

AMI: Agricultural Films 2020

DEVELOPMENT OF UV STABILIZER MASTERBATCHES FOR GREENHOUSE FILM

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Agenda

- Introduction to Ingenia
- Projects Goals
- Experiment Design
- HALS Performance Accelerated Aging with Chemical Treatment
- Formulations Developed

Ingenia at a Glance

- Founded in 1986 as WedTech and renamed Ingenia Polymers Corp. in 1998
- Five manufacturing sites: Brantford (Canada), Calgary (Canada), Houston & La Porte (USA), and Al-Jubail (KSA)
- Specialized in Additive and Pigment Masterbatches, Superlink[®] and Rototuff[®] rotomoulding compounds, and additive Ingenia Superblends[®]

Greenhouse film

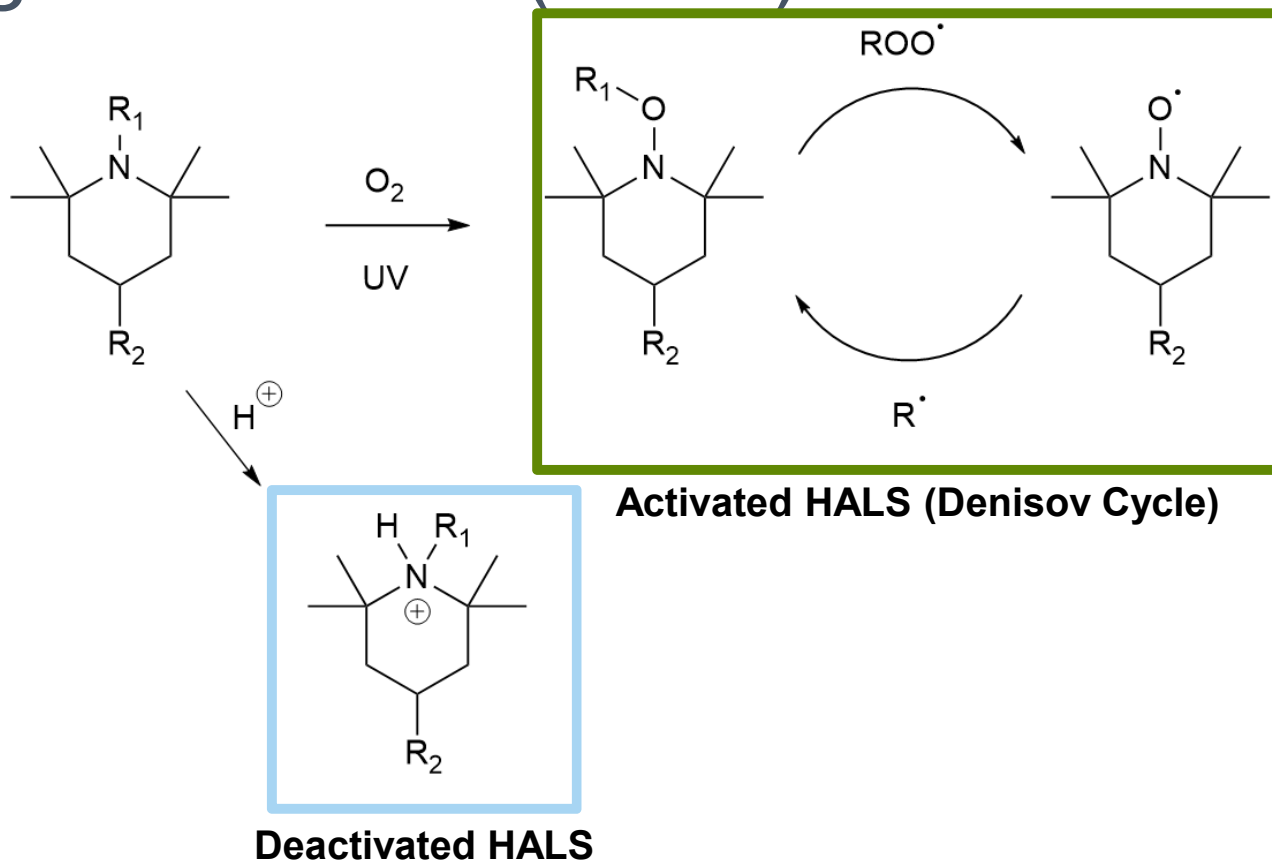
- Greenhouse Film Trend
 - Due to increased worldwide population growth and global food demand, the global greenhouse film market is estimated to reach USD 8.3 billion by 2026 growing at a CAGR of 9.8%.¹
- Requirements of Greenhouse film
 - Longer service life: 2-4 years typical
 - High light transmittance for better crop yield
 - High resistance to agrochemicals featuring sulfur and chlorine.

