

Advancements in Friction Management Consumable Products

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HEAVY HAUL SEMINAR • JUNE 23 - 24

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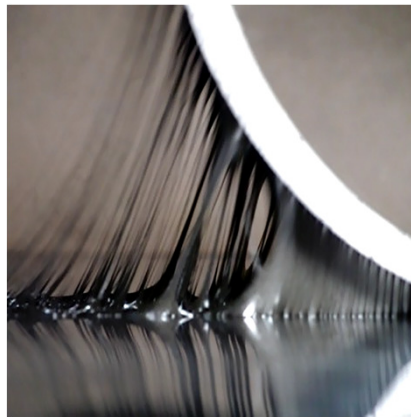
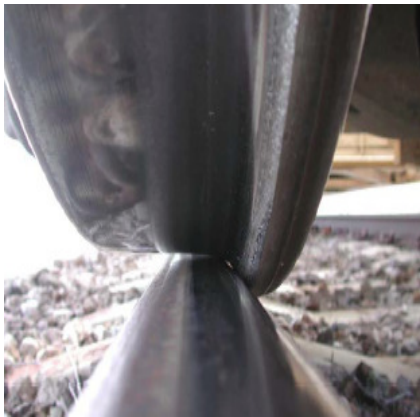
Outline

- Background
- Trackside Top-of Rail (TOR) Advancements
- On-Board TOR Product Advancements
- Gauge Face (GF) Product Advancements



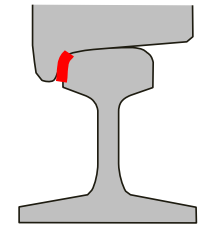
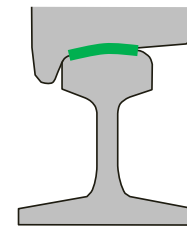
Consumable

- Chemical product applied to the wheel or rail to optimize friction characteristics
- Product is “consumed” under wheel/rail conditions



Segmentation of Consumables

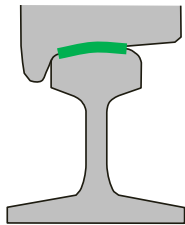


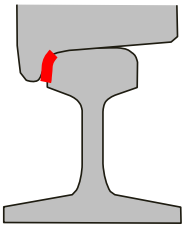
- **The Targeted Location:**
 - Top of Rail/Wheel Tread
 - Gauge Face/Wheel Flange



- **The Application:**
 - Trackside
 - On-Board



Consumables Overview

		APPLICATION METHOD	
		Trackside	On-Board
APPLICATION LOCATION	 <p>Top of Rail / Wheel Tread</p>	 <ul style="list-style-type: none"> - Friction Modifiers - Hybrids - Top-of-Rail (TOR) Oils 	 <ul style="list-style-type: none"> - TOR Friction Modifier Spray - Solid Friction Modifier Wheel Tread Application
	 <p>Gauge Face / Wheel Flange</p>	<ul style="list-style-type: none"> - Gauge Face (GF) Greases 	<ul style="list-style-type: none"> - Solid Lubricants for Wheel Flange Application - On-Board Oil Spray



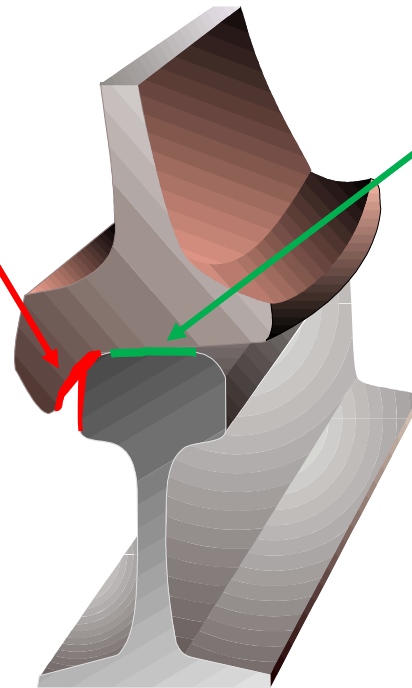
Benefits of Using Consumables

Gauge Face / Wheel Flange

Benefits:

- Reduced Rail / Wheel Wear
- Improved Fuel Efficiency
- Lowers Derailment Potential
- Mitigates RCF Development
- Reduced Flange Noise

Target CoF: < 0.25



Top-of-Rail / Wheel Tread

Benefits:

- Reduced Rail / Wheel Wear
- Improved Fuel Efficiency
- Reduced Lateral Forces
- Lowers Derailment Potential
- Mitigates RCF Development
- Reduces Hunting
- Mitigates Noise

