Novel plant-based dialkyl hydroxylamine antioxidant

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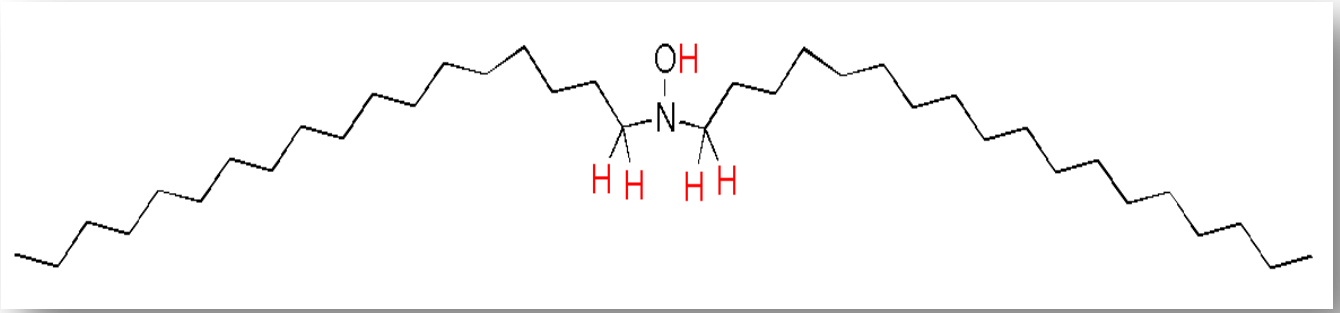
Dr. Chingfan Chris Chiu
President, Chitec Technology Co., Ltd.

Dialkyl Hydroxylamine Antioxidants (AOs)

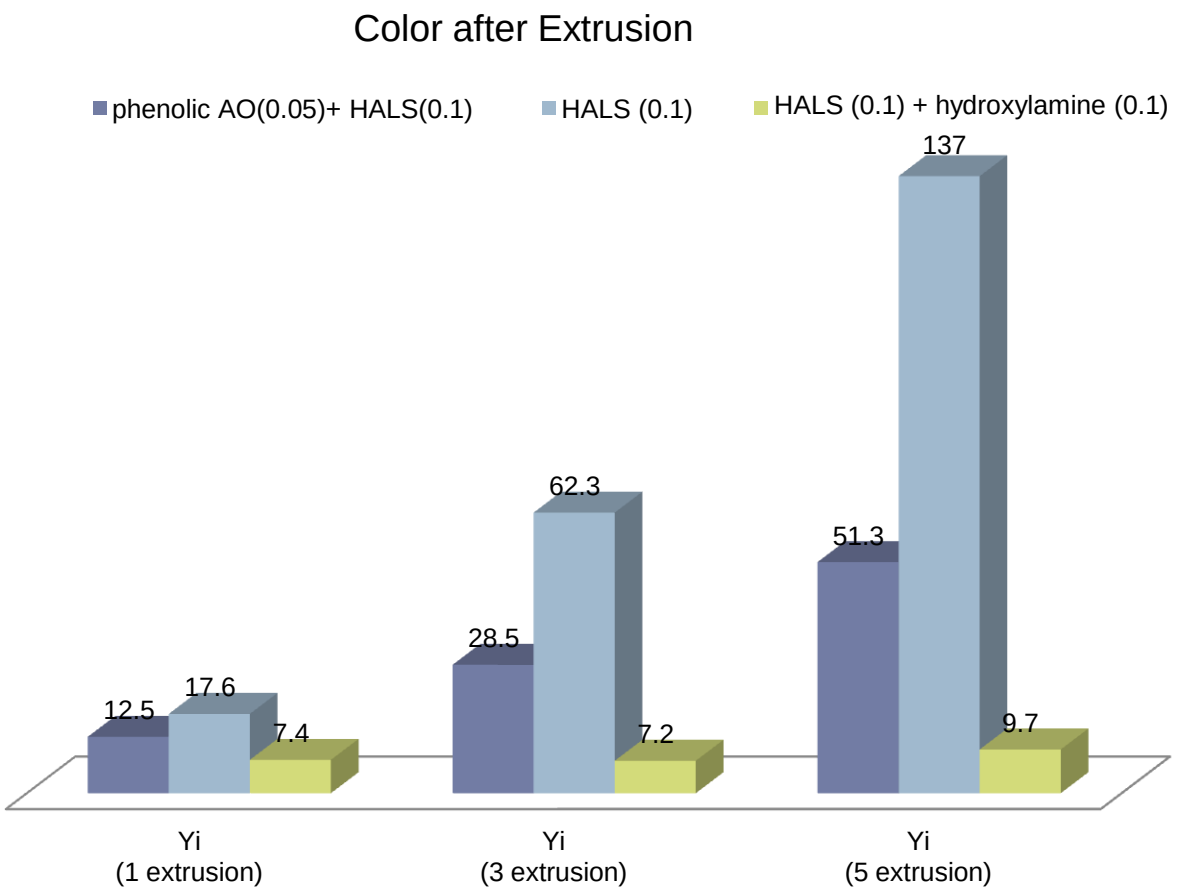
- Belongs to the amine-based AO family.
- Discoloration-free and gas fading-free after service.
- An excellent stabilizer for melt strength of polyolefins.
- Melt strength and color are the two most critical criteria for film and fiber applications.



