Ca/Zn Stabilisers for PVC Processing

Lead replacement program in wire and cable application for Thailand (3rd phase)

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Agenda

- Baerlocher at a glance
- Review –switching to Ca-based stabilisers
- Ca-based stabilisers for cable applications
- Regulatory situation at a glance
- Summary

Baerlocher at a glance

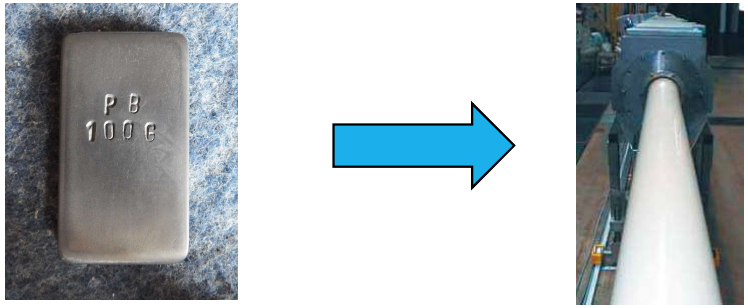
Baerlocher is the global PVC additive supplier

- Family owned business with global footprint
- 11 production sites all around the globe
- Local technical teams to support PVC converters
- Recent investments:
  - Completely new production facility erected in India to support existing production site
  - Investments in capacity increase in Turkey and Malaysia

Review – switching to Ca-based stabilisers

PVC Stabilisation in the early 2000s

- Pb stabilisers dominated most PVC stabiliser market in the early 2000s
- Rigid extruded PVC was virtually completely Pb stabilised
- First attempts to introduce Ca-based stabiliser for plasticised extrusion (e.g. cables, tubes) have been made already in the late 1990ies



Lead has been forced out by pressure

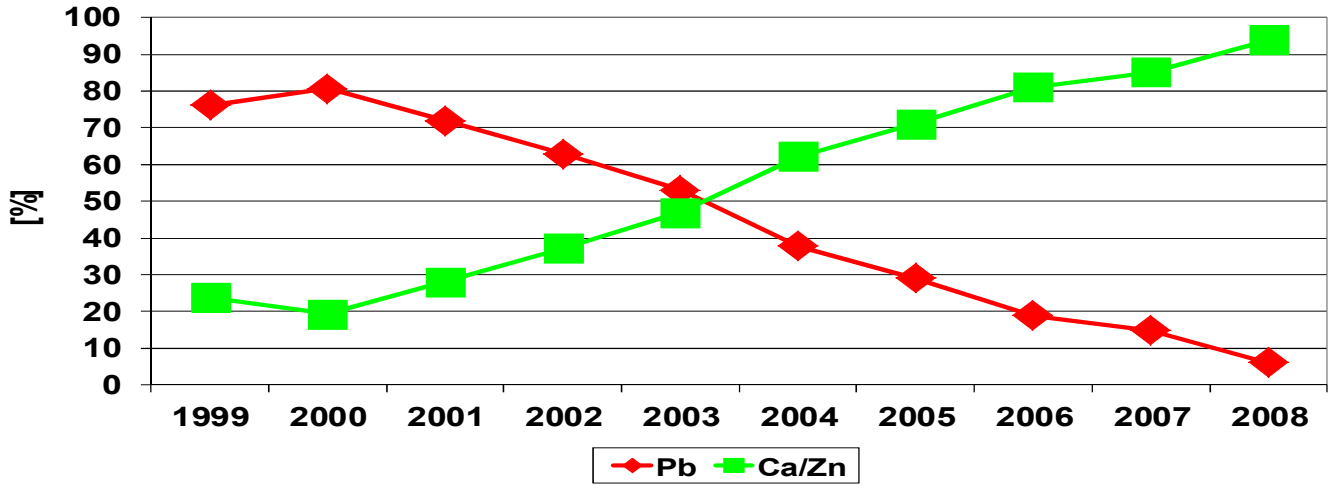
- Discussions regarding heavy metals and pre-REACh actions created inherent pressure on Lead stabilisers
- Proactive industry measures (Vinyl 2010) eased the pressure as soon as the industry was able to demonstrate their commitment
- Although initially considered to be ambitious the timeframe allowed a smooth changeover
- A price rally for Lead derivatives supported the change but wasn't sufficient to significantly speed it up

