AMI: Polyethylene Films 2019

DEVELOPMENT OF HIGH LOADING ANTI-FOG MASTERBATCH WITH IMPROVED ANTI-FOG PERFORMANCE

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Fogging

- Fogging on polymer films and packaging is due to the condensation of water droplets on the film.
- Fogging occurs when the dew point is reached in an enclosed space or at the film interface.
- The difference in surface tension between polymer film surface and water causes the water to form droplets on the film surface, which refracts light.



Fogging



- Droplets of water on the film surface can lead to diffraction of light and reflection.
- Loss of transparency, the contents in the package cannot be seen clearly.
- The package and contents are perceived to have low quality.



Anti-fog Additives

- Work similar to Anti-stats
 - > They are incorporated into the polymer and migrate to the surface of the film
 - They have a hydrophilic moiety which reduces the surface tension difference and spreads the condensed water droplets into a continuous film of water, which does appear clear.
 - >They are consumed over time.



- Film structure and composition will affect the performance of anti-fogs
- Very efficient anti-fogs are required for thin film and metallocene-LLDPE film



Assessment of Anti-fog Performance

Cold Fog Test – 7 days



• Hot Fog Test – 3 hours





Rating of Anti-fog test*:

- 1: Completely opaque film
- 8: Presence of four droplets
- 9: Presence of two droplets
- 10: Completely clear film
- All other intermediate rating are subjective

Good anti-fog performance must have a rating of 8 or higher than 8.

* ICI's cold fog test

Application Requirements of Anti-Fogging Additives

- Must have good compatibility with resin, with controlled migration to the surface of the film.
- Minimum adverse effect on critical film properties, such as clarity, cling, strength, sealability, printability etc.
- In food contact applications, the additive must meet all the relevant regulatory requirements including SML.



Ingenia has developed two new Anti-fog grades

• ITZ-291

20% additive loading in PE;

Food contact approval in US, EU and China (no SML);

Cost efficient grade with good cold and hot fog performance;

Recommended letdown ratio: 2.5% to 5%.

• ITZ-292

20% additive loading in PE;

Food contact approval in EU and US (SML: 0.14mg/in²);

Premium grade with excellent hot fog performance and improved cold fog performance at low loadings; Recommended letdown ratio: 1% to 5%.

Both grades can be applied in LDPE, LLDPE and thin metallocene-LLDPE film. Dosage levels will vary in the above specified ranges depending on film thickness, structure and desired effect.

Selection of ITZ-291 or ITZ-292 depends on specific application, film formulation and structure



Performance of ITZ-291

• ITZ-291 in 2 mil LDPE film

Cold fog results

Sampla		Ν	linute	S			Но	urs	-	Days				
Sample	1	5	10	20	30	1h	2h	3h	6h	1	2	3	7	
LDPE control film	10	4	4	3	3	3	3	3	3	3	3	3	3	
2.5% ITZ-291	10	10	10	10	10	9.5	9.5	10	10	10	10	10	10	





LDPE control film

2.5% ITZ-291

Hot fog results

Sample	Seconds		Minutes									Hours								
	30	1	2	3	5	8	10	20	30	45	1	1.25	1.5	1.75	2	2.5	3			
LDPE control film	6	6	5	5	5	4	4	4	4	1	1	1	1	1	1	1	1			
2.5% ITZ-291	10	10	10	9.5	9.5	9	9	9	9	9.5	9.5	9.5	10	10	10	10	9.5			





2.5% ITZ-291



Performance of ITZ-291

- ITZ-291 in 0.6 mil metallocene-LLDPE (m-LLDPE) film
 - Cold fog results

Comple	Minutes						Но	urs		Days				
Sample	1	5	10	20	30	1h	2h	3h	6h	1	2	3	7	
m-LLDPE control film	8	7	6	6	6	6	6	6	6	5	5	5	5	
2.5% ITZ-291	10	10	10	10	10	10	9.5	8	9	9.5	9.5	10	9.5	





m-LLDPE control film

2.5% ITZ-291

Hot fog results

Sample	Seconds		Minutes									Hours								
Campio	30	1	2	3	5	8	10	20	30	45	1	1.25	1.5	1.75	2	2.5	3			
m-LLDPE control film	5	5	5	3	3	3	3	1	1	1	1	1	1	1	1	1	1			
2.5% ITZ-291	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10			



m-LLDPE control film



2.5% ITZ-291

Performance of ITZ-292

ITZ-292 in 2 mil LDPE film



1% ITZ-292, Cold fog test after 7days



1% ITZ-292, Hot fog test after 3 hours

ITZ-292 in 0.6 mil metallocene-LLDPE film



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2.5% ITZ-292, Cold fog test after 7days



5% ITZ-292, Hot fog test after 3 hours

Films made with ITZ-292 maintain excellent anti-fogging performance through the entire test, including in metallocene-LLDPE film (all 10 rating).

Effect on Clarity

• Both ITZ-291 and ITZ-292 have minor effect on clarity of films.







Effect on Mechanical Properties

 Both ITZ-291 and ITZ-292 have limited adverse effect on tensile properties of films.





Effect on Cling



*Competitive AF: 20% antifog additive loading in PE





Anti-fog does affect the cling of the film, but it won't cause big issue for cling film in food packaging application.

Interaction with Slip and/or Anti-block

- Slip: Erucamide
- Anti-block: Diatomaceous Earth (DE)
- Film: 1mil metallocene-LLDPE (m-LLDPE)

Film Formulation	Dynamic COF					
	3h	24h				
m-LLDPE	1.642	1.562				
3%ITZ-291+5000ppm DE	0.234	0.236				
3%ITZ-291+5000ppm DE+1000ppm						
Erucamide	0.201	0.208				





3%ITZ-291+5000ppm DE; Cold fog 7days

3%ITZ-291+5000ppm DE+1000ppm Erucamide; Cold fog 7days

Anti-block has little adverse effect on anti-fog performance. Antiblock can be used in combination with ITZ-291 or ITZ-292 to achieve low COF as well as good antifog performance



Thermal Stability



For both ITZ-291 and ITZ-292, the weight loss below 200 °C is very limited and the rate is slow. The fastest of weight loss rate of ITZ-291 is at 303.44 °C, while the fastest weight loss rate of ITZ-292 is at 290.53 °C.



Summary

- Both ITZ-291 and ITZ-292 are highly efficient Anti-fog masterbatches for both hot fog and cold fog applications.
- Can be used in both blown film and cast film applications.
- Limited adverse effect on tensile properties, film clarity and cling.
- Both grades can be applied in LDPE, LLDPE and thin gauge metallocene-LLDPE films.



Meats wrapped in film made with Ingenia's anti-fog masterbatch



Thank You! Questions?

