Global developments for PVC pipe applications in the light of upcoming restrictions

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Agenda

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- **PVC pipes / stabiliser one-packs**
- **Triggers for stabiliser changes**
- **Replacements for Tin stabilisers**
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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

PVC pipes / stabiliser one-packs

Pipes are the dominant PVC application, new technologies are developed

- Applied in water distribution networks, waste water management, cable ducting and venting systems, used in conjunction with appropriate fitting systems
- Stabiliser technology differs around the globe
  - Ca-based in Europe / Asia / parts of South America / parts of Africa
  - Sn-based in the US
  - Pb-based in small parts of Asia and Africa
- Orientation is known to strenghten mechanical properties, additive requirements for O-PVCare different from conventional compact pipes
- C-PVC is used for specific applications, resin structure requires different means to adjust thermostability and rheology

Triggers for stabiliser change

Regulatory actions are the most relevant trigger for change

- Voluntary switches are common for market leaders to use the first mover advantage as a unique selling point
- Changes of stabiliser systems are also often made proactively to be ahead of regulatory pressure
- Finally regulatory actions force changes and regional regulations influence other parts of the world
- Regulatory actions will ever continue and will get components into focus which are currently considered safe

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

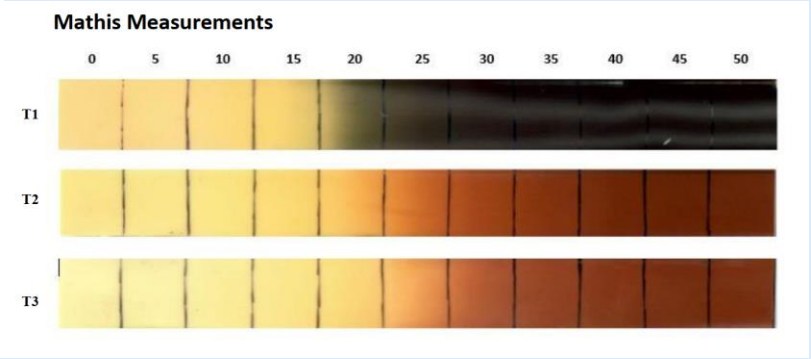
Tin replacement

Experiences and challenges

Requirements for O-PVC pipes

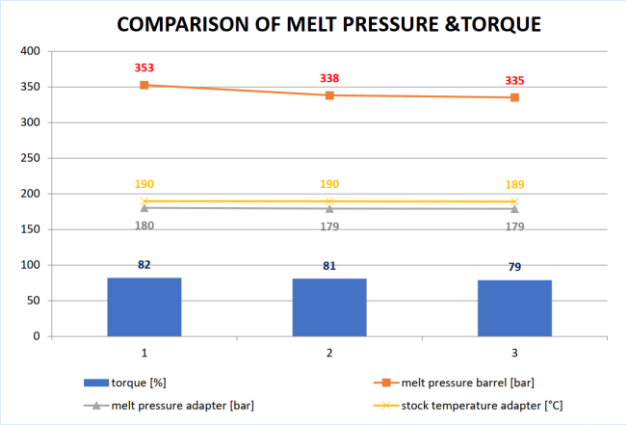
- O-PVC pipes are a relatively new pipe application requiring specific properties
- In EU rather Ca-based systems are required, in the US conventional Tin stabilisers are considered
- High wall thickness of preforms and long processing time require high thermostability
- Reheating for offline process also requires good heat stability
- Rheology adjustment must guarantee proper gelation
- Lubricant selection shall provide good material viscosity to allow proper Bi-orientation process

Solutions developed with sufficient heat stability



Std. pipe grade

O-PVC grades



Rheology remains unchanged

Congo Red Measurement

SAMPLE ID	HCl (min)
T1	13
T2	21
T3	22

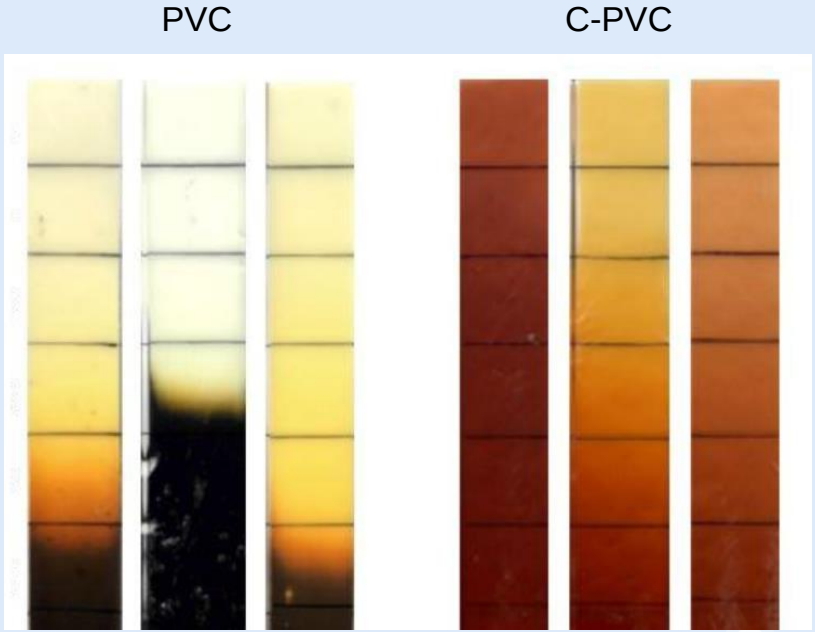
- Correlation seen between lab and full-scale production