=> The threat of regulatory pressure was able to create a climate of change

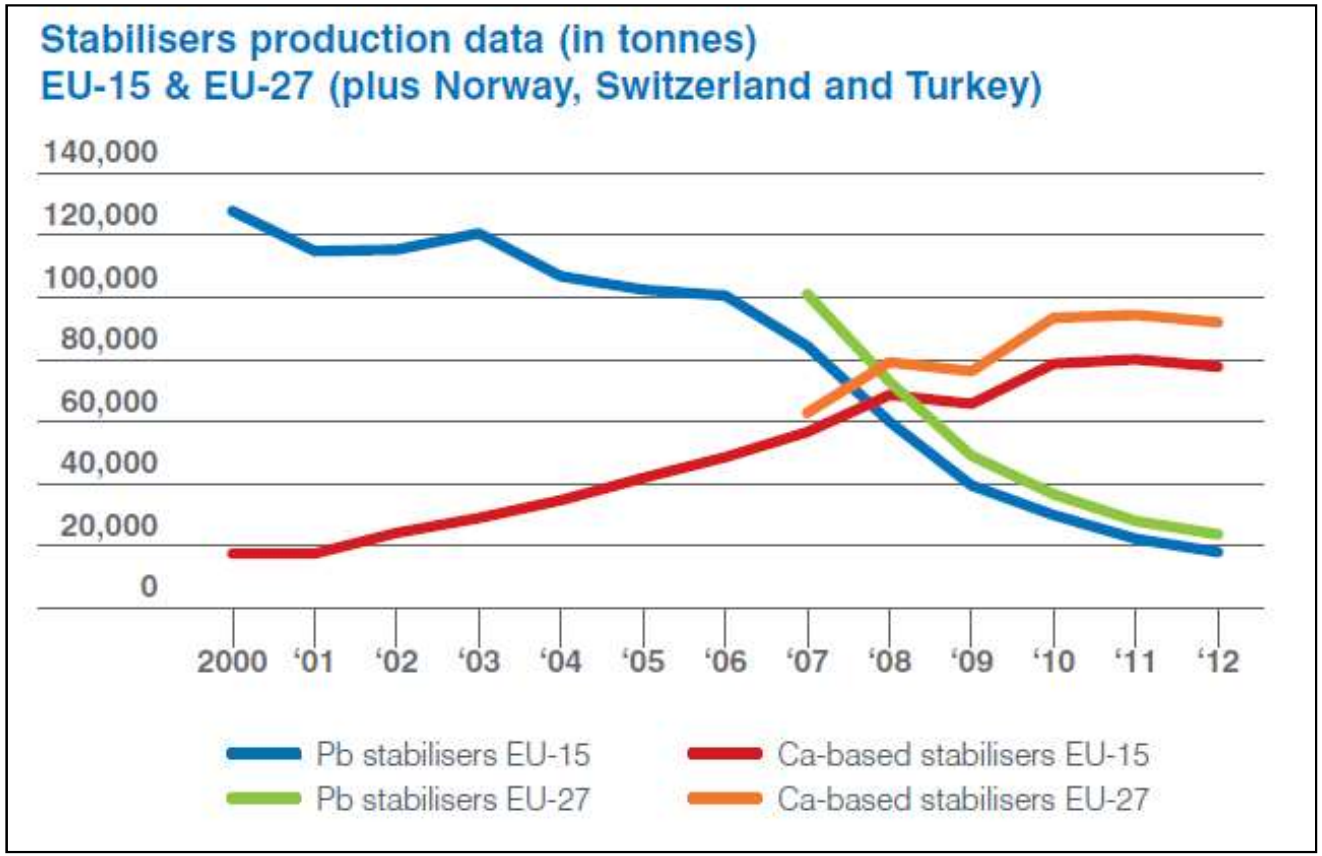
=> Industry was able to lead the process by proactive measures - united and proactive industry approach through regional associations has proven to be effective, market follows with changes to regulatory framework.