Target CoF: ~0.35

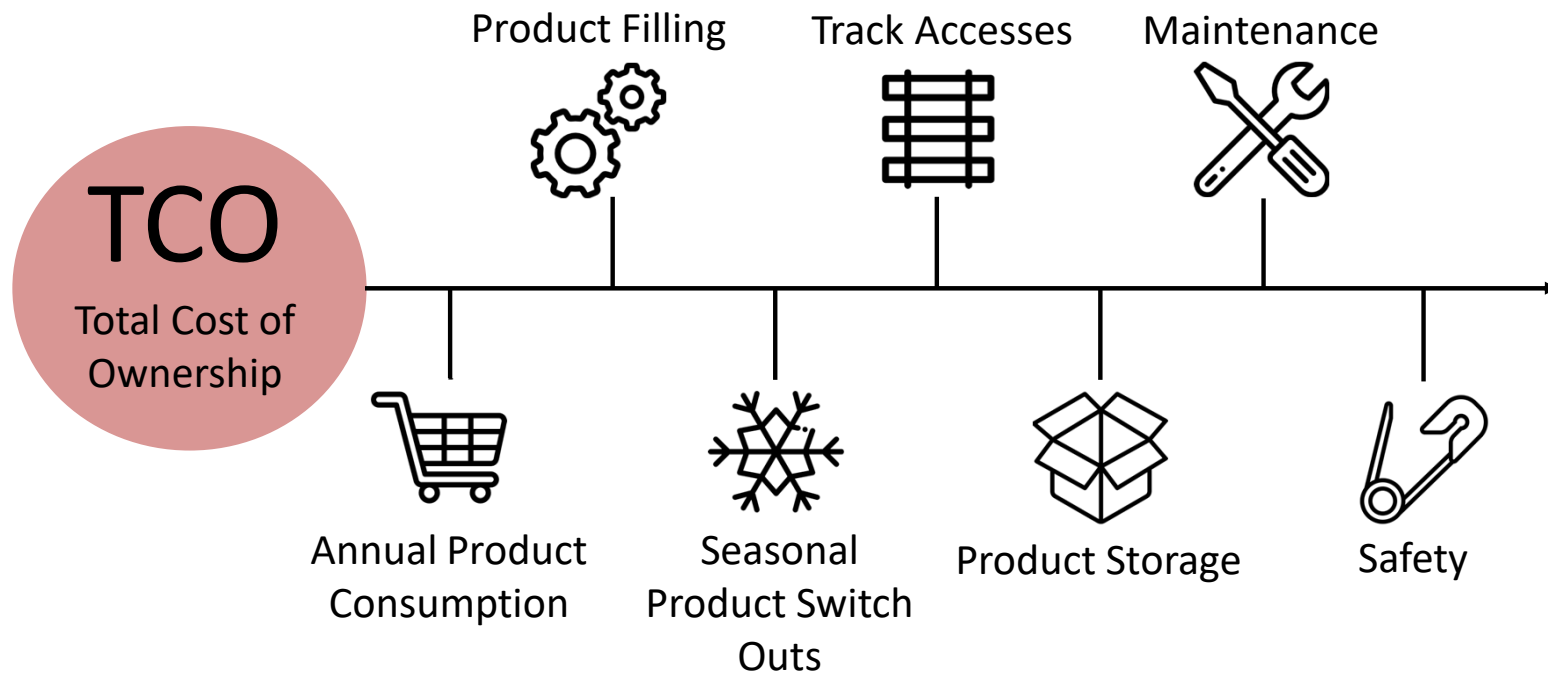
CoF = Coefficient of Friction



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Consumable Advancement



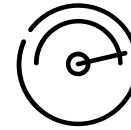
Consumable Advancement



Cost/Price



Location



Performance



Application
Method/Strategy



Operating
Temperature
Range



Environmental









Regulations



Friction
Characteristics

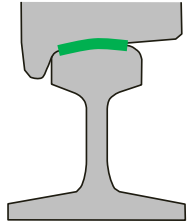


Advances in Consumables Themes

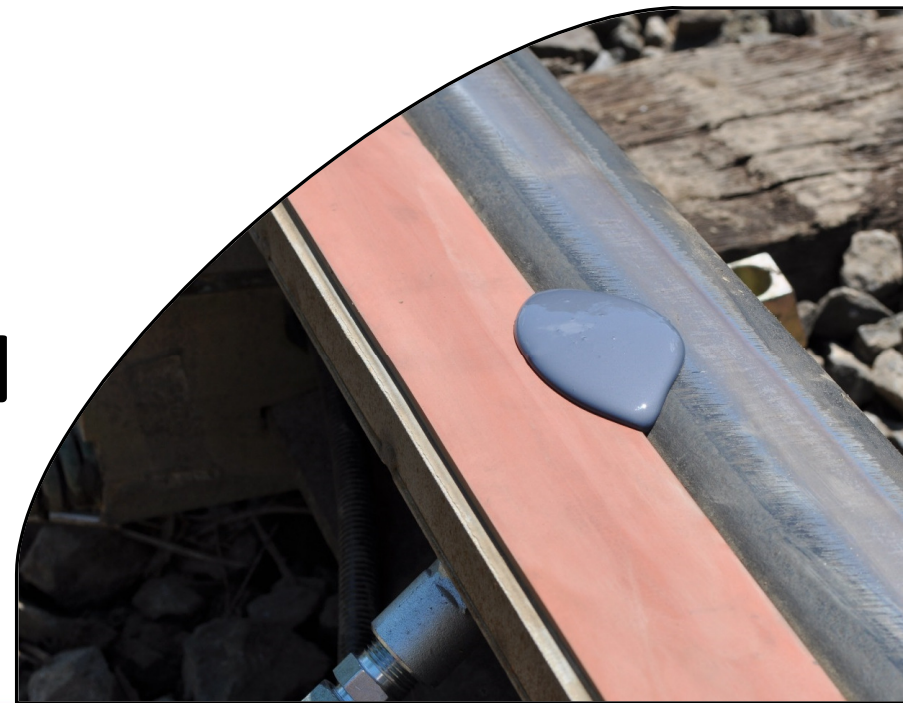
- All-season products  
- Premium raw materials leading to higher performance  
- Environmental considerations  

TCO
Total Cost of
Ownership





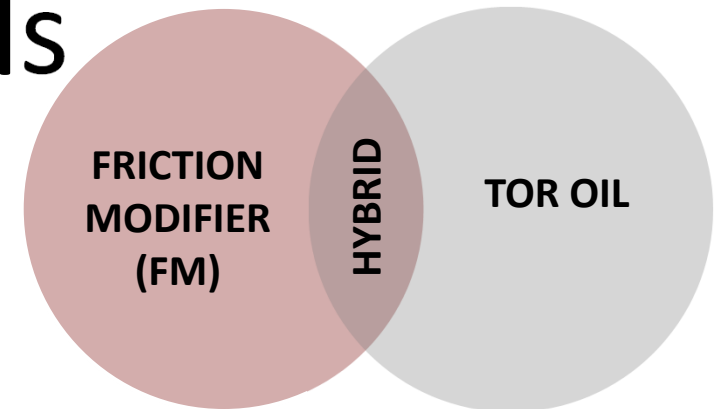
TOR PRODUCTS TRACKSIDE APPLICATION



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Trackside TOR Materials

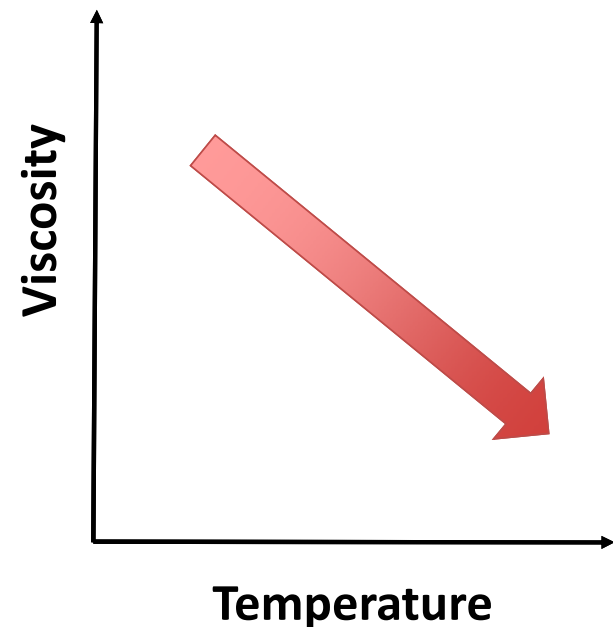


	Friction Modifier	Hybrid	TOR Oil
Base	Water	Oil and Water	Oil
Friction Level	Intermediate	Intermediate to Low	Intermediate to Low
Drying Characteristics	Dry film	Non-drying	Non-drying
All-Season Available?	Yes	Yes	Yes



