International Polyolefins Conference 2019 – Houston, Texas

Developing Synergistic Stabilizers for Improving the Process Stability, Color, and Long-Term Performance of Polyolefins

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February 25, 2019

Outline

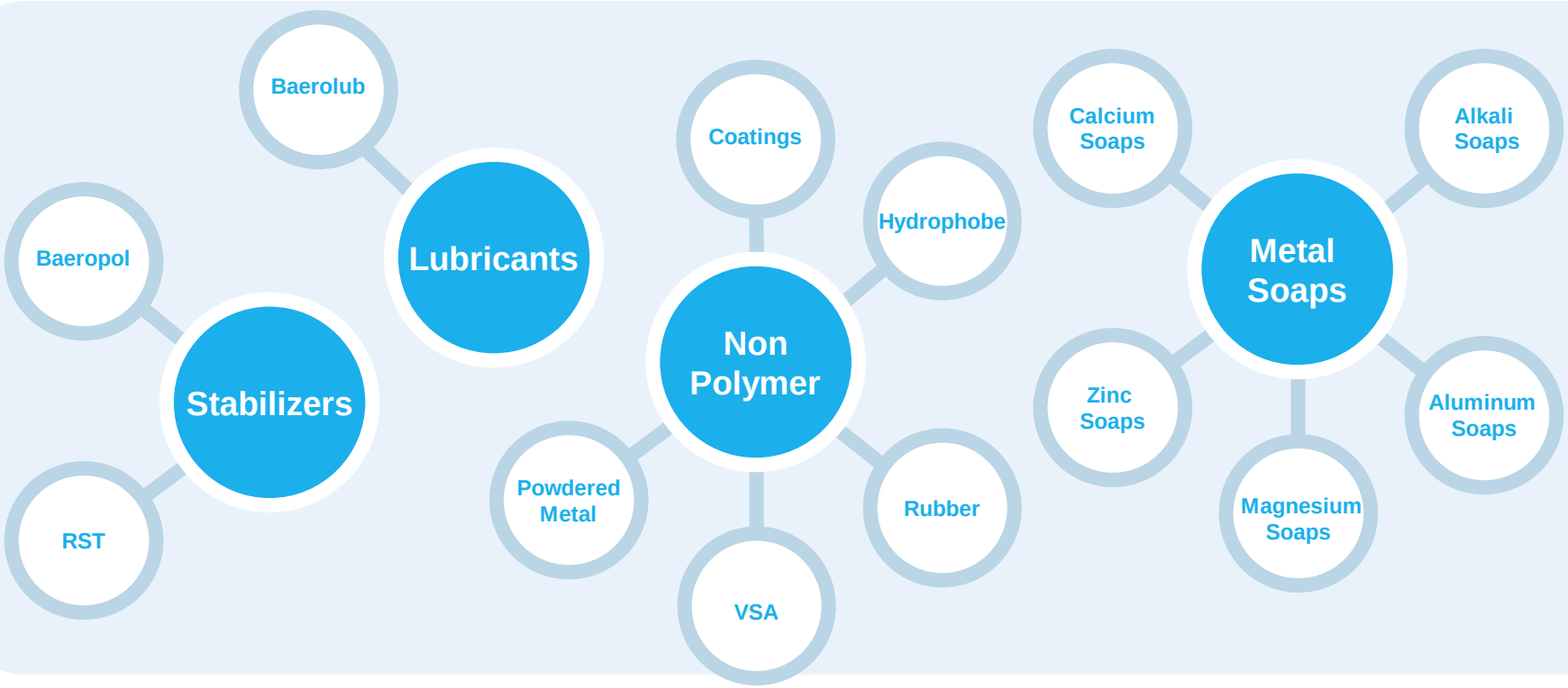
- Baerlocher Overview
- Creating a Synergistic Stabilizer
- Examples
- Conclusions

Your global partner for additives

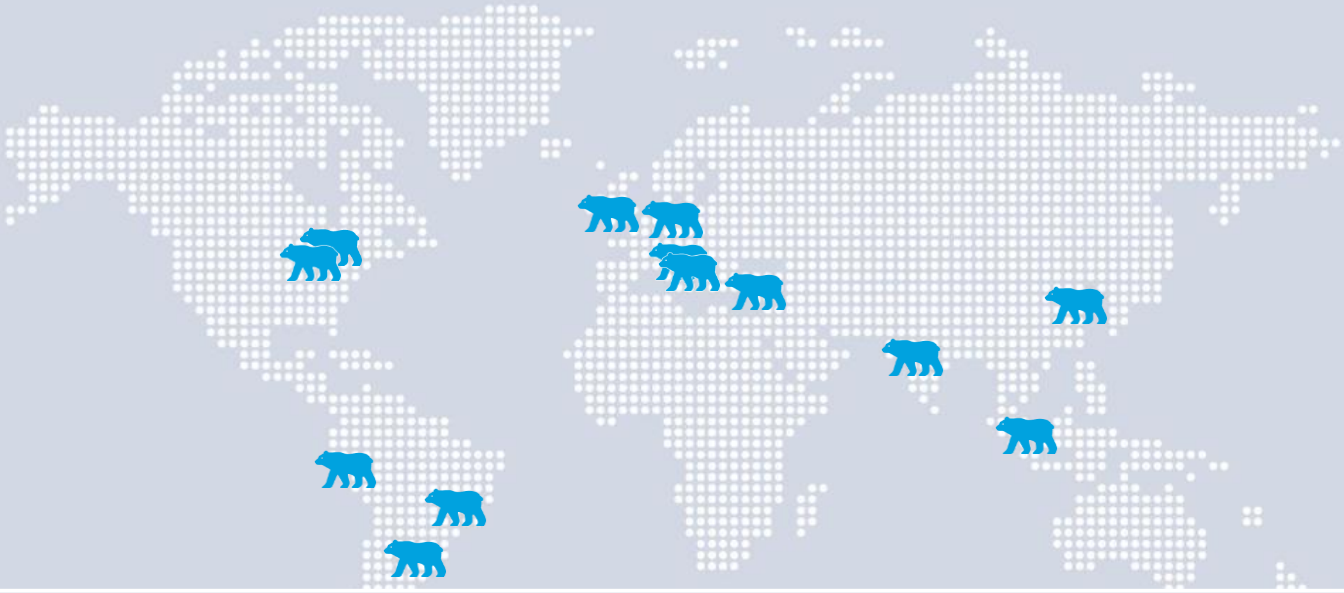
Baerlocher Group of Companies serve local customer needs with innovative / customer tailored solutions.