A hawk-like amine

The most effective primary AO to combat gas fading

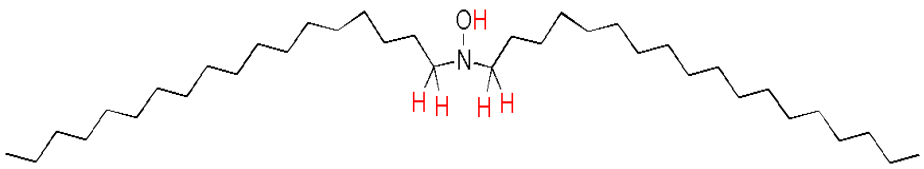
- The phenol-free structure ensures there are no color-shifting byproducts after oxidation.



US patent 4,876,300

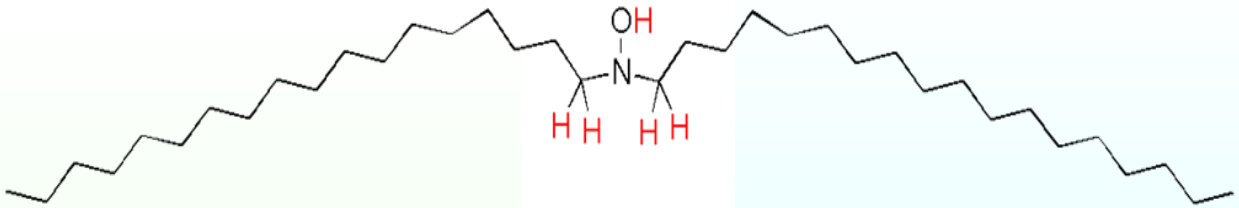
Reason for developing a plant-derived hydroxylamine AO

- First generation hydroxylamine is a derivative of tallow amine, as described by its chemical name.
- The word “tallow” has raised concern among customers especially for vegetarians, some religious groups, and those concerned about mad-cow disease.
- A hydroxylamine AO of non-animal origin has been long expected by the market.



Chemical name:
Amines, bis(hydrogenated tallow alkyl), oxidized

Plant origin



Chemical name

Amines, bis(hydrogenated palm-oil alkyl) hydroxy

CAS RN. 1374859-51-4

vs.

