

# AddWorks® Solutions for PE flexible packaging

Confidential

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05.10.2016

what is precious to you?

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# Polymer Additives Solutions and Branding **ADDWORKS®**



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## AddWorks® Solutions







- A unique combination of a differentiated chemical formulation offered in the most-convenient-to-handle physical form.
- Solutions developed by Clariant Polymer Additives to satisfy specific market needs.
- By leveraging on Clariant's products, expertise, know-how, production capabilities, AddWorks® remove complexity and cost at our customers.



# Solution nomenclature

## Commercial products – Product oriented solutions

### Products: AddWorks LXR

	2	Acid Scavengers
	3	UV/Light Stabilizers
	4	Surface Effects
	5	Antioxidants
	6	Polymerization Agents
	7	Process Stabilizers

# Solution nomenclature

## Commercial products – Segment oriented solutions

### Segments: AddWorks “ABC”



**PKG** Packaging



**ATR** Automotive and Transportation



**AGC** Agriculture



**ELC** Electrical & Electronics



**IBC** Industrial Building & Construction



**TFB** Textile & Fibers

# Film Extrusion Process

## **BENEFITS OF ADDWORKS<sup>®</sup>**

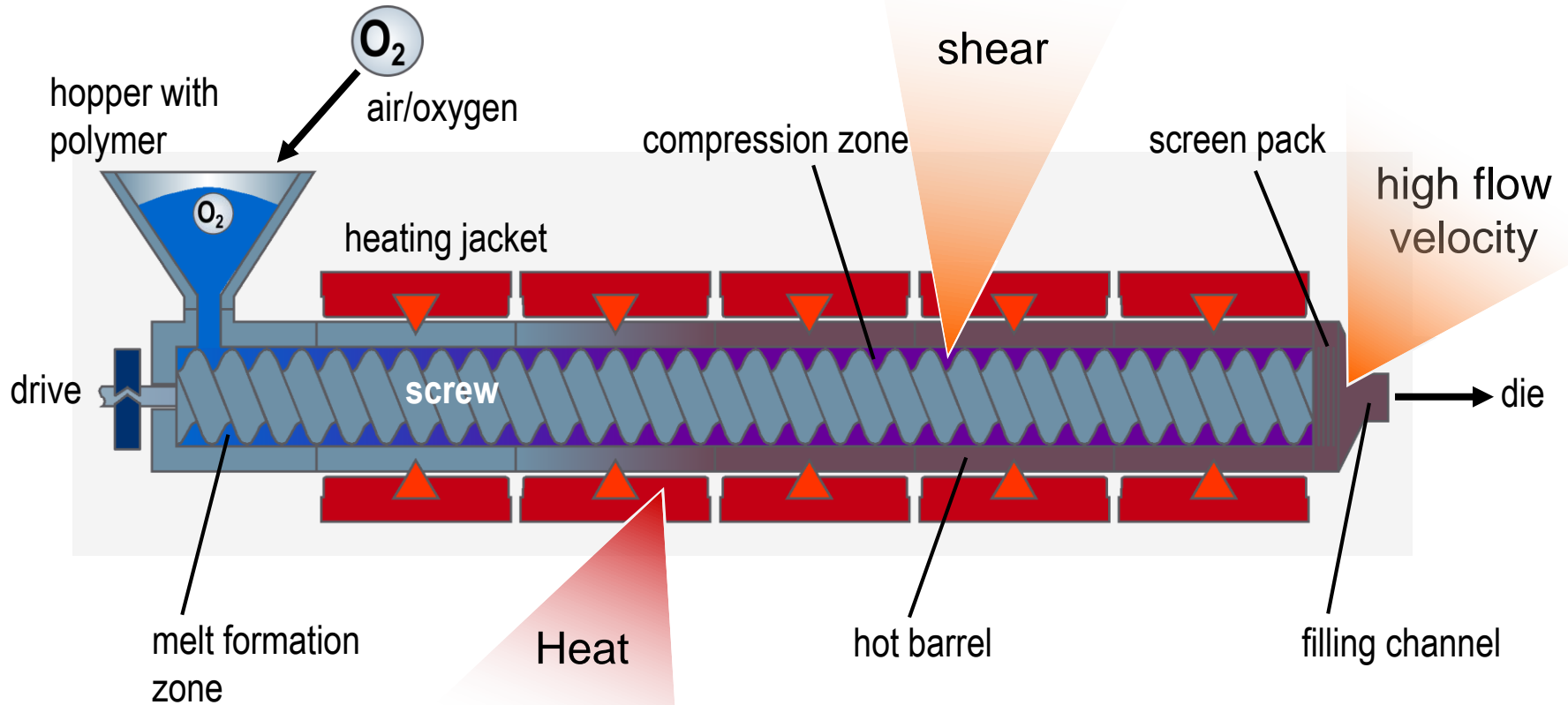
### **LXR<sup>®</sup>(ƏLİKSİR)**

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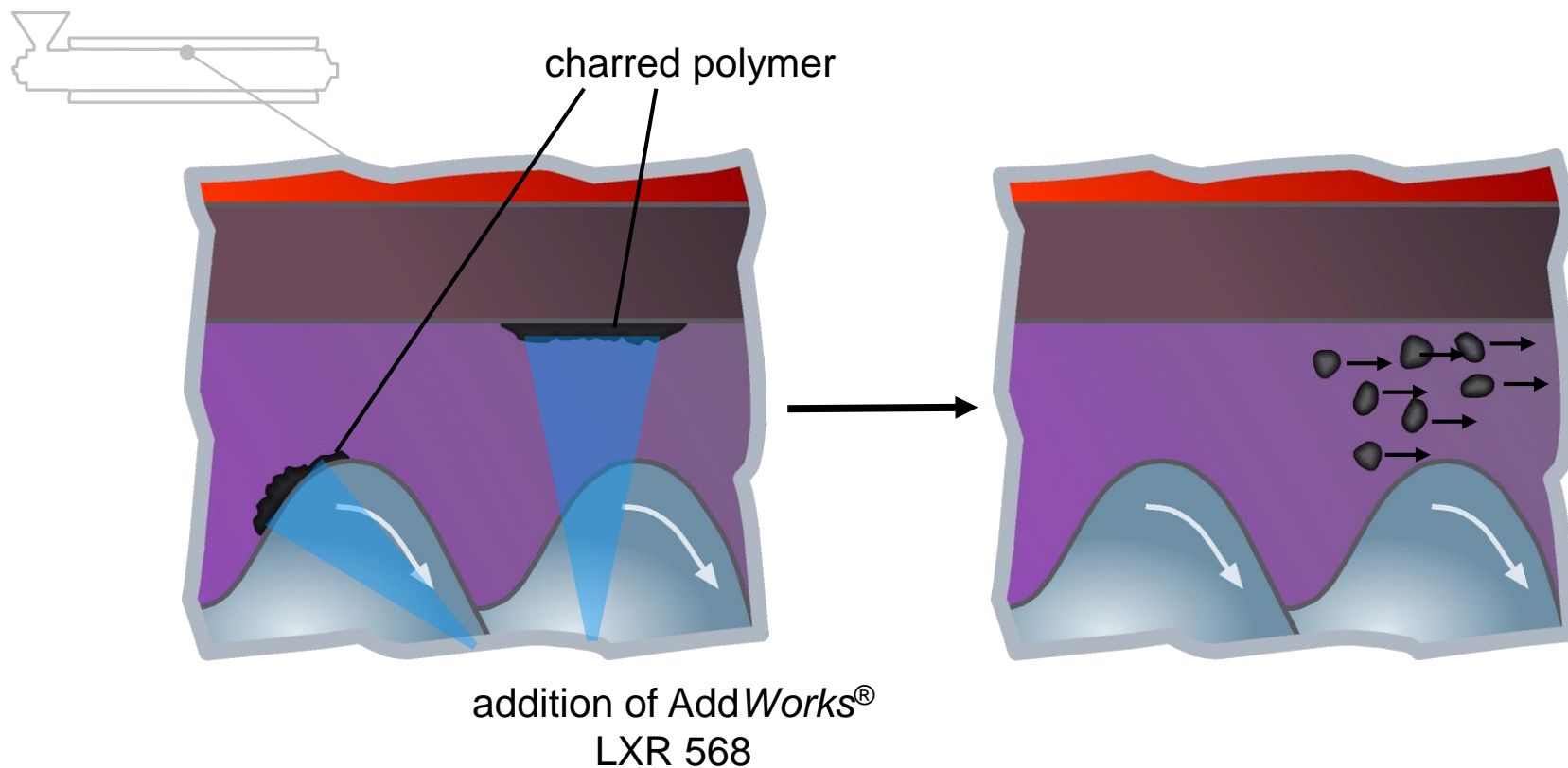
# Melt formation and extrusion



► Several critical zones for polymers in the extrusion process

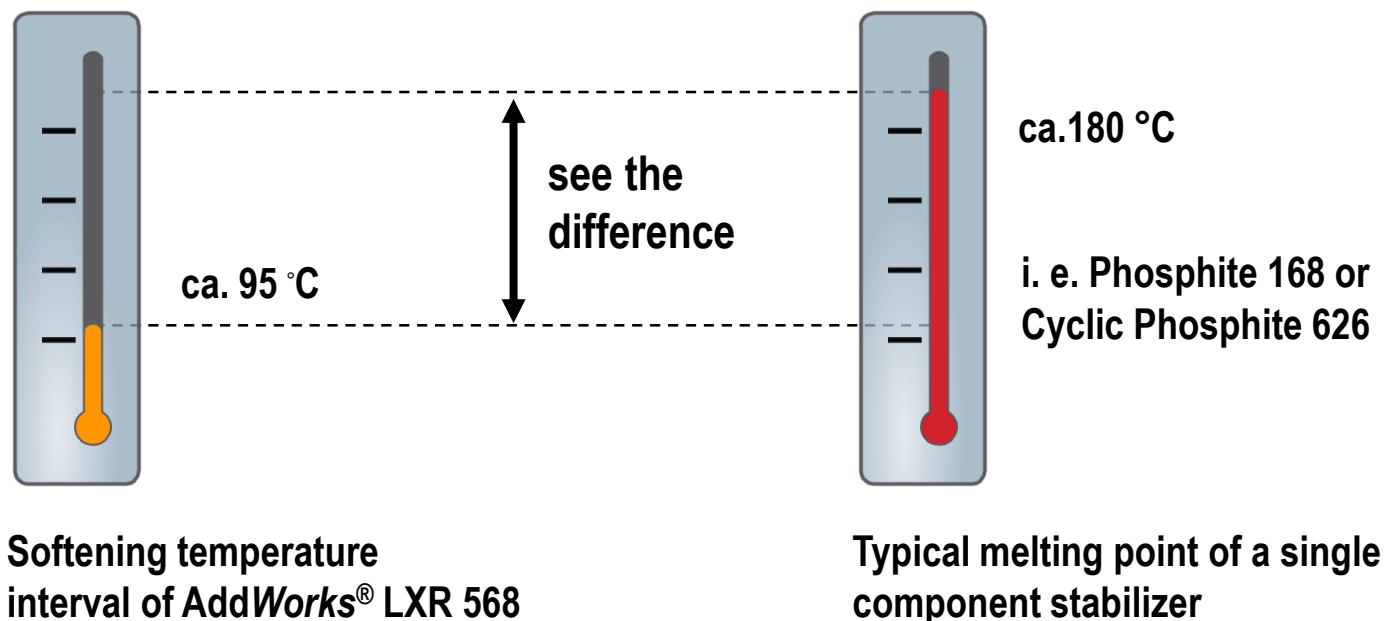


# Processing: Cleaning power of AddWorks® LXR 568



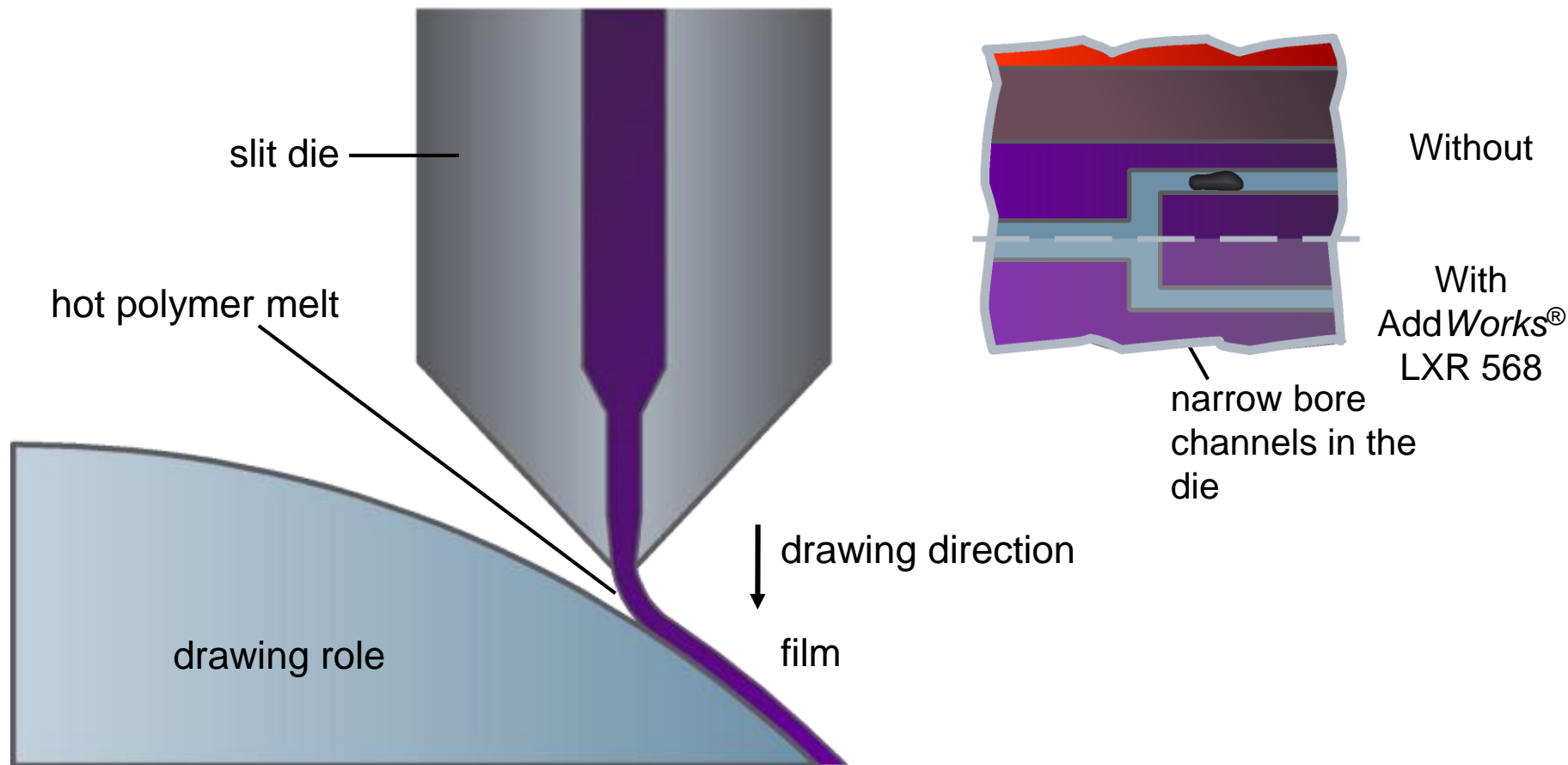
- ▶ By adding AddWorks® LXR 568 charred polymers can be removed
- ▶ AddWorks® LXR 568 is very effective for cleaning entire extrusion lines without disassembly

# Early melt protection by low melting temperature



- ▶ Compared with single compound stabilizers, AddWorks® LXR 568 has a very low softening and melting temperature range
- ▶ Early melt protection, superior melt homogeneity, low gels