- Global leader in PVC additives
- Leader in Ca-based solutions
- Global metal soaps specialist
- Customer focused blend solutions
- Global footprint of 1200 employees representing a trusted and reliable partner
- 190 years of experience

Specialty Additives Products



Manufacturing Companies: Countries

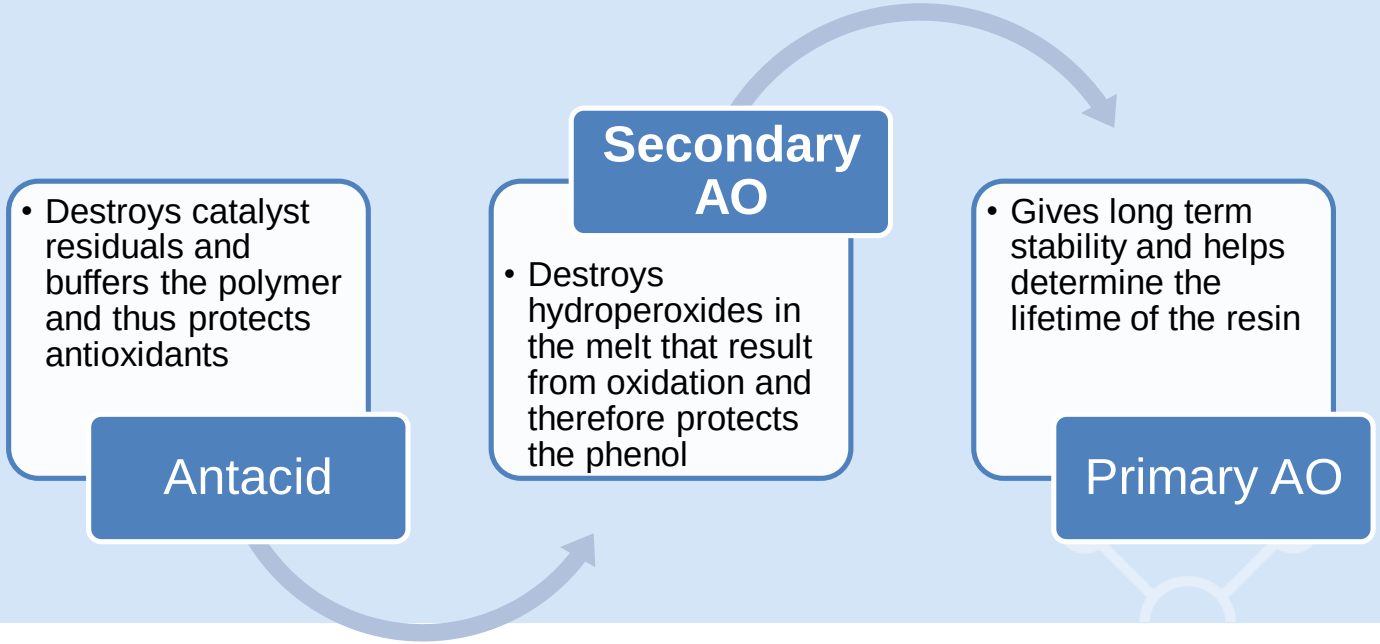


Germany	Italy I		Brazil	USA I	Argentina	India
UK	Italy II	Turkey	Peru	USA II	China	Malaysia

Creating a New Type of Stabilizer

Standard Stabilization Background

- Polymer stabilization is a well established concept



Antioxidants, Synergists, and Boosters

- Other additives such as boosters, synergists, and functional additives can increase the effectiveness of standard antioxidants
  - Example: Thiosynergists (i.e. DSTDP) for improved long term heat stability
  - Example: Lubricant (i.e. Zinc Stearate, PPA) reduce shear during extrusion and reduce antioxidant consumption

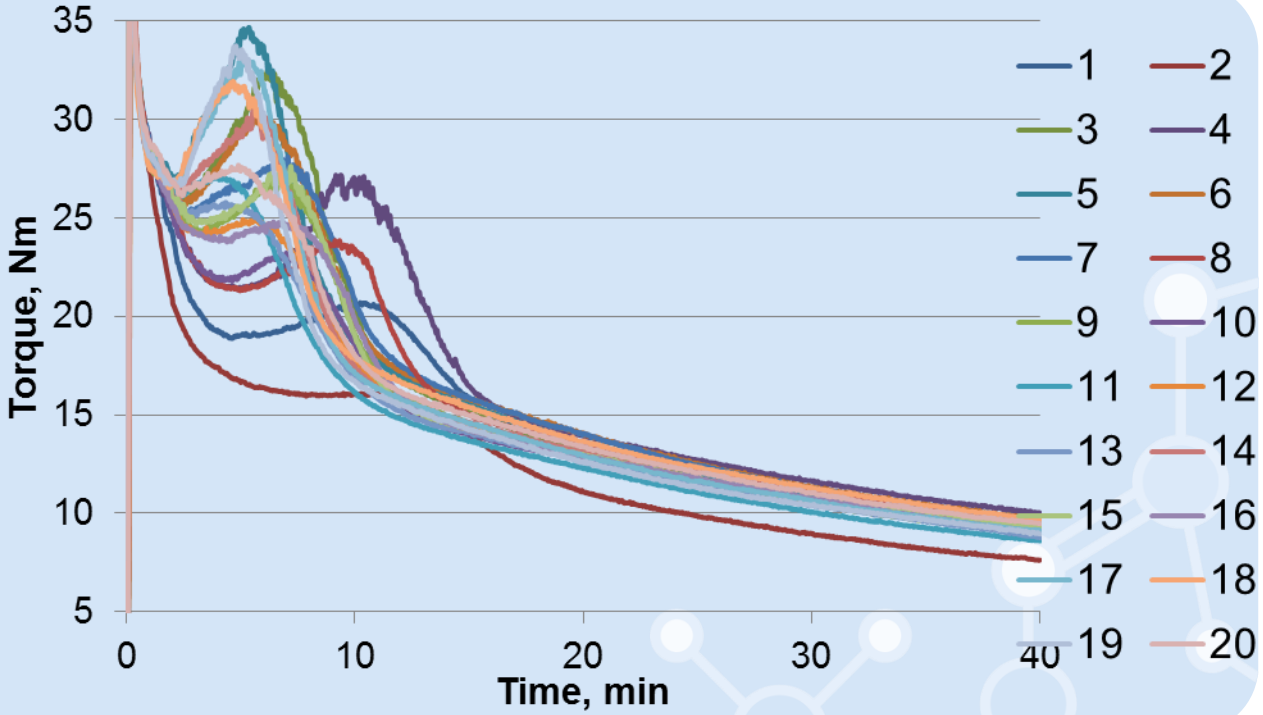
Additive Development

- Baerlocher investigated blends of common additives to determine their efficacy at improving performance of common antioxidants
- We found that certain blends synergistically improved the performance of commodity phenols and phosphites
- Further found that the process by which they were combined boosted efficacy
- Baerlocher named this product: RST (Resin Stabilization Technology)

Screening

- Blends of various functional additives were quickly screened using mixing bowl techniques

