FUNCTIONAL PRODUCTS INC.

Innovative Chemistry for Lubricants

Biobased Lubricant Technology Opportunities in Forestry: Saw Guide and Chain Oil Packages SGP-567 and CO-545

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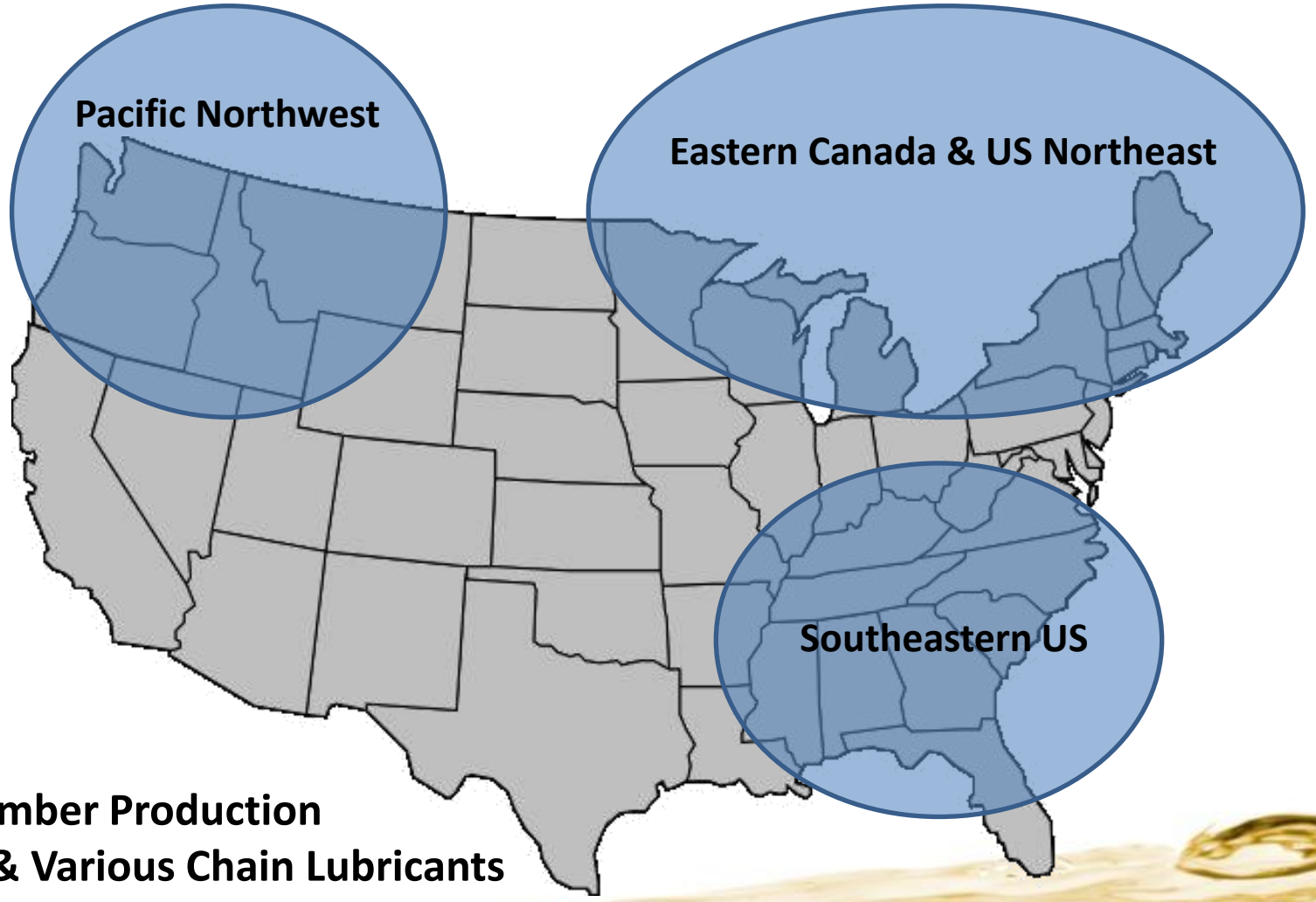
Market Assessment

- Saw Guide Oil: 3 – 5 million gallons in North America
- Multiple types of chains (Sharp Chain, Green Chain): unknown, but overall volume is likely much greater than SGO
- “Small” overall market size has eliminated major additive companies from investing in specific additive packages designated and tested for these applications
- Primarily a regional demand business

Primary Market Areas



Forestry/Lumber Production
Saw Guide & Various Chain Lubricants

- Saw Guide SGP-567 and Sharp Chain Oils CO-545
  - Used in multiple areas inside lumber mills
  - Represent unique niche lubrication applications in forestry
  - Traditionally served with conventional mineral oil formulations