¹ Polaris Market Research. *Greenhouse Film Market Share, Size, Trend & Analysis Report [...]* Segment Forecast, 2019-2026.



Hindered Amine Light Stabilizers (HALS)

- The regenerative Denisov Cycle allows HALS to provide highly efficient long-term protection
- Acidic chemicals deactivate the HALS, preventing it from stabilizing the film
- HALS is the best option for UV stabilization of films



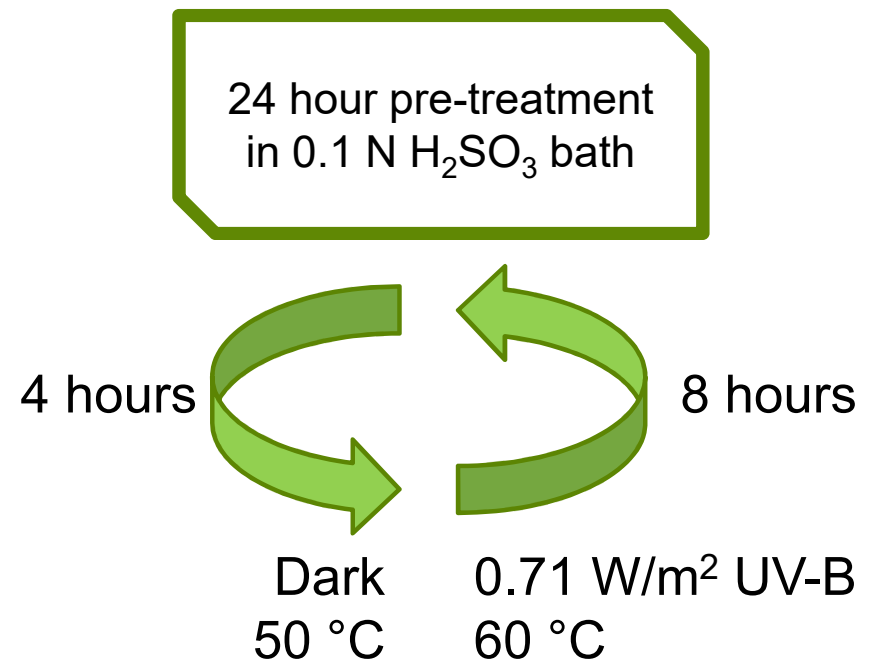
Objectives

- Evaluate and benchmark a range of HALS and HALS packages in the market
- Develop an optimized mid-range HALS package for greenhouse film with pesticide resistance
- Develop the highest performance HALS package for greenhouse film with best-in-class pesticide resistance

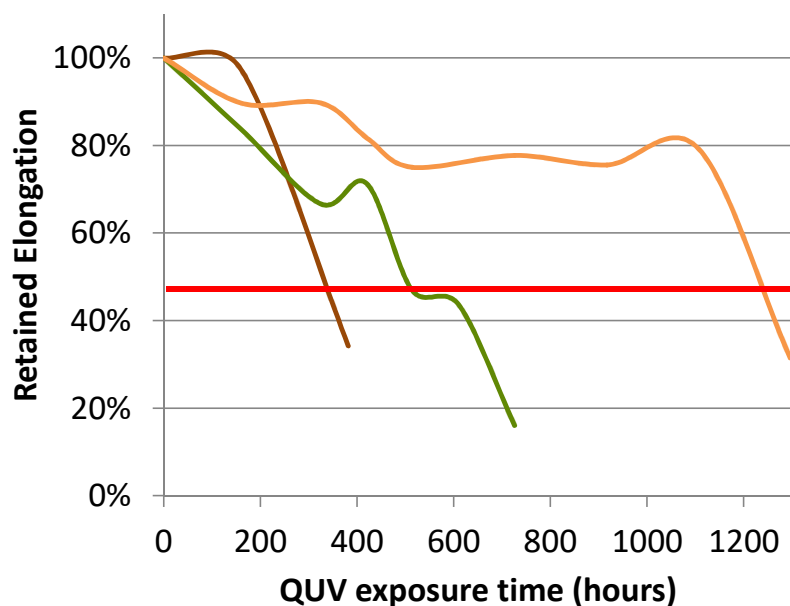
Experiment

- Accelerated testing under UV-B to determine mechanical failure point for formulations of interest
- Test film
 - 6 mil (150 μm) *octene*-LLDPE (o-LLDPE) monolayer (MI = 1, ρ = 0.916 g/cm³)
 - Blow-up ratio = 2.9
 - Processing Temperature = 185 °C