Cable insulations changed first

- Additional pressure was felt for the cable industry due to regulations of heavy metal content in electronics (RoHS guideline, WEEE) and automotive industry (ELV directive)
- Almost all applications have switched away from lead until 2008



Rigid extrusion followed



Main selection criterion was cost

- Initially various options (organic stabilisers, (heavy) metal free stabilisers, CaZn-stabilisers…) have been considered as alternatives especially for rigid extrusion
- Market players wanted to anticipate „the next step of pressure“ to select a future-proof option
- Tin stabilisers have been deselected as Lead alternative rather early for various reasons, completely metal free systems never appeared
- All other systems which were able to meet the technical requirements were considered future-proof

=> Little discussion about components used to formulate stabilisers

=> Cost / performance drove decisions

Ca-based stabilisers – terminology

- Ca/Zn-Stabilisers are based on Calcium- and Zinc soaps
  - They contain additional inorganic acid scavengers (e.g. Zeolithe, Hydrotalcite, …) based on Aluminium, Magnesium or Silica
  - Costabilisers are included to ensure good colour
- OBS™ is based on Calcium-stearate and a patented combination of two costabilisers
  - They contain additional inorganic acid scavengers (e.g. Zeolithe, Hydrotalcite, …) based on Aluminium, Magnesium or Silica
  - The basic patent has expired, the trademark is still registered

➢ The only difference is the presence of Zinc Stearate and the type of Costabilisers used

➢ OBS™ is not metal free

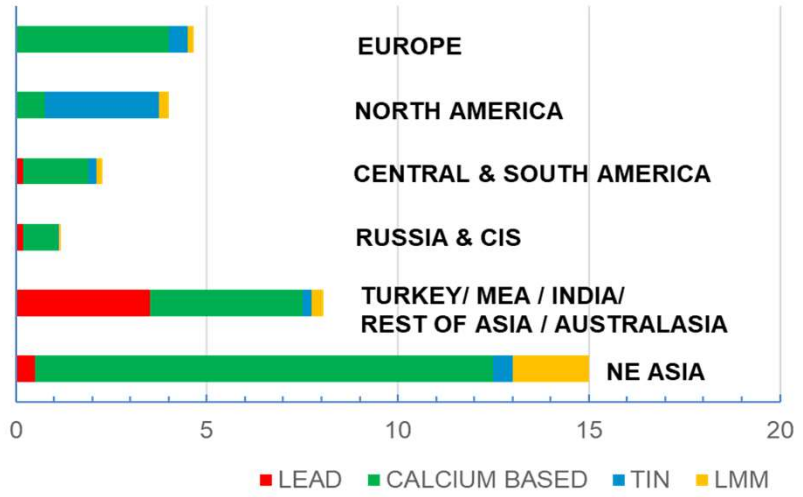
➢ Ca-based and Calcium organic stabiliser (COS) are the generic names which are used for both technologies

Ca-based stabilisers are well established

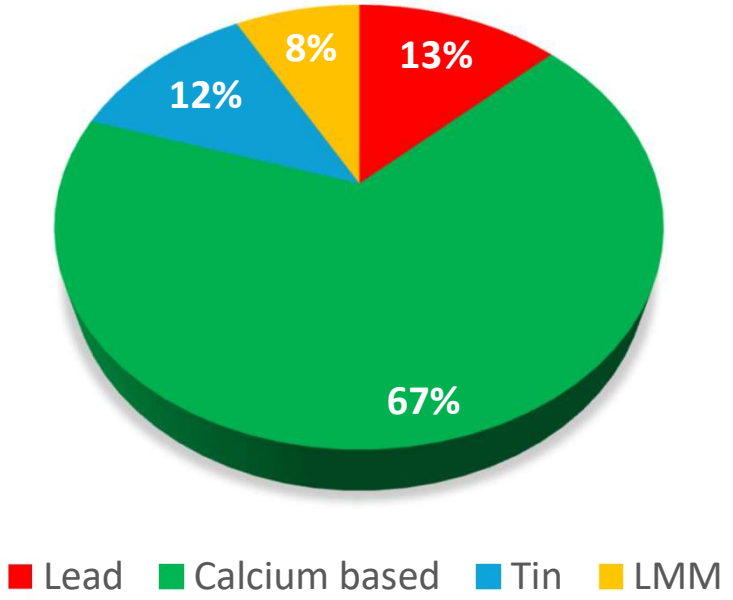
- Solutions in Ca-based stabilisers are available for ALL applications
  - Rigid extrusion of pipes and profiles
  - Injection moulding
  - Standard and automotive cable insulation and sheathing
- For colour demanding applications fine-tuning with Costabilisers is required
- After gathering of experience processing is as smooth as with Pb stabilisers, neither output rates nor product quality are finally affected
- Cost-effective Ca-based stabiliser systems helped the change
- Right selection of raw material qualities ensured high consistency of our products
- Backwards integration supported consistent quality