Animal origin

Chemical name

Amines, bis(hydrogenated tallow alkyl), oxidized

CAS RN. 143925-92-2

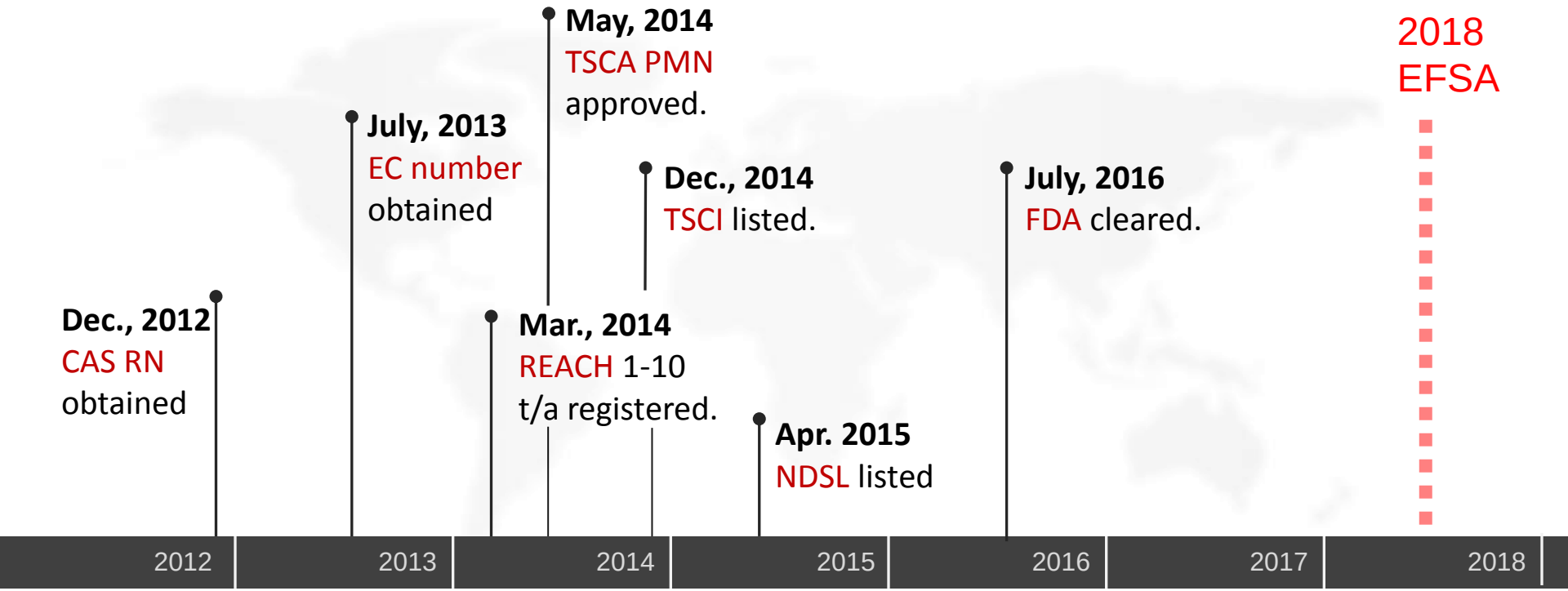
- A new global registration is required for the palm-oil based hydroxylamine.

Comparison of the composition

Both AOs contain 8 major constituents, but in slight different ratio due to the different feedstocks and processes:

No.	Constituents	Tallow-based hydroxylamine	Palm oil-based hydroxylamine
1	Hydroxylamines	67.1-67.4%	72-74%
2	Nitrones	5.1-5.6%	13-15%
3	Amines	13.9-14.4%	2-4%

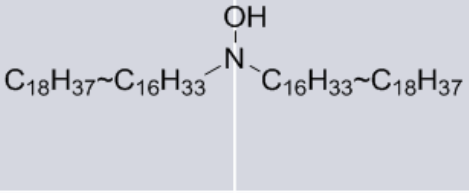
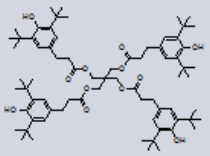
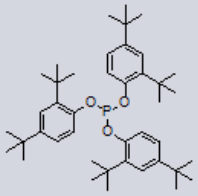
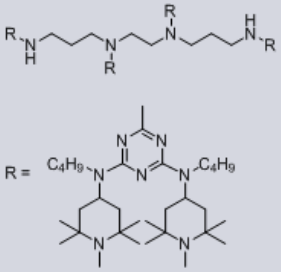
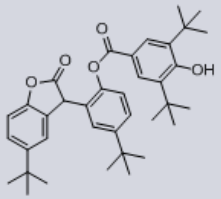
Our regulatory achievements