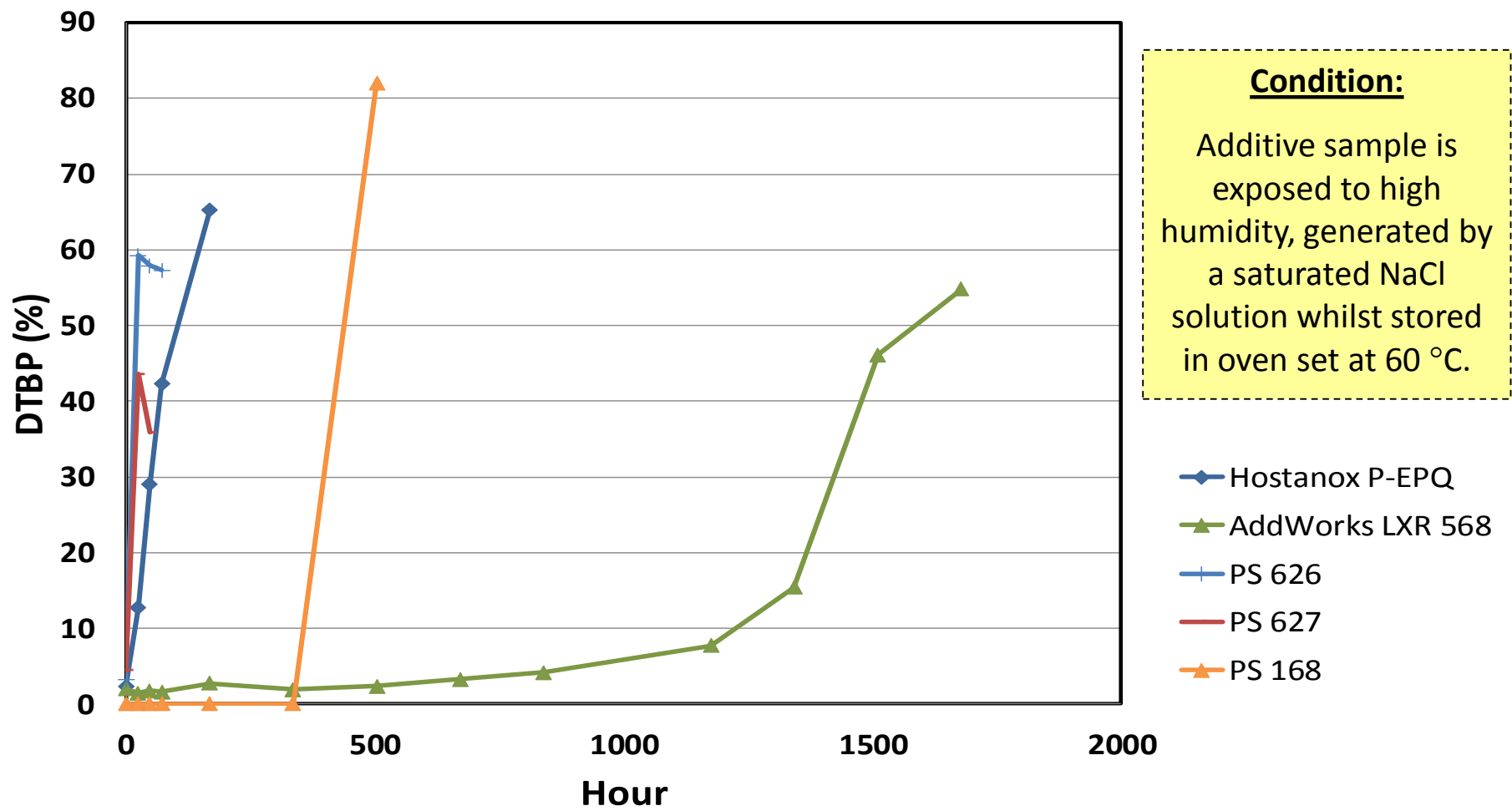
# AddWorks® LXR 568 and cast film extrusion



Challenges: Incrustation, lumps, specks and dirty slit die

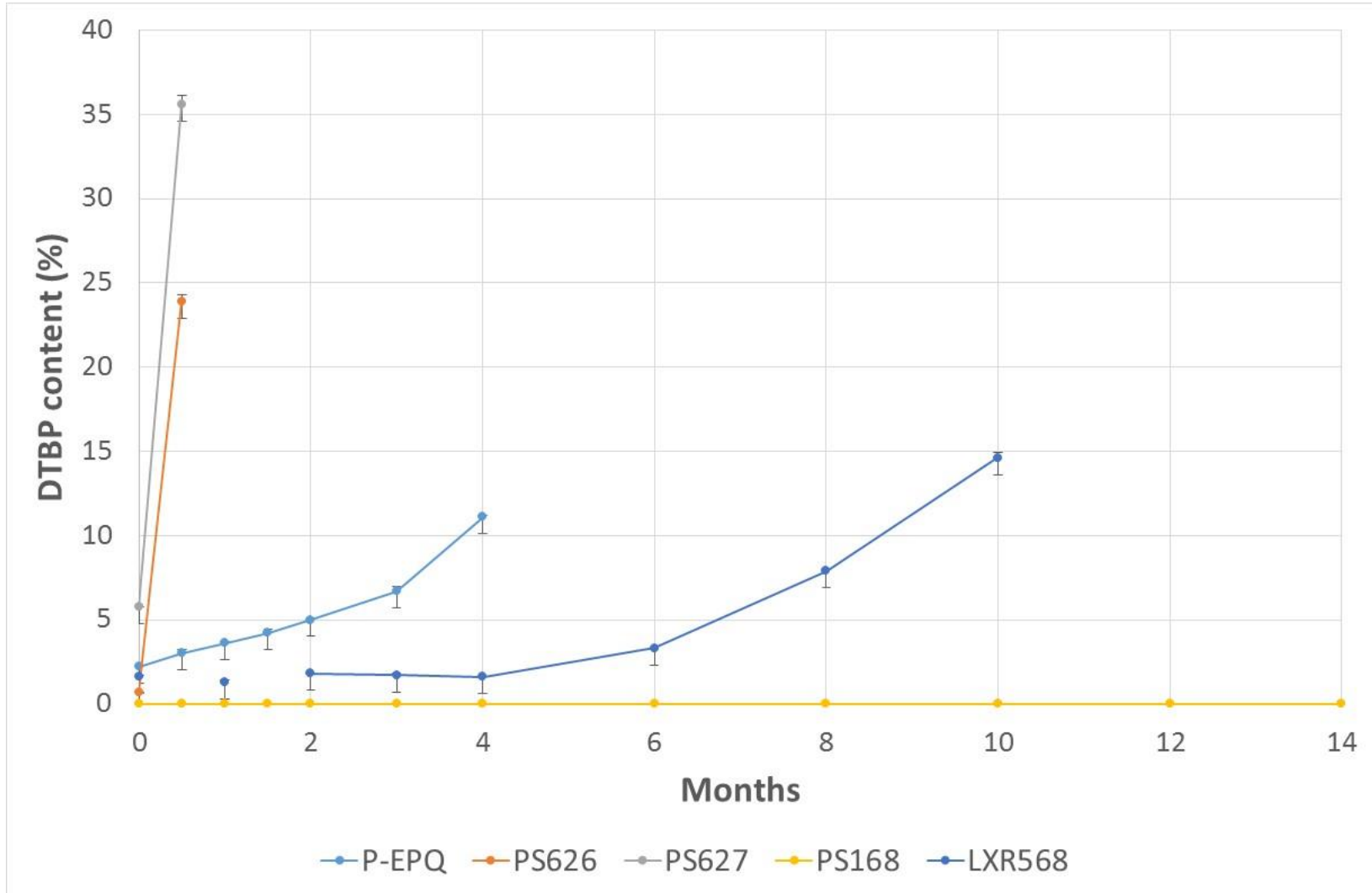
► AddWorks® LXR 568 gives a clean slit die and prevents casted film from surface defects

# Enhanced Hydrolytic stability – Easy to handle



▶ Significant improved hydrolytic stability versus Hostanox P-EPQ

# Hydrolysis Stability in Zip Bag



▶ Doubling of lifetime of LXR 568 versus P-EPQ in Zip Bag

Cost efficient solutions for  
LLDPE processing  
**BENEFITS OF ADDWORKS®**  
**LXR®(ƏLİKSİR)**

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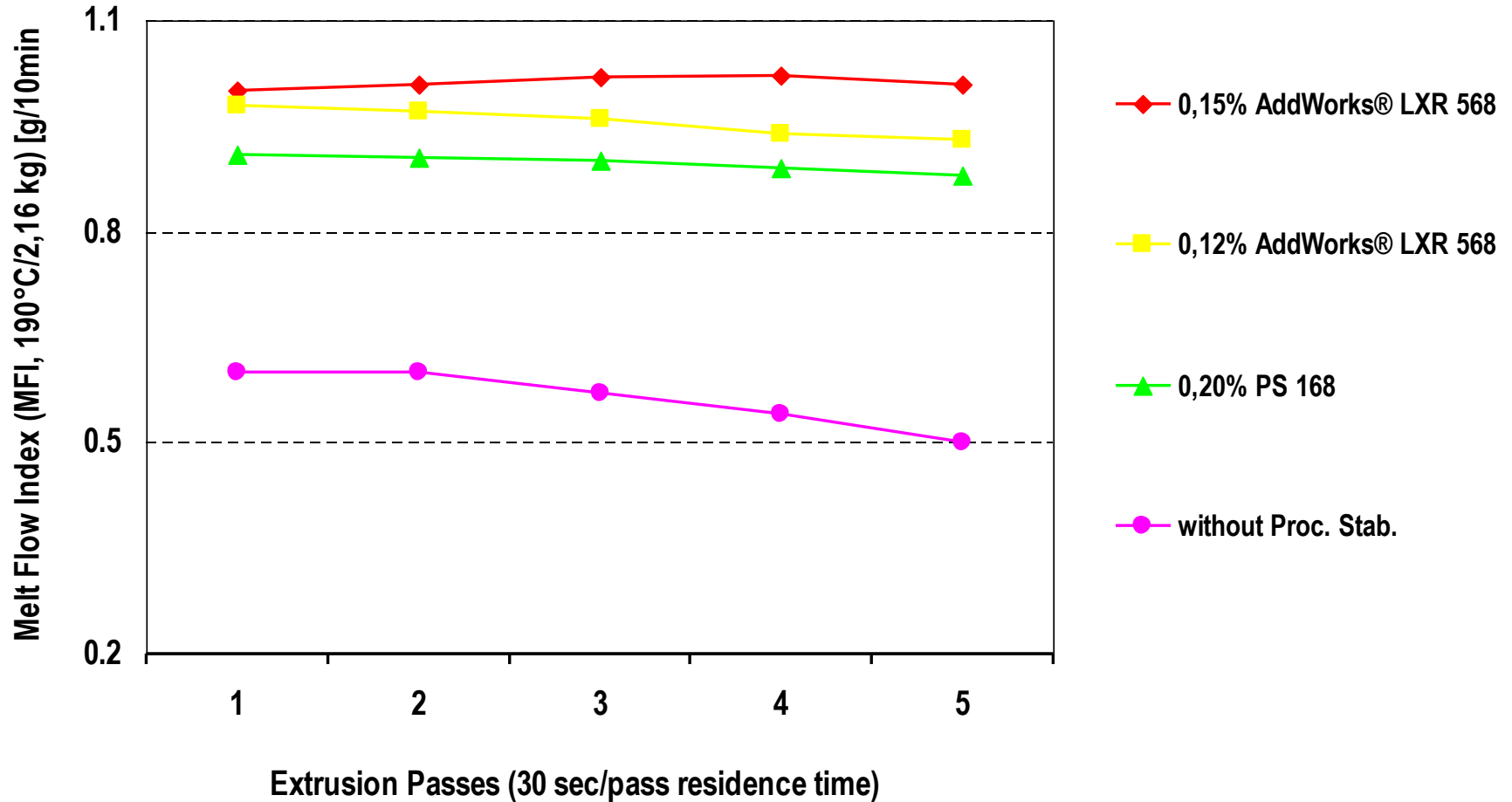
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# General requirements for film

- Melt and Colour Stability
- High Transparency
- Low Gels
- Even film thickness profile

# Processing of LLDPE (0,918 g/cm<sup>3</sup>) at 240°C

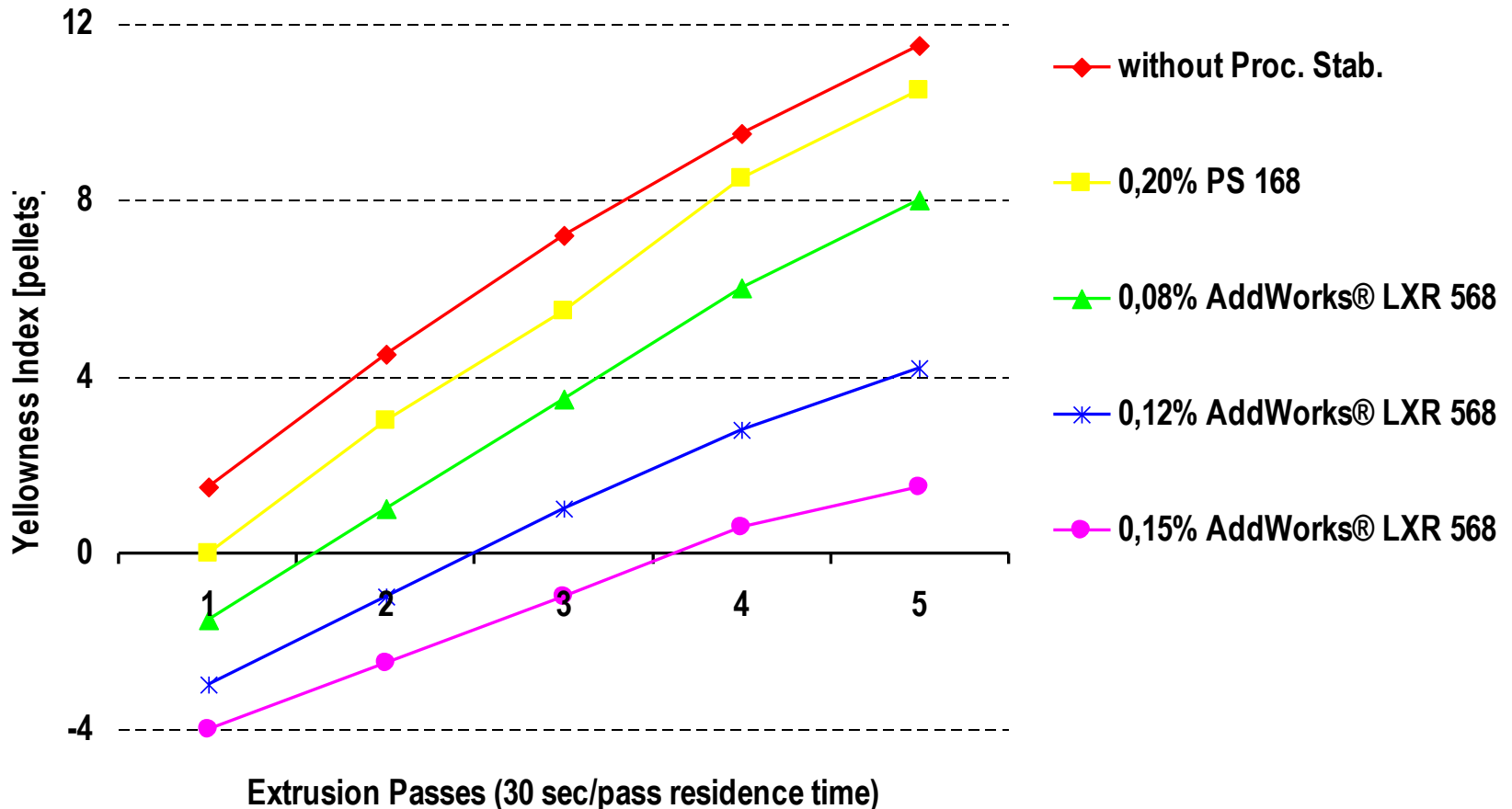


Base stabilization: 0,1% AO 1076 + 0,1% Ca-stearate

► Superior MFR retention of LLDPE stabilized with solutions based on AddWorks® LXR 568



