





Lead Replacement Program to W&C application in Thailand

PVC Cable Stabilisation

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Agenda

- **Historical use of Pb-based Stabilizer**
- **A Safer Alternatives**
- **Challenges – A Different Approach in Formulation**
- **Challenges – A Different Production Mindset**
- **Challenges – Is The Same Properties Possible?**
- **Case Studies**
- **Industry Trends & Future Outlook**



Historical Use of Pb-based Stabilizer

Lead-based Cable Stabilisers Systems

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.



A Safer Alternative

Calcium-based Stabilisers System

Calcium-based stabilisers

- ... is a general term for all stabilisers without Lead, Barium, Cadmium and Tin

current systems are based...

- on Acid scavengers
- on Calcium and Zinc metal soaps
- contain internal lubricants e.g ester waxes, ...
- contain external lubricants e.g paraffines, PE waxes, ...
- contain co-stabilisers to influence early colour and colour hold
- contain Antioxidants to maintain long term stability



Challenges – A Different Approach in Formulation

Pb-based stabiliser one-packs are complex mixtures

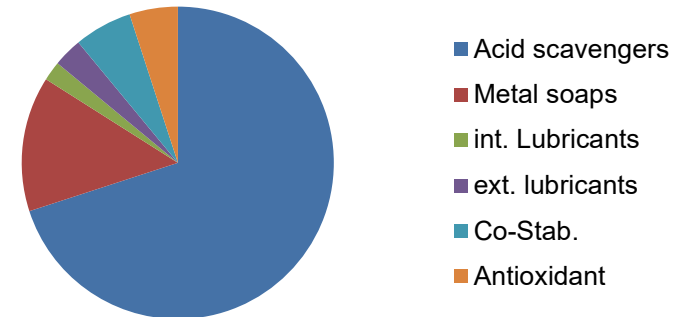
- Pb one-packs contain **lead salts** such as tri-basic Pb-sulfate (TBLS) and dibasic lead phthalate (DBLP) or di-basic Pb-phosphite (DBLP, for rigid weathered applications)
 - Additional **Lead stearate** acts as heat stabiliser and lubricant
 - Lead metal content of cable stabiliser one-packs was between 60% – 70%
 - Close correlation between **Lead content and thermostability (Congo Red)**
 - Increased **lubrication** by increased stabiliser dosage
- Variation of dosage allows many adjustments!



Basic concept of Ca-based stabilisers

- Calcium-based stabilisers
... is a general term for all stabilisers without Lead, Barium, Cadmium and Tin
- current systems are based...
 - on Calcium and Zinc metal soaps
 - on Acid scavengers
 - contain external lubricants e.g paraffines, PE waxes, ...
 - contain internal lubricants e.g ester waxes, ...
 - contain Antioxidants to maintain long term stability
 - might contain co-stabilisers to influence early colour and colour hold

typical Ca-based stabiliser



Challenges – A Different Production Mindset

General properties of Ca/Zn stabilisation to take into account.

- 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.



Adjustments are necessary

Managing the change means knowing about general properties and necessary changes of a Ca/Zn cable stabilisation:

- underdosing or overdosing of Ca/Zn stabiliser will reduce its performance
- Simple increase of stabiliser dosage does not automatically boost overall performance
- Rheology adjustment is more critical
- influence on Ca/Zn stabiliser performance by additional components: Ca stearate, CPE, CPW, stearic acid
- heavy metal pigments have to be replaced completely to be “heavy-metal-free”