Performance data

Latest application experiments on PP

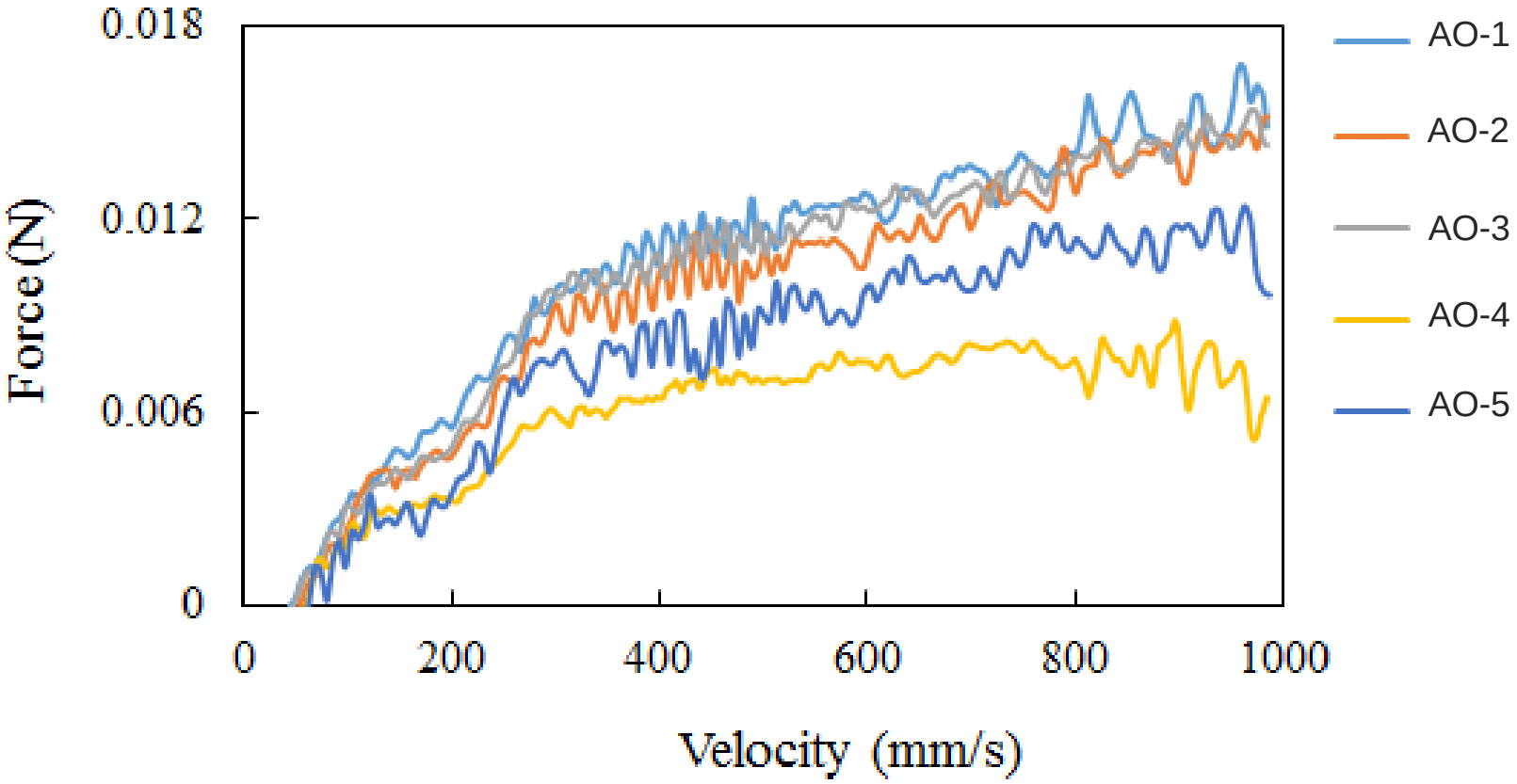
- PP : virgin (MI = 16.47) available from Formosa Plastics
- AO dosage: 1,000 ppm
- AO formulations:

	Palm-based hydroxylamine	Tallow-based hydroxylamine	1010	168	HALS-1	Lactone
						
AO-1	1			2		
AO-2		1		2		
AO-3			1	2		
AO-4				2	1	
AO-5			1	2		0.2

Note: Lactone is another patented antioxidant from Chitec. Two FDA FCNs were obtained.