# Processing of LLDPE (0,918g/cm<sup>3</sup>) at 240°C

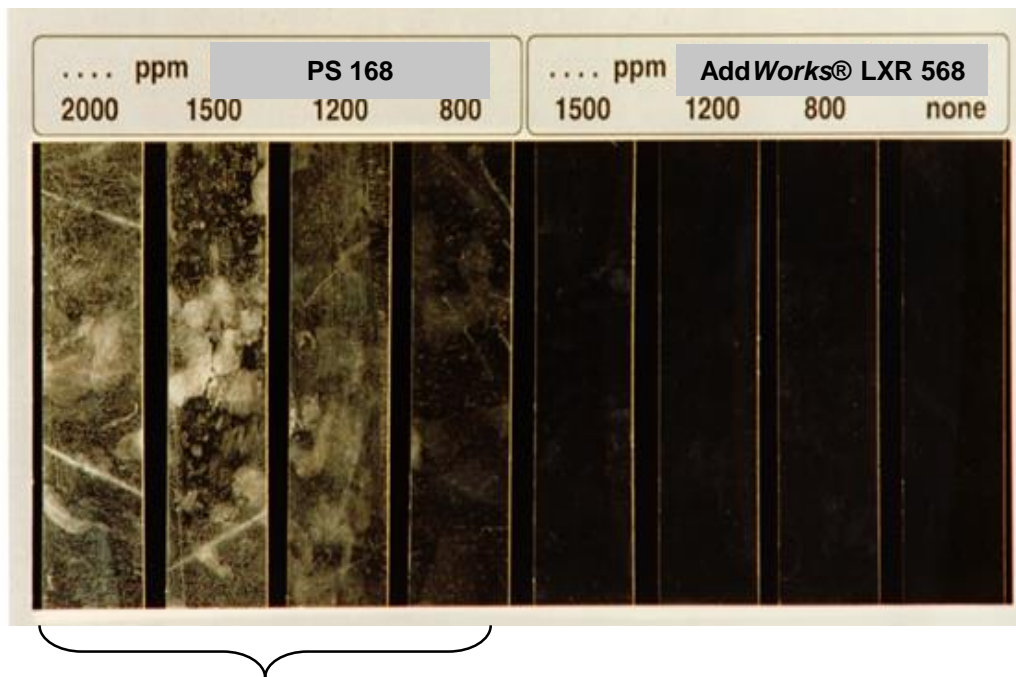


Base stabilization: 0,1% AO 1076 + 0,1% Ca-stearate

▶ Outstanding YI protection for LLDPE stabilized with solutions based on AddWorks® LXR 568

# Enhanced transparency of LLDPE film

LLDPE film samples (Density = 0.917 g/cm<sup>3</sup>)  
After 1 Year Storage at 23 °C (73 °F)



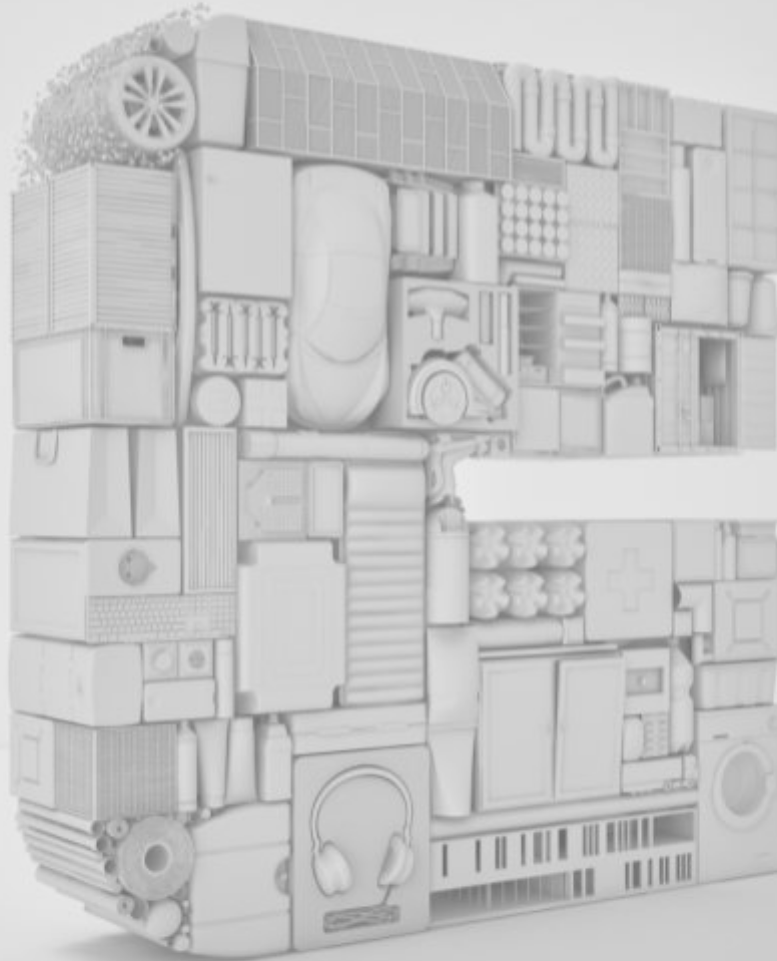
**Strong exudation / “blooming”**

Additive formulation: 200 ppm AO + Processing Stabilizer

- ▶ Excellent solubility of AddWorks® LXR 568 in LLDPE
- ▶ High transparency
- ▶ No blooming
- ▶ Nonyl-Phenol free solution

# AddWorks® PKG Solutions

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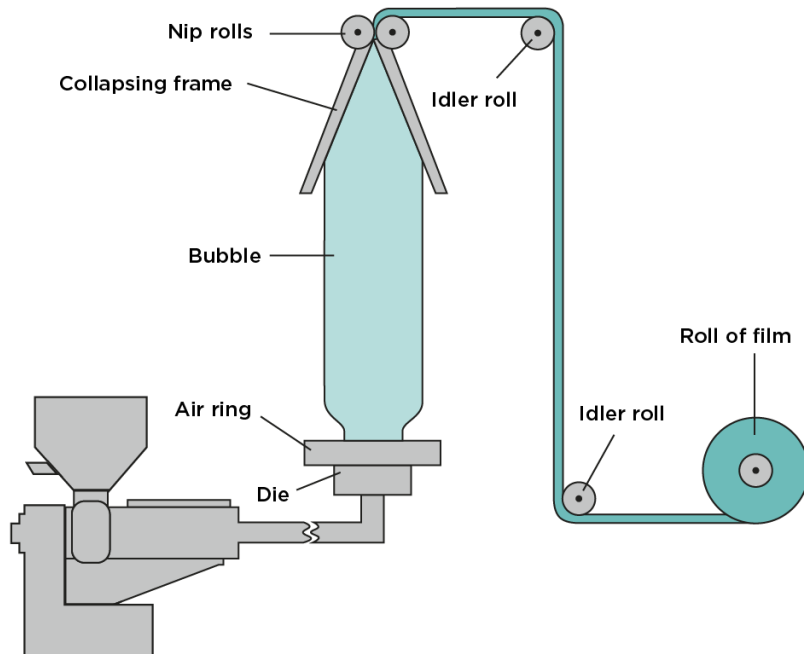
## for Gel Reduction in LLDPE

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# LLDPE blown film requirements

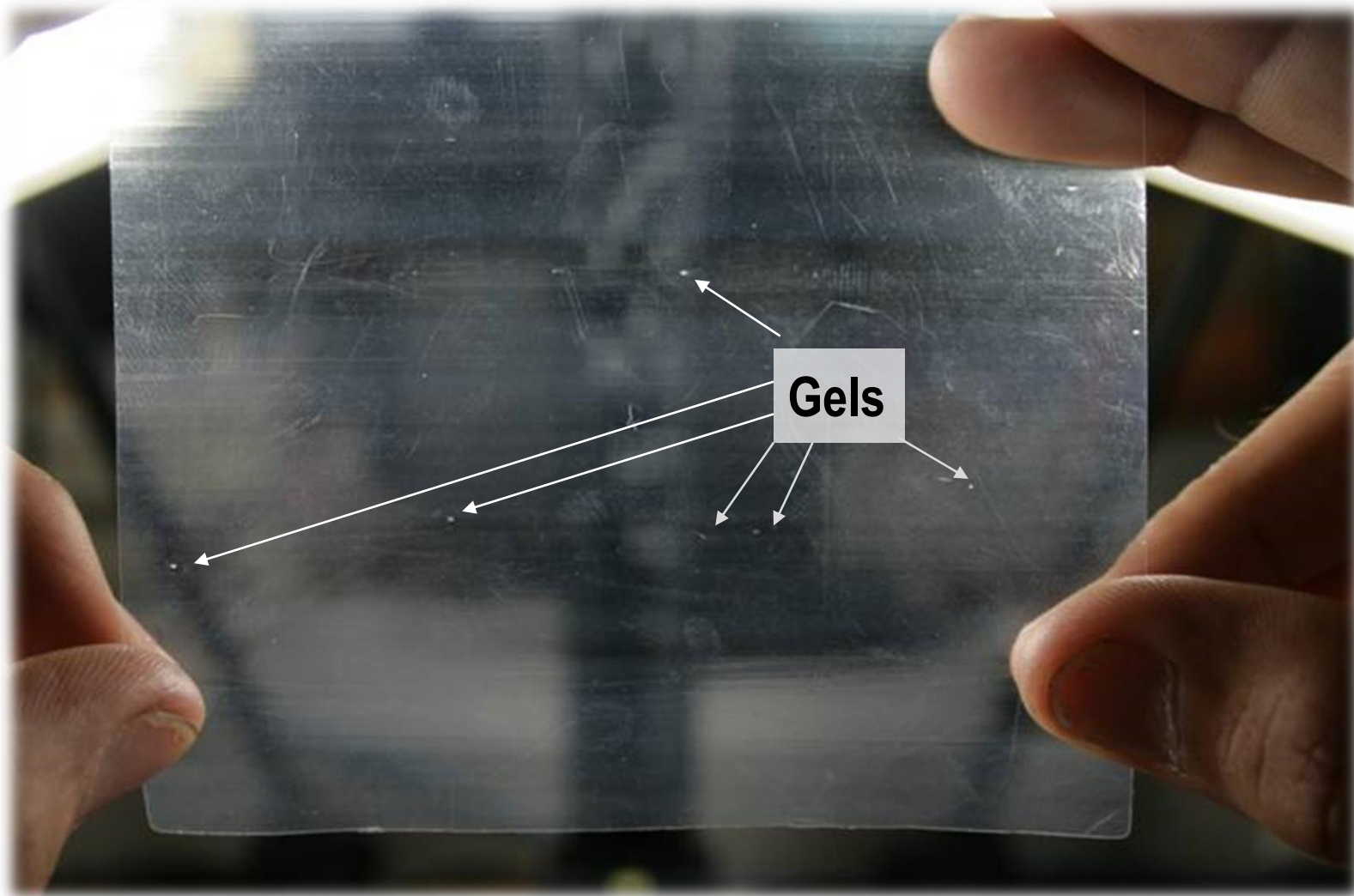
- Low gel formation
- Low Haze
- Smooth Processability
- Broad processing window
- Good bubble stability



Root causes of gels can be classified as below

- Fibers/Contamination from packaging
- Cross-contamination
- Unmelt/Unmixed
- Cross-linked polyethylene/Oxidized material  
 → Suitable additives package is able to solve gel formed by this cause.

# Example of gels in PE film



# Consequences of gels

## Visual

- Larger than 100 microns

## Disturb multilayer structure for thin film

- Food Packaging EVOH

## Affect Stretching

- Weak point in the film structure:
- Tearing, Splitting

## Disturb Coating Layers

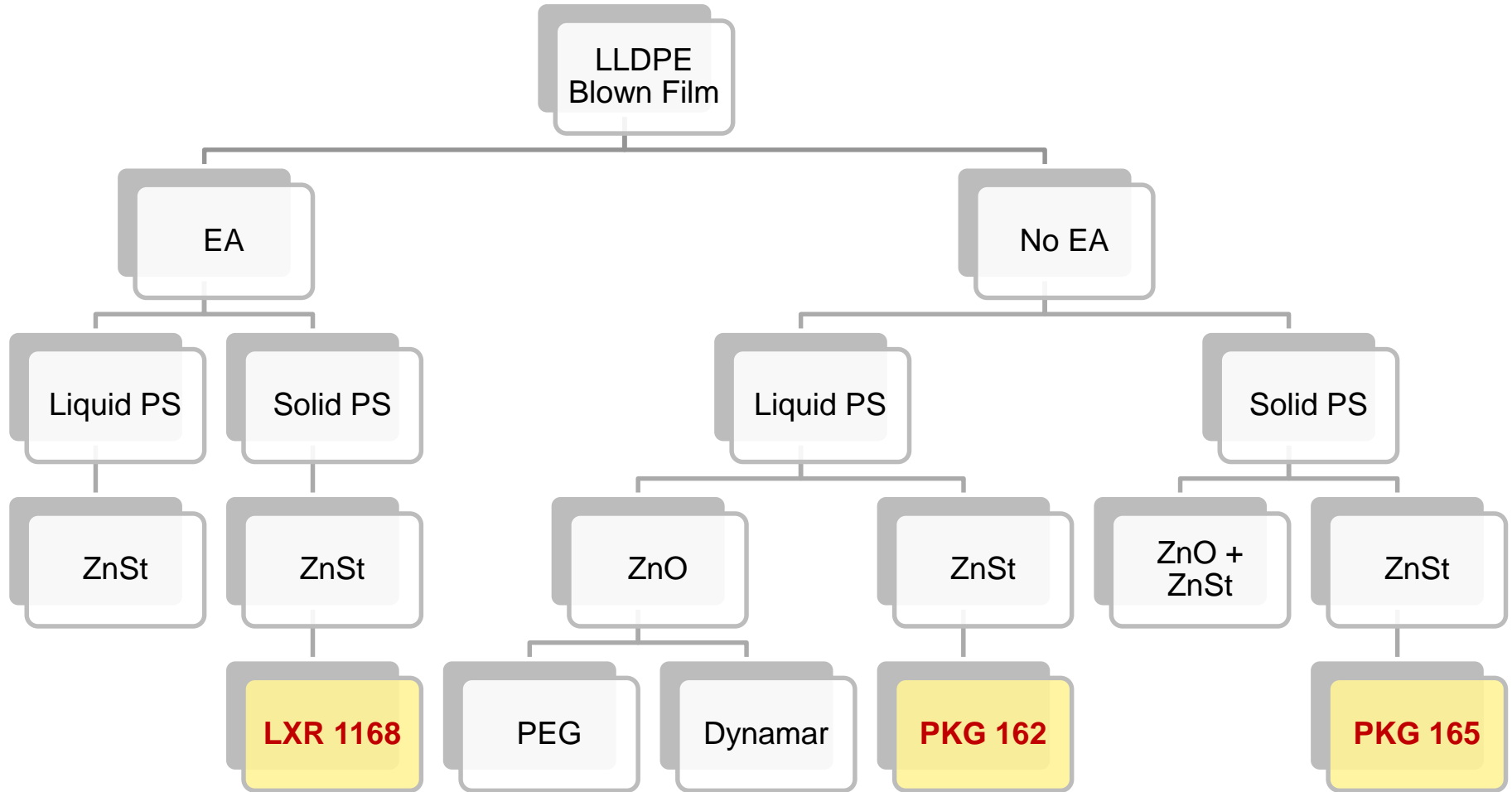
# Solutions LLDPE Blown Film Low Gel & Low Discoloration

LXR 1168	PKG 162	PKG 165
<ul style="list-style-type: none"><li>• No TNPP*</li><li>• EA**</li></ul>	<ul style="list-style-type: none"><li>• TNPP*</li><li>• No EA**</li></ul>	<ul style="list-style-type: none"><li>• No TNPP*</li><li>• No EA**</li></ul>

\*TNPP = Tris(nonylphenyl)phosphite

\*\*EA = Ethoxylated Alkylamine, typically Alkyl(C16-C18)bis(2-hydroxyethyl) amine