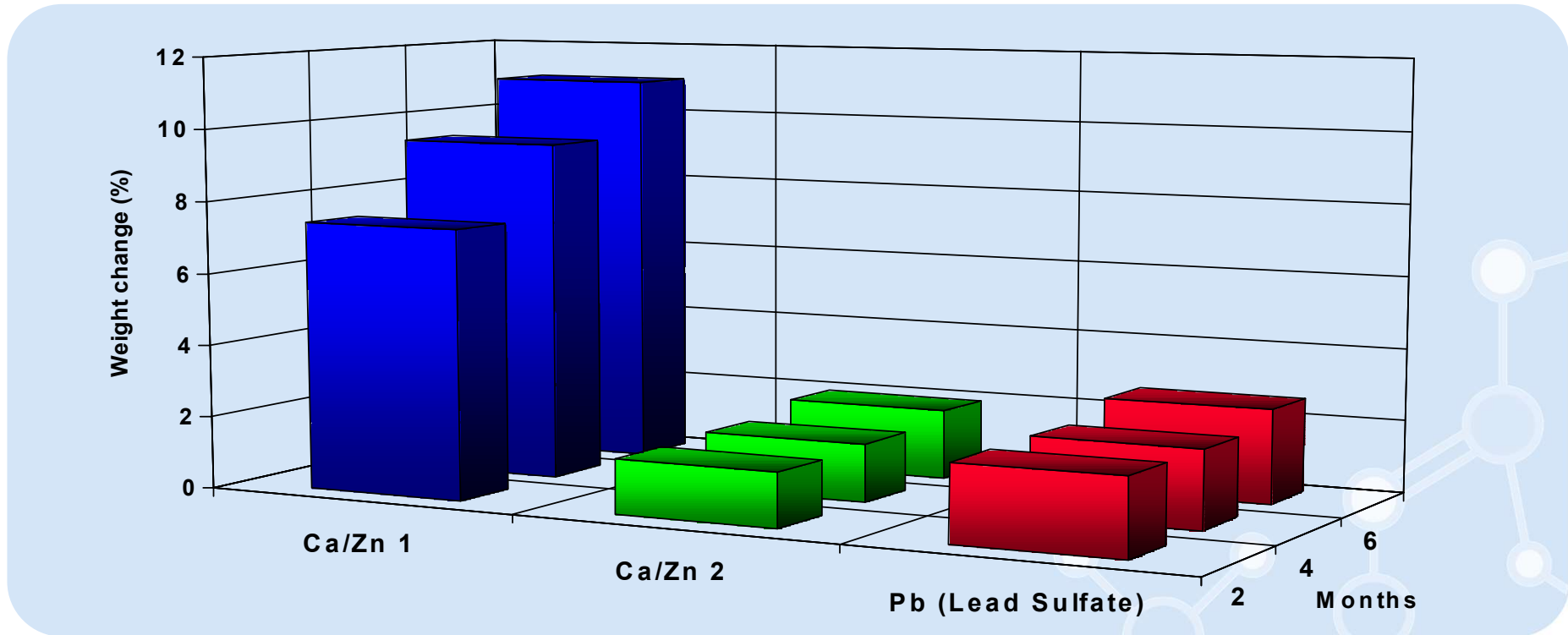
**Challenges – Is The Same
Properties Possible?**

Choice of ingredients is important

- **Many different grades of basic chemicals are available to formulate, but.....**
 - **... physical form must allow proper dispersion, otherwise pitting might occur!**
 - **... needs to be free of volatiles, otherwise plate-out might happen**
 - **... needs to be free of moisture, otherwise pin holes might come up. (Spark test failures)**
 - **... shouldn't have a significant impact on electrical properties of the final product**
 - **... the mixture of ingredient mustn't deteriorate during storage due to cross reactions**
 - **... Baerlocher is backwards integrated in terms of metal soaps and can control raw material specifications tightly.**
 - **... purchased raw material are made according to our specifications**