Test Procedure



HALS Performance under UV-B with Chemical Exposure



— Secondary HALS
— Tertiary HALS
— Amino Ether HALS

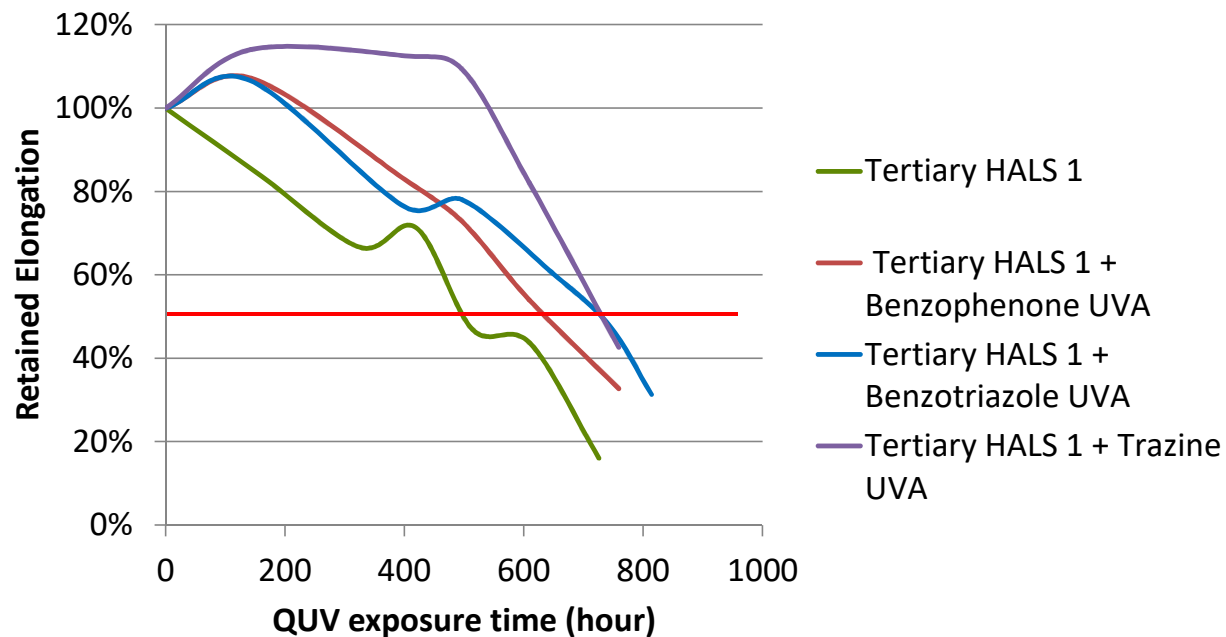
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Basicity

- Less basic HALS has better chemical resistance
- Amino ether HALS is the best option for pesticide-using greenhouse films