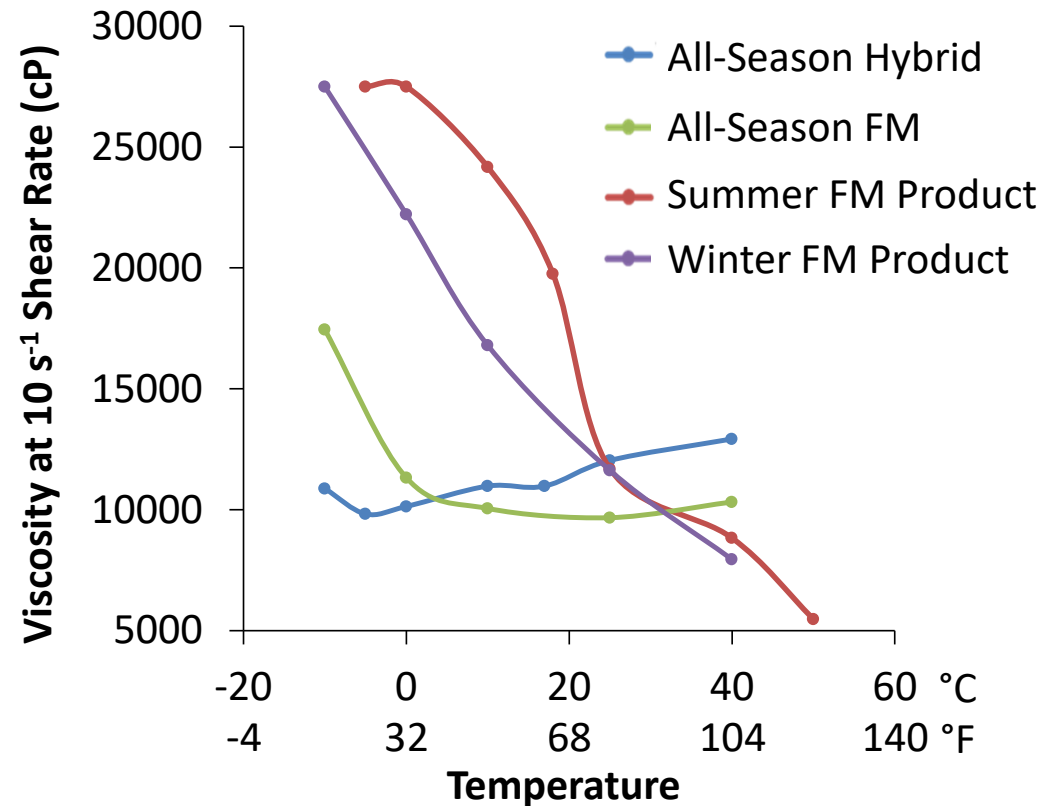
Why do we have seasonal products?

- Diverse operating temperatures
 - -40 to 50°C, -40 to 122°F
- Seasonal products are used to maintain consistent application for their respective seasons
- All water and oil-containing materials will follow trend for viscosity vs temperature



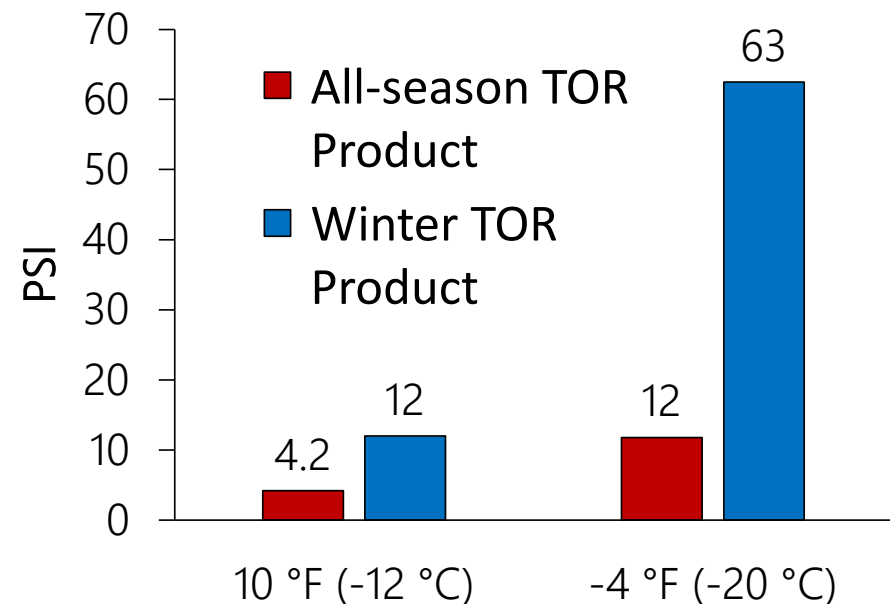
Viscosity-Temperature Relationship

- Flat viscosity-temperature relationship leads to:
 - Consistent carry down and adhesion properties
 - Consistent product output
 - Better product stability in tanks



Low Temperature Pumpability

- Low pressure viscometer simulates trackside pumpability
- All Season requires less pressure than the Winter product → easier to pump in colder temperatures
- Improved low temperature pumpability results in faster fill times



Pressure Viscometer Data

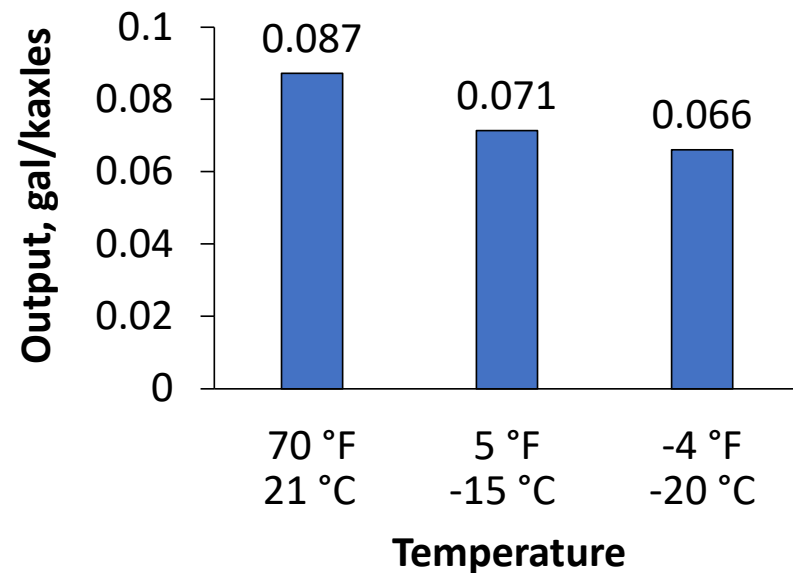


Low Temperature Pumpability

- Low temperature pumpability also assessed using a cold chamber*
- All Season TOR FM product has minimal volumetric output changes



* Pump setting was kept consistent



High Temperature Properties

- Product stability in higher temperatures
 - Standardized test, 1 week temperature cycling, -18 to 70 °C, 0 to 158 °F
- Optimized carry down transfer mechanism
- Adhesion to hot rails (drying time)



Stable Product



Unstable Product



All-Season TOR Product Comparison

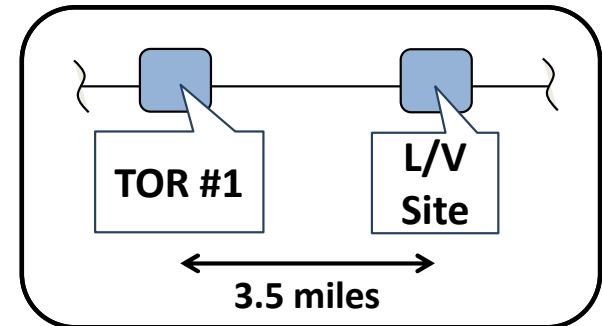
- Field trial conducted to determine All-Season product performance in direct comparison to a Winter FM
- Laboratory results for trial products:

Properties	All-Season FM	All-Season Hybrid	Winter FM
Base	Water	Oil and water	Water
Freezing Point °C (°F)	-30 (-22)	-25 (-13)	-16 (3.2)
High Temperature Properties	Good	Good	Inadequate
Low Temperature Properties	Good	Good	Good