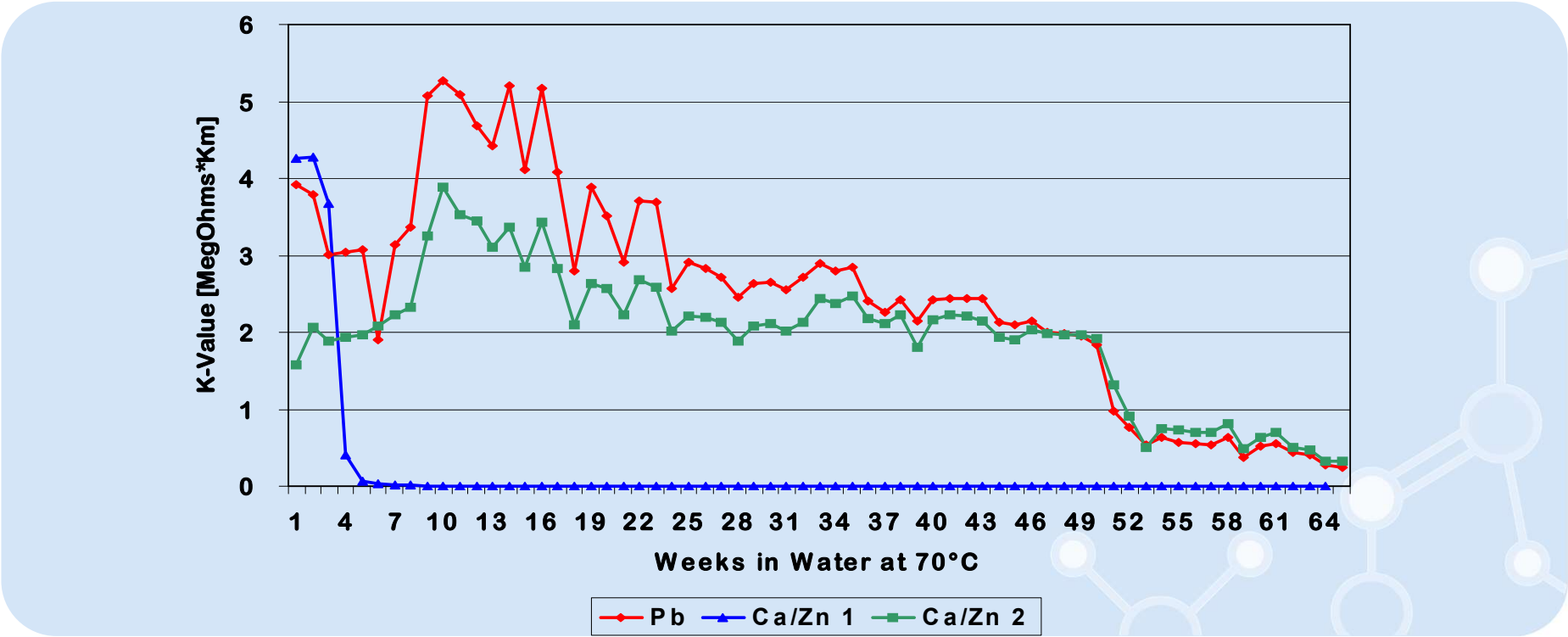
Water Absorption of PVC Sheathing in Water (70°C)