6 mil o-LLDPE monolayer film: 4000 ppm active loading

— Failure point: 50% retained elongation

HALS Performance under UV-B with Chemical Exposure

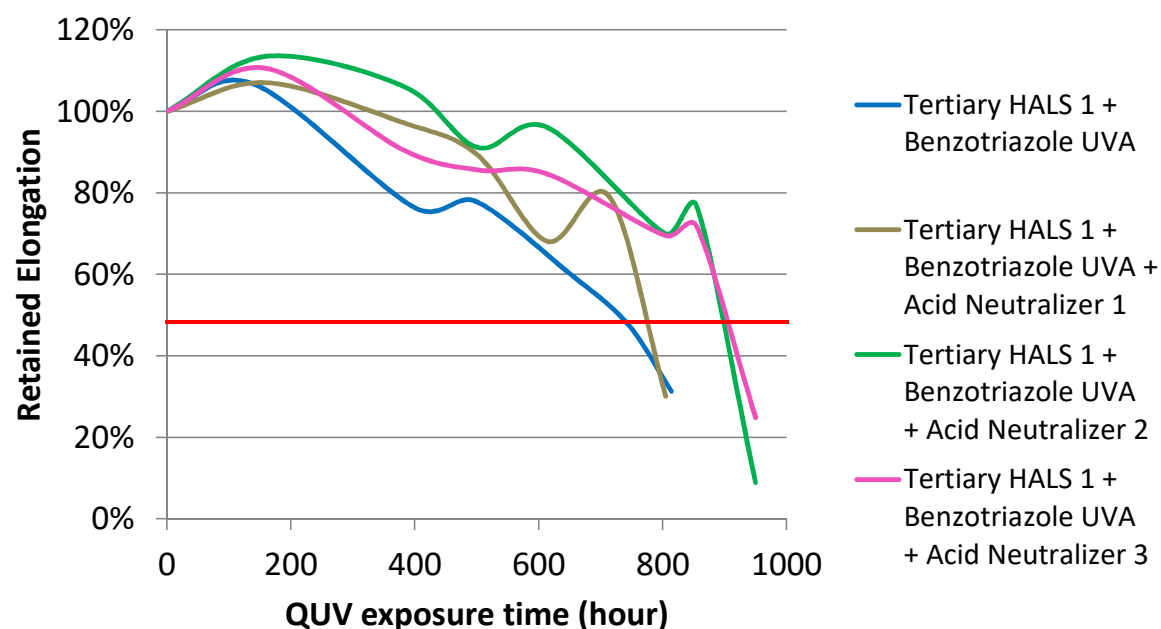


6 mil o-LLDPE monolayer film: 4000 ppm active loading

— Failure point: 50% retained elongation

- Use of UV absorbers alongside HALS increases the UV stability of film
- Triazine is the most effective, while Benzotriazole is more cost-efficient

HALS Performance under UV-B with Chemical Exposure



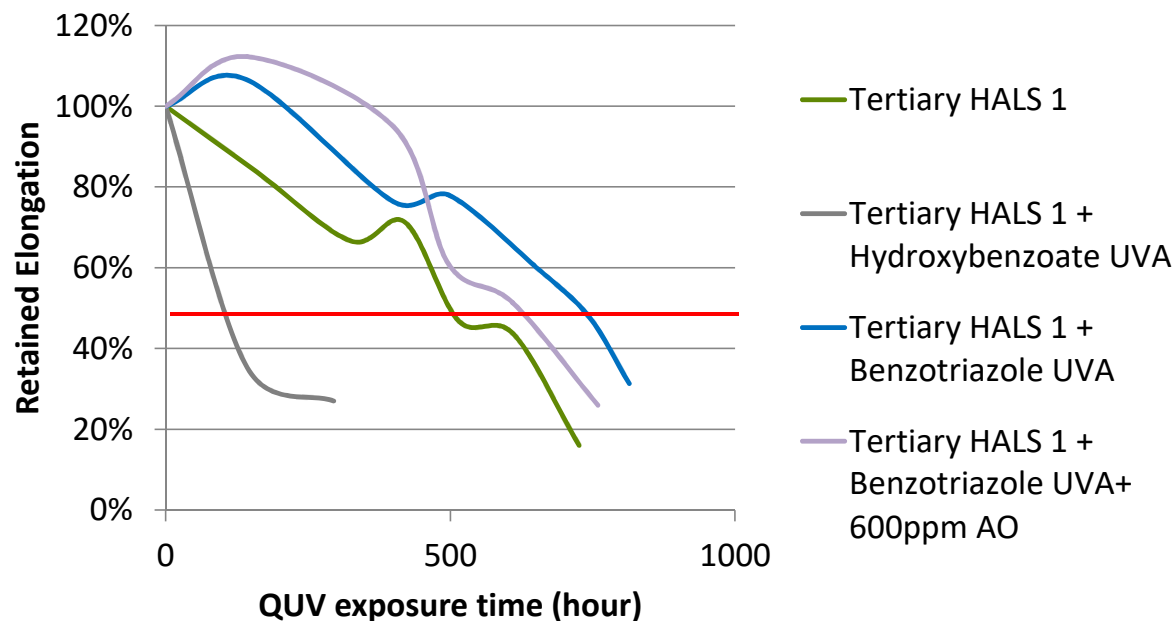
6 mil o-LLDPE monolayer film: 4000 ppm active loading

— Failure point: 50% retained elongation

□ Acid neutralizers can protect HALS from agrochemicals by reacting with agrochemicals prior to HALS

□ Choice of neutralizer is important!