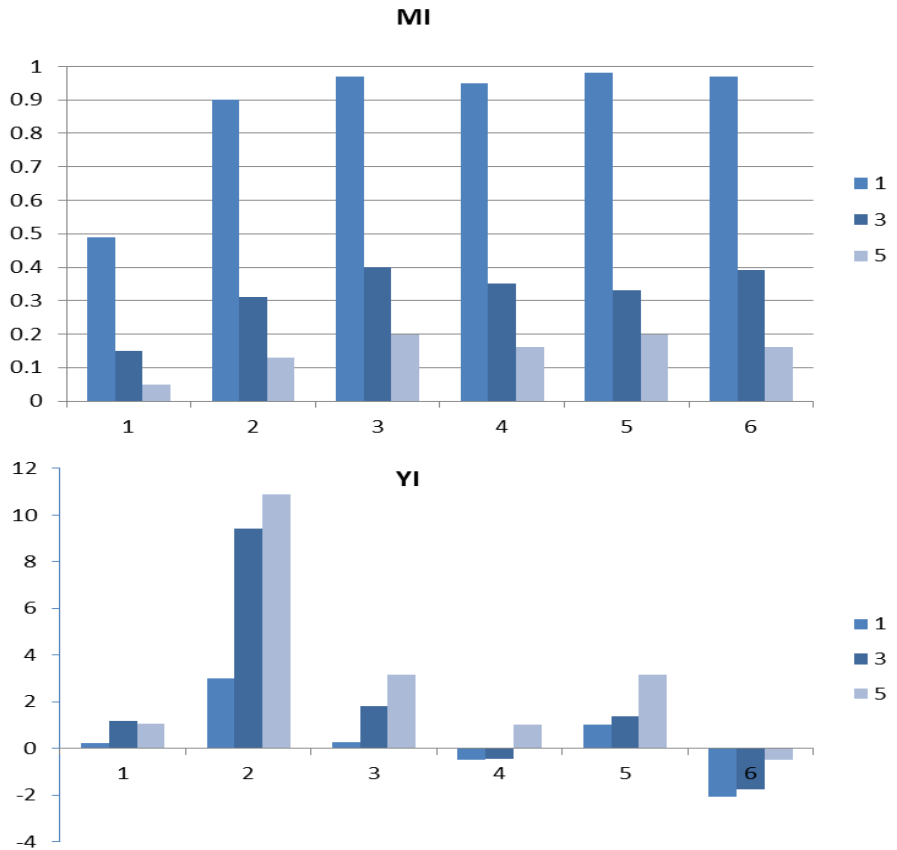
- Determining the suppression of crosslinking in CrHDPE resin was fast and effective for small scale screening



RST Development

- Early results showed that we could improve melt stability and color of both PE and PP.

- Since we could make RST composition from a variety of materials it was decided that:
  - RST will have the broadest food contact
  - Be multifunctional
  - Be cost effective



RST Development

- Since RST can be made from a variety of commonly used polymer additives Baerlocher has been able to tune the properties of RST:
  - Regulatory:
    - RST is specifically composed of additives with the broadest global food contact approvals
  - Use:
    - RST is a partial or total phosphite replacement
    - RST is a total antacid replacement
    - RST is a partial or total lubricant replacement
  - Results:
    - Improved color of the resin
    - Improved melt stability
    - Excellent long term heat stability and OIT
    - Reduced blooming

RST Product Family

Baeropol® RST

- Pure RST additive
- For direct formulation in resins

(Neat Additive)

Baeropol® T-Blends

- For formulating unstabilized resin
- For boosting stabilization of recycle or prime/virgin resin
- Use as a one-pack solution

(Simple Stabilizer Blend)

Baeropol® DRS

- Alternate to pure phosphites
- Formulated for processors that do not use additive blends

(Commodity Phosphite Substitute)

RST Containing Baeropol®

- Custom blends that contain RST
- Use as one-pack or for delivery of specialty additives

(Complex Stabilizer Blend)

Ways to Use RST Products

- Stabilization of polyolefin resins during:
  - Resin production
  - Processing
  - Recycling
- Reduction/replacement of phosphite usage
- Replacement of antacids in formulation

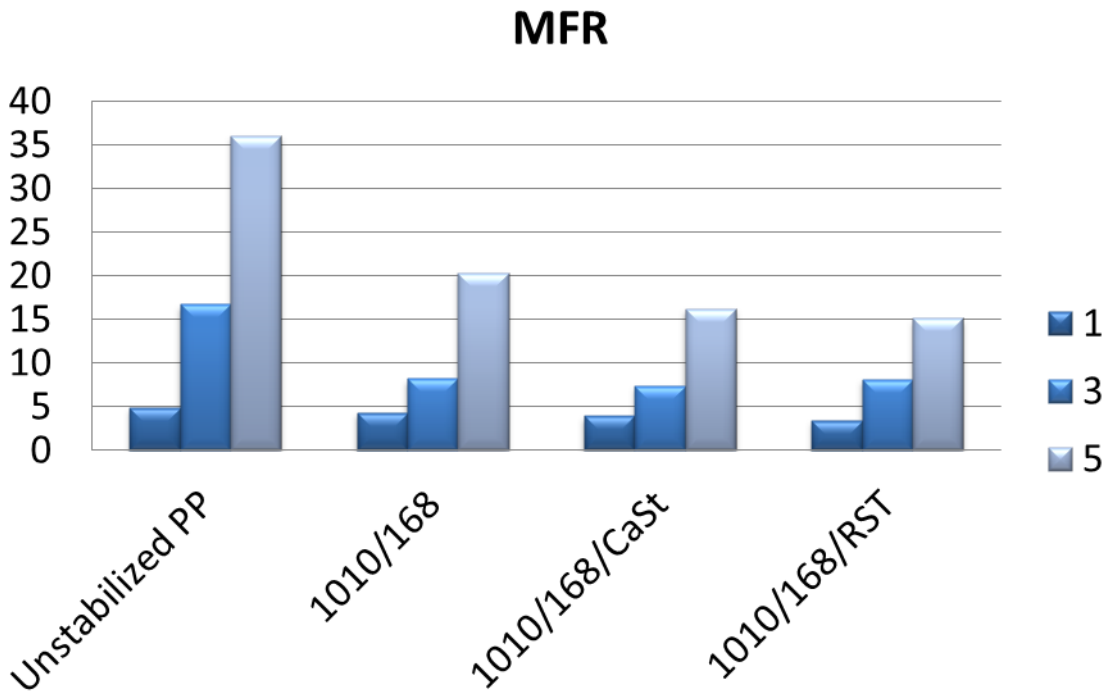
Examples

Stabilizing Reactor Powder with RST(PP Homopolymer)

- 2 MFR PP resin
- Extrusion conditions : 160, 200, 240, 240, 220 (die) ˚C
- Multipass 5x with strand pelletization
- All stabilized samples have 500 ppm of AO 1010 and 500 ppm of AO 168 unless noted differently
- All stabilized samples have 500 ppm of either CaSt or RST