Respect Integrity Excellence



Insulation Resistance on a final cable on an equal level



Respect Integrity Excellence



Case Studies

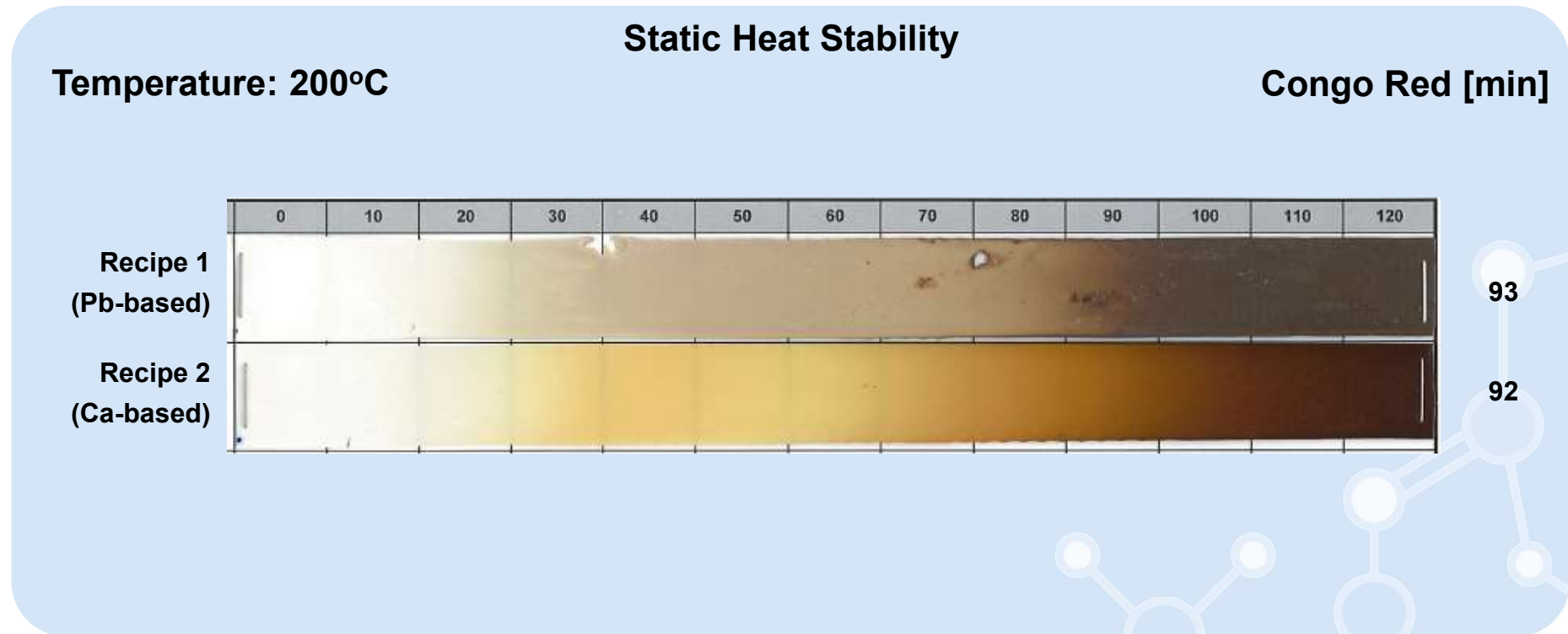
Ca based systems offer good thermal stability.

Test Formulation

	Recipe 1	Recipe 2
S-PVC, K-value 70	100	100
Coated CaCO3	60	60
DOP	40	40
TBLS	5	-
Lead stearate	1	-
MC 90827 KA	-	6



Ca based systems offer good thermal stability.