Requirements for C-PVC applications

- C-PVC application require Ca-based stabilisers for tin replacement
- High thermostability is needed due to high processing temperatures
- Different components need to be applied for good heat stability and colour hold compared with PVC applications
- Polymer and stabiliser system affects lubricant performance
- Mode of action of lubricants needed to be worked out completey new
- Toolbox for formulation development has been developed

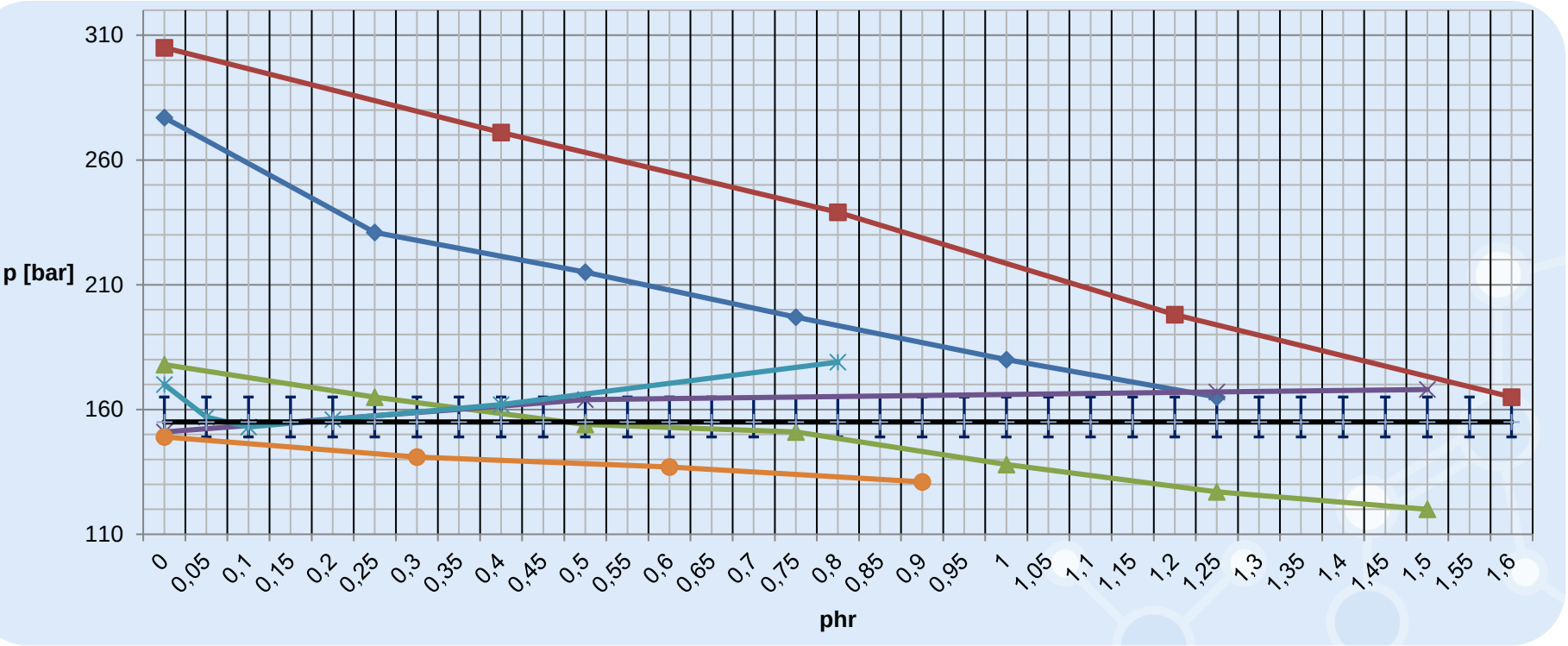
Comparison of heat stabilisers in PVC vs. C-PVC

- Costab A improves initial colour, but affects stability differently
- Costab B improves colour and stability in C-PVC, hardly any effect in PVC



	PVC			C-PVC		
	Std.	A	B	Std.	A	B
Congo Red (min)	11	6	12	13	13	18

Comparison of lubricants in C-PVC



Comparison of C-PVC resins

- Two sets of 5 different resins, processed with two different stabilisers
- Significant differences in terms of colour development

1 2 3 4 5 6 7 8 9 10

The ECHA investigation implications on circularity

ECHA assessment creates pressure on various components

- Biggest group of components for PVC processing in focus of ECHA are plasticisers
- Ca-based stabilisers are considered as a low hazard – a small number of substances liste as „of concern“ but not yet targetted for regulation – known substitutes are available
- Tin stabilisers, some of which are already under a formal restriction process within REACh, are proposed to the EC for further regulations with exceptions
- The industry needs to make PVC future proof

1. Enable increased use of post consumer waste

- Post-consumer PVC shows a broad variety of properties (stability, viscosity, colour)
- Known additive components can be applied to modify and level out inconsistencies
- They are available to be added at a compounding step to homogenise larger amounts of post consumer material
- Ideally they are provided as separate packs (viscosity improver, stability improver,….) to be added directly at an extrusion line

2. Removal of legacy additives from post consumer waste

- Legacy additives (e.g. Pb, Cd) are present in current post consumer waste
- Currently an exception from REACh regulations allows the processing of Pb- and Cd-containing post consumer PVC regrind
- Removal is required to sustain the rework of legacy additive containing post consumer material
- Baerlocher has developed a procedure for Pb- and Cd-removal

3. Monitoring of regulatory actions

- The acepted components of today might get the legacy additives of tomorrow
- Baerlocher is investing in thorough monitoring of ongoing regulatory actions around the world to remain ahead of the game

Conclusion

- Continuous evolution of stablisation technology is imperative - to manage regulation and new technologies
- Ca based solutions for O-PVC are available and in use
- Tin free solutions are available for C-PVC applications
- Management of Legacy additives is in focus – to support progress towards circularity