HALS Performance under UV-B with Chemical Exposure

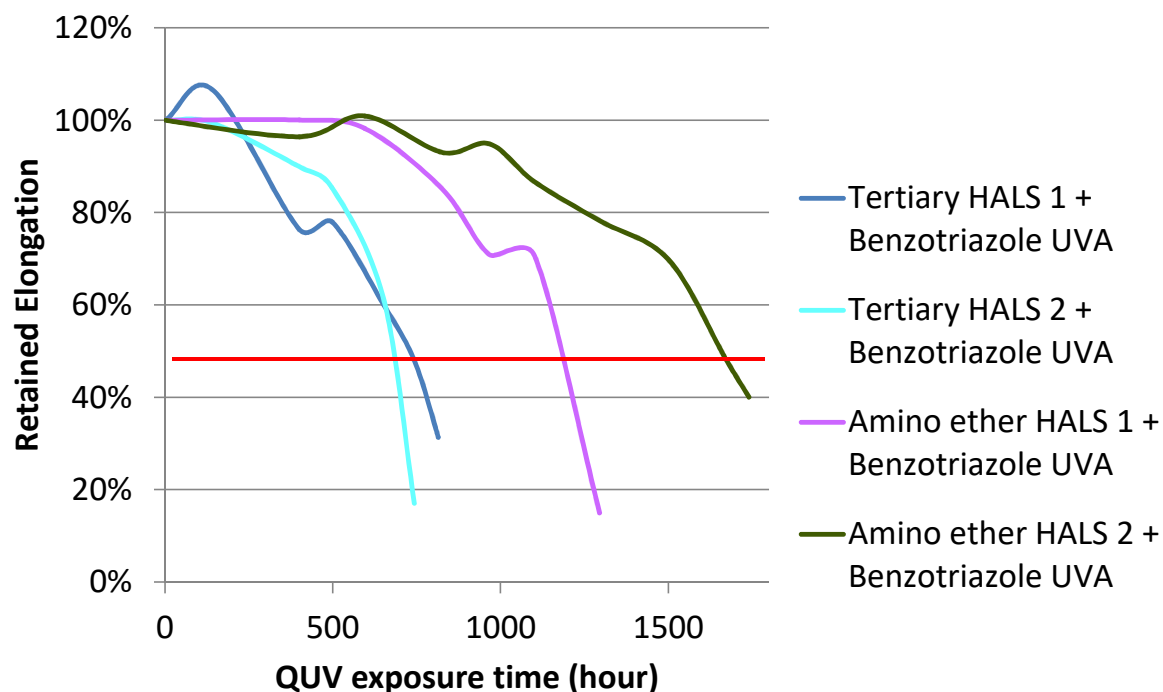


- ❑ The tested hydroxybenzoate UVA is antagonistic to UV stabilization of chemically-treated PE films
- ❑ Additional phenolic and phosphite AO does not improve performance

6 mil o-LLDPE monolayer film: 4000 ppm active loading

— Failure point: 50% retained elongation

HALS Performance under UV-B with Chemical Exposure



- Different HALS shows different performance when combining with UV absorbers
- The two tested tertiary HALS have similar performance
- Amino ether HALS 2 outperforms Amino ether HALS 1.

6 mil o-LLDPE monolayer film: 4000 ppm active loading

— Failure point: 50% retained elongation

Ingenia has developed two HALS packages

- **IP1368**

Optimized mid-range performance combination of GH film stabilizers.

Recommended for Greenhouse film and other agriculture film with pesticides exposure.