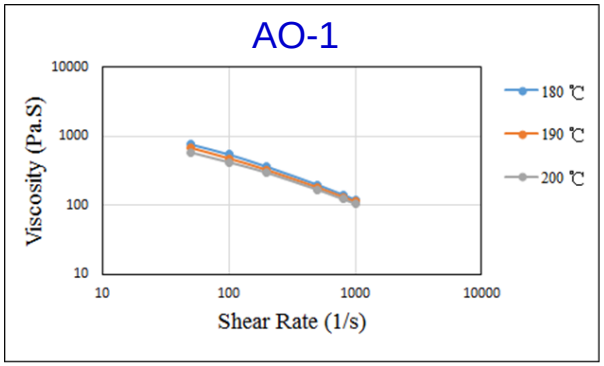
Analysis of melt strength (elongational flow behavior)

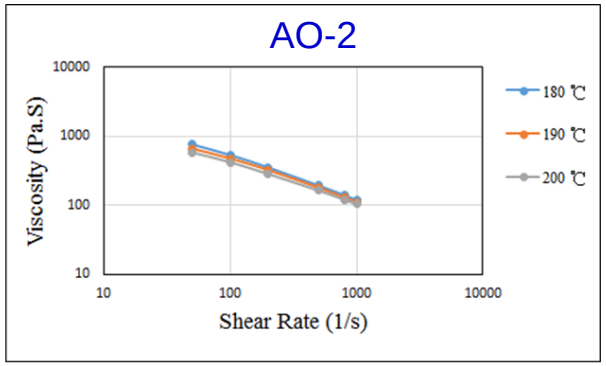
- Test equipment: Elongational rheometer for polymer melts
- Model: Rheotens 71.91 from Goettfert
- Temp.: 180 ˚C