# Clustering of LLDPE formulations: Univation



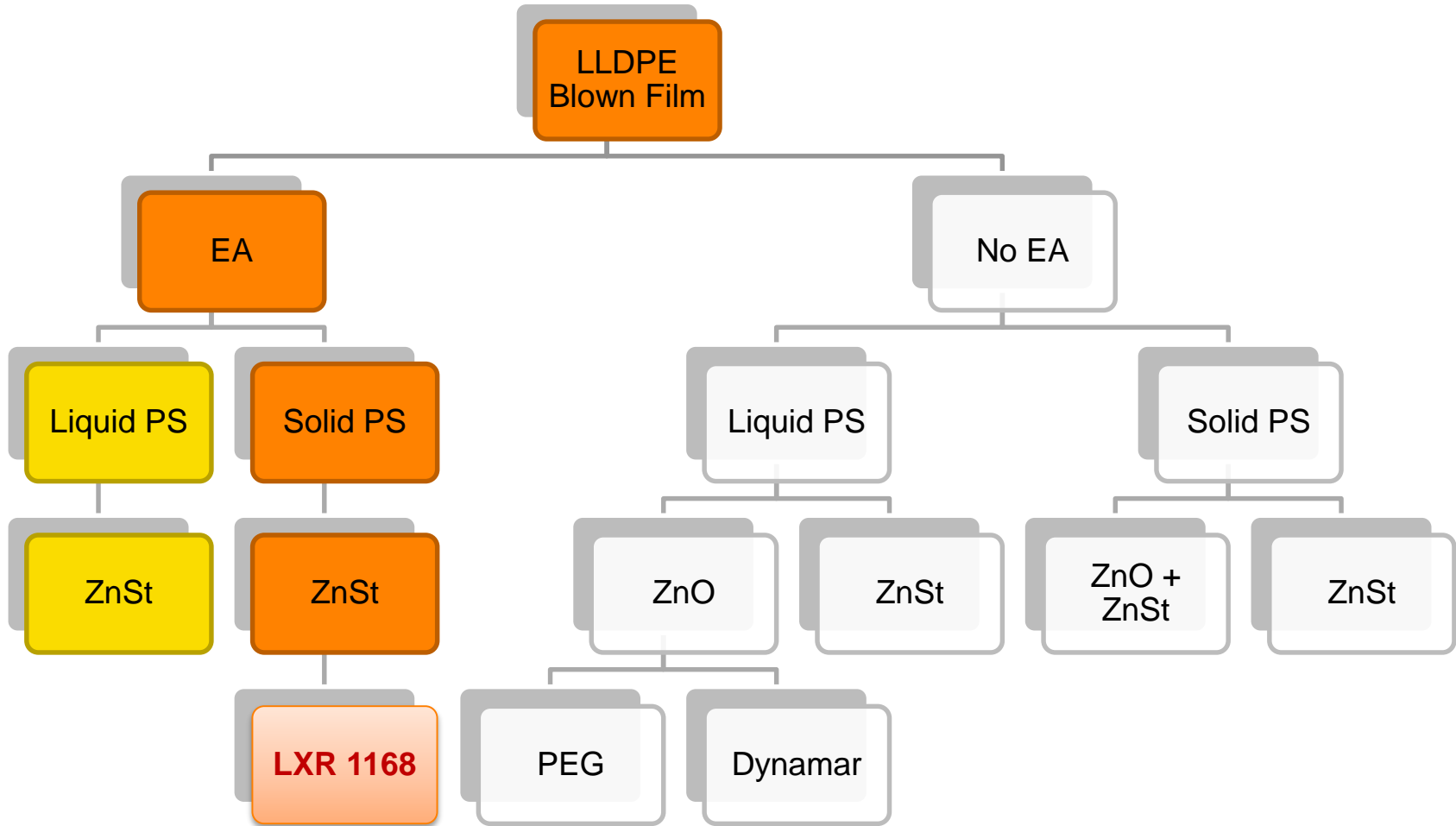


# No TNPP with EA **ADDWORKS<sup>®</sup> LXR<sup>®</sup> 1168**

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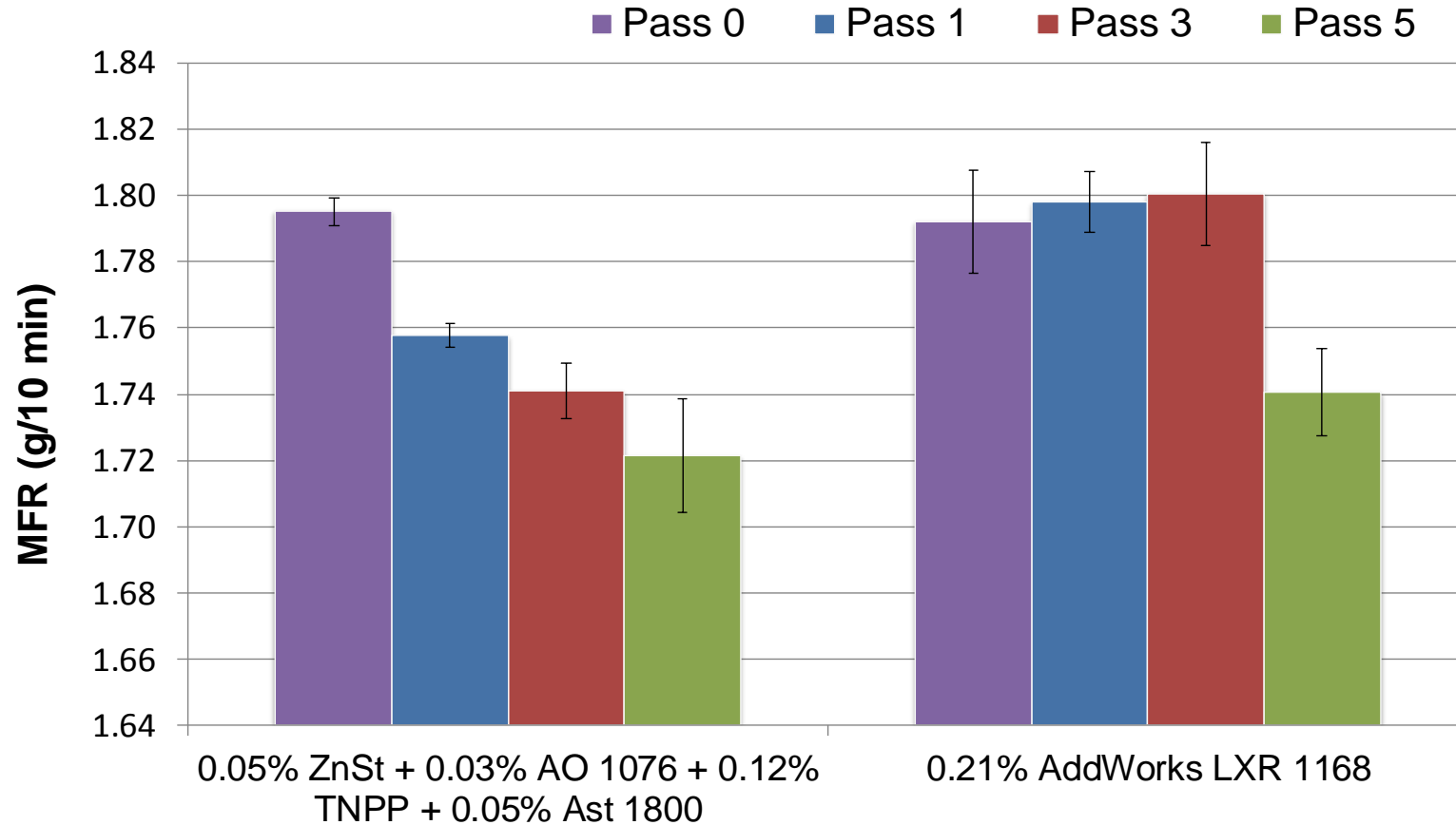
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# Clustering of LLDPE formulations: Univation



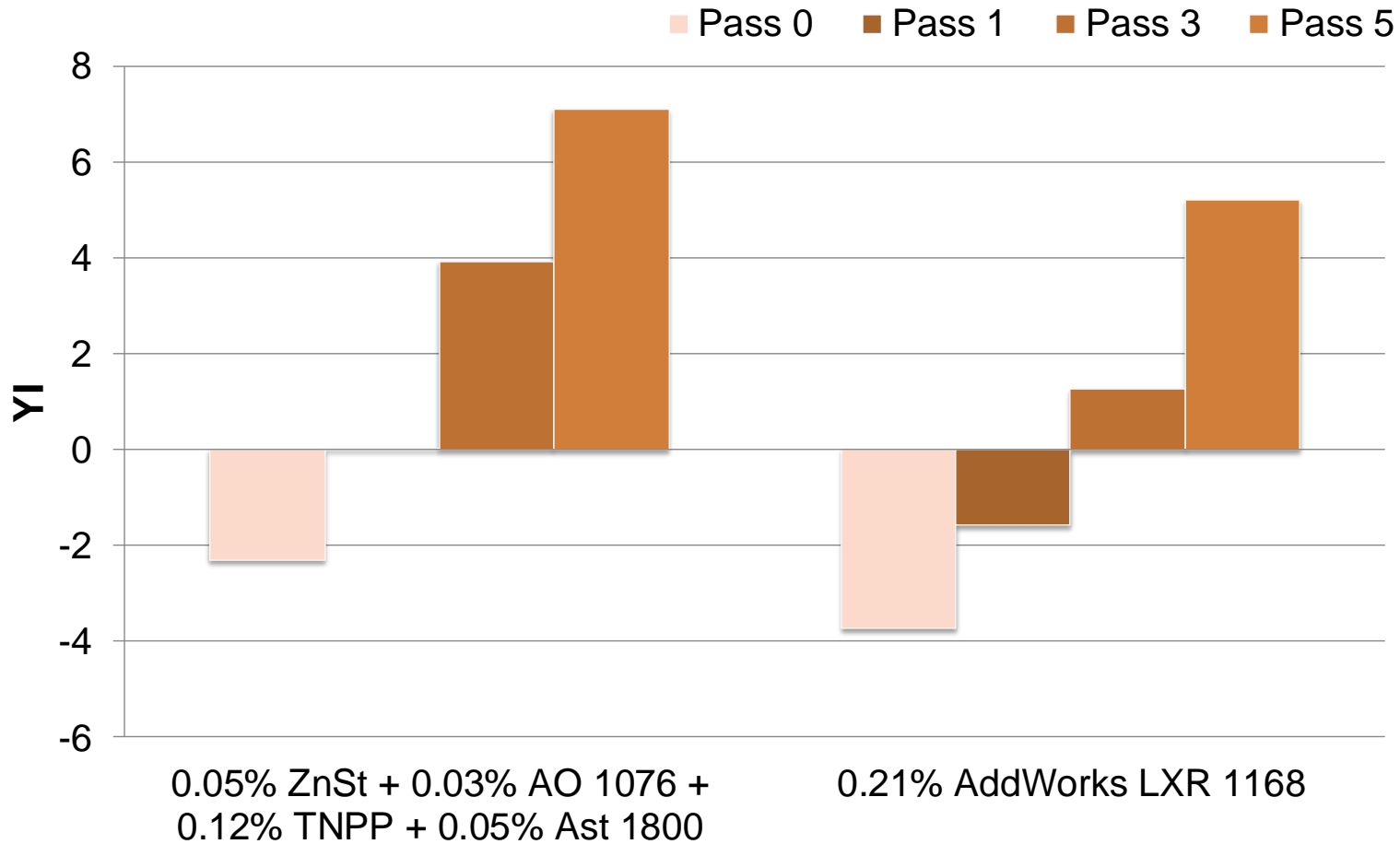
# AddWorks LXR 1168 in LLDPE

Multiple extrusion at 240°C

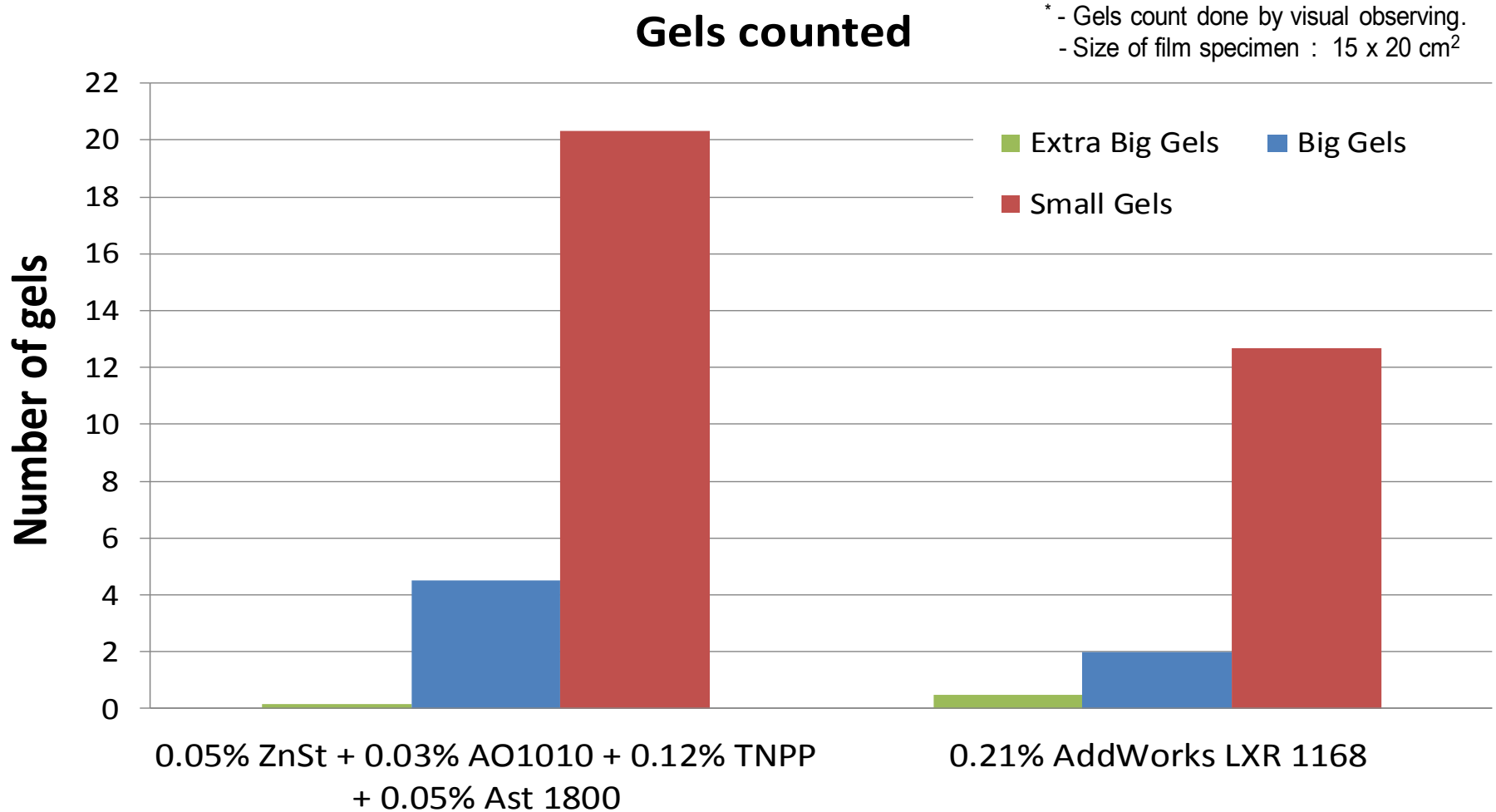


# AddWorks LXR 1168 in LLDPE

Multiple extrusion at 240°C



# AddWorks LXR 1168 in LLDPE



# AddWorks LXR 1168 in LLDPE

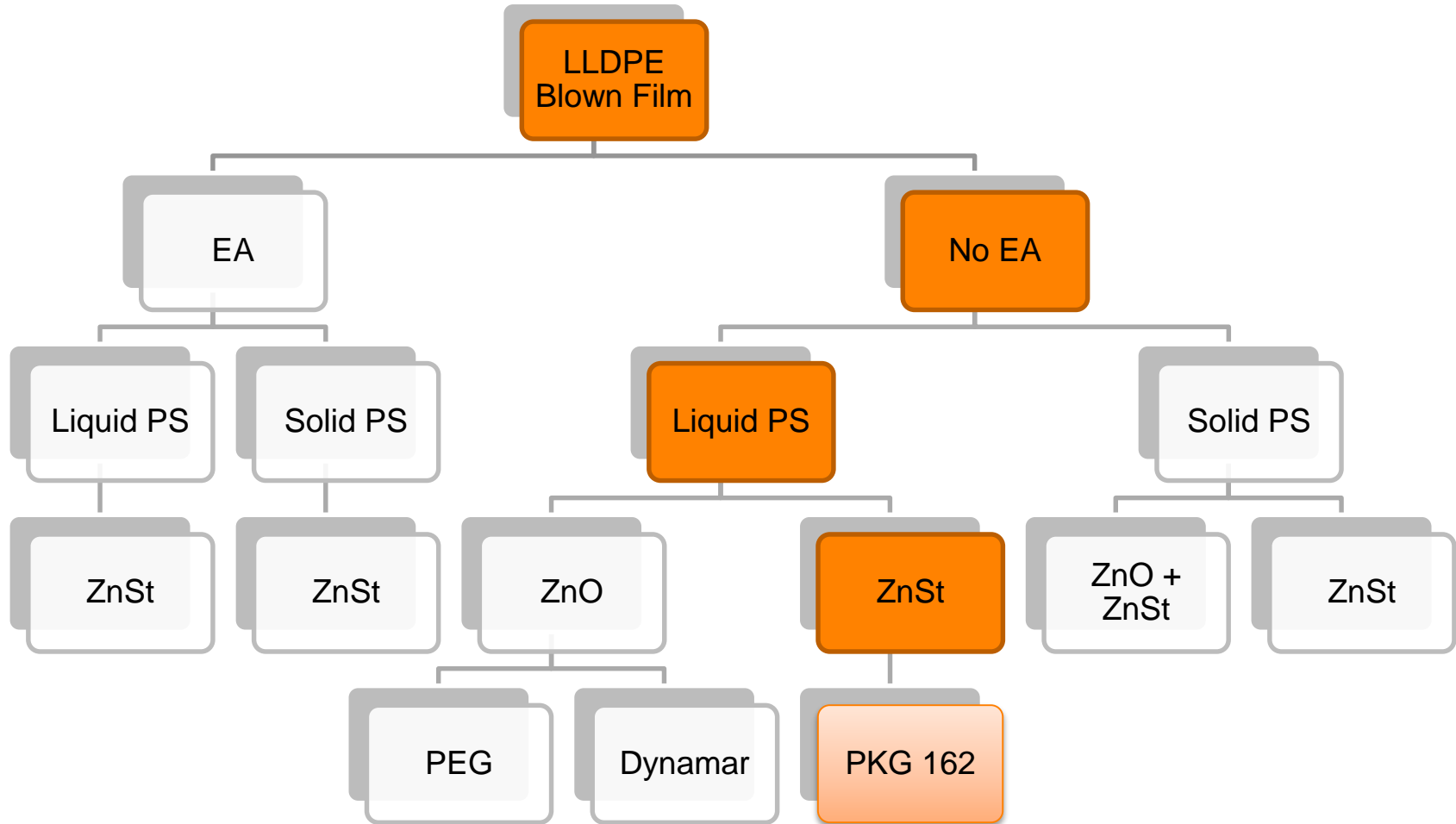
AddWorks LXR 1168 provides superior performance on MFR retention and color stability after multiple extrusion as well as better gel reduction in LLDPE film than reference formulation with 0.12% TNPP.