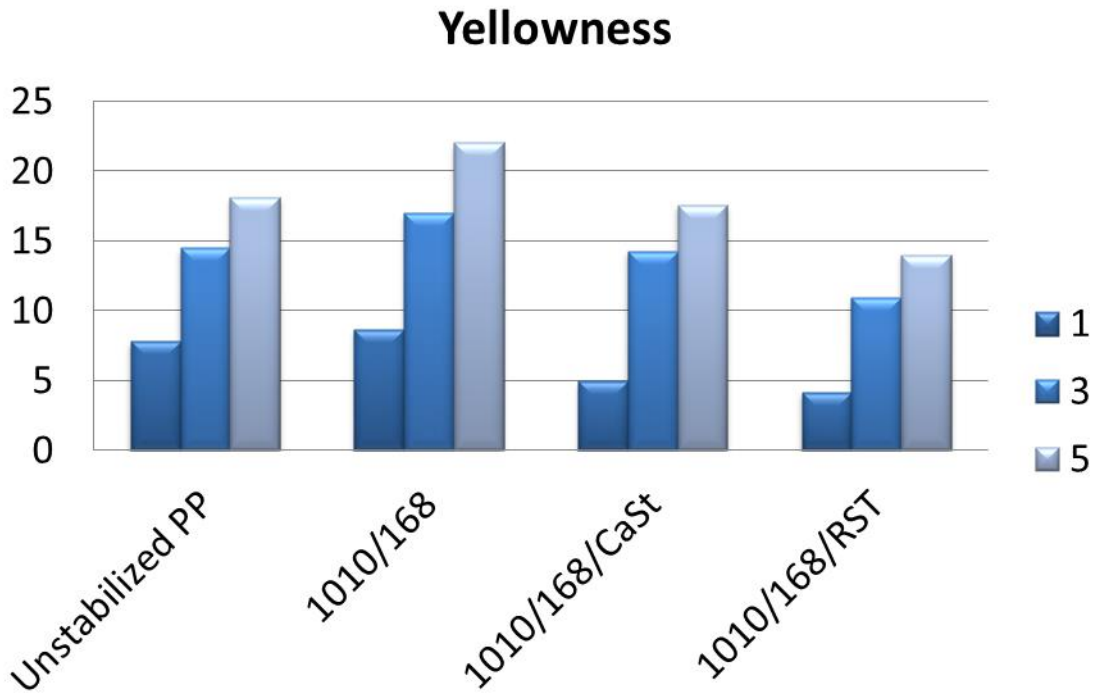
Stabilizing Reactor Powder with RST(PP Homopolymer)

- Replacement of standard antacid with RST improves melt stability



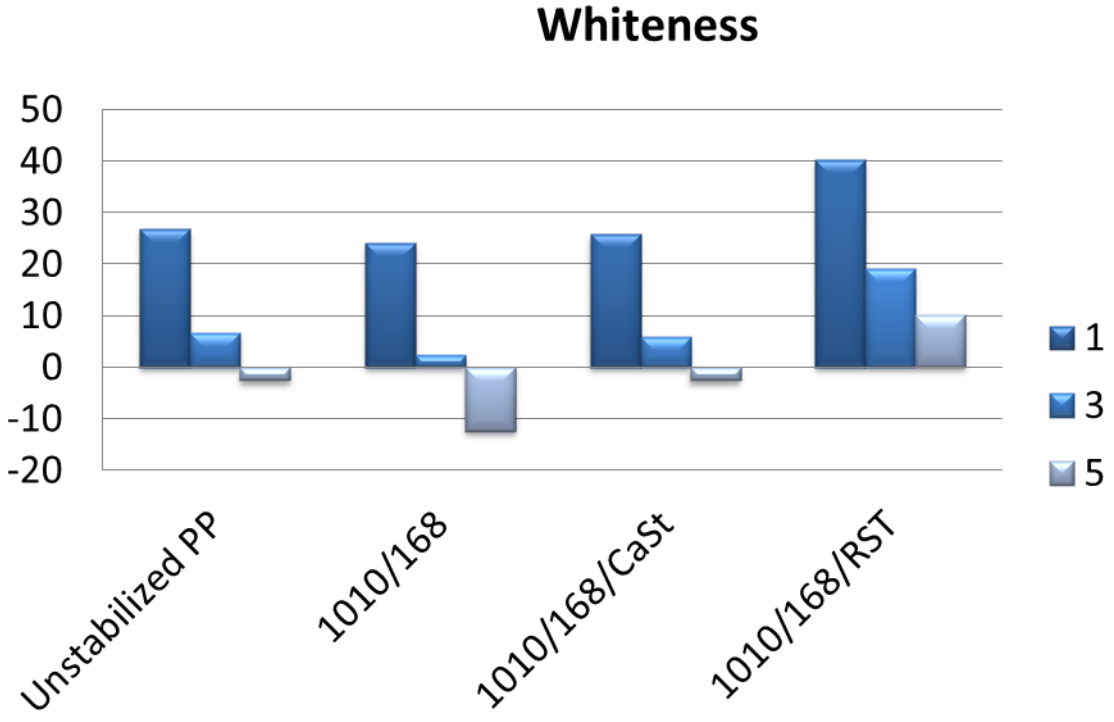
Stabilizing Reactor Powder with RST(PP Homopolymer)

- Replacement of antacid with RST reduces yellowness



Stabilizing Reactor Powder with RST(PP Homopolymer)

- Replacement of antacid with RST improves whiteness



Use of RST as a Partial Phosphite Replacement in HDPE

- RST can be used by polyolefin manufacturers and compounders as a phosphite reducer
- RST can be used to replace high end phosphites with commodity PH 68 type of products

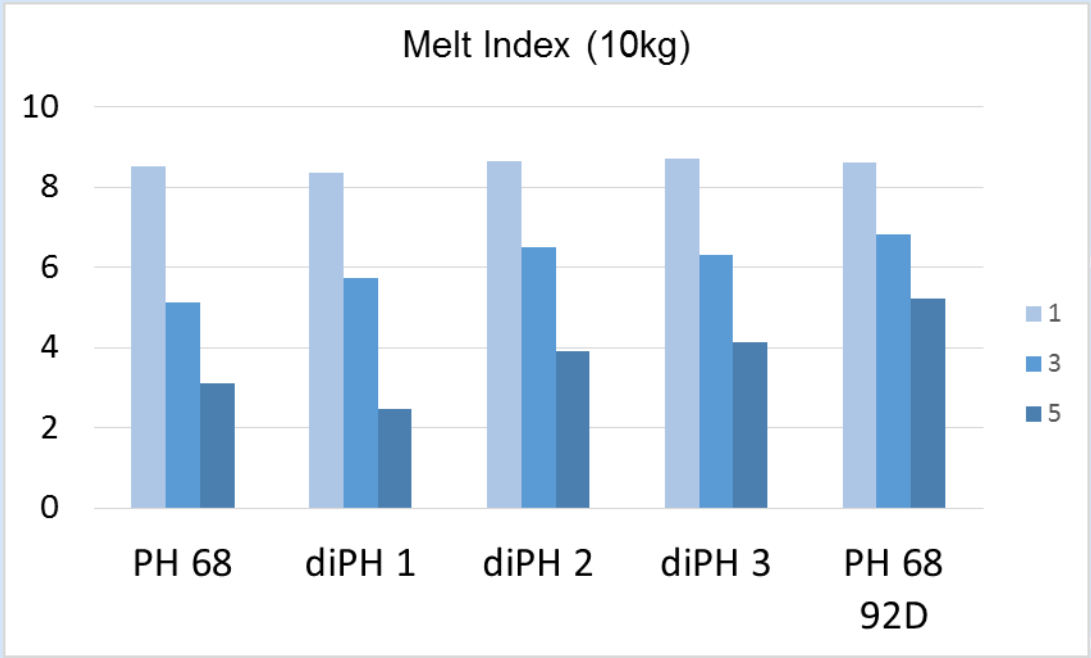
- Propose: replace high end phosphite 1:1 with PH 68 and replace antacid with RST