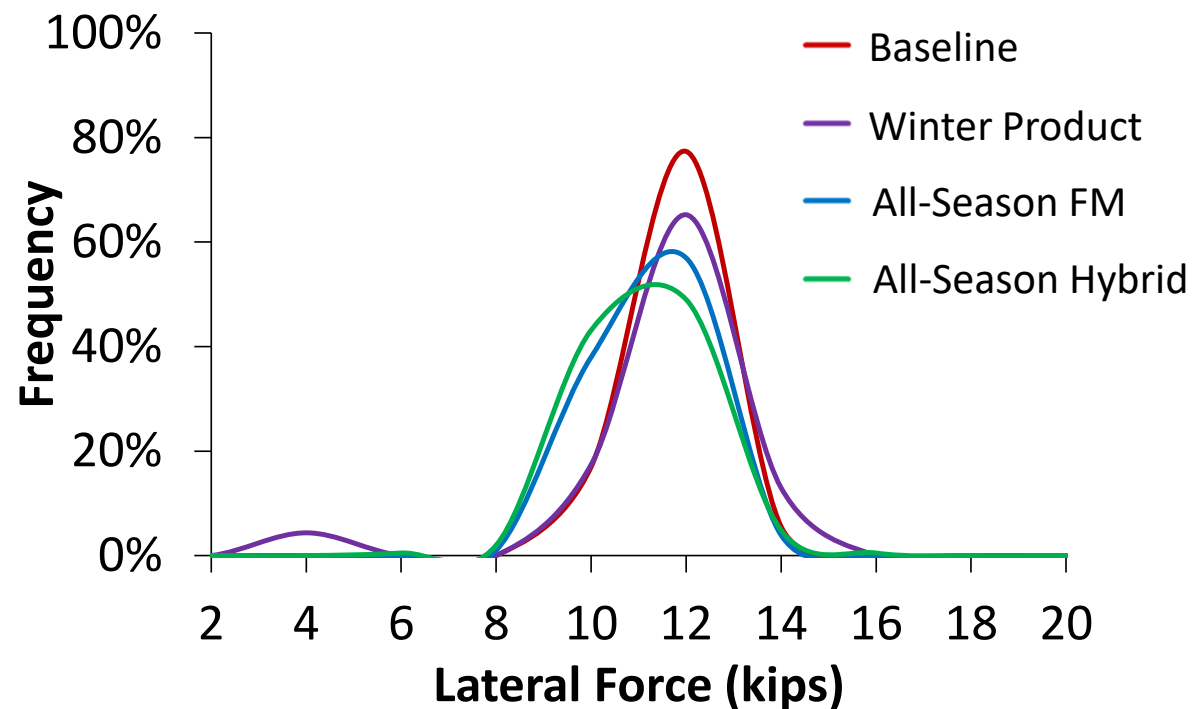
TOR All-Season Product Trial Location

- River grade, bidirectional traffic
- Environmental temperatures between:
 - 10 and -25 °C with an average of -8 °C
 - 50 and -14 °F with an average of 17 °F
- 8°08' instrumented curve



TOR All-Season Trial

- All-season FM and Hybrid have comparable results
 - Both improved over Winter product



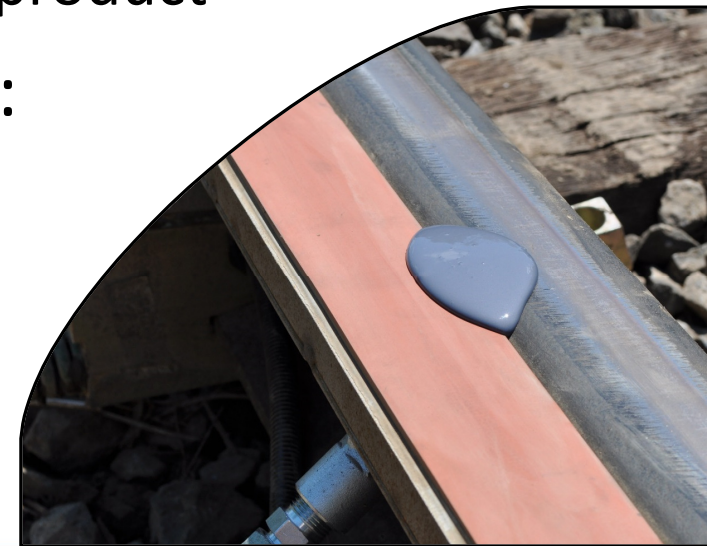
Demonstrated All-Season Performance

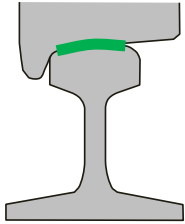
- All-season Friction Modifier has been observed over a few years in different territories:
 - Dry desert-like location with above 32 °C/90 °F summer and -9 °C /15 °F average winter temperatures
 - Mountainous territory with average yearly temps of -10 to 30 °C (14 to 86 °F)
- Product performance was good in all weather conditions:
 - Good pumpability at low temperatures
 - Not too thin in warm temp → effective wheel pick up and carry down



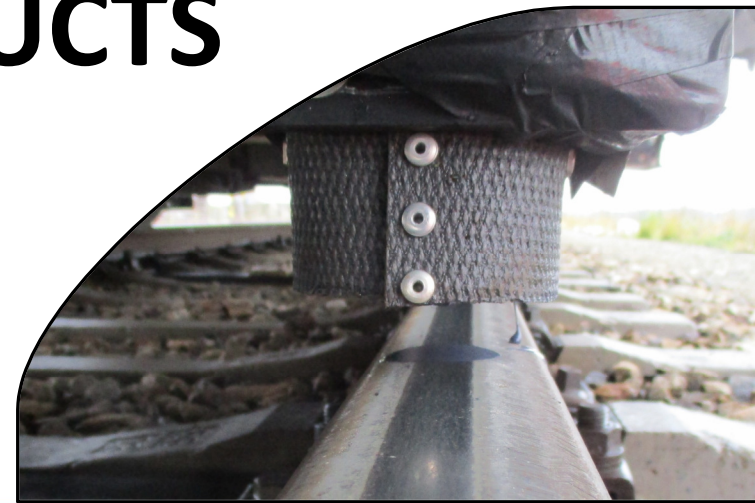
TOR Trackside Consumable Advancement

- Advances in TOR product led to enhanced performance
 - Demonstrated all-season use
 - Longer product carry down over seasonal product
- Consumable advances drive lower TCO:
 - Less site visits for product switchover and filling
 - High-quality coverage in shoulder seasons
 - Less product to manage and inventory





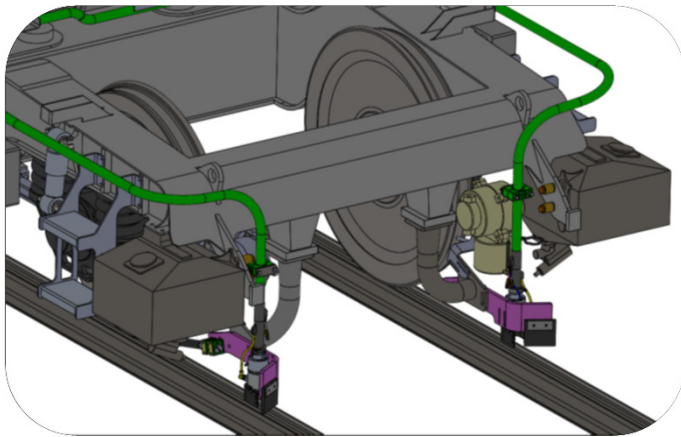
TOR CONSUMABLE PRODUCTS ON-BOARD APPLICATION