# TNPP AND No EA ADDWORKS<sup>®</sup> PKG 162

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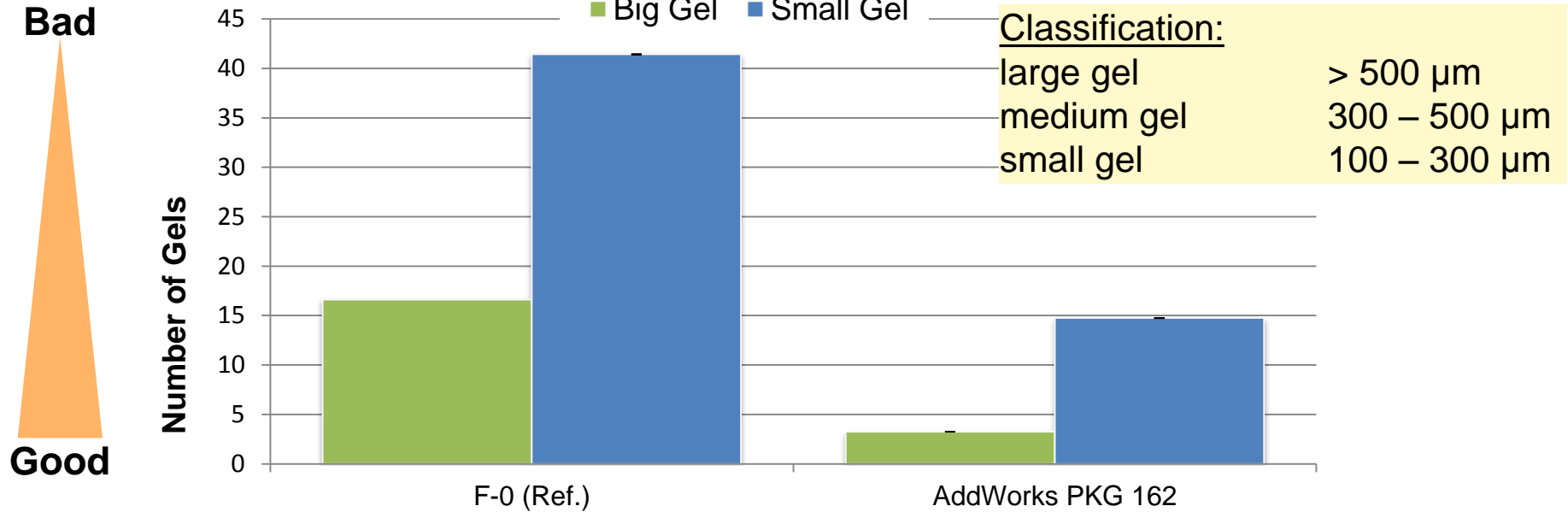
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# packaging Clustering of LLDPE formulations: Univation





# Number of big gels and small gels in LLDPE film

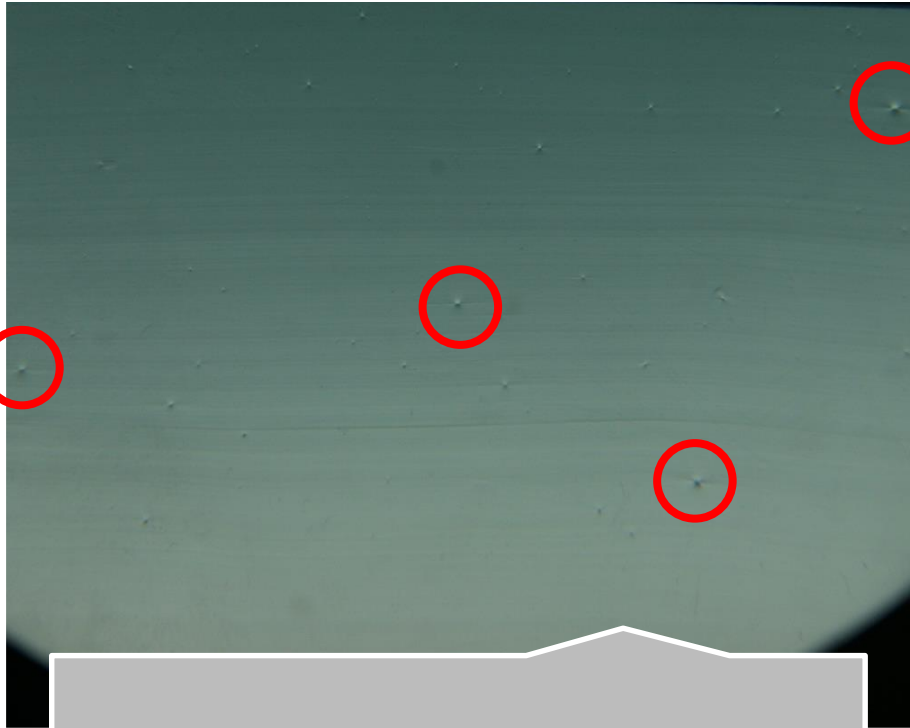


F-0 (Reference):  
ZnSt 500 ppm  
AO1076 800 ppm  
TNPP 1500 ppm

*If TNPP or another liquid processing stabilizer is used, it has to be dosed separately by a liquid feeder.*

**Not commercial! - Development Product!**

# Film Appearance – Superior film quality with AddWorks® PKG 162



Reference LLDPE



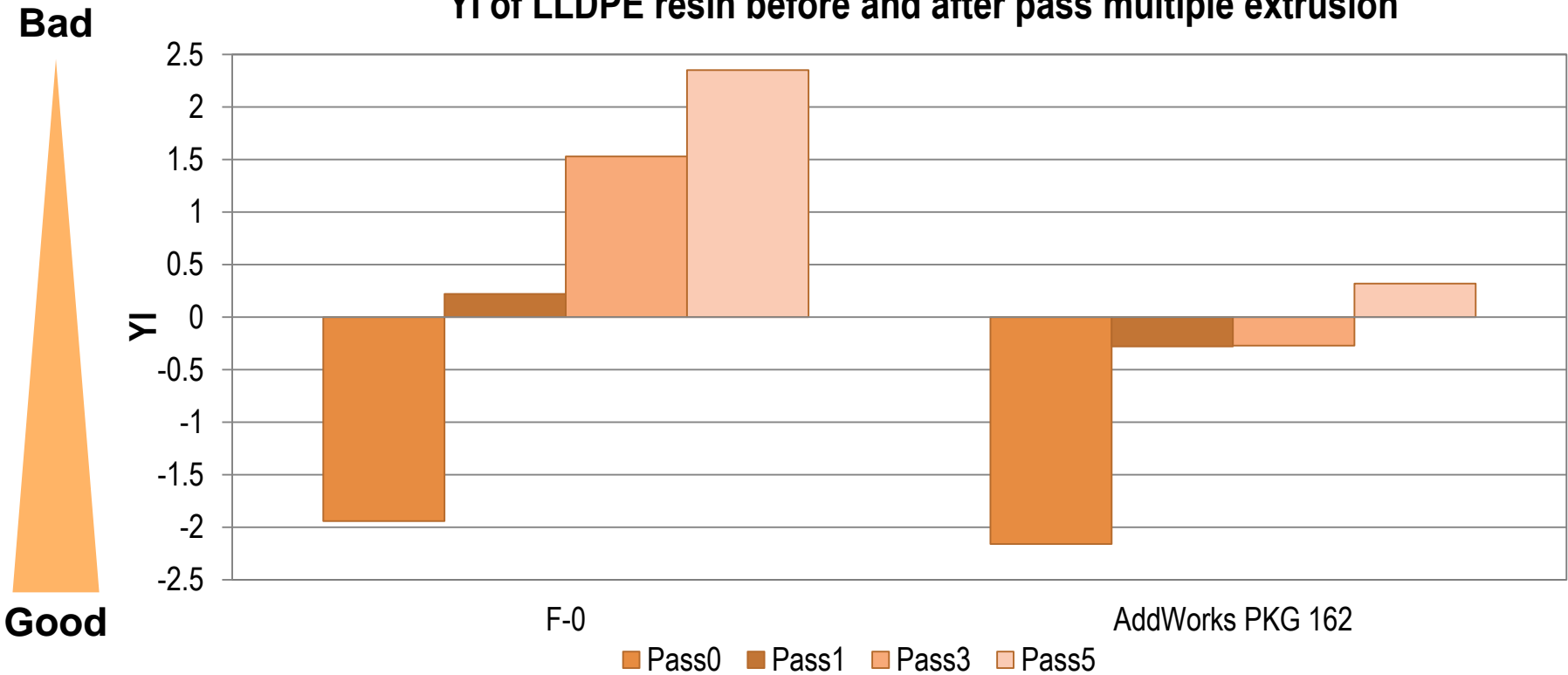
LLDPE with AddWorks® PKG 162

▶ Significant gel reduction with AddWorks® PKG 162



# Results: Yellowing (YI)

### YI of LLDPE resin before and after pass multiple extrusion



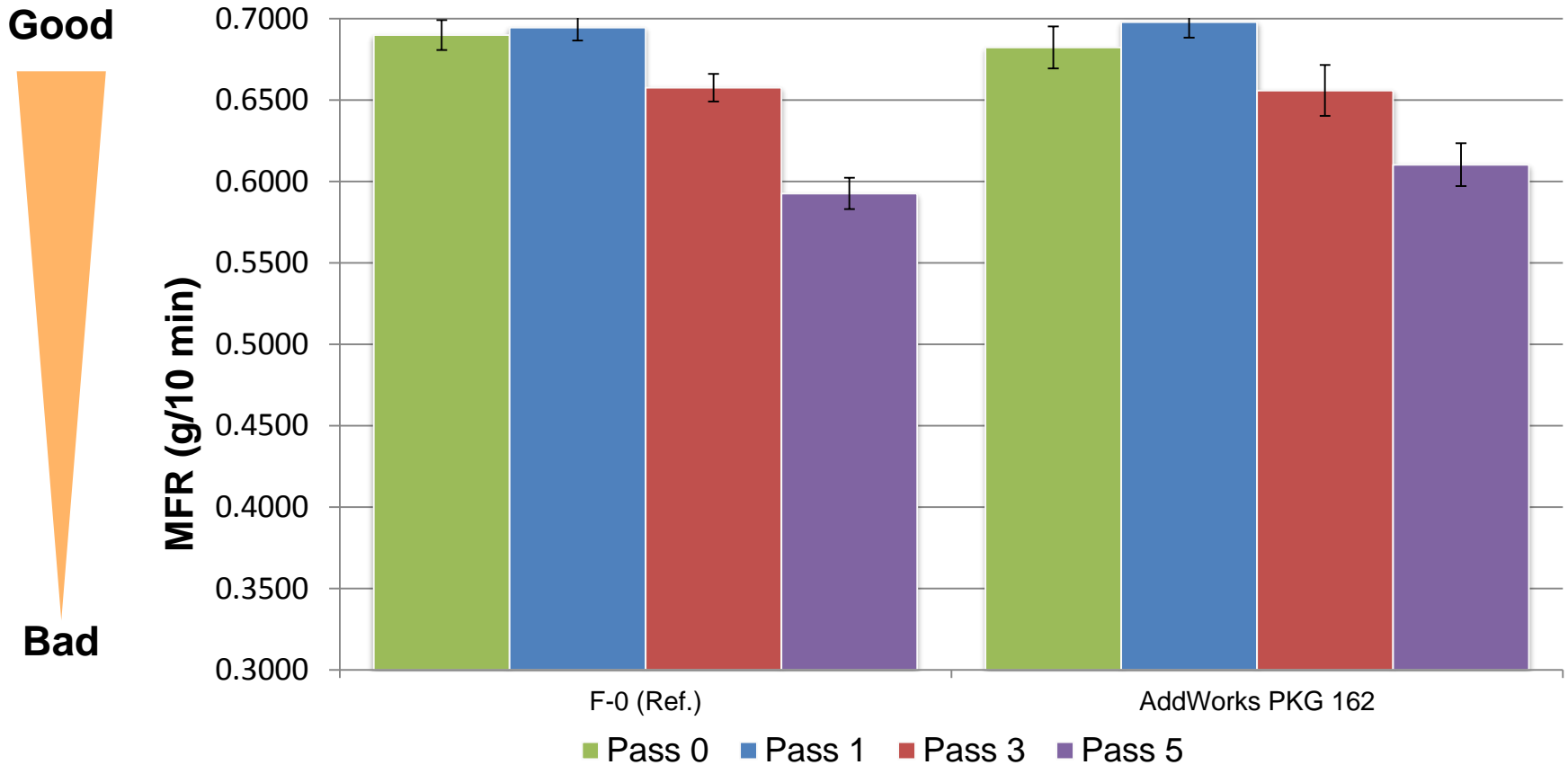
▶ Outstanding YI retention with AddWorks® PKG 162

# Results: MFR after Multiple Extrusion at 240 °C

(LLDPE, Load 2.16 kg, 190 °C)

