



# 2024 FlexPack PLACE Conference

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## In Search of PFAS Free PPAs – An Evaluation of Their Efficacy

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## Agenda

- Background
- Polymer Processing Aid Overview
- Alternative Polymer Processing Aids
- Polymer Processing Aid Study





## Background

- Fluoropolymer processing aids (PPAs) have been used in the blown film industry for many decades.
- Many of the traditional PPAs contain per- and polyfluoroalkyl substances (PFAS) are currently undergoing regulatory restrictions due to potential harmful effects to people and environment.
- These restrictions are driving converters and film producers to search for potential PFAS free PPA (next-generation PPA) replacements.
- This presentation does not identify the specific commercial PPAs used during these trials.





## Why does industry use PPAs? What is melt fracture?

- PPAs are typically used to reduce melt fracture and improve the processability of high-molecular weight polymers
- Melt fracture is a type of flow instability that begins as a roughening of the surface and at higher output can lead to severe distortion of the polymer

Higher Output = Increase Production

Processing equipment design – narrow die gap, increase physical strength of films





## Examples of Traditional PPAs:

- 3M- Dynamar®
- Chemours- Viton®
- Arkema - Kynar®

## Traditional PPAs

1. Reduce motor load
2. Lower extrusion melt pressure
3. Minimize or eliminate melt fracture at high outputs
4. Reduce die lip buildup



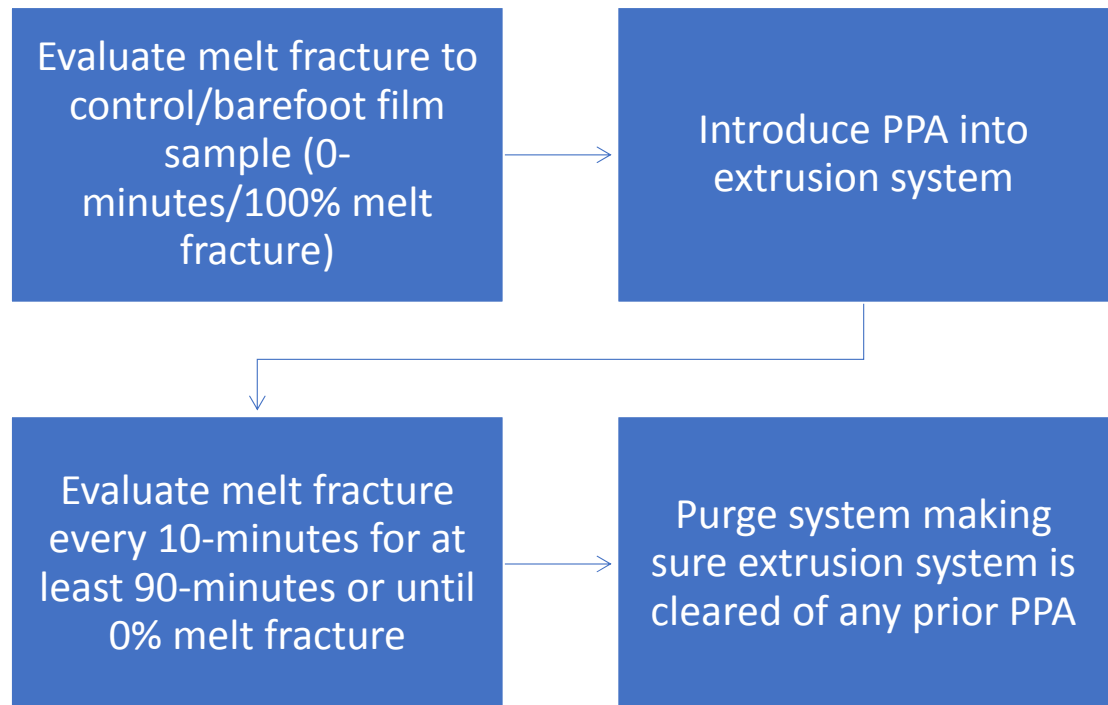


## Trial Design

The goal of the trial was to compare the efficacy of PFAS Free PPAs with an industry-standard fluoropolymer PPA.

### Criteria Measured:

- Extruder RPM
- Motor Load
- Melt Temperature
- Melt Pressure
- Gauge Variation
- Time to Clear Melt Fracture





## Other Qualification Criteria

- FDA
- Environmental (SVHC)
- Melt fracture
- Output maximum
- Amps
- Backpressure
- Die build-up
- Leaching/pooling on the die surface
- Optics
- Taste & odor
- Hot tack/heat seal
- Corona treatment (setting/dyne level)
- Printability
- Leaker rate
- Blooming/migration (short/long term)
- Compatibility
  - Other PPA's
  - Other Additives
  - AO's
  - Pigments
- Smoke/haze during processing
- Ease of use (letdown vs concentrate)





## Blown Film Equipment

### Specifications:

Monolayer Blown Film

Die Diameter – 250mm

Screw – 75mm

L/D – 30:1

Dual Lip Air Ring IBC

Die Pin – 2mm

Screen Pack – 20/30-250DW/20

4-Component Vibratory Blenders





## Blown Film Evaluations

- Complete multiple next-generation PPA runs to evaluate time-to-clear and processing parameters vs. traditional PPA (FX 5929M)
- Complete studies on blending vs. fully compounded PPA
- Complete lower/higher parts per million (ppm) limits
- Complete extended run checking for die lip build up