- Example:

Current	Proposed
AO 10 500 ppm	AO 10 500 ppm
diphosphite 500 ppm	PH 68 500 ppm
CaSt 500 ppm	RST 500 ppm

Use of RST as a Partial Phosphite Replacement (HDPE)

- RST containing samples gave comparable control of melt stability compared to most high end phosphites

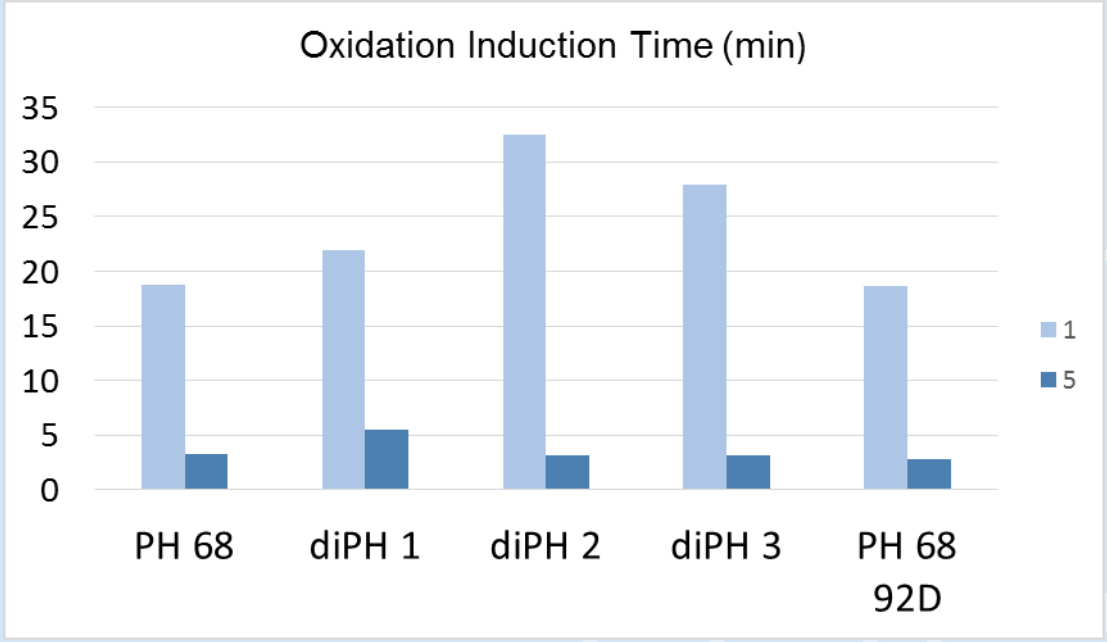


all samples contain
500 ppm AO 10
500 ppm phosphite
500 ppm antacid or RST

Extrusion Conditions: 240 ºC

Use of RST as a Partial Phosphite Replacement (HDPE)

- RST gave comparable OIT compared to high end phosphites

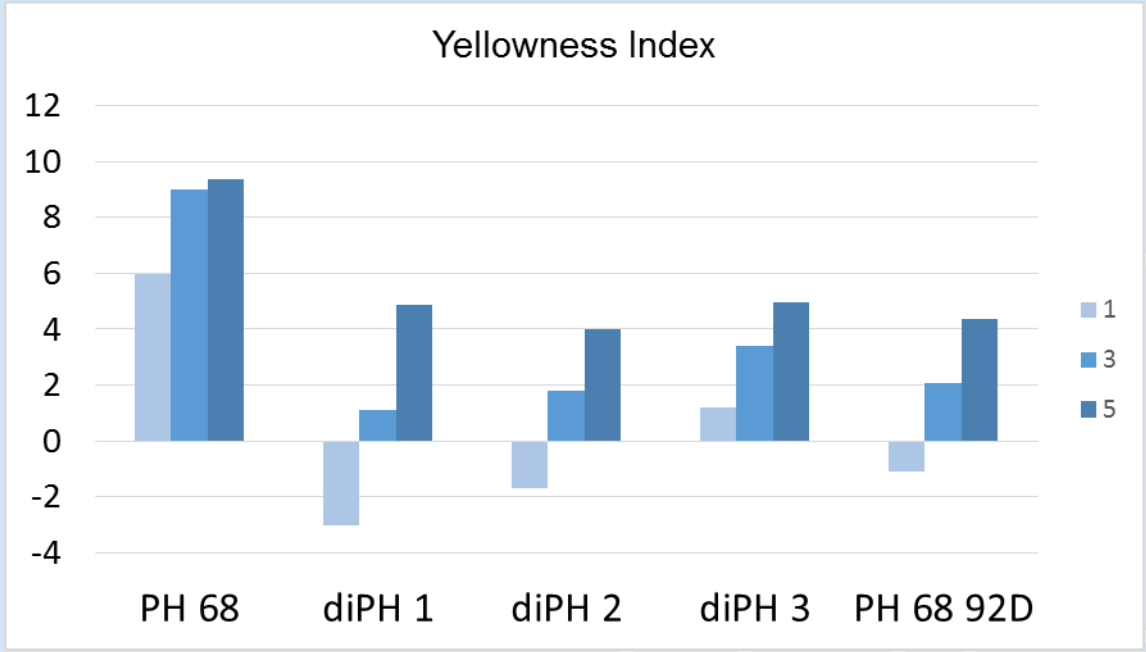


all samples contain
500 ppm AO 10
500 ppm phosphite
500 ppm antacid or RST

Extrusion Conditions: 240 ºC

Use of RST as a Partial Phosphite Replacement (HDPE)

- The diphosphite samples gave better color compared to PH 68 as expected
- RST gave color comparable to most high end phosphites compared to standard PH 68