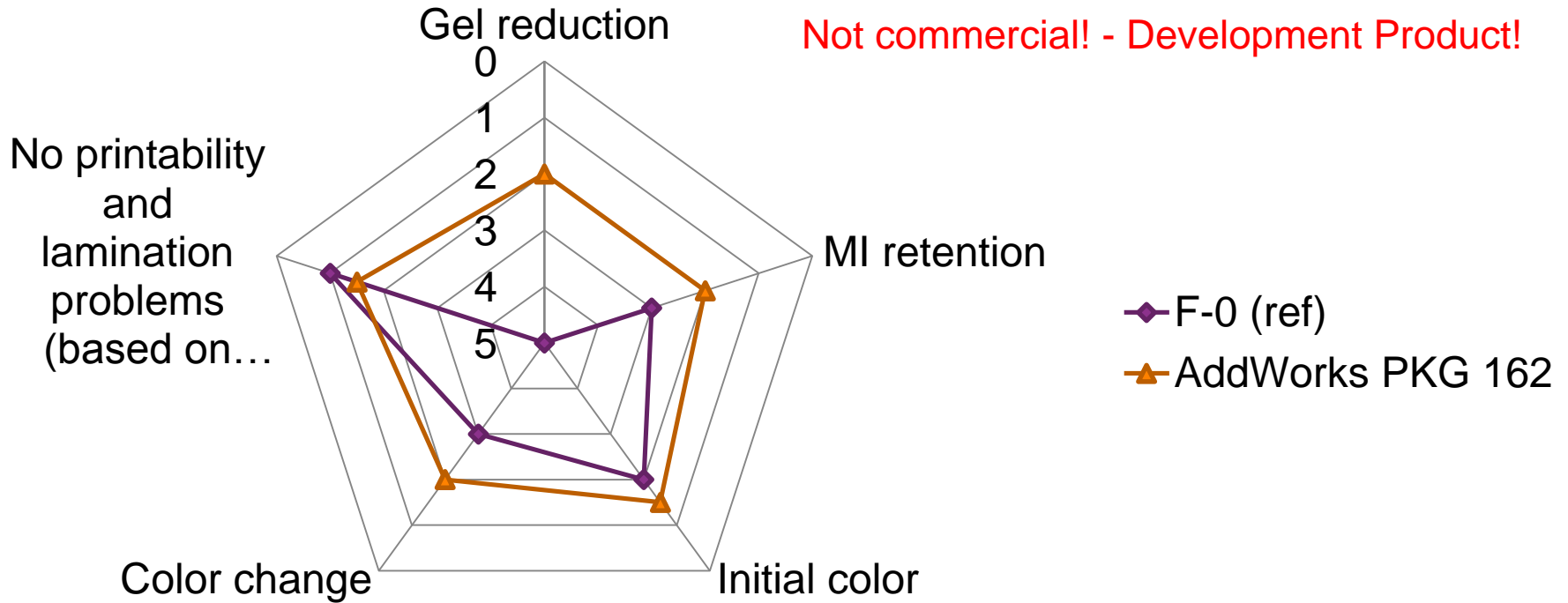
**Remark:**

- ISO 1133 standard tested
- Load test 2.16 Kg., @ temp. 190 °C
- Assume melt density of resin is equal to 0.74 g / ccm



▶ Superior MFR retention with AddWorks® PKG 162

# Conclusion



\*Score from 1 to 5 is rated from good to bad properties i.e. Score 1 for gel reduction means less gel, score 1 for no printability and lamination problems means less possibility to face the problems

► AddWorks® PKG 162 provides outstanding performance for LLDPE films



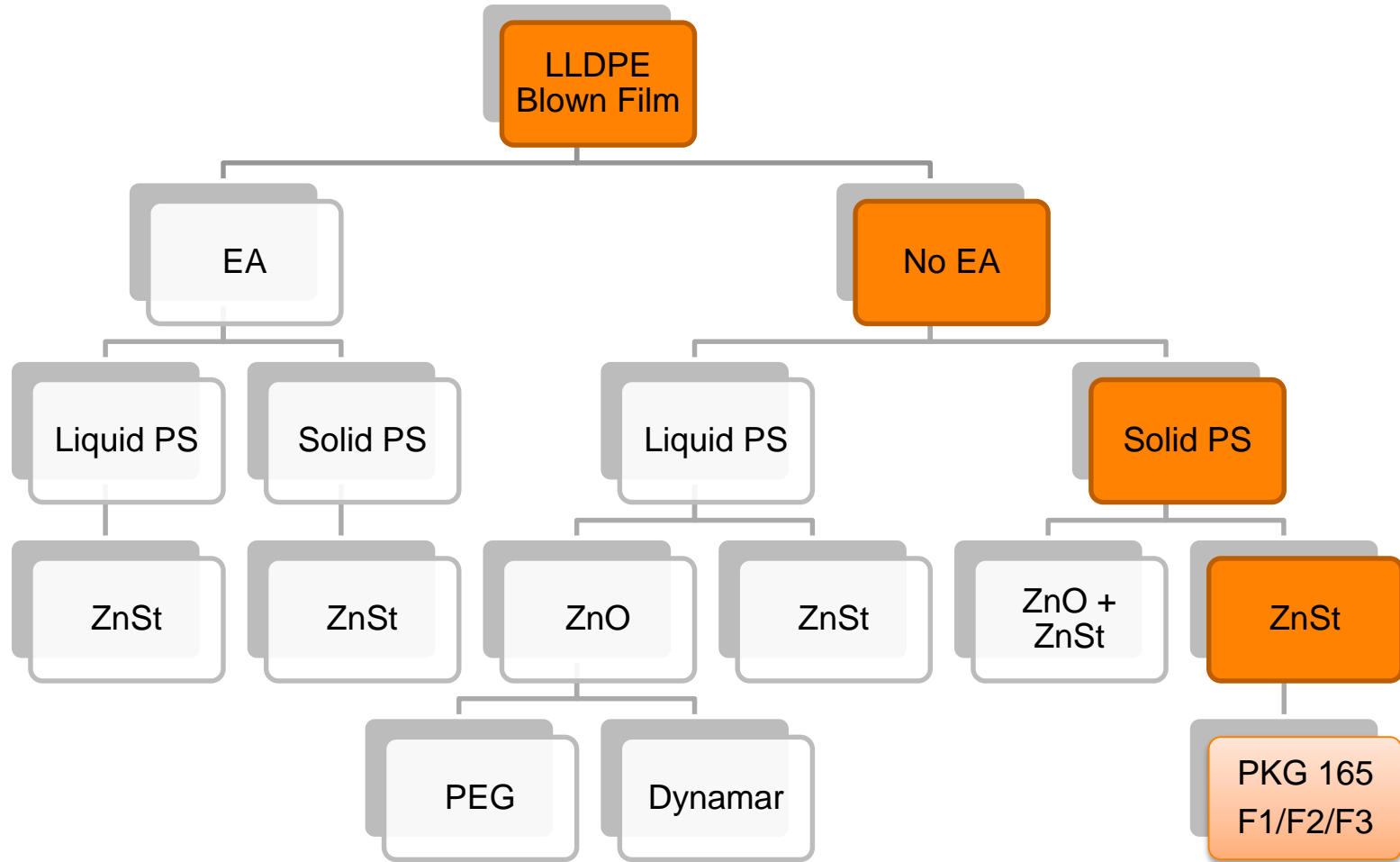
Without TNPP and without  
EA

**ADDWORKS<sup>®</sup> PKG 165**

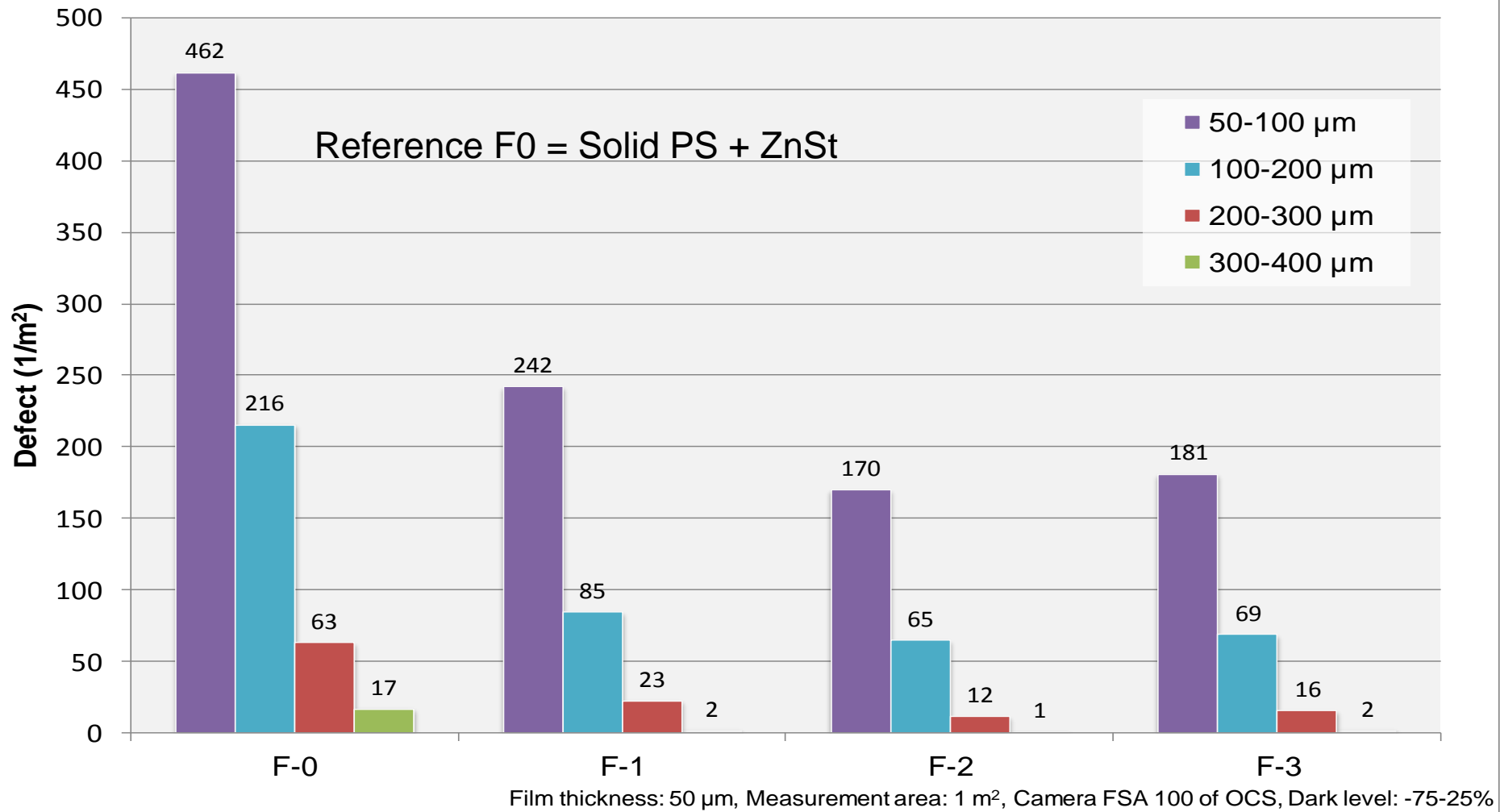
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# Clustering of LLDPE formulations: Univation



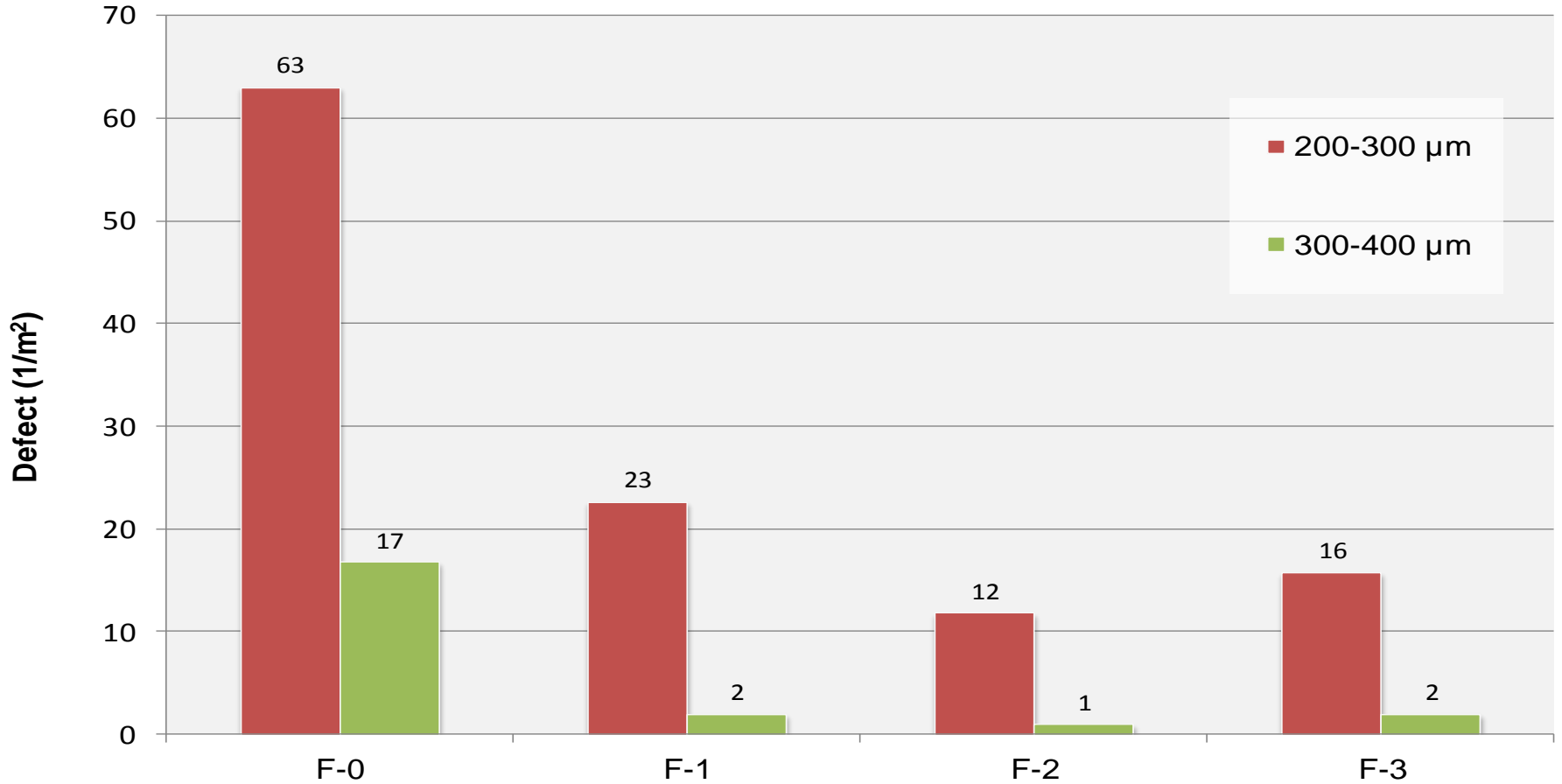
# Number of gels in LLDPE film (Size classification)



► 60 % Gel reduction with Solutions F-1/F-2 and F-3



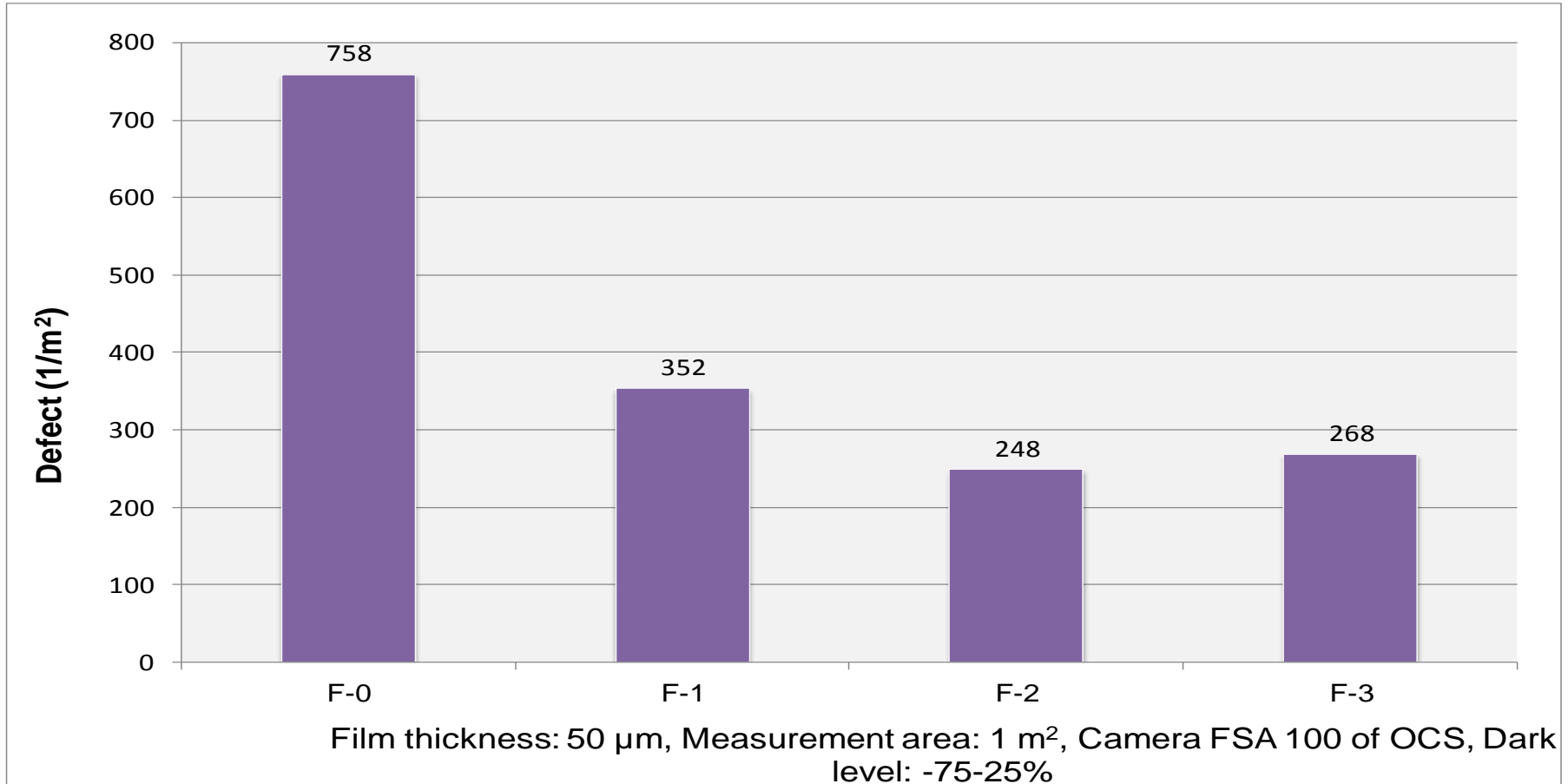
# Number of gels in LLDPE film (Size classification)