Ca-based stabilisers dominate globally

Stabiliser usage expressed by PVC consumption (mio. T, 2023)

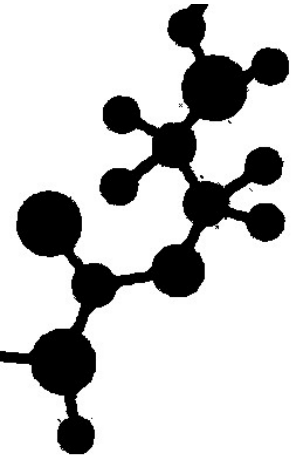


Expressed as % of PVC consumption globally 2023

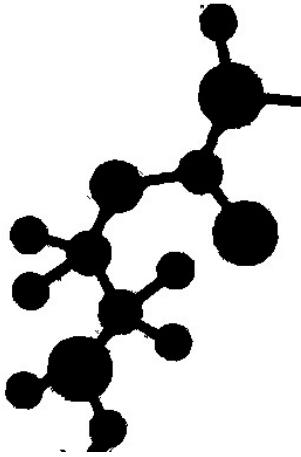


New stabiliser technologies are developed

- There‘s no „one size fits all“ solution when changing stabiliser technology
- Technical requirements and environmental situations (e.g. climate) are different and require adjusted solutions
- Replacement of a Pb-one-pack is different to replacement of a Sn stabiliser plus separate lubricant addition
- Mode of action of every single component needs to be understood



Pb stabilisers for cables



Variation of dosage allows many adjustments!

- Lead salts: tri-basic lead sulfate (TBLS), di-basic lead phthalate (DBLP)
- Additional Lead stearate acts as heat stabiliser and lubricant.
- Lead metal content of cable stabiliser one-packs ca 60% – 70%.
- Close correlation between Lead content and thermostability (Congo Red).
- Increased lubrication by increased stabiliser dosage.

High performance of Lead-based stabilisers

- Good initial colour due to pigmenting properties of inorganic Lead compounds.
- Excellent long-term thermostability.
- Broad processing window.
- Linear correlation between dosage and performance.

Different performance of Ca-based solutions

- Processing windows got smaller.
- Congo Red thermal stability was equal, however the colour hold during processing was reduced.
- Colour adjustments have been necessary due to missing self pigmentation effect of lead based stabilisers
- Water absorption properties of compound is depending on the stabiliser base and must be respected.
- Storage stability of stabiliser and cable compound depending on the stabiliser base had to be established.