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On-Board TOR Consumable

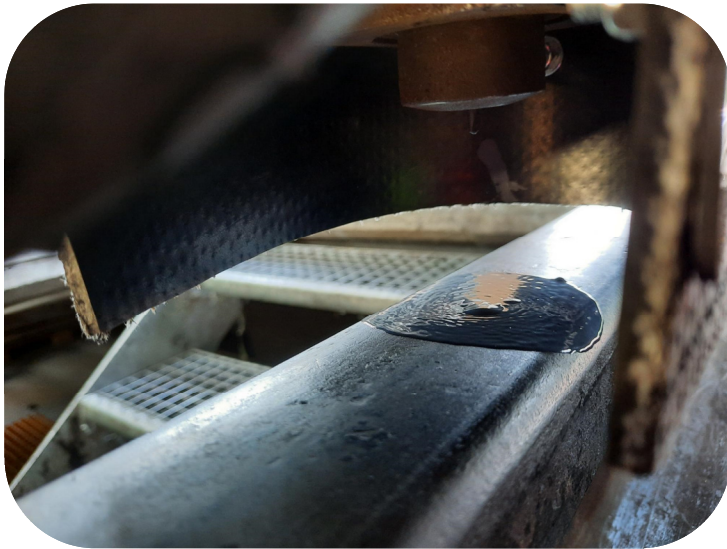


Water-based friction modifier material sprayed direct to the TOR

- Same benefits as trackside application
- Product is continuously /selectively applied to the TOR
 - ~3-5% in energy reduction
 - Reduction in lateral forces in curves
 - Reduction in wheel tread wear and tread defects




On-Board TOR FM Application



- Historically, systems use heating due to freezing point of the consumable
- All-season material development:
 - Provides wider operating temperature range without heating
 - Reduces unit price of the system
 - Reduction in life cycle cost
 - Reduction in unplanned maintenance activities
 - Improvement in overall uptime of system

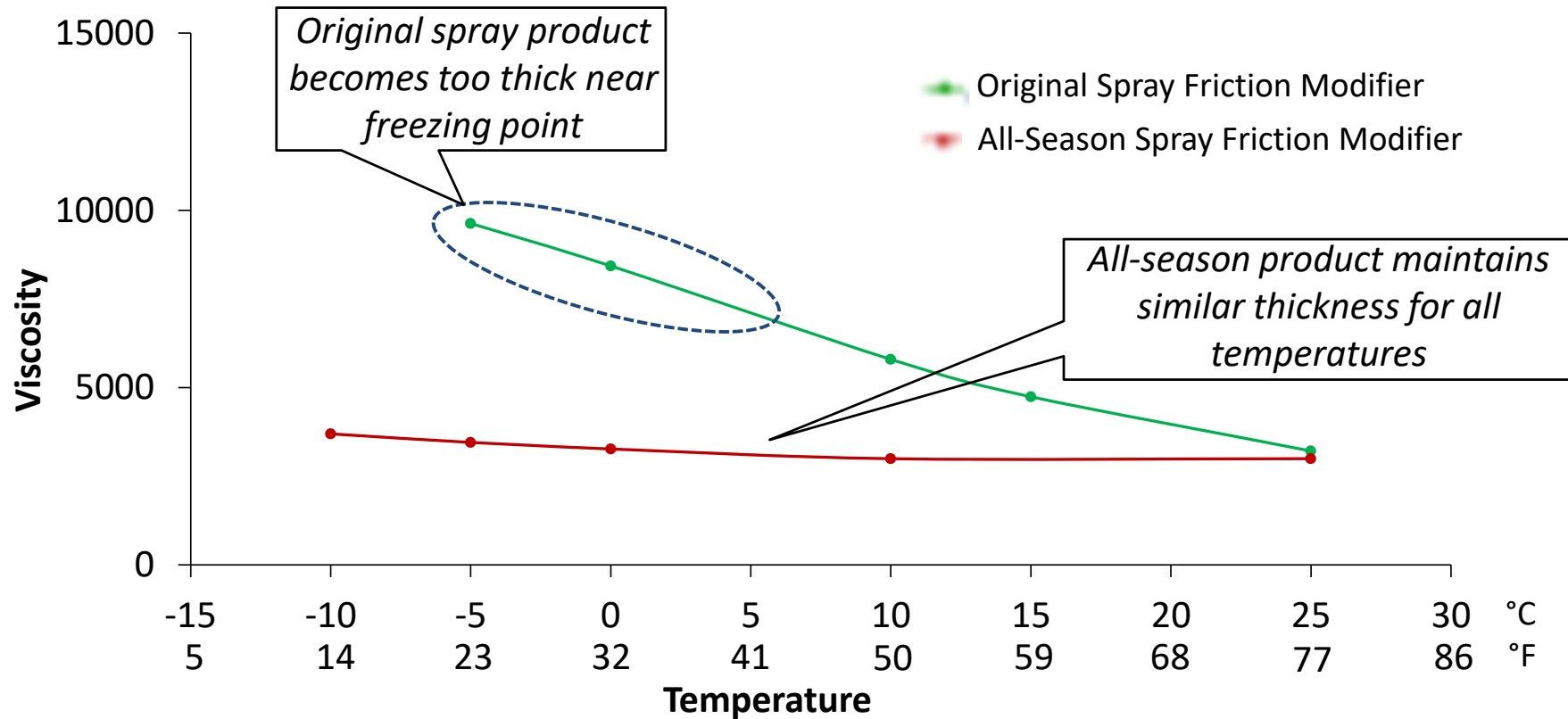


Trackside vs On-Board Consumable

	Trackside Water-Based Friction Modifier	On-Board Water-Based Friction Modifier
Appearance		
Viscosity	Thick (22,000 cP @ 25° C)	Thin (2,400 cP @ 25° C)

