David DeVore

Present Affiliation	**Functional Products Inc.**
Areas of Interest	• **Polymer additives for lubrication** • **Strategies to reduce formulation costs**
Achievements / Awards	**PPC Gonsalves Memorial Award (NLGI-IC 2018)** **NLGI Author Award (2018), ELGI Best Paper Award (2011)**

Upgrade Your Grease with FUNCTIONAL Polymer Technology

David DeVore, Erik Willett
Functional Products Inc.
NLGI-IC 27th Lubricating Grease Conference – Pune, India

Functional Products Inc.

FUNCTIONAL PRODUCTS INC.
Innovative Chemistry for Lubricants

- US-based additive manufacturer – 40 years in the industry
  - Specializing in polymer-based technology with excellent service
- ISO 9001:2015 with Design
- NLGI-IC attendee for 17 years (Aurangabad 2008)
- Distributed by Environ in India for 20+ years
  - NLGI-IC sponsor, please visit their booth

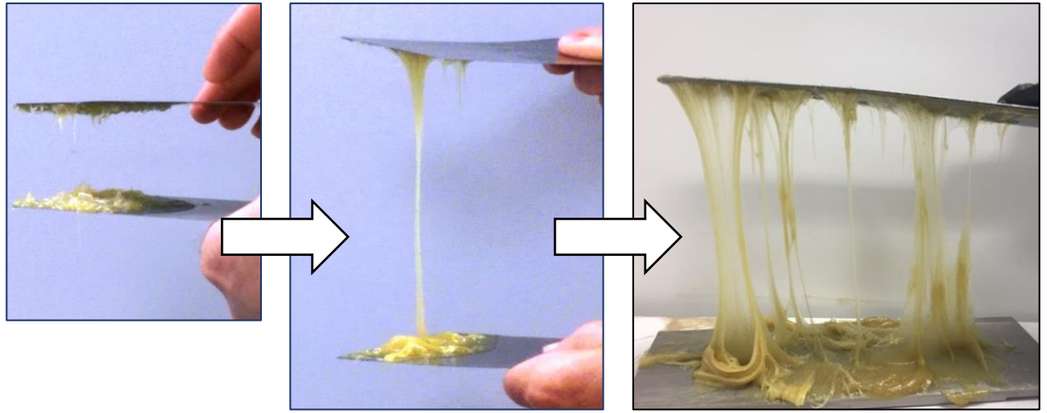
environ

Agenda

- Polymer additives to enhance grease
  - Tackifiers for adhesion/cohesion and tactile feel
  - Specialty “grease polymers” to improve test performance
- How Functional Products can help you succeed in grease R&D

Tackifiers

- Very high molecular weight polymers used to add viscoelasticity (“tack”)
- Treat rates from 0.25 – 4.0wt%
- Tack and feel is the first thing a customer experiences



Key Benefits

- Improved adhesion of the grease to metal surfaces
  - Prevents fling-off from high speed machinery
  - Allows stiffer greases to adhere properly
- Improved cohesion of the grease film layer
  - Enhanced ability to seal out dirt, dust, water
  - Prevents grease from channeling in a bearing, rack and pinion, etc.

Recommended Options

FUNCTIONAL V-176

- **Standard grade**
- Well-balanced performance
- Light color

Improved cost

FUNCTIONAL V-178N

- Higher molecular weight
- Lower cost and treat rate
- Dark color

Improved milling resistance

FUNCTIONAL PARATAC

- Lower molecular weight
- Resistant to loss of tack during milling (polyurea, clay, CaSX)

Specialty Tackifier Options

Some examples of specialty tackifiers developed for specific markets/needs

Colorless for Textile Machinery
FUNCTIONAL V-298

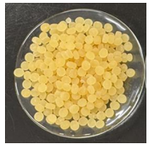
Biobased & Biodegradable
FUNCTIONAL V-584

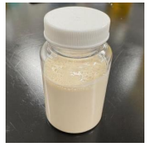
“Full Synthetic” / “Oil-Free” Claim
FUNCTIONAL V-188P2

“Grease Polymer” Technology

- “Grease polymers” are polymer concentrates that reinforce the thickener
- Polymer-modified greases outperform on tests including:

	Oil Bleed	Water Resistance	Mechanical Stability	Antiwear Testing	Bearing Life and EMCOR Corrosion
Test Method	D6184, D1742	D4049 (WSO), D1264 (WWO)	D217 (100K), D1831 (roll)	Promotes retention of grease in contact zone	Improves grease retention in unshielded bearings



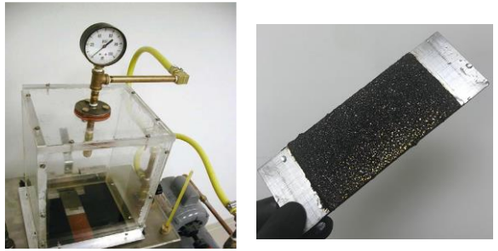


What Can Grease Polymers Do?