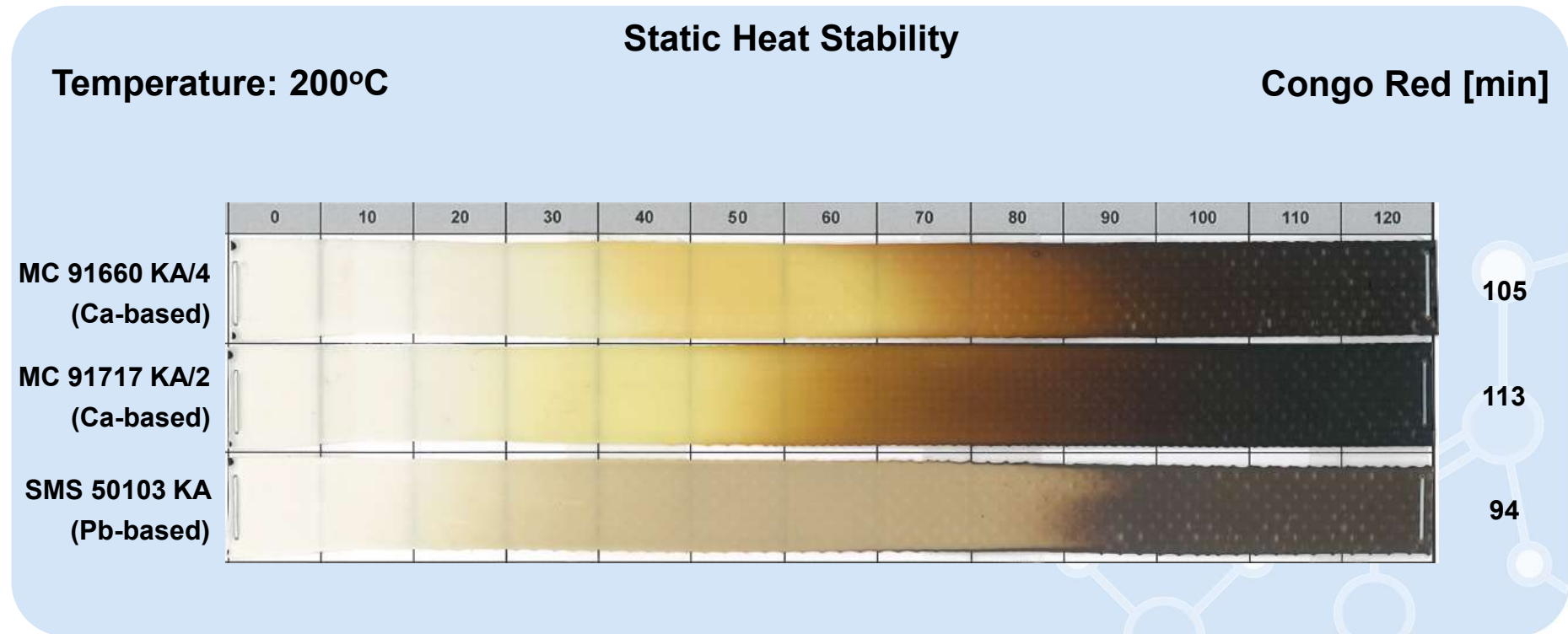
Colour hold of cable compound (Ca-based and lead)

Test Formulation

	Recipe 1	Recipe 2	Recipe 3
S-PVC, K-value 70	100phr	100phr	100phr
Coated CaCO ₃	50	50	50
DINP	50	50	50
MC 91660 KA/4	5	-	-
MC 91717 KA/2	-	5	-
SMS 50103 KA	-	-	5

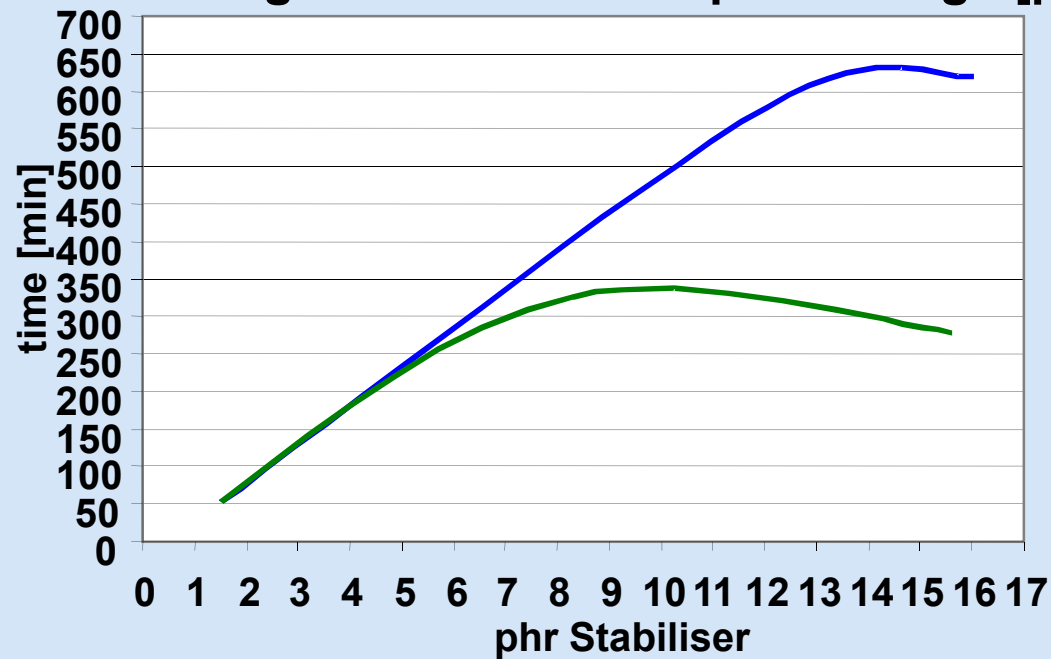


Colour hold of cable compound (Ca-based and lead)



High Temperature requirement can be met.