- Ecological factors and new lubrication technology bring about the transition towards biobased formulations

The Case for Biobased Lubricants

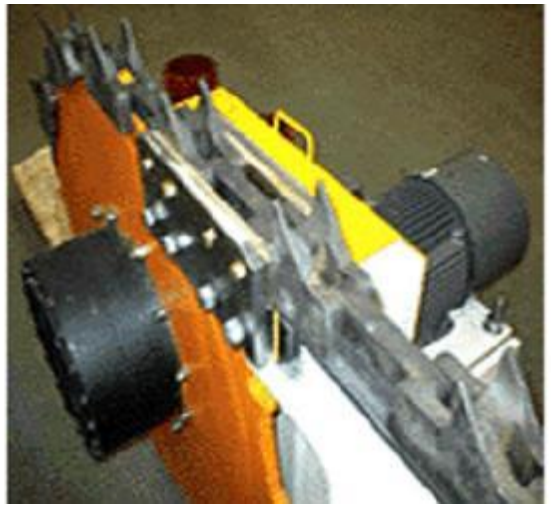
- Improved biobased technology – results in superior performance
- Both applications are “total or high fluid loss” leading to contamination concerns
- Properly formulated biobased products for these applications may be better lubricants than their petroleum based counterparts

The Case for Biobased Lubricants

- Distinct finished products
  - Saw Guide Oils of varying viscosity grades and degrees of tackiness
  - Chain Lubricant specific to a variety of chain only applications

Forestry Applications

Saw Guide array



Sharp Chain links

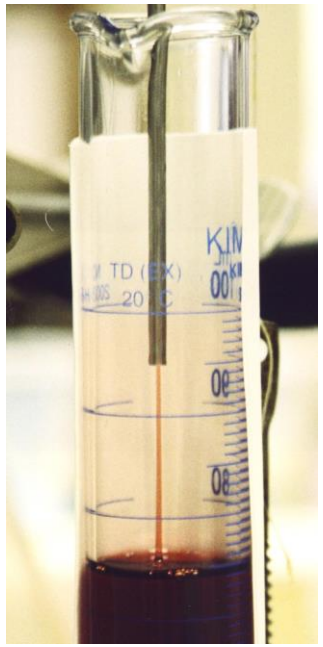
Green Chain

Benefits of Biobased Saw Guide using SGP-567 Oils over Conventional Formulations	
Excellent tackiness	Equivalent tack in biobased formulation using Functional V-584 and conventional formulations
Low friction	Coefficient of friction lower in biobased formulations
Available in several viscosity grades (68, 100 and 150)	All ISO grades can be met using Functional V-515 and Functional V-584 biobased thickener
Good demulsibility	ASTM D1401
Superior rust protection	ASTM D665 A/B plus improved humidity/salt fog performance using Functional SGP-567 XRP
Dispersancy/Cleaning	Solvency important to reduce pitch buildup
Low temperature handling	Pour point of -30°C in canola oil with added pour point depressant
AW/EP characteristics	Increased weld load in biobased formulation, acceptable wear scar in both biobased and conventional

Measuring Tack

This is not a scientific measurement of tackiness

Measuring Tack: Ductless Siphon Test



- Fluid is drawn through a standardized capillary via controlled vacuum
- Initial capillary position is below the fluid surface
- Fluid level within the cylinder drops as siphoning occurs
- A uniform string of viscoelastic fluid is formed
- Measurements of string length are objective vs. entirely subjective

Rating Tack by String Length

- Starting formulations available for:

	String Length
Tacky Saw Guide Oil	50 - 65
Very Tacky Saw Guide Oil	65 - 80
Exceptionally Tacky Saw Guide Oil	> 80

Starting Point Saw Guide Formulation: Biobased Very Tacky ISO 100 and 150

Component	Name	Treat Rate (%)
Tackifier	Functional V-584	7-11
Thickener	Functional V-515	8-11
Performance Additive Package	Functional SGP-567	1.5
Base Oil	Canola Oil	Balance

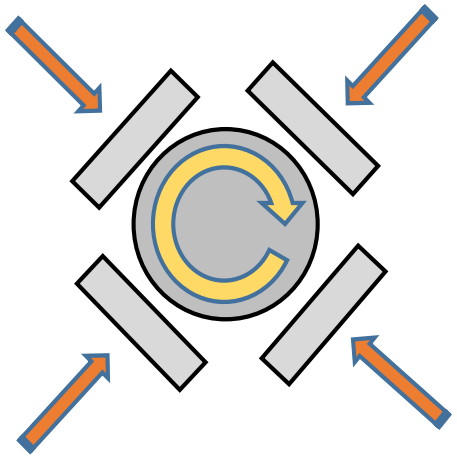
Functional Products has identified a unique bench test that provides relevant data to forestry applications