Film thickness: 50 µm, Measurement area: 1 m², Camera FSA 100 of OCS, Dark level: -75-25%

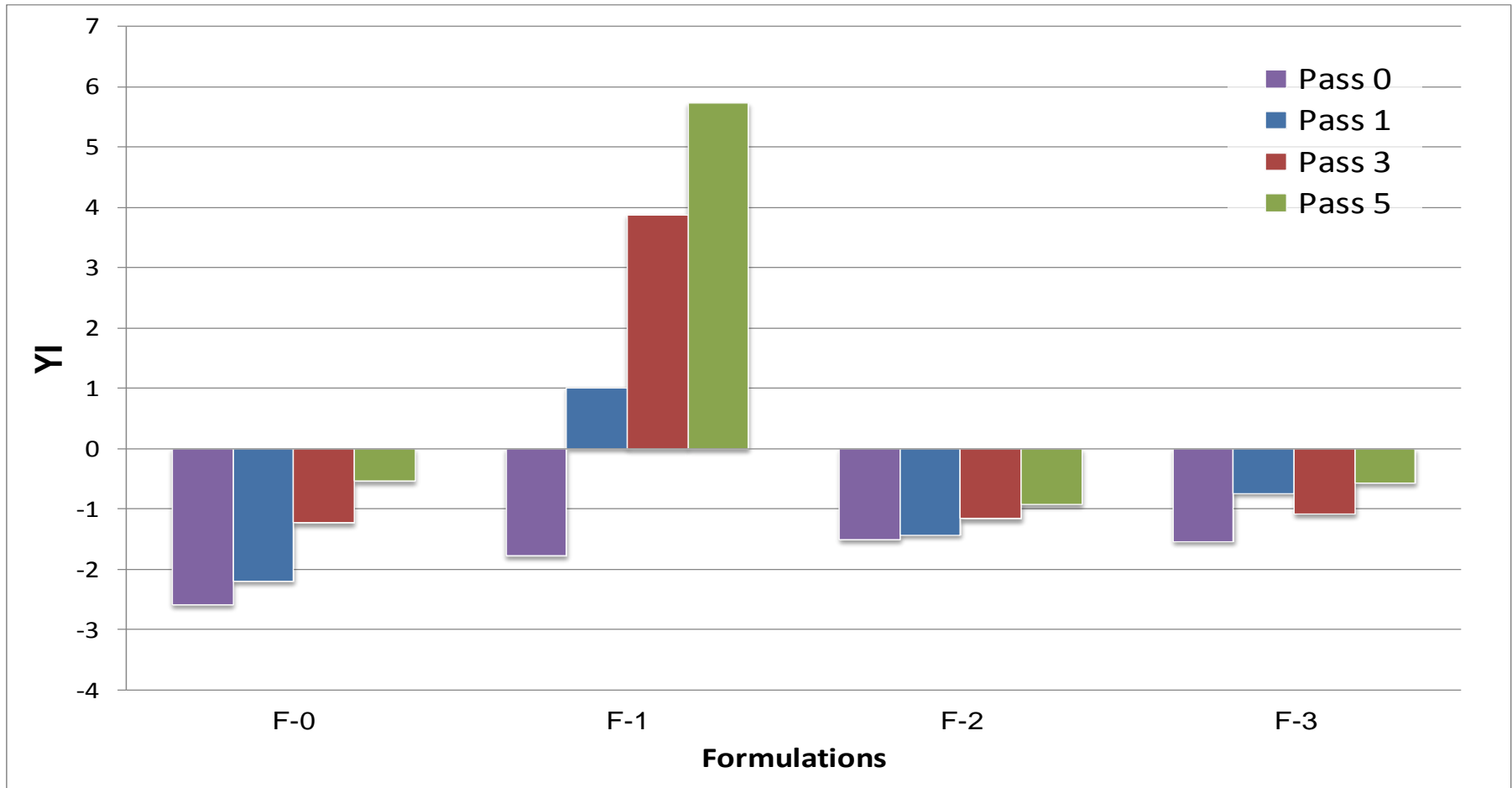
▶ 80 % reduction of large gels! Outstanding is solution F-2

# Number of total gels in LLDPE film



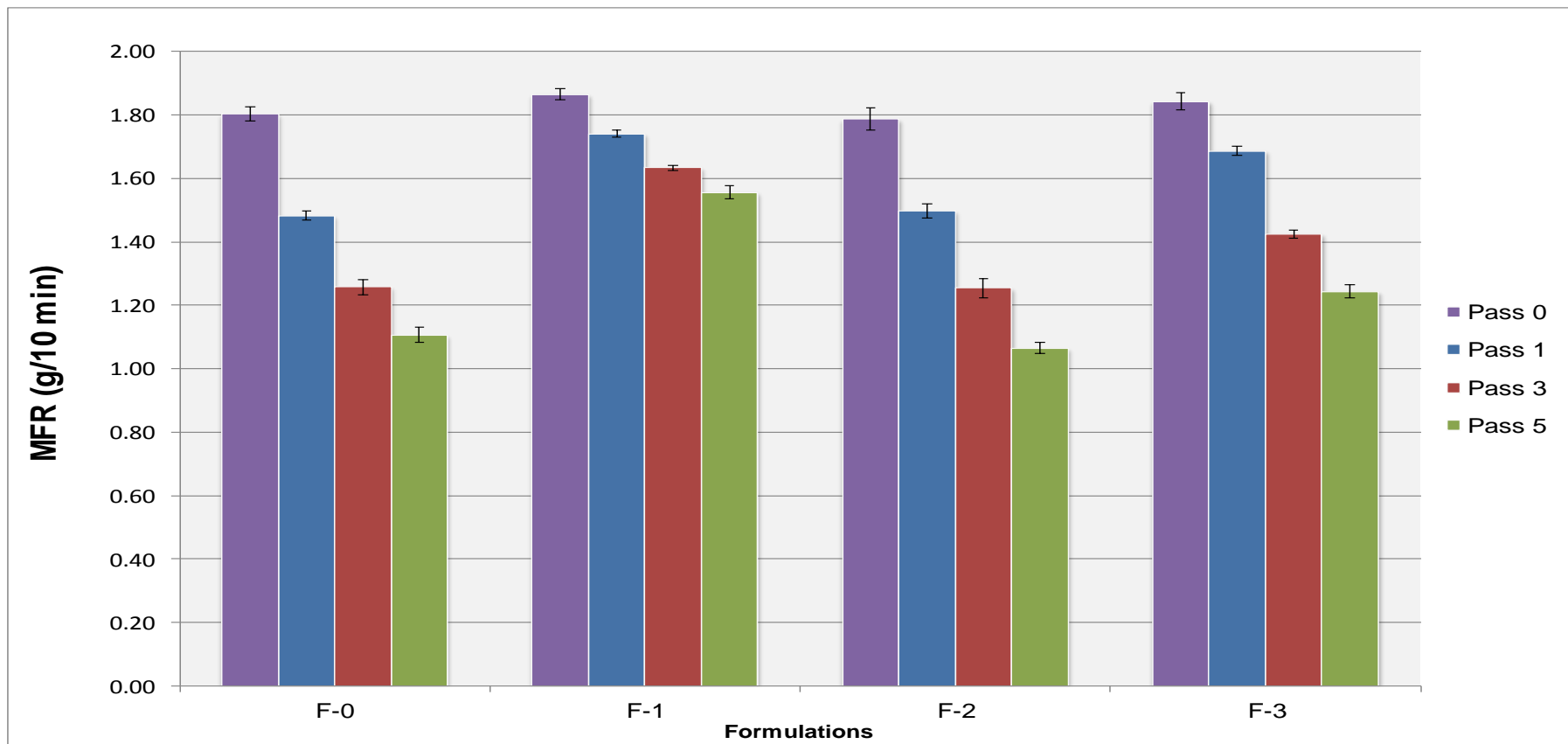
▶ 60 % gel reduction, Outstanding solution F-2 with 70 % gel reduction

# YI before and after Multiple Extrusion at 240 °C



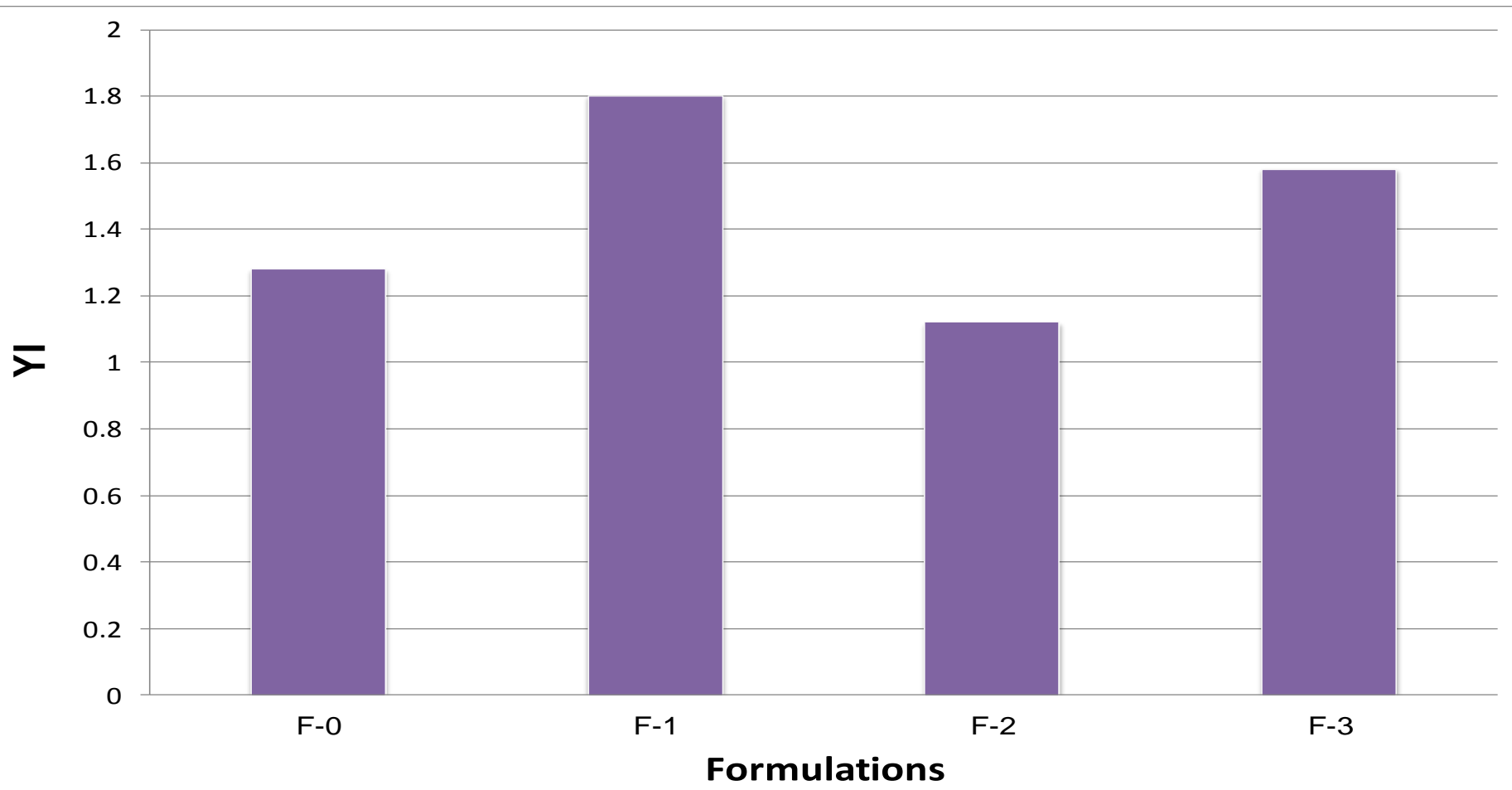
► Enhanced color stability with solutions F-2 and F-3, worse with F-1

# Results: MFR after Multiple Extrusion at 240 °C



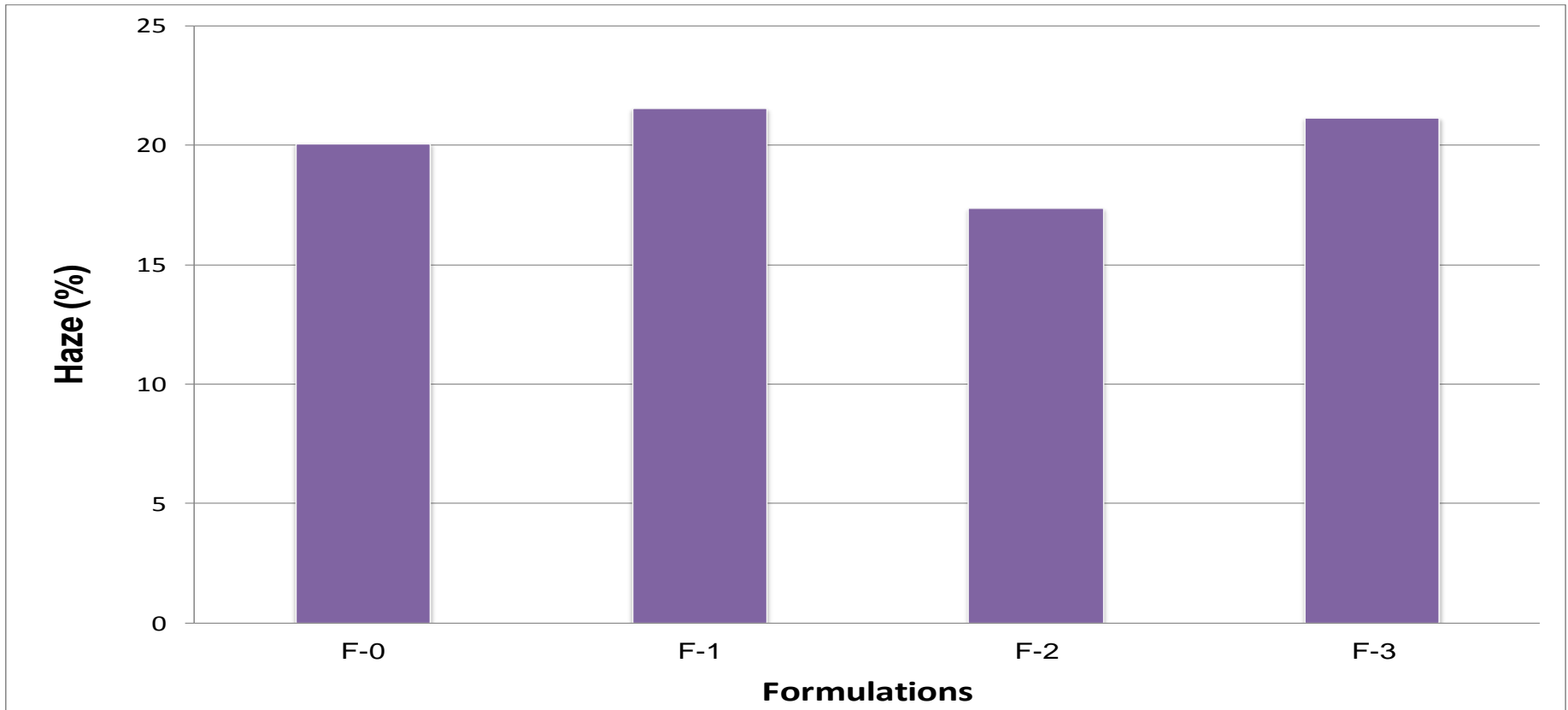
► Enhanced MFR stabilization with solutions F-1 and F-3

# YI of LLDPE films



▶ Enhanced color stability of the film with solution F-2

# Haze of LLDPE films



▶ Better Haze with solution F-2

# Conclusion

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F-2 is suitable to recommend for gel reduction purpose with good color stability and good film quality i.e. low haze and similar MFR retention to reference formulation.