Reduction in static and dynamic oil bleed

Oil bleed reduced by 90%

Reduction in water sprayoff and water washout %



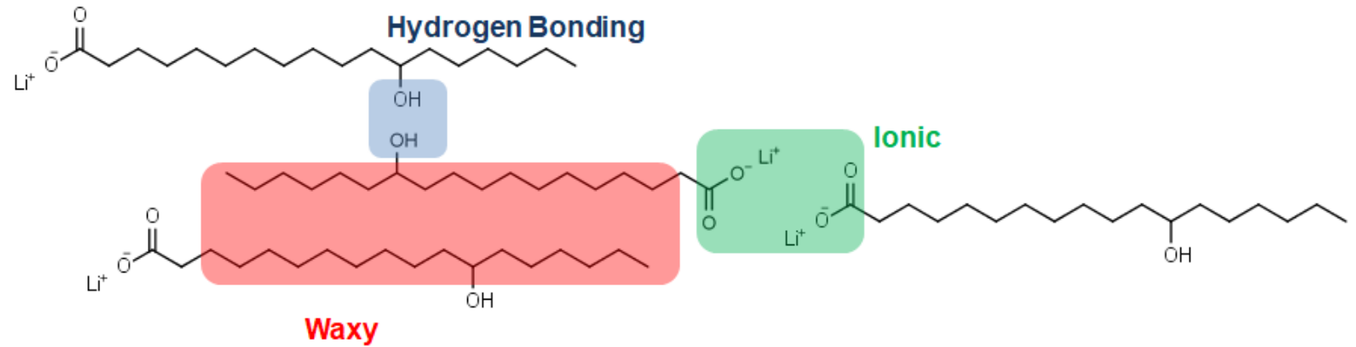
90% water sprayoff reduced to 20%

Improve mechanical stability

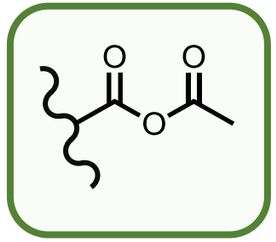
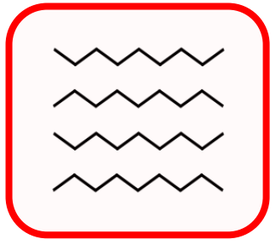
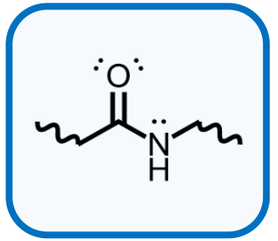
Up to 95% reduction in % change with roll stability

How It Works – Modifying the Structure of Grease

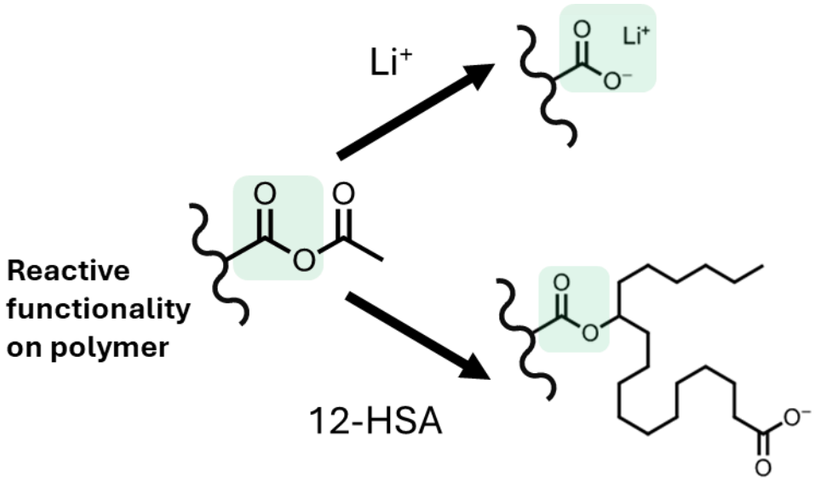
- Greases are held together by three fundamental interactions
- For example, in lithium grease:



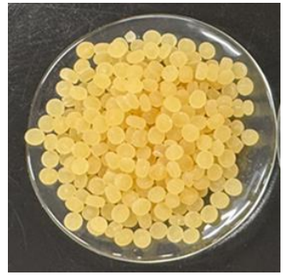
Three Types of Grease Polymers

	Reactive Polymer	Crystalline Polymer	Associative Polymer
			
Highest Effect With:	Soap-based greases (Li/LiX)	Detergent-based greases (sulfonates)	Particle-based greases (clay, silica, PU)

Reactive Grease Polymer: FUNCTIONAL V-4020

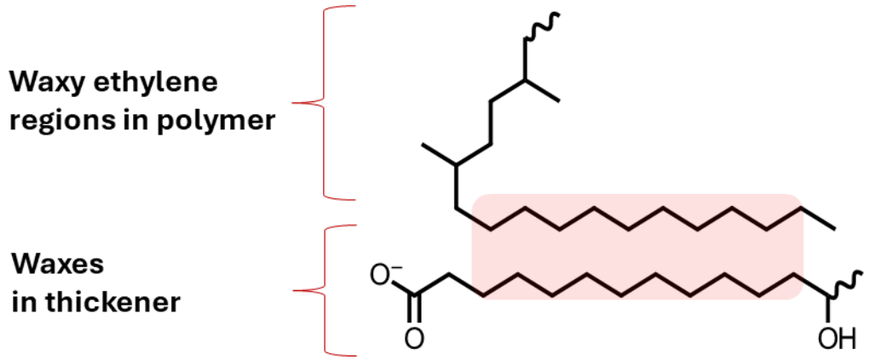


- V-4020, “multi-functional” chemistry that is added during saponification
- Forms polymer complex like a diacid with Li^+
- Forms ester like a borate with hydroxyls / 12-HSA