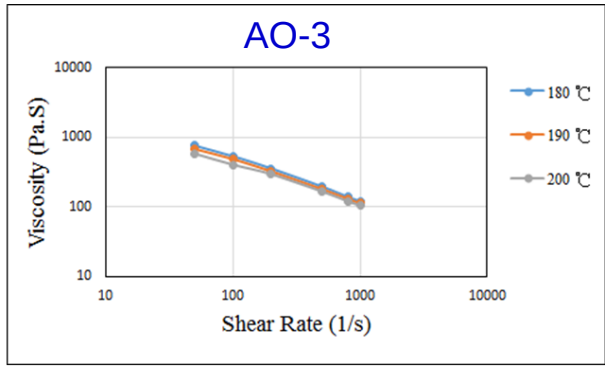


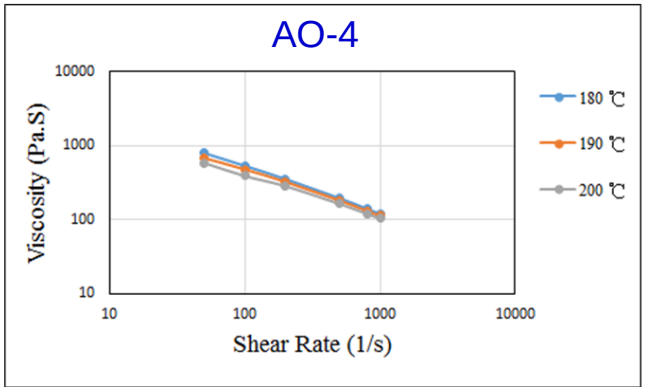
Shear rate vs. viscosity

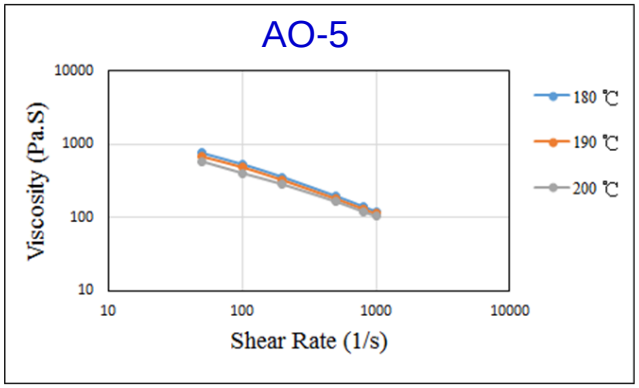
- Test equipment: High pressure capillary rheometer.
- Model: Rheograph 2003 from Goettfert
- Temp.: 180 ˚C, 190 ˚C and 200 ˚C