Congo Red at 200° C per Dosage [phr]



BP MC 8890 KA/2 (125° C)

BP MC 8553 KA-ST/3 (105° C)



Colour hold of heat resistant compound (Ca-based and lead)

Mathis oven test at 200 °C

Standard formulation [phr]: 100.0 PVC, k-value 70
 50.0 TOTM
 20.0 Filler
 8.0 Pb- or Ca/Zn-stabiliser

System Stabilizer



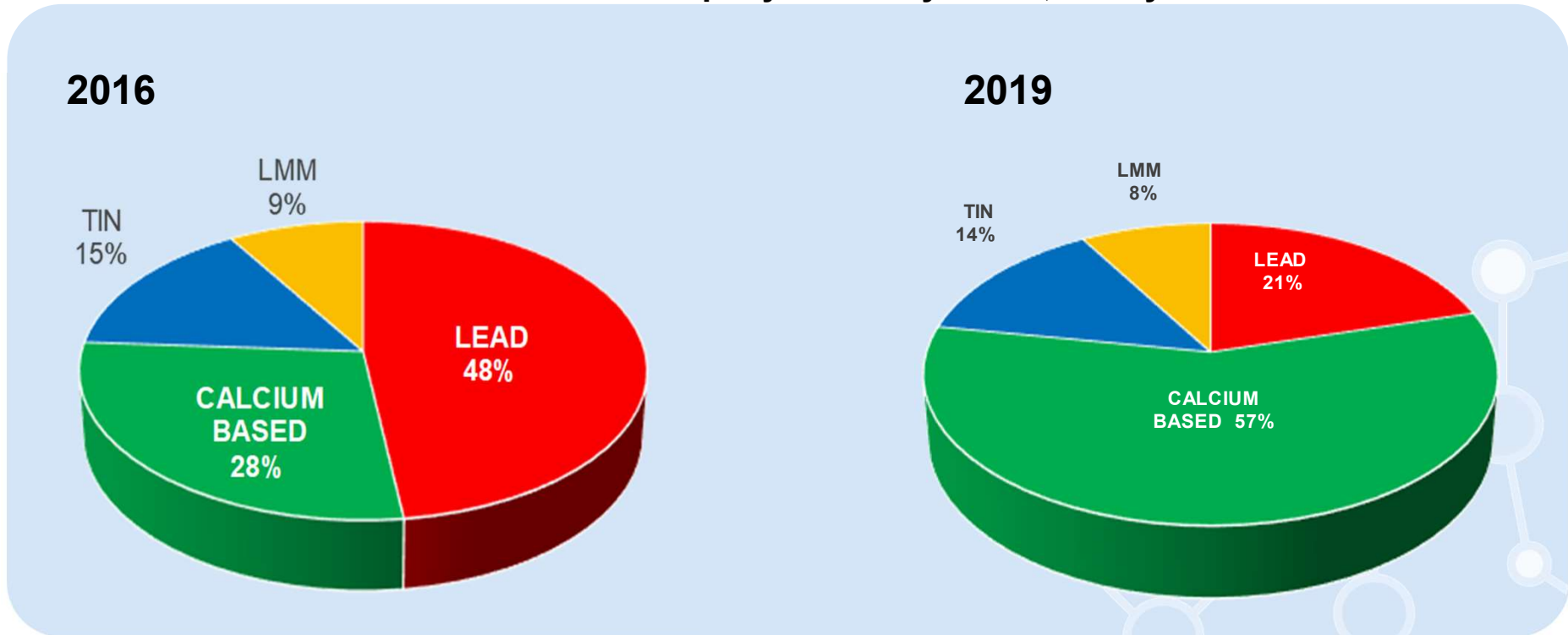
minutes: 0 20 40 60 80 100 120 140 160 180 200 220 240