Pellet Form

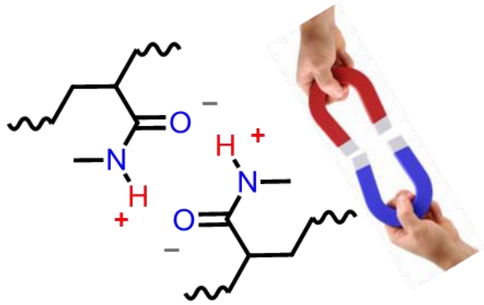
Crystalline Grease Polymer: FUNCTIONAL V-207



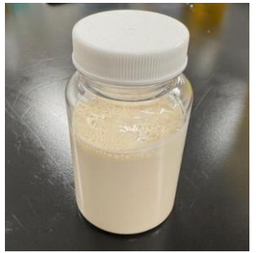
- V-207 is cooked into grease after saponification
- Used in detergent greases: calcium sulfonate, calcium sulfonate complex
- Adds fiber-like reinforcement for significant water resistance

Flake Form

Associative Grease Polymer: FUNCTIONAL V-191

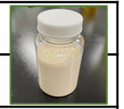


- Best for greases with particle structure like clay, silica, polyurea
- Positive/negative charges between the polymer and thickener bind them together and reinforce
- V-191 is added with cool down oil, before additives



Emulsion

Grease Polymer Summary

Polymer Type	Reactive 	Crystalline 	Associative 
Additive	FUNCTIONAL V-4020	FUNCTIONAL V-207	FUNCTONAL V-191
Best Application	Soap based grease • Li, Li Complex • Anhydrous Calcium • Aluminum Complex	Detergent based grease • Calcium Sulfonate & Complex	Particle based grease • Clay • Silica • Polyurea
Typical Treat	0.20 – 0.40wt%	0.25 – 1.0wt%	0.25 – 1.0wt%
Key Benefits	Water Resistance Mechanical Stability Yield Improvement	Water Resistance Oil Bleed	Oil Bleed Water Resistance

Grease Projects and Testing

- Send 5 liter sample of base grease to us
- Functional lab can top treat to scout the best additive and wt% to achieve your goal
- We support NLGI's new HPM specification program and will help you pass the tests

Area	Tests	GC-LB	HPM	HPM WR	HPM CR	HPM HL	HPM LT
Consistency, Worked Cone	D1403 (1/4-scale), D217 (100Kx)	X	X	X	X	X	X
Roll Stability	D1831 (2hrs@RT, 50hrs@80C)		X	X	X	X	X
Dropping Point	D566 (old), D2265 (new)	X					
Low Temperature Rheology	Brookfield viscometer to -60C		X				XX
Low Temperature Torque	D1478 (-20 or -30C)		X	X	X	X	XX
Kesternich Mobility	DIN 51805 (-30C)						X
Oxidative Stability RPVOT	D942 (100hrs@100C)		X	X	X	X	X
Oil Separation, Conical	D6184 (30hrs@100C)		X	X	X	X	X
Oil Separation, Storage	D1742 (24hrs@25C)	X	X	X	X	X	X
Water Washout	D1264 (1hr@79C)	X	X	XX	X	X	X
Water Sprayoff	D4049 (5min@40C)			X			
Roll Stability with Water	D8022 (2hrs@RT)			X			
4-Ball Wear Scar	D2264	X	X	X	X	XX	X
4-Ball EP and Load Wear Index	D2596	X	X	X	X	XX	X
Copper Corrosion	D4048 (24hrs@100C)		X	X	X	X	X
Elastomer Compatibility	D4289 (168hrs @ 125C)	X	X	X	X	X	X

"XX" = improved requirements for this category

Summary

To get you started with improving your greases using FUNCTIONAL polymer technology

For tacky grease

Good – **FUNCTIONAL V-178N** for economics

Better – **FUNCTIONAL V-176** for balanced performance/cost

Best – **FUNCTIONAL PARATAC** for resistance to milling

To improve oil bleed / water resistance / stability:

Soap Grease (LiX) – **FUNCTIONAL V-4020**

Detergent Grease (Sulfonate) – **FUNCTIONAL V-207**

Particle Grease (Clay, PU) – **FUNCTIONAL V-191**

Thank You! and Let's Start a Project

For questions: **ddevore@functionalproducts.com**

Product information and brochures online:
www.functionalproducts.com

FUNCTIONAL PRODUCTS INC.
Innovative Chemistry for Lubricants

Contact Environ, our distributor for India:
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