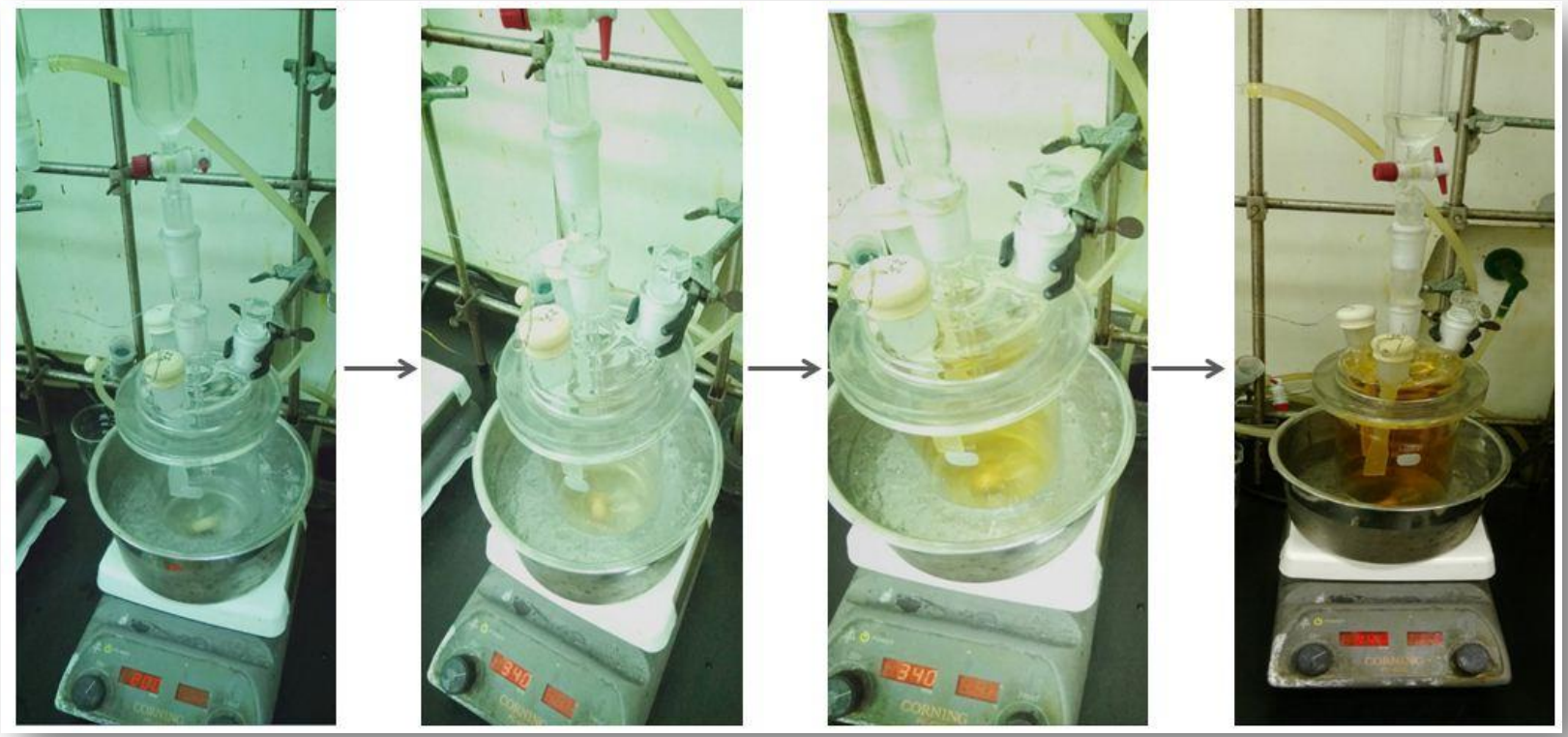






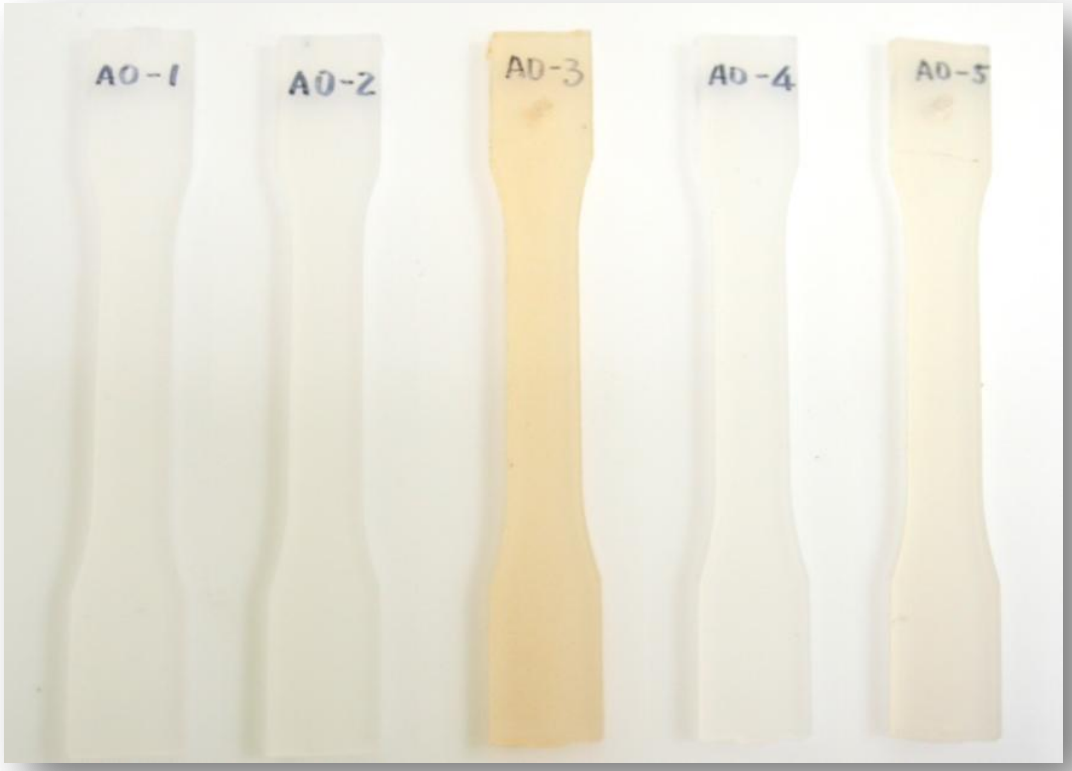
Gas-fading experiment

- These five specimen were placed in a gas-fading in which nitrogen oxides were generated by sodium nitrate reacting with sulfuric acid.



Gas-fading result

- Only the specimen containing AO-3 showed severe yellowing in contrast to the other four AO packages.
- This result is predictable as hindered phenolic AO is known to turn yellow on exposure to nitrogen oxide.
- Specimens containing AO-1 and AO-2 again are shown to be resistant to gas-fading without any visual differences.



Summary

1. A new palm oil-based dialkyl hydroxylamine AO is commercially available which is slightly different from the tallow-based predecessor in terms of composition.

2. The difference in composition between them does not affect AO efficiency in protecting melt-strength of polypropylene in combination with a secondary phosphite AO, as demonstrated by the rheometer.

3. Both palm oil-based and tallow-based dialkyl hydroxylamine AOs are highly resistant to gas fading in contrast to hindered phenolic AOs.