F-3 is suitable to recommend to use for improving MFR retention and gel reduction with quite good color stability.

F-1 is suitable to recommend to use for improving MFR retention and gel reduction but its drawback is yellowing after multiple extrusion.

**Not commercial! - Development Products!**

*AddWorks*<sup>®</sup> LXR<sup>®</sup> 568

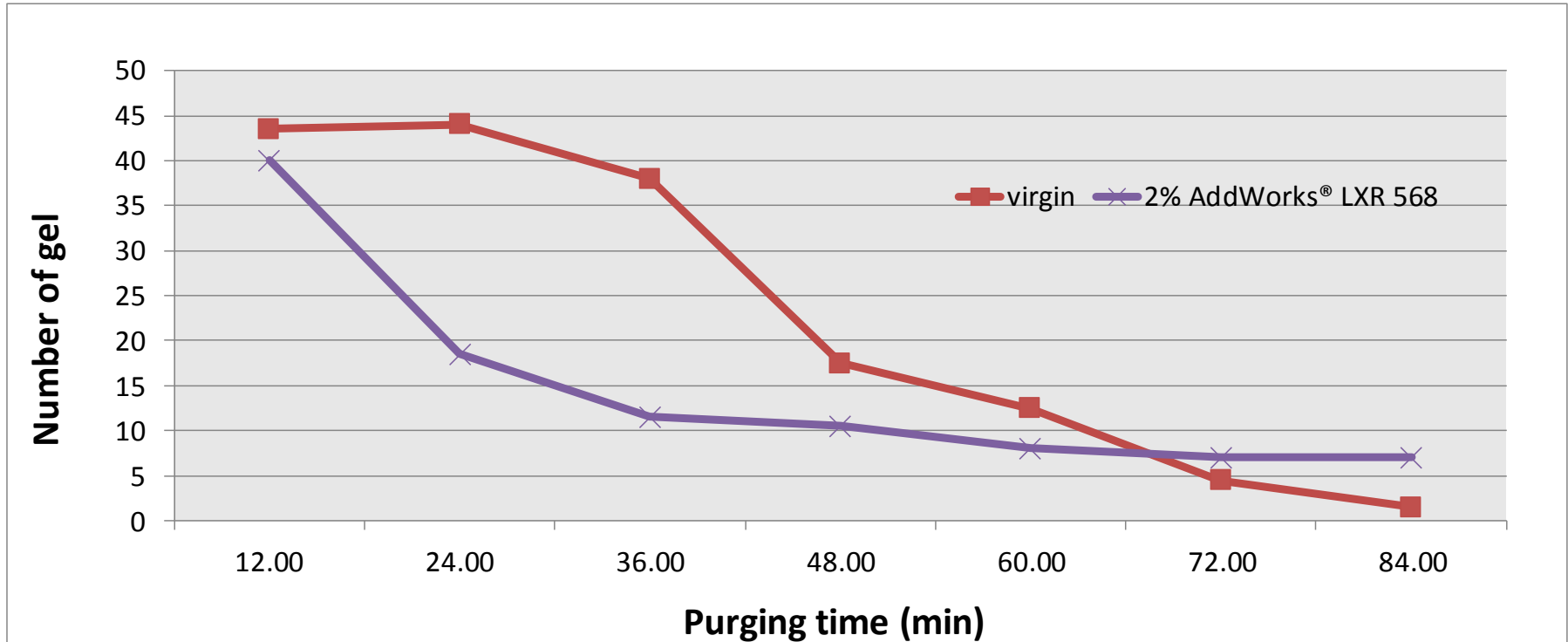
**FOR GEL REDUCTION IN  
LDPE**

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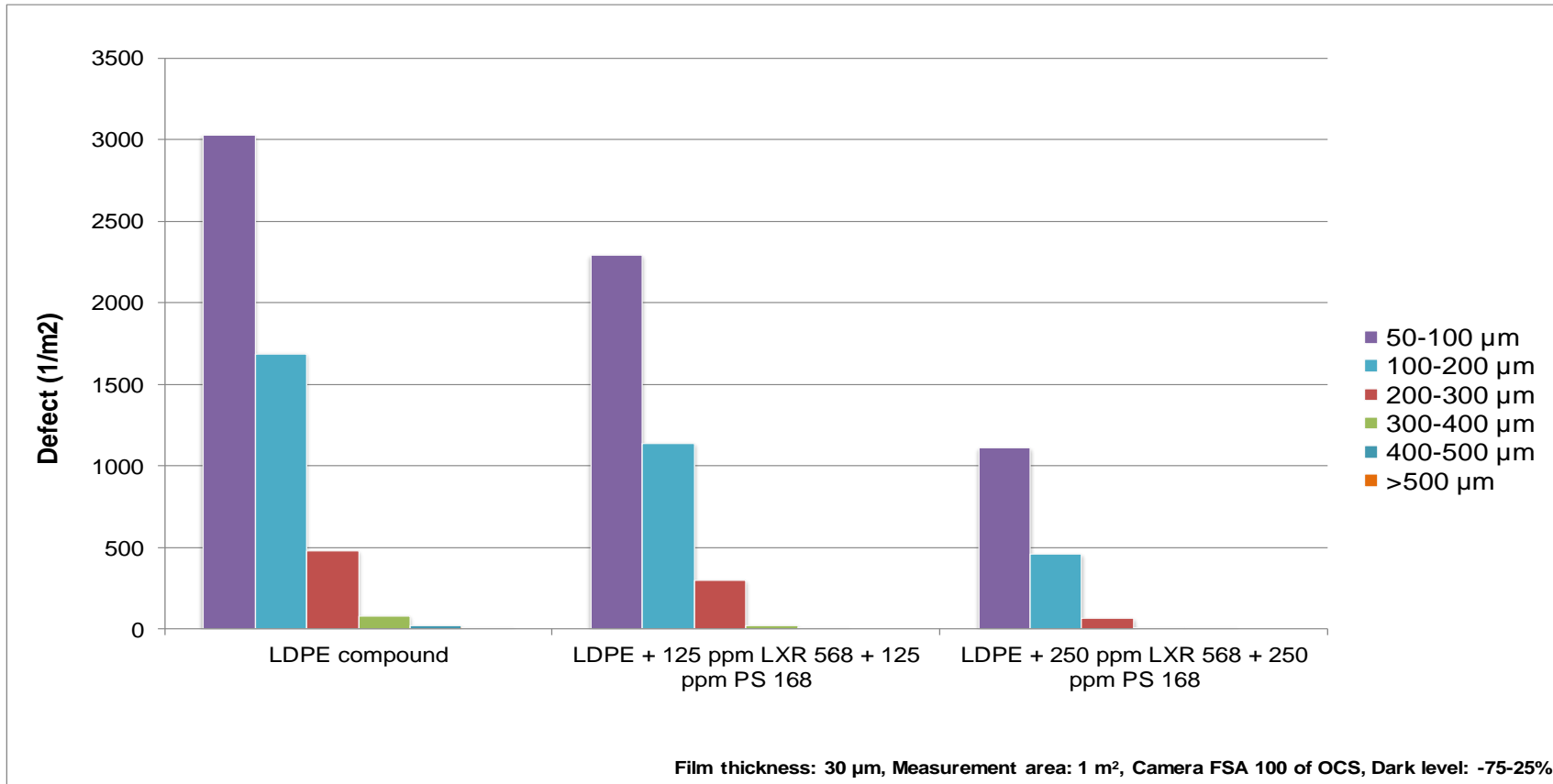
# Gel reduction for LDPE film over purging time



- ▶ Significant improvement of film quality with AddWorks® LXR® 568
- ▶ Faster start-up of film line

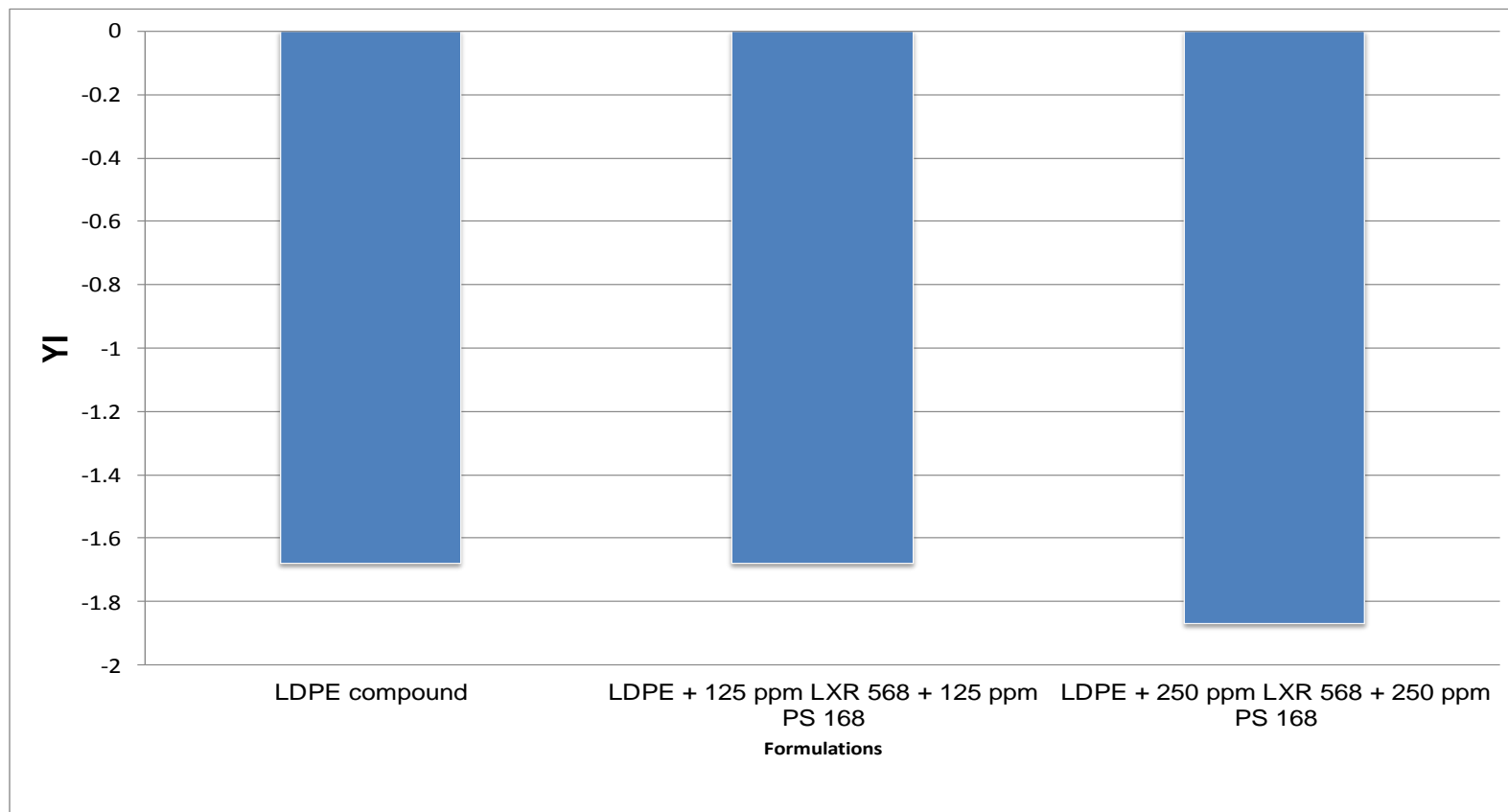
# Number of gels in LDPE films

## Size classification



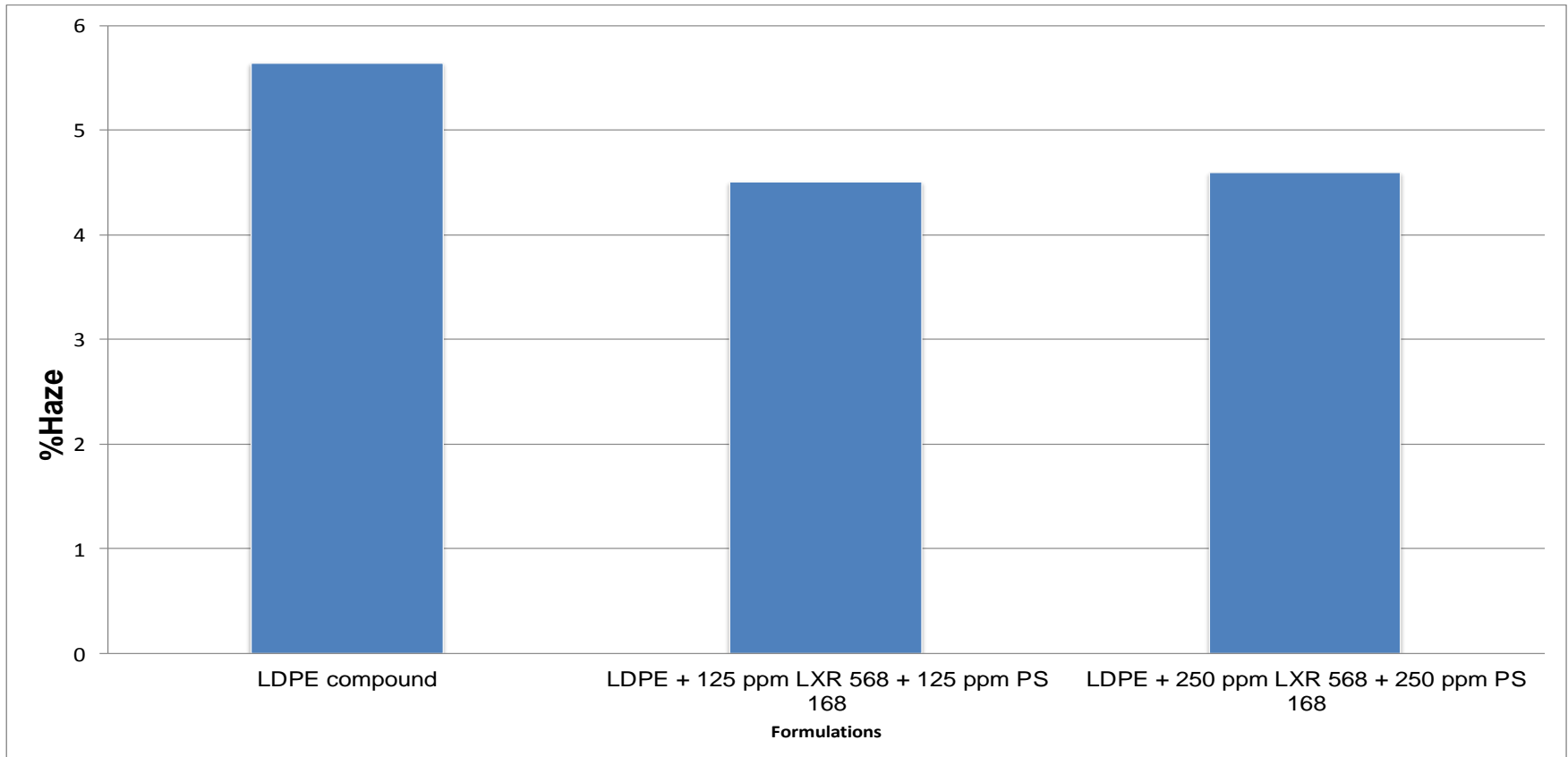
► 50 % gel reduction with AddWorks® LXR® 568

# Yellowness Index (YI) of LDPE films



► Superior color with AddWorks® LXR® 568

# Haze of LDPE films



▶ Lower Haze with AddWorks® LXR® 568

# Conclusion

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Only 125 ppm of AddWorks LXR 568 together with 125 ppm PS 168 significantly reduce gel in the LDPE film by half.

Power of gel reduction enhance by increasing concentration of AddWorks LXR 568 together with PS 168.

Incorporation of 250 ppm AddWorks LXR 568 together with 250 ppm PS 168 significantly improve quality of LDPE film i.e. lower of gel, yellowness and haze of the film.