Shelf life of Ca-based solutions

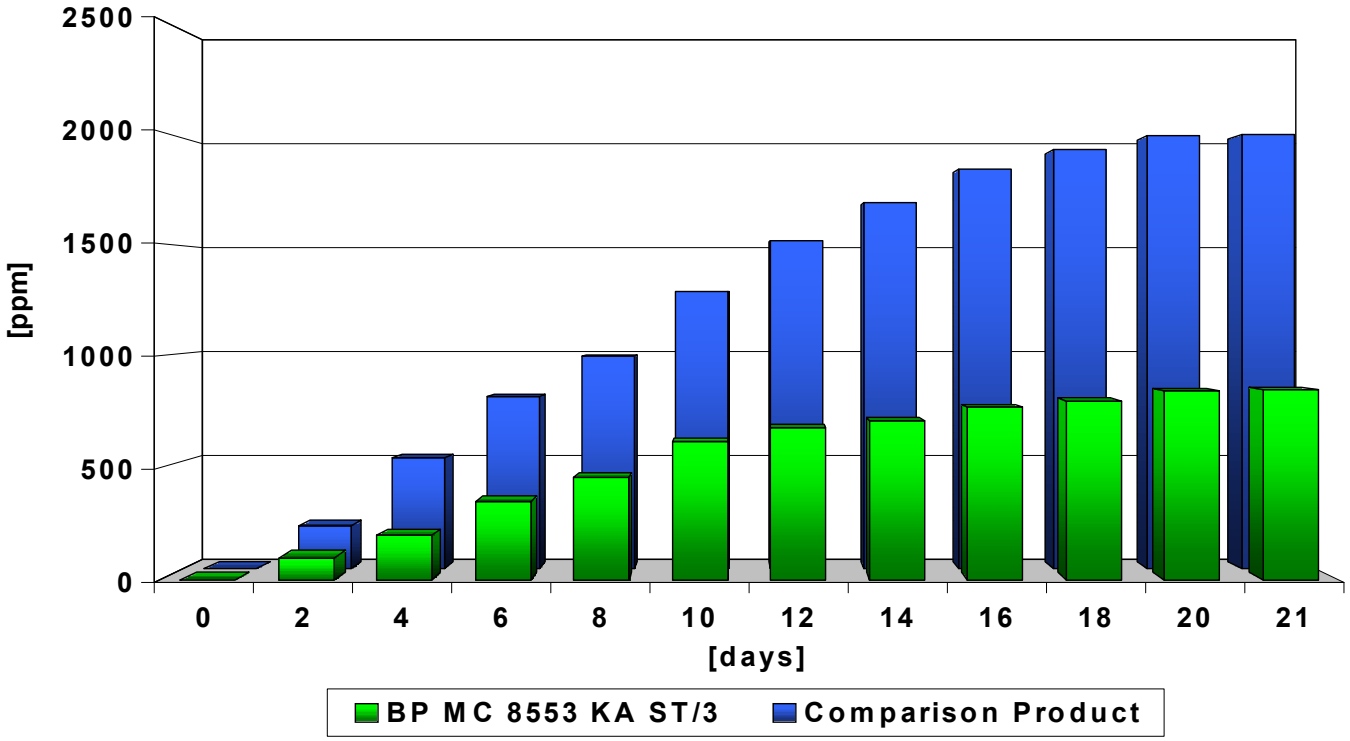
How to store Ca/Zn *stabiliser*?

- Stabiliser should be stored under appropriate conditions (dry, moderate temperatures).
- The shelf life is an individual property of each stabiliser and can range from half up to one year.
- Your local representative can confirm this information for your individual stabiliser in use.