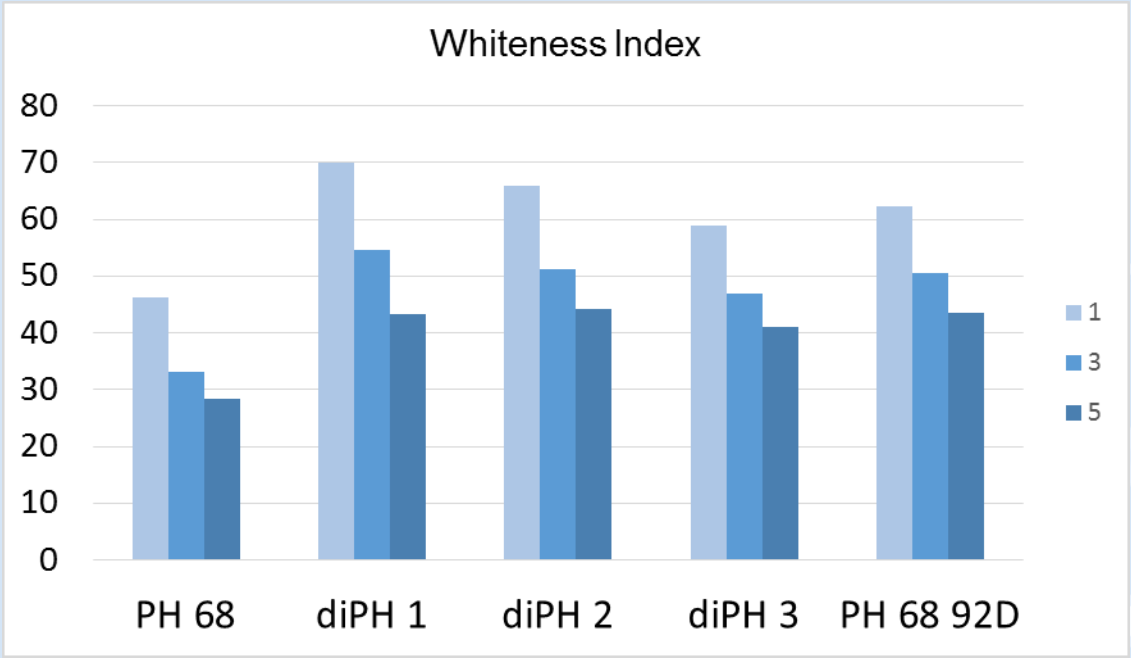


all samples contain
500 ppm AO 10
500 ppm phosphite
500 ppm antacid or RST

Extrusion Conditions: 240 ºC

Use of RST as a Partial Phosphite Replacement (HDPE)

- RST gave color comparable to most high end phosphites compared to standard PH 68

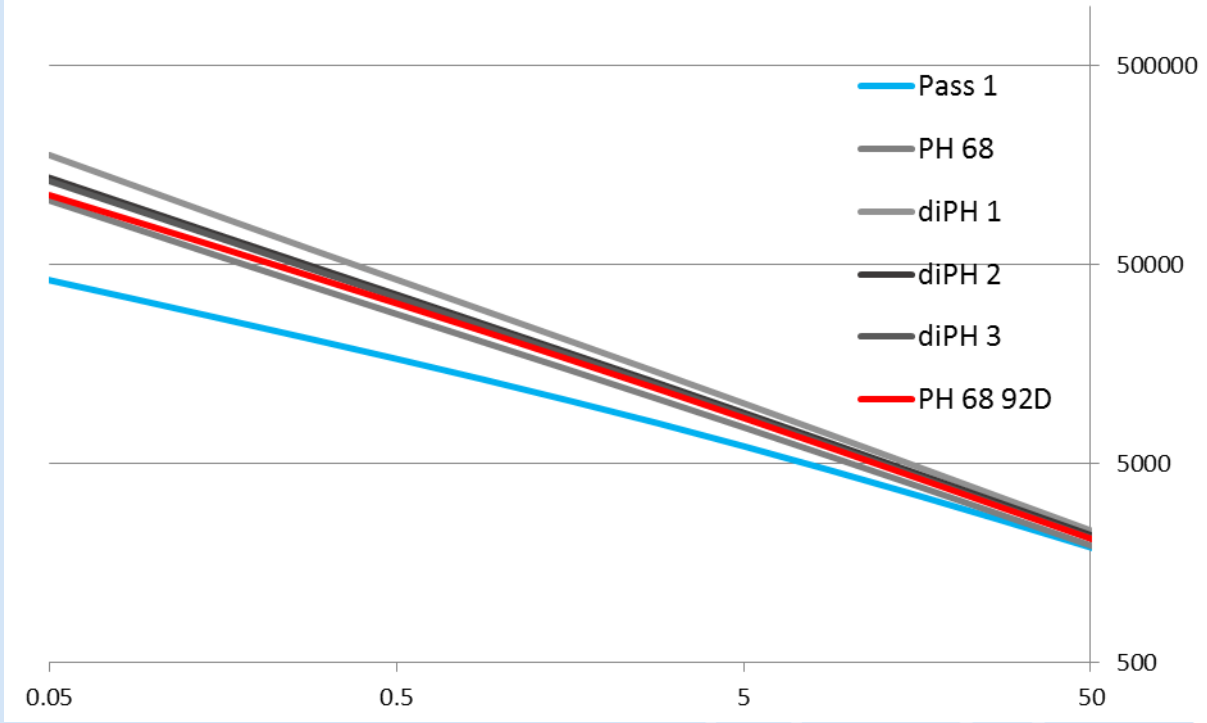


all samples contain
500 ppm AO 10
500 ppm phosphite
500 ppm antacid or RST

Extrusion Conditions: 240 ºC

Use of RST as a Partial Phosphite Replacement (HDPE)

- Complex rheology showed that RST gave excellent control of rheology at 5 passes



all samples contain
500 ppm AO 10
500 ppm phosphite
500 ppm antacid or RST

Extrusion Conditions: 240 ºC

Use of RST in Cast film (LLDPE)

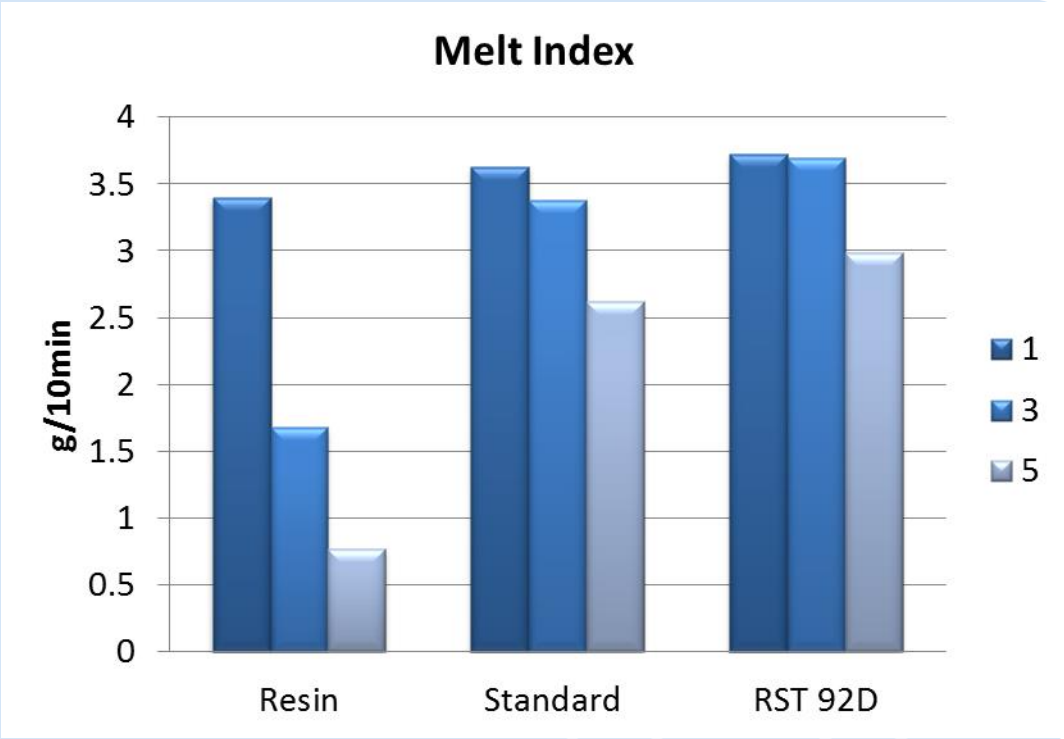
- RST can also be use to assist with switching away from the phosphite TNPP in cast resins
- RST can allow for lower phosphite dosage
- Less additives means less blooming

