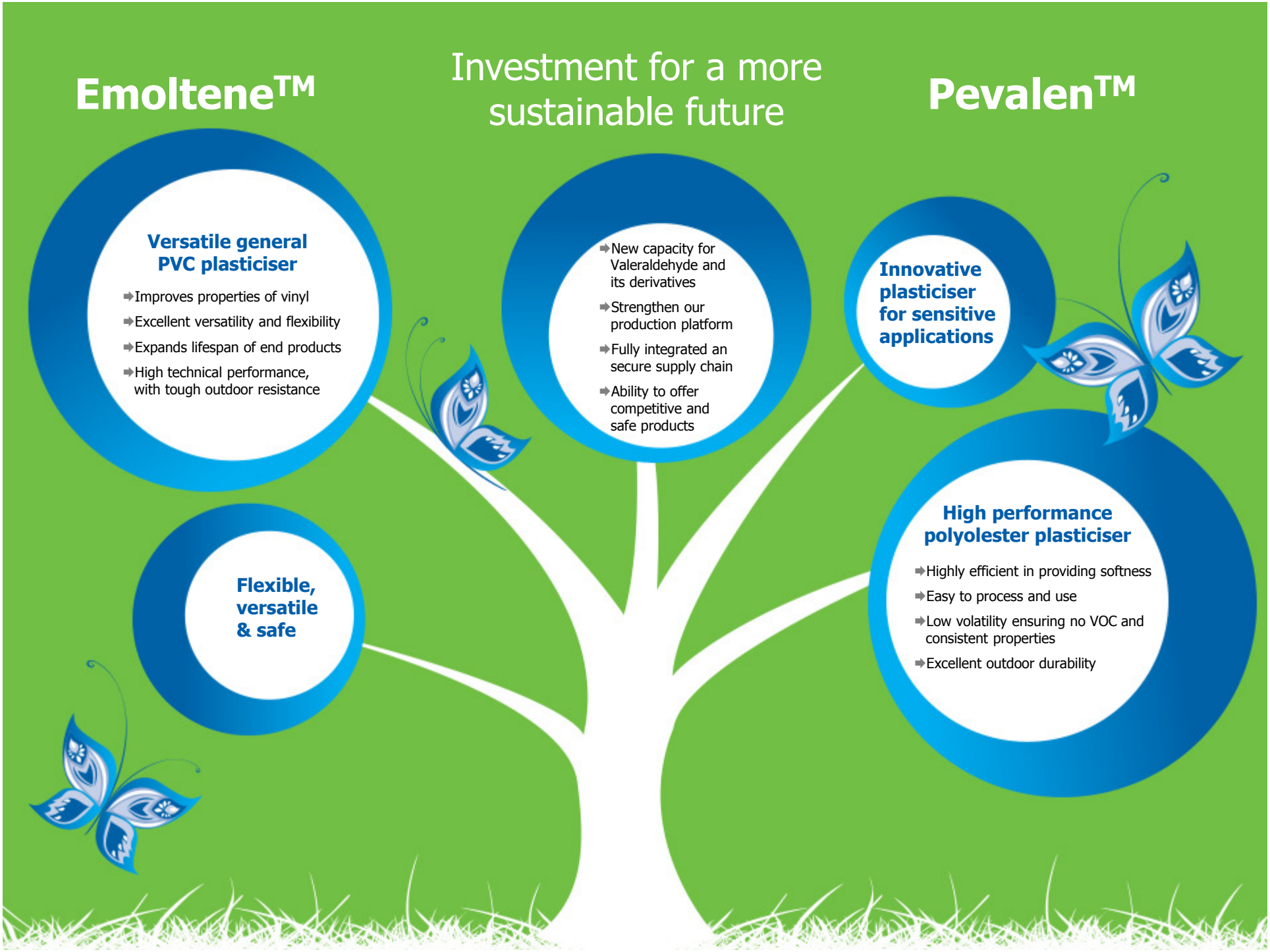
- After heat ageing at 120°C



Elongation at break

- After heat ageing at 120°C

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High performance polyolester plasticiser
Highly efficient in providing softness
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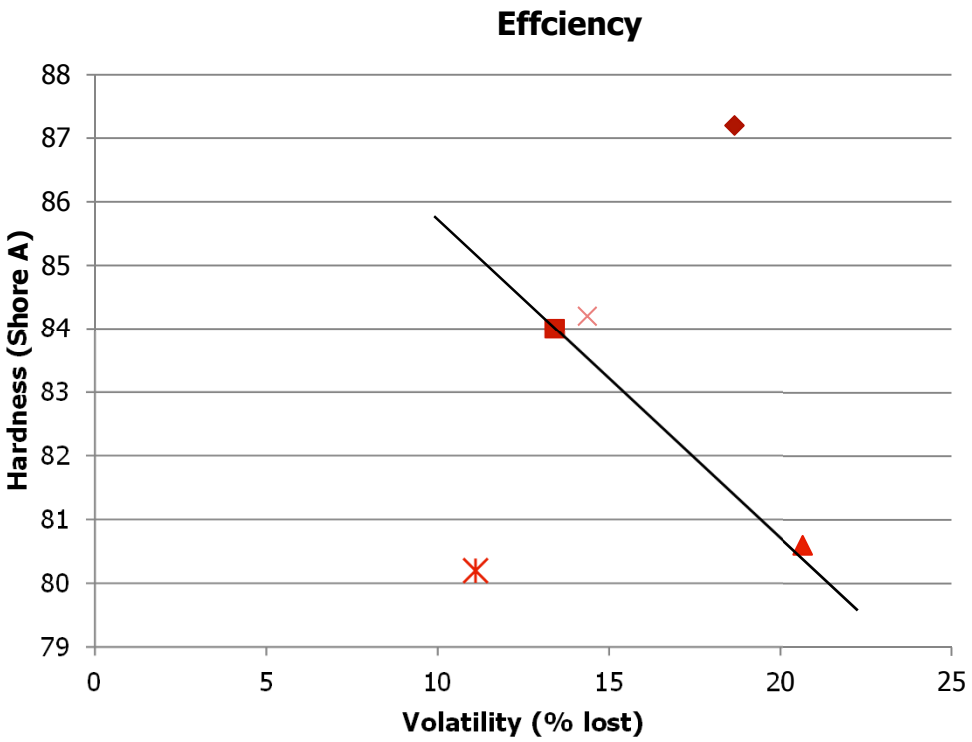
Low volatility ensuring no VOC and consistent properties
Excellent outdoor durability

Pevalen™ -Unique product performance

Key advantages

- Unique combination of low volatility and high plasticizing efficiency
- High PVC compatibility



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Summary

- **Perstorp** is a reliable supplier of **Emoltene™ 100**, the major type of plasticiser for cable and wire
- Many aspects to consider when selecting antioxidants
- Perstorp choses two antioxidants for **Emoltene™ 100,** Topanol® CA-SF and Irganox® 1076
- Perstorp is an innovative company developing a polyolester plasticiser - **Pevalen™**

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Thank You for your attention!

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Perstorp Group