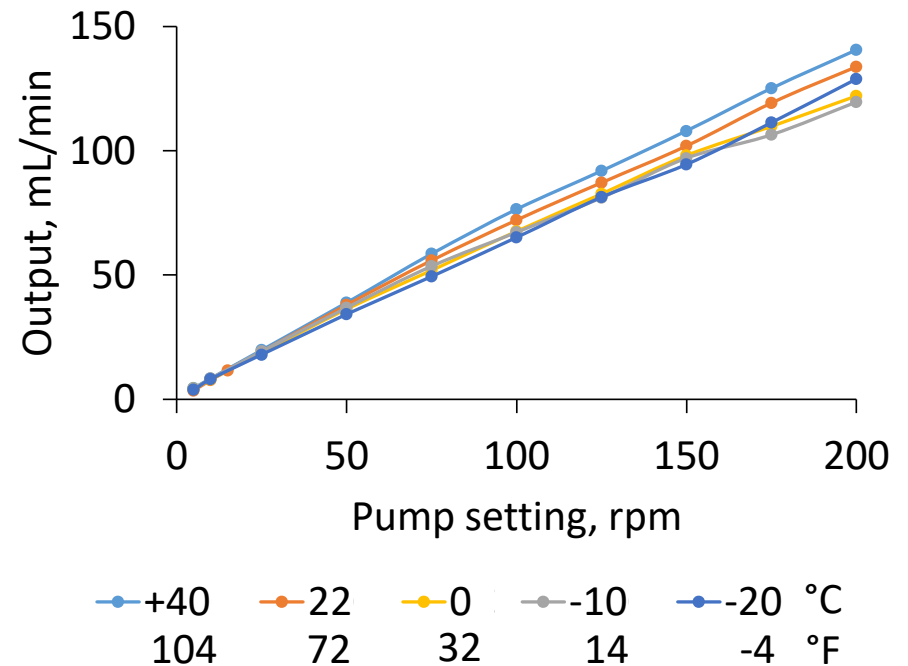


All-season TOR Spray



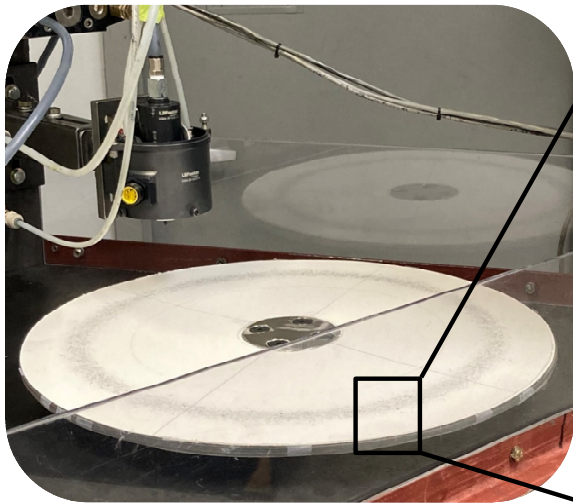
Product Output

- Stable output vs. temperature



Spray Quality

- Spray Test Rig used to assess spray pattern at varying temperatures



Original Product
@ -5 °C (23 °F)

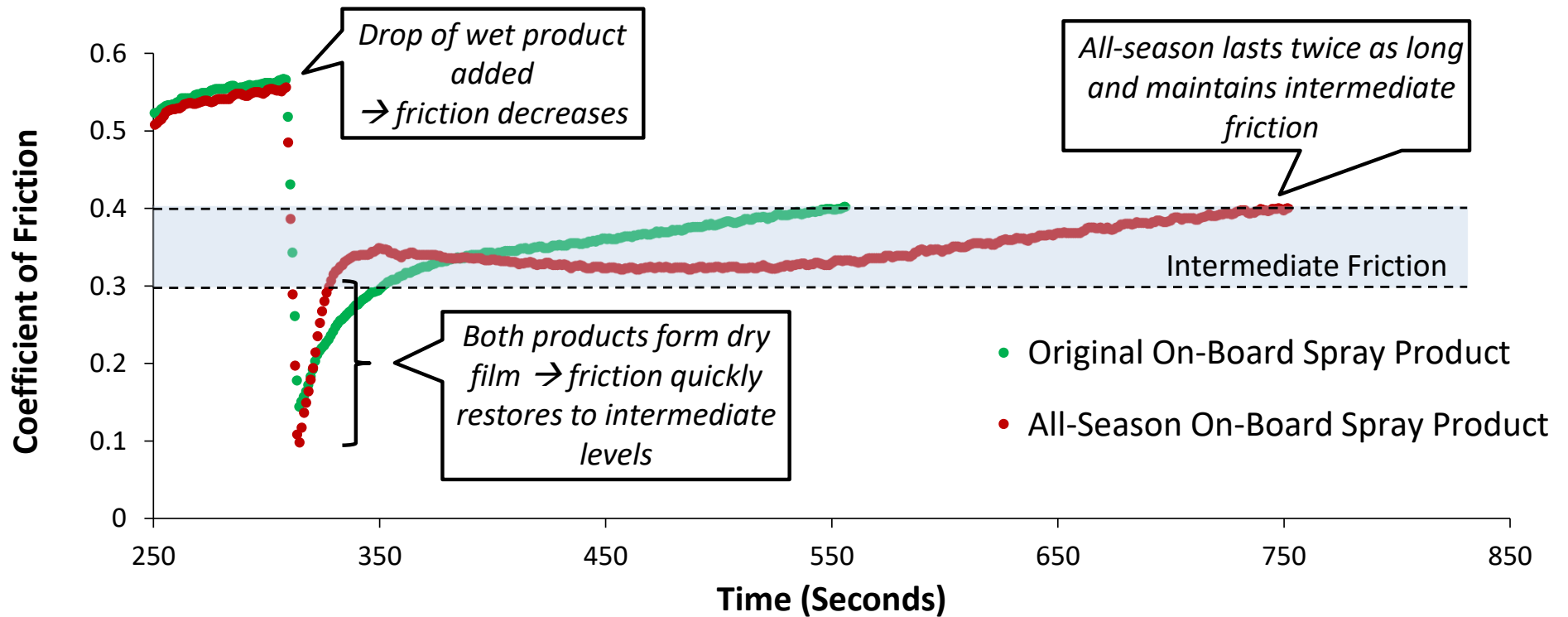


All-Season Product
@ -20 °C (-4 °F)



Performance Testing

- Premium raw materials were added to improve performance



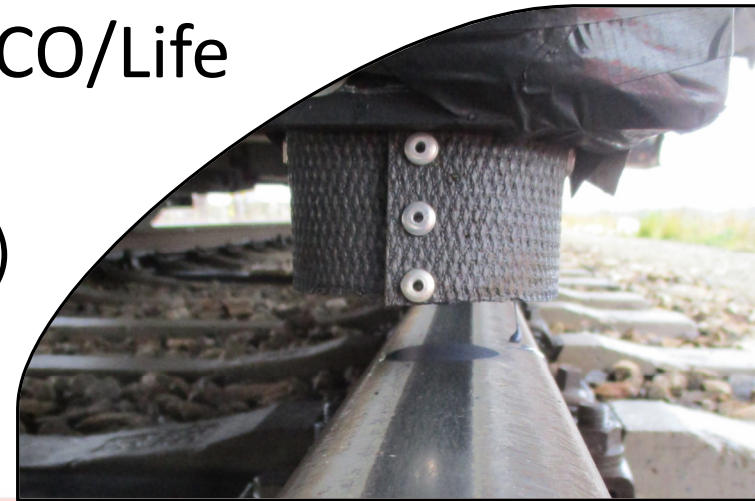
On-Board TOR Formulation Development

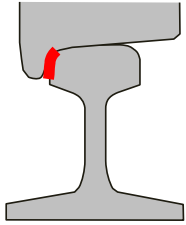
- Advancements in raw material development has led to more environmentally friendly offsets
- Latest technology of additives used in all-season TOR spray product



On-Board TOR Development

- Premium raw materials led to increase performance
 - Optimized spray quality for operating temperature range
 - Use of environmentally friendly raw material replacements
- Consumable advances drive lower TCO/Life Cycle Cost:
 - Reduced maintenance (simpler system)
 - Lower cost for application equipment





GAUGE FACE (GF) PRODUCTS TRACKSIDE APPLICATION



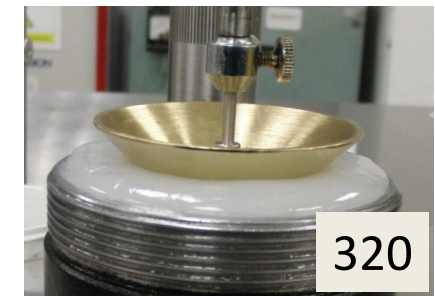
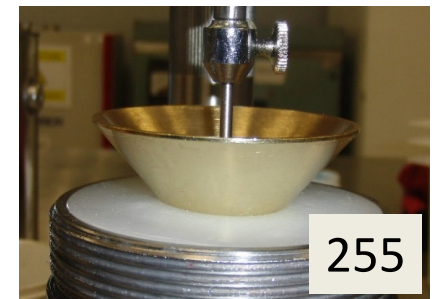
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Grades of GF Grease