Industry Trends & Future Outlook

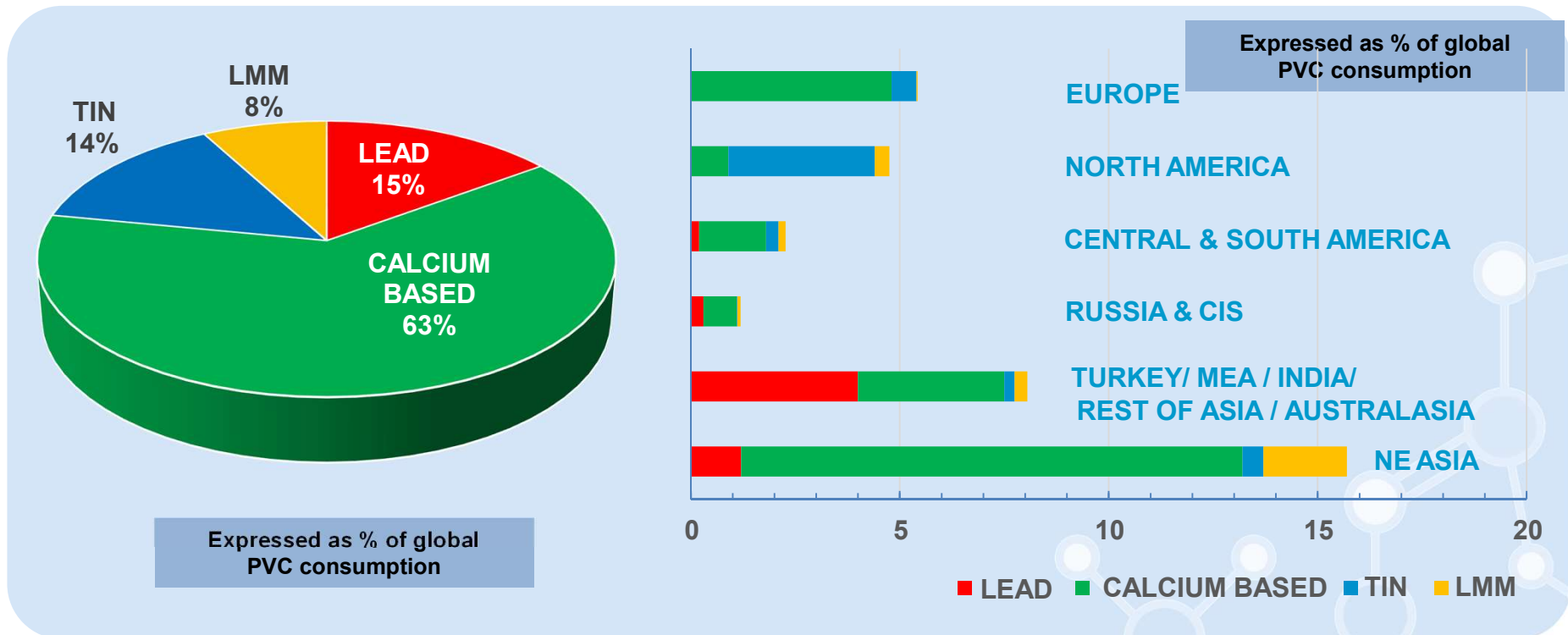
Looking back to pre pandemic PVC stabiliser use

Use of Calcium based stabiliser increase rapidly driven by China, Türkiye & ASEAN



Analysis of global stabiliser demand 2022

Substitution of Lead stabilisers in Russia, Turkey, ASEAN and China by Calcium based stabilisers





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