- Example:

AO 76 500 ppm	AO 76 500 ppm
TNPP 1000 ppm	PH 68 500 ppm
Antacid 1000 ppm	RST 500 ppm

Use of RST in Cast film (ZN LLDPE)

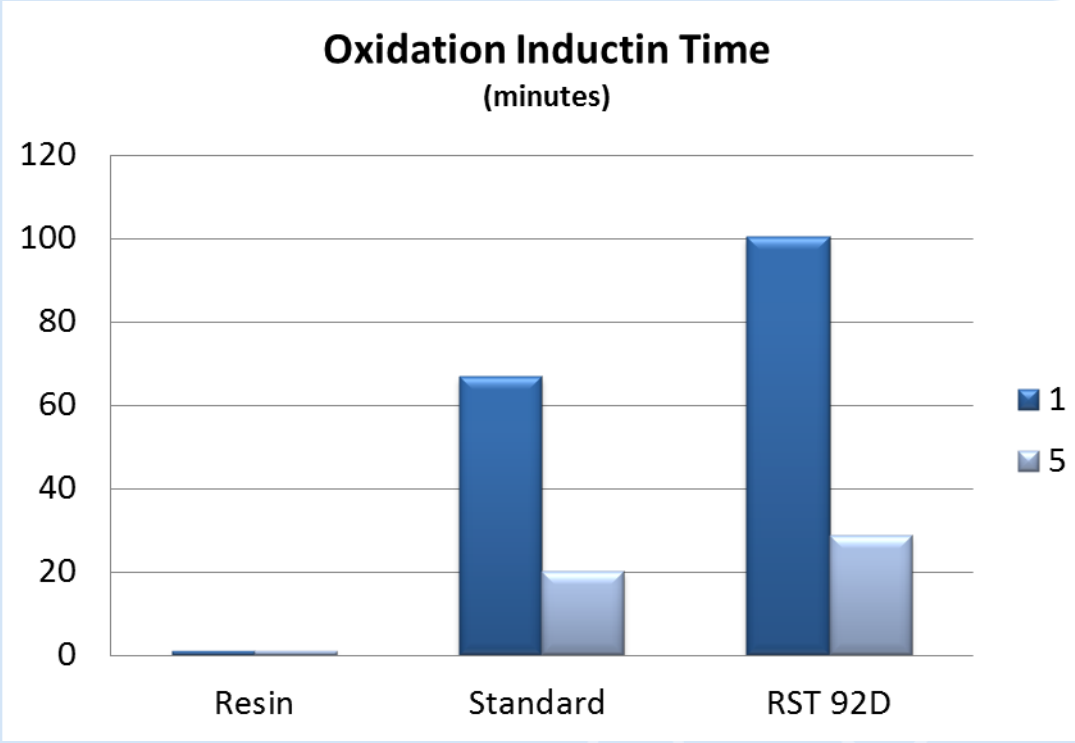
- RST gives better melt stability compared to standard formulations



Extrusion Conditions: 220 ºC

Use of RST in Cast film (ZN LLDPE)

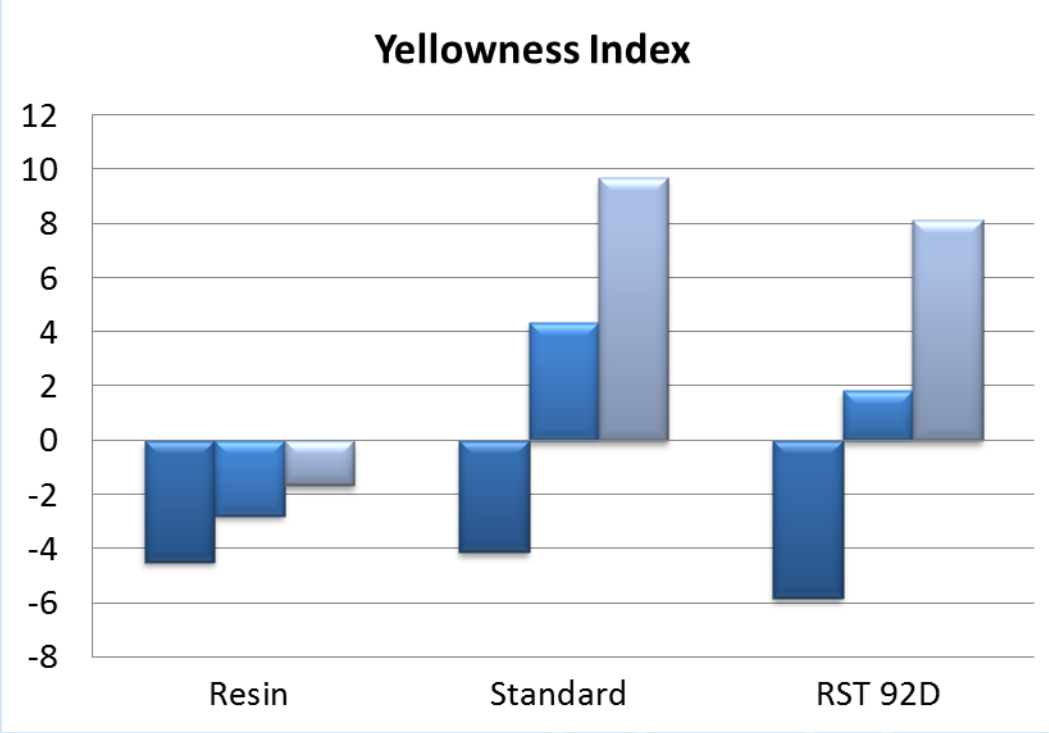
- RST dramatically boosts OIT while using less AO