- The consistency of a grease will **harden** with lower temperatures and **soften** with high temperatures
- All-season greases must have flat viscosity vs temperature profiles

Season	Penetration	NLGI Grade	Analogy
Summer	265-295	2	Peanut Butter
Winter	310-340	1	Tomato Paste
All-season	295-330	1 to 1.5	-



Seasonality

Grease features at hot temperatures

- Acceptable product thickness (not too thin)
- Acceptable oil separation
- Low propensity for bar clogging
- Good adherence to hot rails and wheels

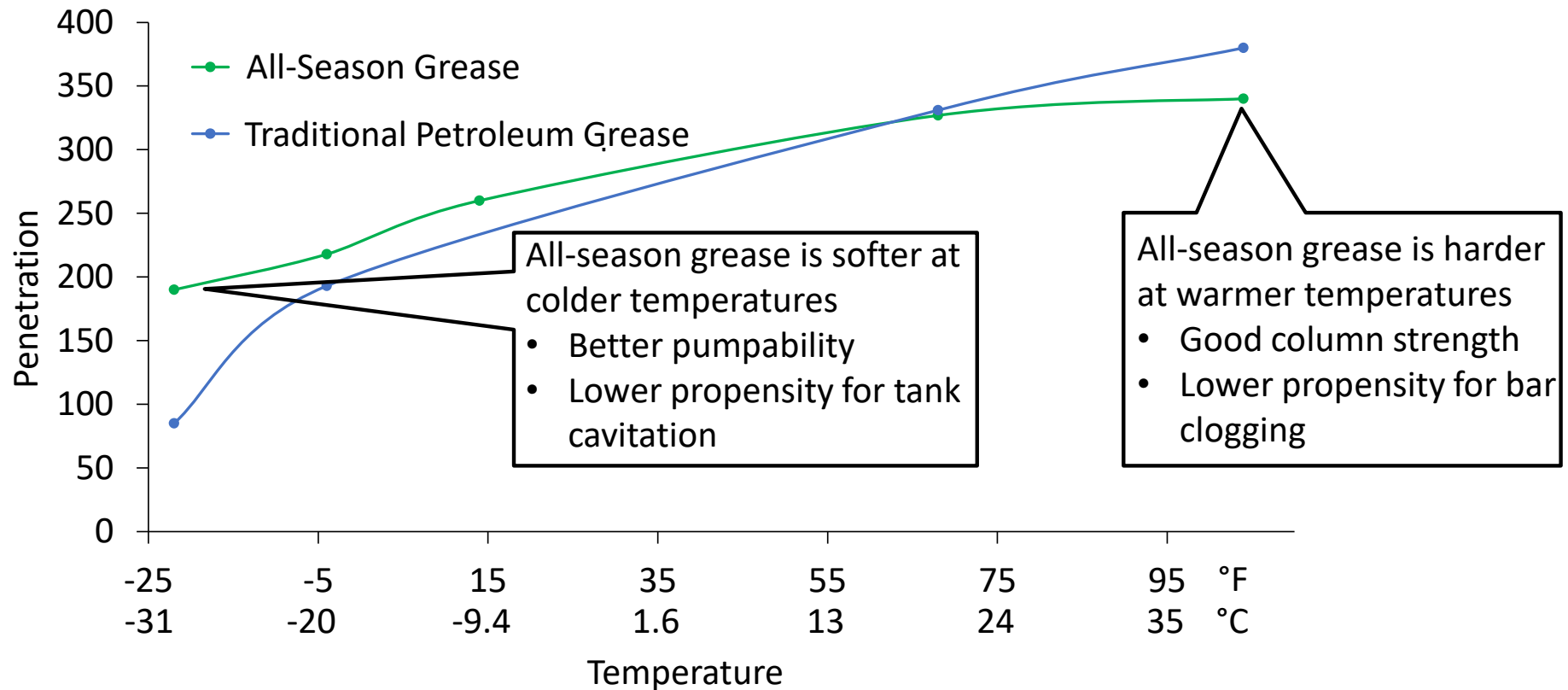


Grease features at cold temperatures

- Good grease pumpability
- Acceptable tank cavitation
- Consistent product volumetric output as a function of temperature
- Good adherence to cold rails and wheels

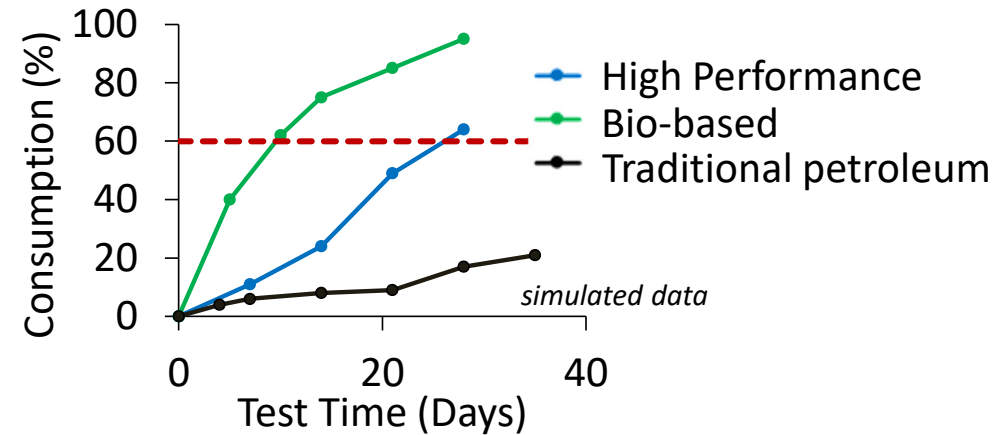


Penetration vs Temperature



Environmental Considerations

- Three levels of oil-based product biodegradability*
 - “Ready” – Material will be consumed quickly in the environment
 - “Ultimately” – Complete breakdown of material will eventually be achieved
 - “Inherently” – Some degradation is seen, but full breakdown of material will take years