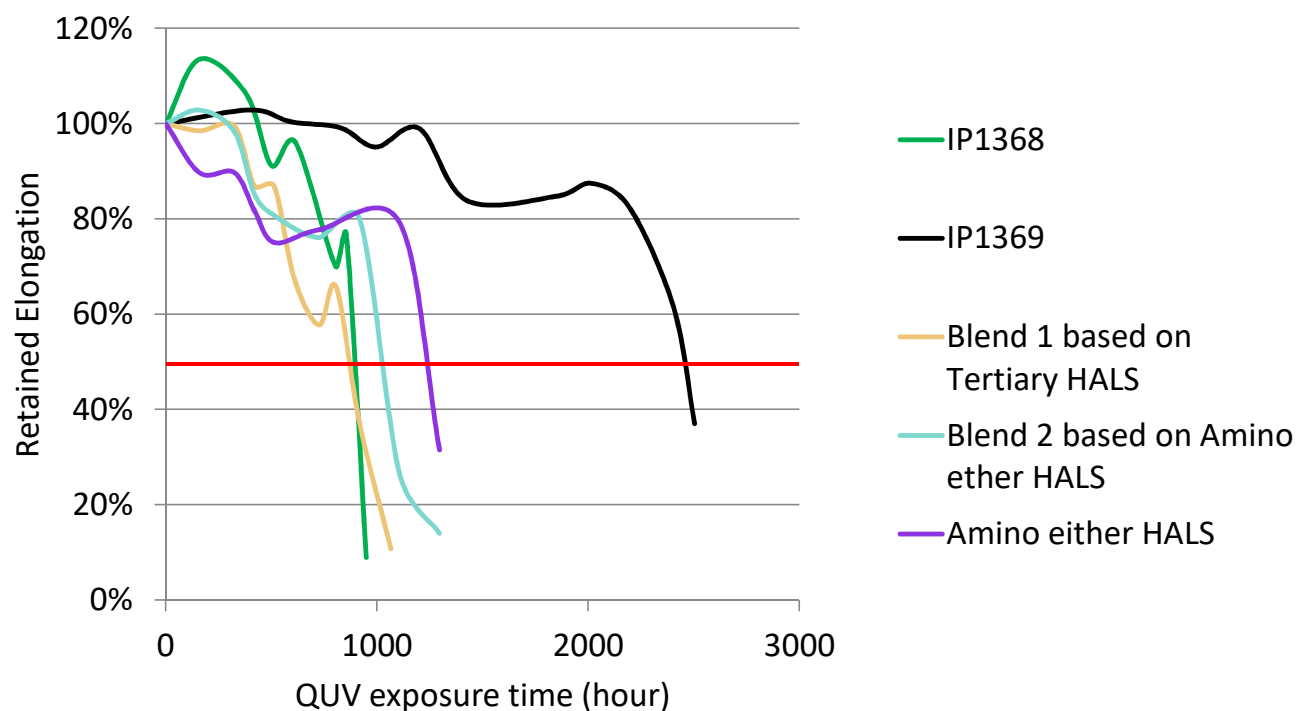
- **IP1369**

Optimized highest performance combination of GH film stabilizers.

Recommended for long service life (≥ 4 years) Greenhouse film with pesticides exposure

➤ *Both grades can be used in typical GH film structures where combinations of LDPE-EVA and LLDPE are used. Dosage levels will vary depending on film thickness, structure and desired service life.*

Performance of Ingenia Formulations

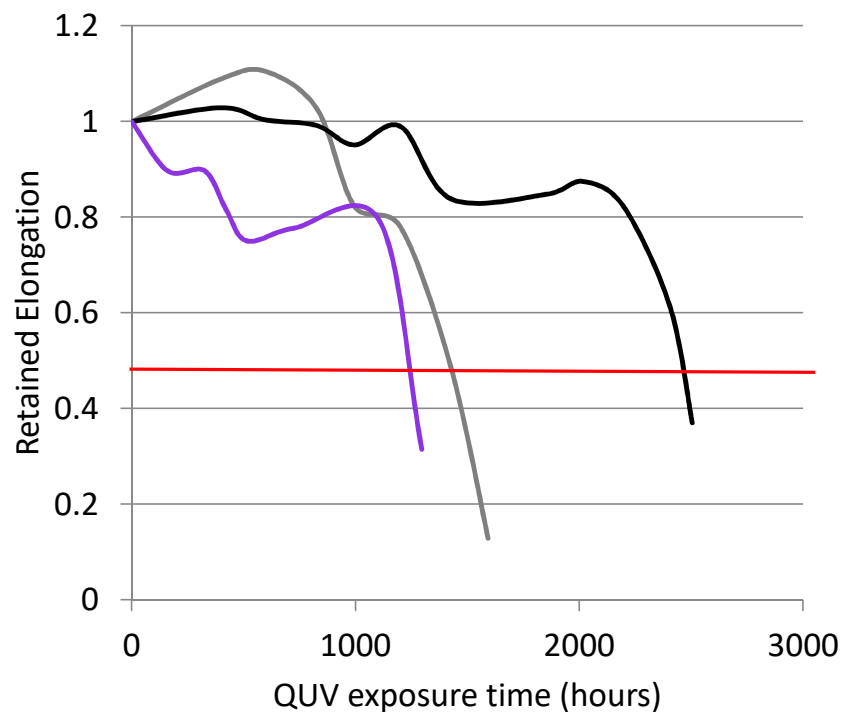


- Ingenia IP1368 is comparable to the performance of HALS packages in the market.
- Ingenia IP1369 outperforms the HALS packages in the market