Extrusion Conditions: 220 ºC

Use of RST in Cast film (ZN LLDPE)

- RST improves yellowness for the catalyst rich cast film grade



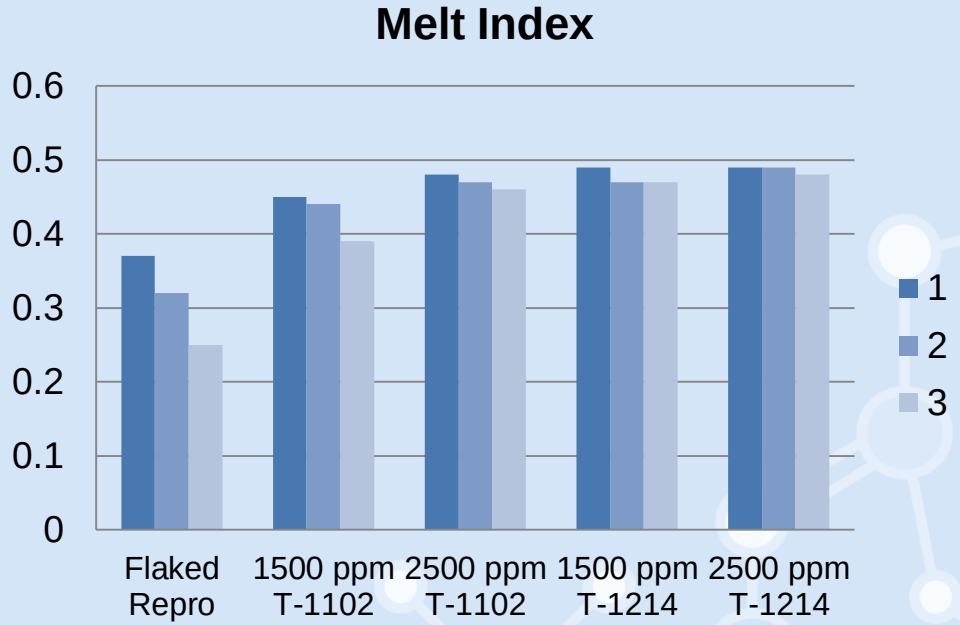
Extrusion Conditions: 220 ºC

Post addition of T-Blends to Polyolefins

- Addition of stabilizer to post consumer recycle allows for retention of the resins initial aggregated properties
- Addition to PCR allows recyclers to have stability similar to prime resin and allows for long term control over properties
  - Stable rheology
  - Improved long term stability

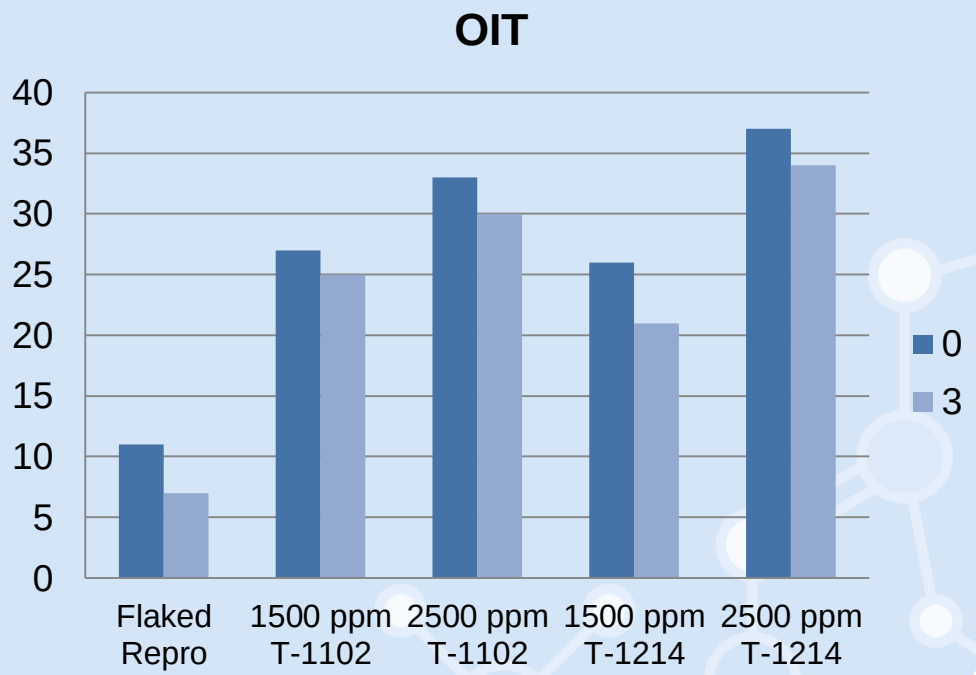
Addition of T-Blends to PCR (Melt Stability)

- Pass 0 is to turn flake into pellets
- PCR HDPE flake has poor stability during multipass extrusion
- Addition of T-Blend stabilizer results in essentially no change to rheology during 3 passes through the extruder



Addition of T-Blends to PCR (Oxidation Induction Time)

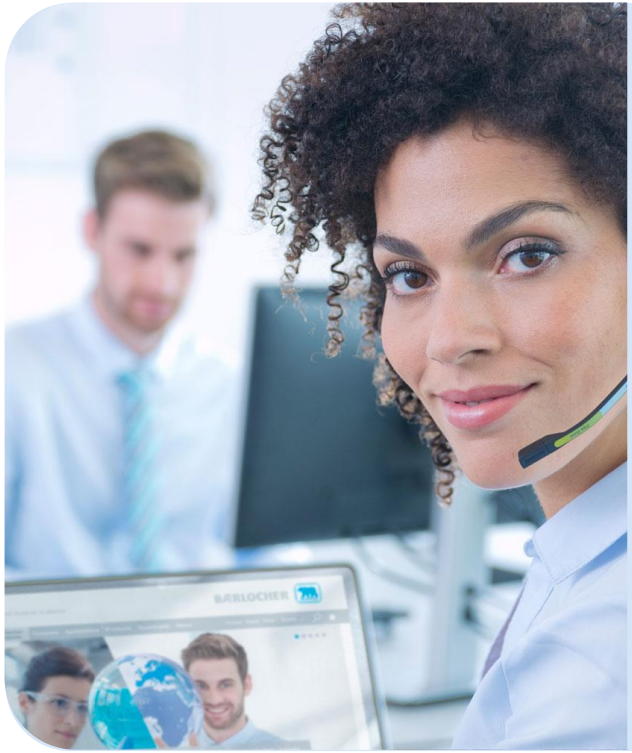
- PCR HDPE flake has poor initial OIT and falls during multipass extrusion
- Addition of stabilizer resulted in better initial OIT as well as retention during 3 passes through the extruder



Conclusions

Conclusions

- RST products have been designed for formulation simplification
- RST brings value by:
  - Reducing phosphite usage
  - Replacing high end phosphites with commodity phosphites
  - Replacing antacids in polyolefin formulation
  - Improving color of the resin
  - Enhancing stability of the resin



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