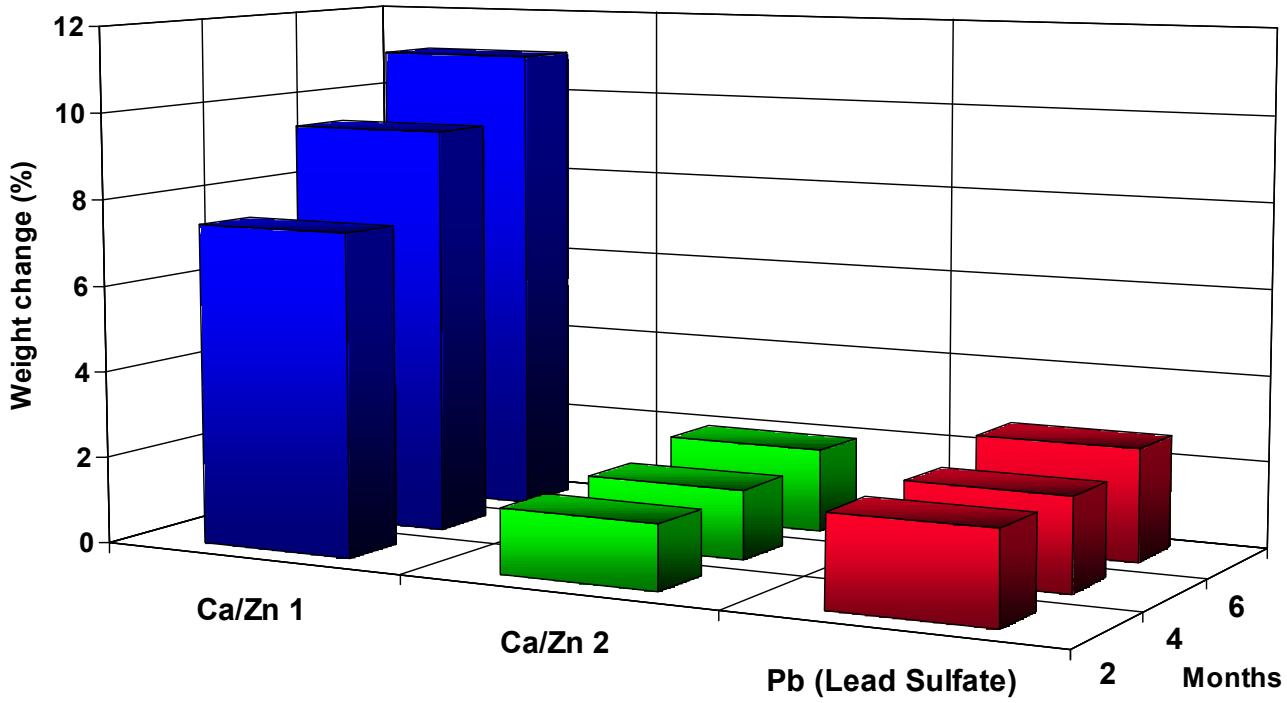
How to store Ca/Zn stabilised PVC cable *compound*?

- Due to the nature of Ca/Zn stabilised PVC granules to absorb humidity, the time is strongly dependant on storage circumstances and Ca/Zn stabiliser itself.
- In a dry surrounding we recommend to use it within 3 to 4 weeks. If cable compound granules by rule of thumb exceed the limit of 1000 ppm humidity problems in cable extrusion will occur: Pin holes, plate out etc.
- In case of exceeding 1000ppm humidity, drying of the granules is possible without problems. (70-80°C/3h) without loosing any performance.