LLDPE ZN C6 1-Melt	mLLDPE C6 1.3-Melt
1.25 mil	1.25 mil
2.25 BUR	2.25 BUR
418 lbs/hr	375 lbs/hr





## Initial Observations (Next-Generation PPAs)

Introduction of **select** PPAs presented:

- Increase in extruder RPM
- Large deviation in melt temperature
  - Peaky frost line
  - Port lines
  - Over time would stabilize to levels closer to the control
- Build-up on die surfaces and blown film equipment

Introduction of **most** PPAs presented:

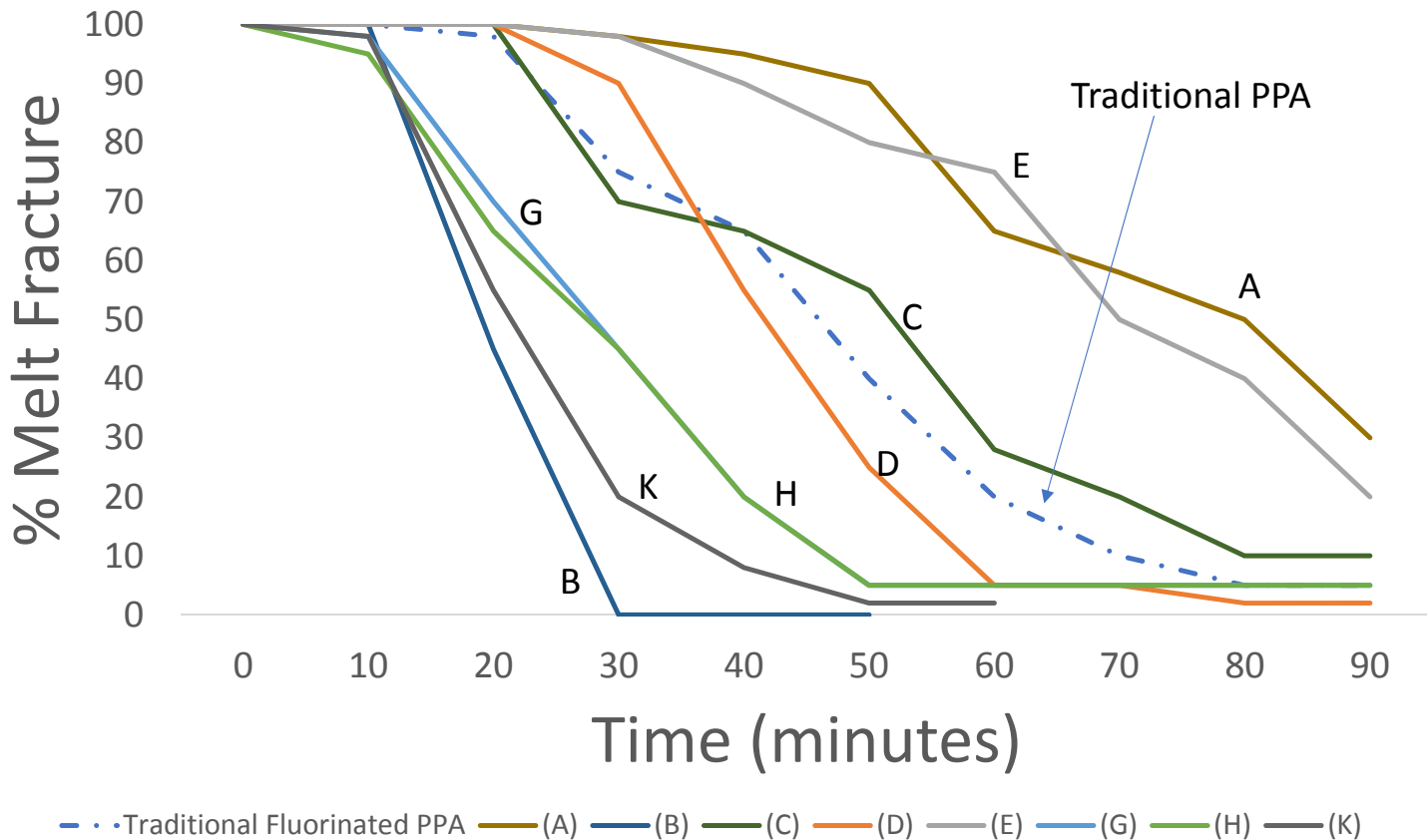
- Decrease in motor load
- Decrease in melt pressure
- Clearing of melt fracture

Most worked well with ZN-LLDPE, mLLDPE resins, as well as in masterbatch, neat, or compounded forms





## Time-to-Clear



### Other Considerations

- Cost
- Compatibility
- Loading
- Printability



## Conclusion

- Most of the next-generation PPAs cleared melt fracture faster than traditional PPAs, and it took less time to purge from the extrusion system
- Possible Limitations:
  - Differences in coating mechanism (traditional vs. next-generation PPAs)
  - Extruder output
  - Melt temperature/pressure deviations
  - Extruder stability
  - Surface build-up
- Although several next-generation PPAs were identified as functional, further studies are ongoing to test other criteria, such as compatibility and printability





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# QUESTIONS?



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