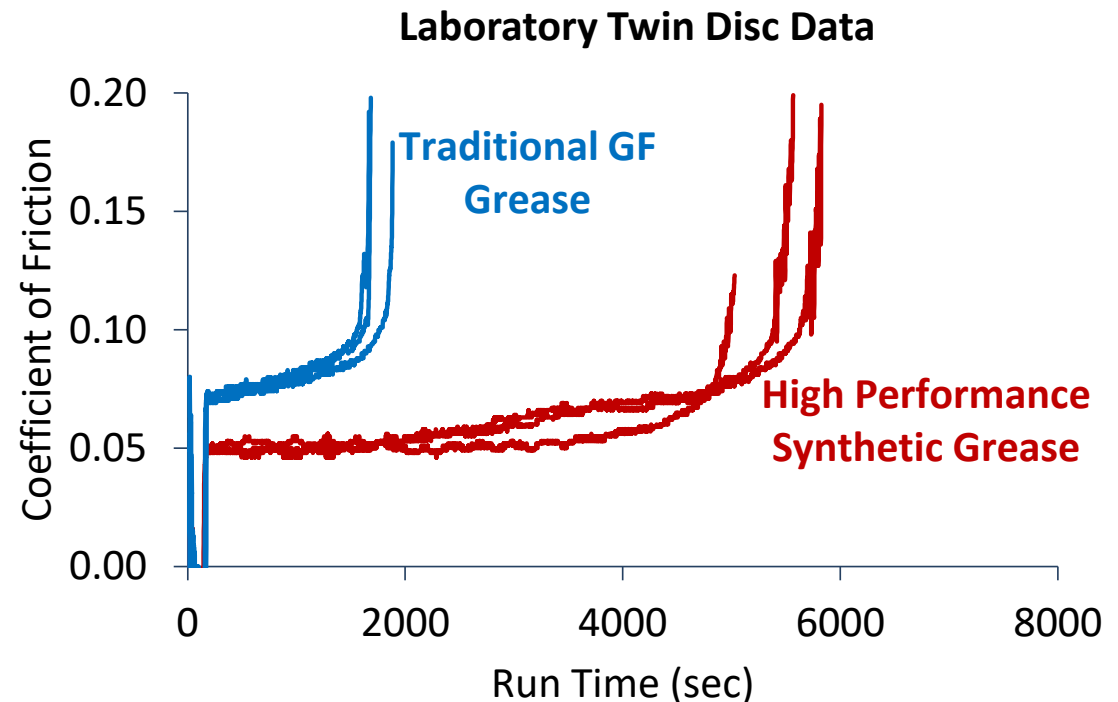
Grease Type	Biodegradability
Traditional petroleum	Inherently
Bio-based	Ready
High performance synthetic	Ultimately

*As per OECD 301B Test for Biodegradability

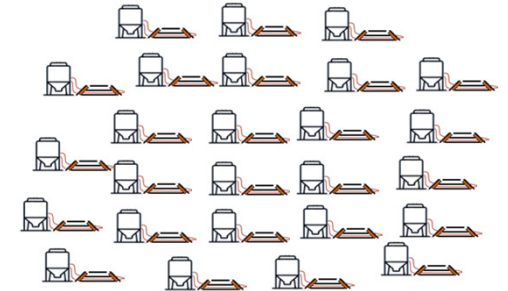
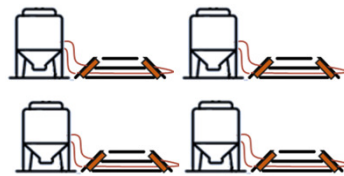


Advances in GF Grease Technology

- Premium raw materials are used in high performance synthetic grease
- Synthetic grease has better durability
 - Potential for reduced application rate to achieve benefits



Advances in GF Grease Technology



1 Unit Assessment

- Assessment of:
 - Product carry down
 - Tank cavitation
 - Bar clogging propensity
 - Pumpability
 - Oil separation in tank

4 Unit Zone Assessment

- Similar assessment in first trial using harsher conditions
 - Loaded traffic
 - Bidirectional traffic
 - Higher temperatures

Subdivision Assessment

- **50%** application rate
- Determine FM benefit
- Wear rate analysis over extended period of time and seasons



Subdivision Wide Assessment



High performance product was used at 50% application of the original seasonal grease



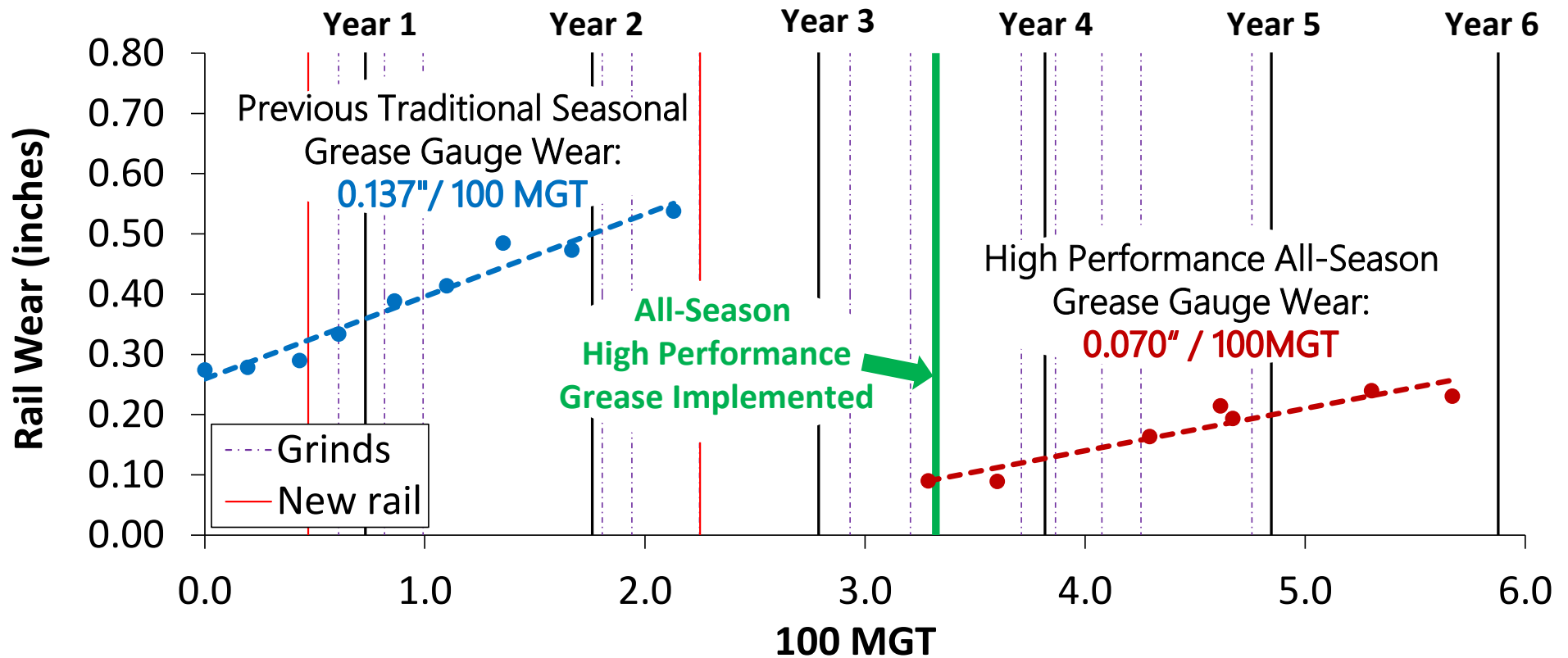
25 GF trackside units filled, 20 curves were monitored over all weather conditions



Wear rate analysis (using geometry car data) was used to show effectiveness of grease



Subdivision Field Trial – 7.6° Curve



Advanced GF Grease

- Premium raw materials led to increase in performance
 - Benefits can be achieved at 50% application rate
 - Demonstrated all-season use
 - Improved biodegradability rating
- Consumable advances drive lower TCO:
 - Reduced rail wear
 - Lower annual product consumption
 - Significantly less track accesses



Summary

- Consumable advancement drives a lower TCO
- Major advancements in Consumables are:
 - Demonstrated all-season products
 - Use of premium raw materials for increased performance
 - More environmentally friendly materials



Thank You!



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