6 mil o-LLDPE monolayer film: 4000 ppm active loading

— Failure point: 50% retained elongation

Performance of Ingenia Formulations

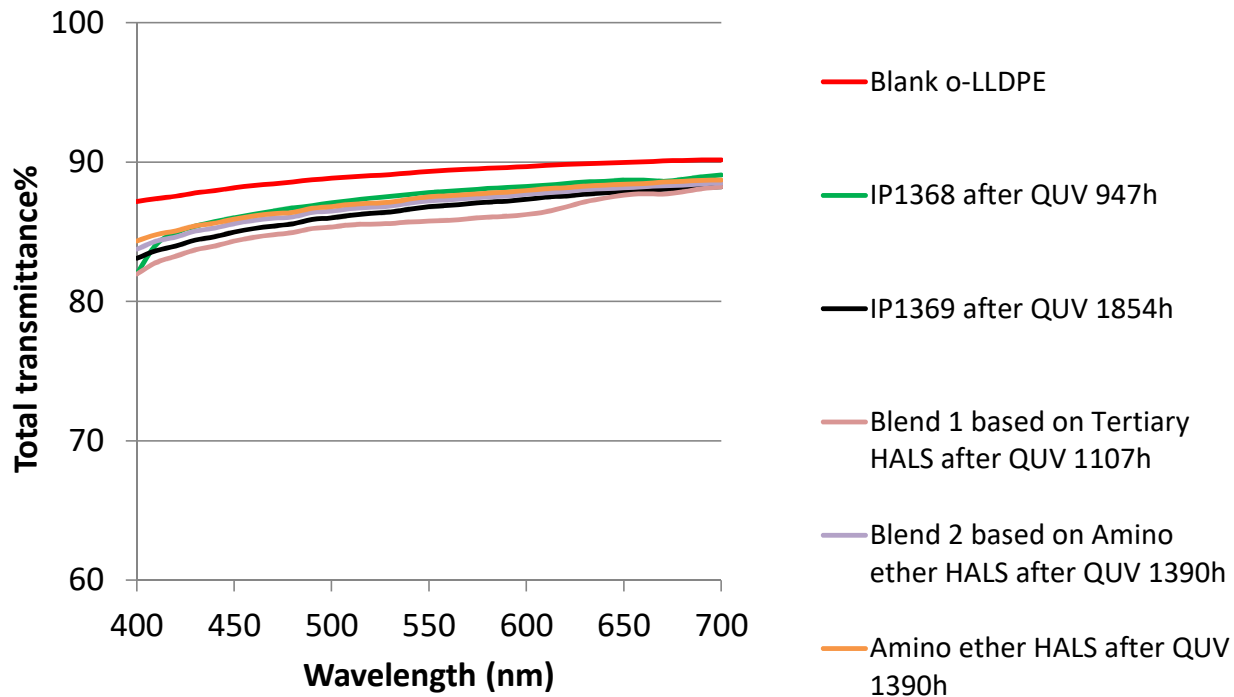


— 2000ppm active loading of IP1369
— 4000ppm active loading of IP1369
— 4000ppm HALS-NO 2

□ 2000 ppm active loading of IP1369 outperforms 4000 ppm Amino ether HALS in chemical-treated film

6 mil o-LLDPE monolayer film: 4000 ppm active loading
— Failure point: 50% retained elongation

Performance of Ingenia Formulations



- UV-B exposure decreases transmittance
- Ingenia grades maintain total transmittance comparable to other grades over lifetime

6 mil o-LLDPE monolayer film: 4000 ppm active loading

Summary

- By thoroughly comparing the performance of different types of HALS and synergistic additives, Ingenia has developed two HALS packages for greenhouse film application: mid-range **IP1368** and the highest performance **IP1369**.
- Both packages show excellent performance with chemical exposure.
- Evaluation efforts continue. Ingenia HALS packages are undergoing accelerated testing under xenon arc to develop additional performance data.



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Thank You!

Questions?