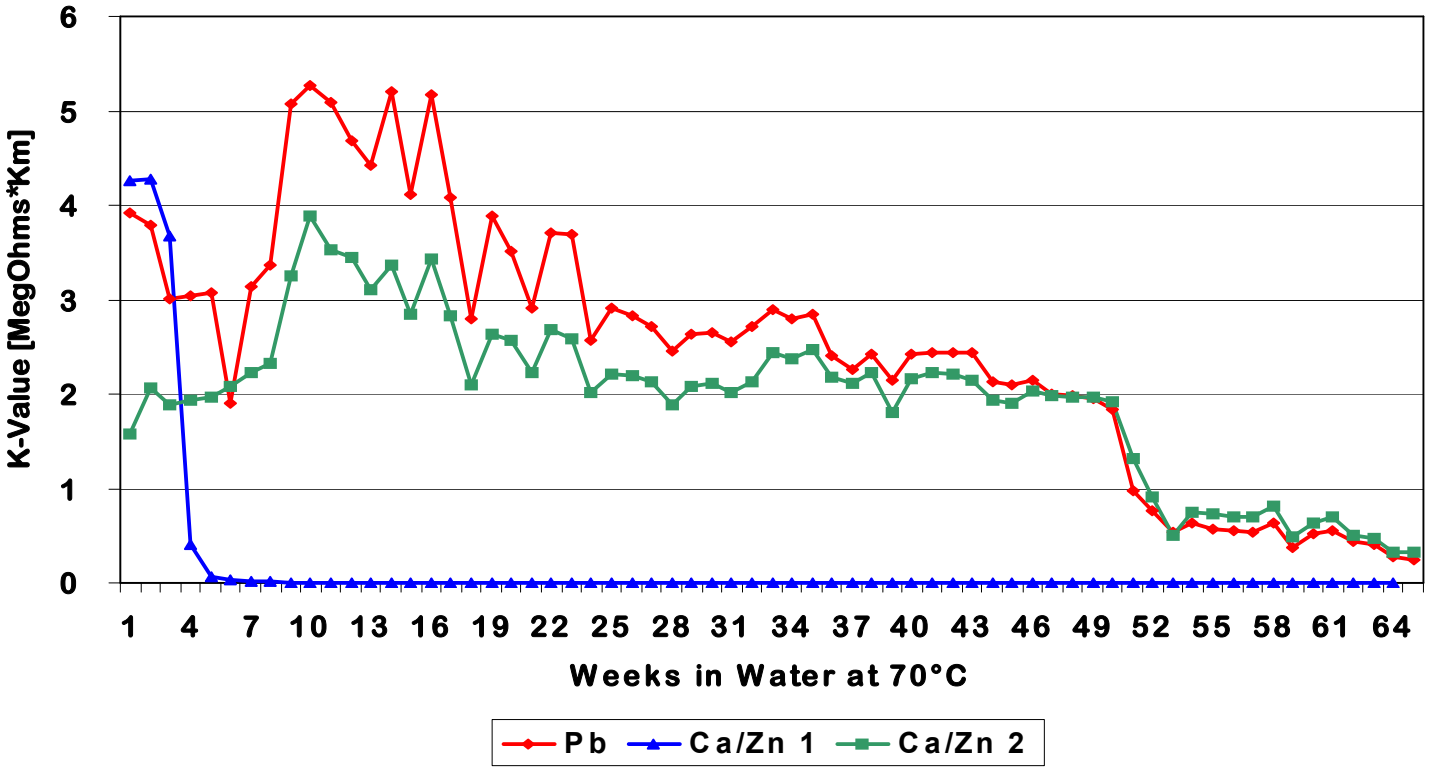
Water Absorption of cable compound



Water Absorption of PVC sheathing in water



Insulation Resistance on a final cable



Regulatory situation at a glance

ECHA investigation on additives

- ECHA investigation on “PVC and its additives” targeted all applications
- 63 “substances of concern” have been identified
  - Plasticisers
  - Tin stabilisers
  - Certain phosphites used in liquid stabilisers
- Almost all ingredienst of Ca-based stabilisers have been considered safe
- Exception: certain Costabilisers which are
  - Of low concern
  - And can be replaced

ECHA investigation on additives

- Tin stabilisers are under heavy pressure but no deadlines fixed yet
- Phthalate based plasticisers are in focus as well
- EU commission requested a “restriction proposal” from ECHA as follow-up of the investigation
- The restriction proposal is due since Sept 2024, no new date communicated yet
- The situation leaves some insecurity for the EU PVC industry

Regulations on Pb

- Pb has been phased out as stabiliser end of 2015
- However Pb is still present in post consumer PVC
- According to REACh handling of Pb stabilisers would require authorization
- The same is true for post consumer PVC containing 0.1 % or more of Pb stabilisers
  ⇒Almost all post consumer PVC is affected!

- However EU 2023/923 exempts recycled rigid PVC and allows up to 1.5 % Pb in the recycle until 2033 (as long as the recycle is used e.g. in middle layers)
- Derogation shall be revised in 2028
- If Pb is not removed post consumer PVC either would need to be landfilled or burnt

We are working on sustainability

- A lot of the recent challenges have been caused by regulatory actions
- Due to the longevity of PVC products solutions which are considered to be safe at one point in time might become an issue when it comes to recycling
  - Pb nowadays, maybe Sn later, and then? What's the next legacy?
- We try to stay ahead of the game, trying to anticipate upcoming regulations not to hamper PVC reuse in future

Asia at a glance

- Not all country in South East Asia have a national standard on control of lead
- RoHS is the general regulations that control the use of lead in SEA
- Apart from automotive wire and cables, Pb still plays an active role as a stabiliser of choice
- In Australia & New Zealand, workplace exposure control is in place which limit the use of lead

Summary

- Regulatory pressures forced a phase-out of Pb, Ca-based solutions are well accepted globally
- Performance profile of Pb alternatives is different, but finally rejection rates, output and quality of final products remained
- Regulatory pressure will continue to be the most relevant driver for developments
- A strong footprint in regulatory insights will keep us ahead of the wave

Thank you