- Performance measurements
  - Wear scar
  - Coefficient of friction (C of F)
  - Specimen and fluid temperature (°F)
  - Torque

Bench Test Parameters

- **Speed – 600 RPM**
- **Rotating pin against machined bars**
  - **Bars – C 1137 steel**
- **Duration – Variable**

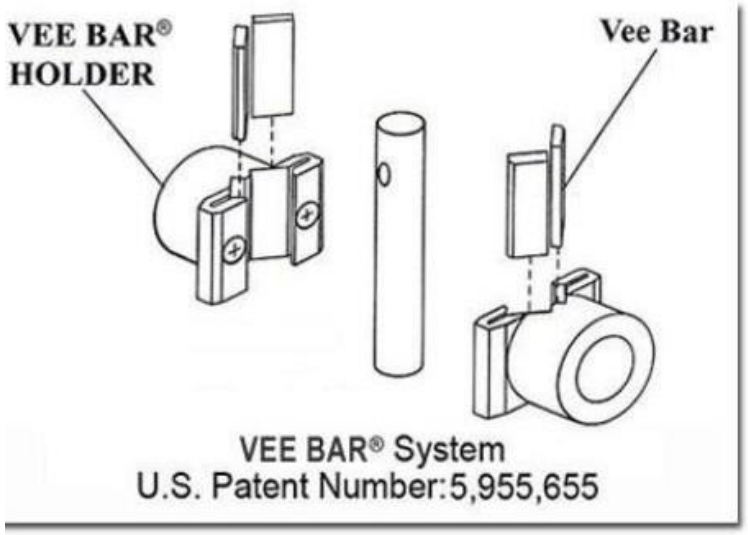
Test



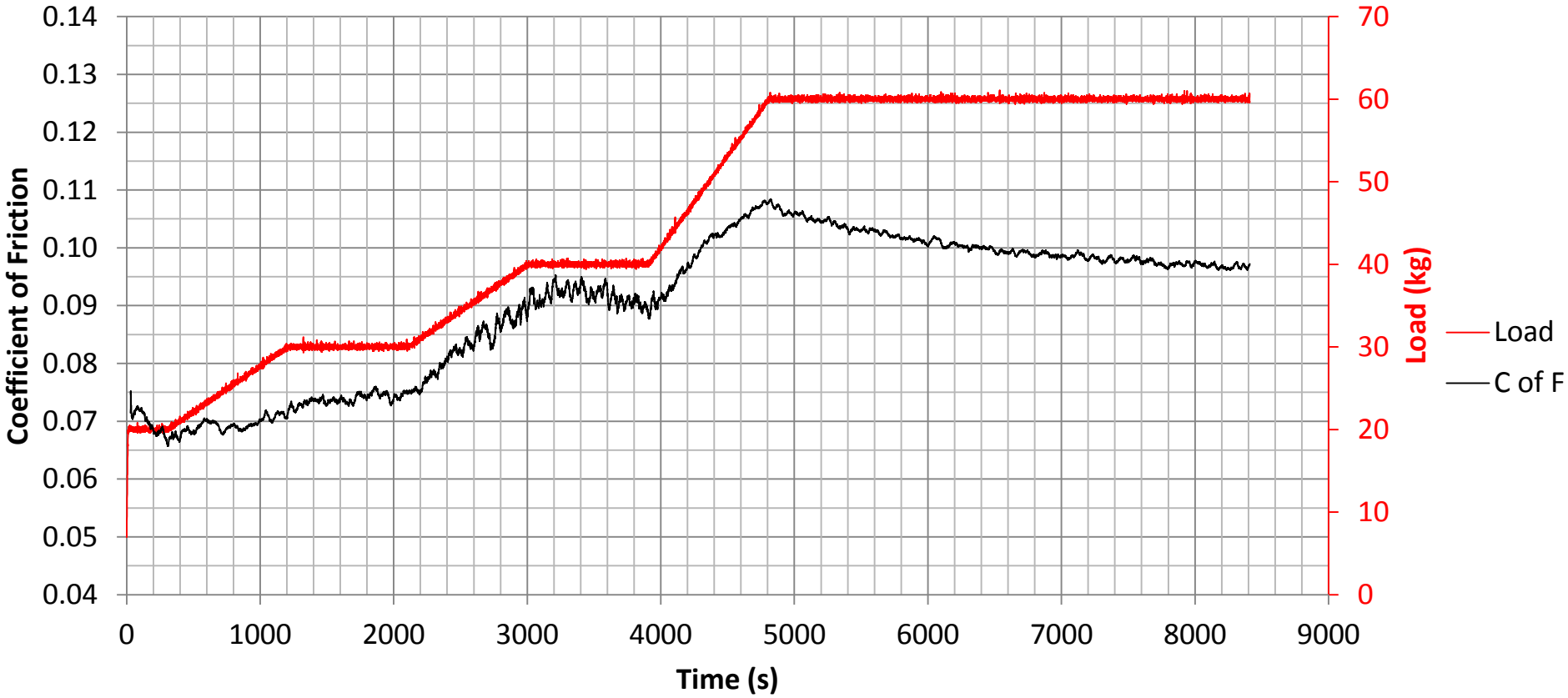
Directed load

Bench Test Parameters

PTI Epsilon Linear Precision Test Machine – a modified Pin and Vee test

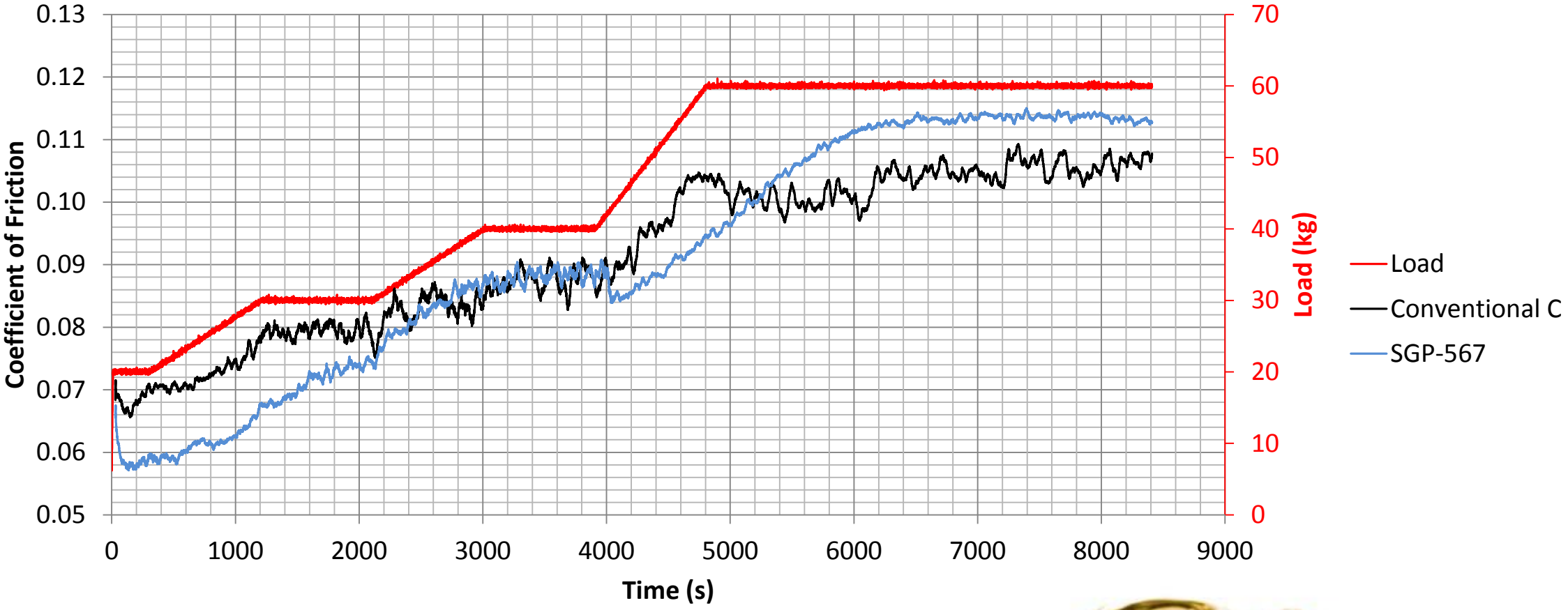


Ramp Up and Staged Load Test: ISO 150 Exceptionally Tacky with SGP-567



15 min ramp up between stages: 5 min at 20 kg, 15 min at 30 kg, 15 min at 40 kg, 60 min at 60 kg.

Ramp Up and Staged Load Test: ISO 100 Tacky Saw Guide Oils



15 min ramp up between stages: 5 min at 20 kg, 15 min at 30 kg, 15 min at 40 kg, 60 min at 60 kg.

Coefficient of Friction

- Coefficient of Friction (CoF) is a ratio

  Force required to move a body over a horizontal surface at constant speed under an applied load

$$\text{CoF} \equiv \frac{\text{Lubricant viscosity x speed}}{\text{Force of the perpendicular load against surface}}$$

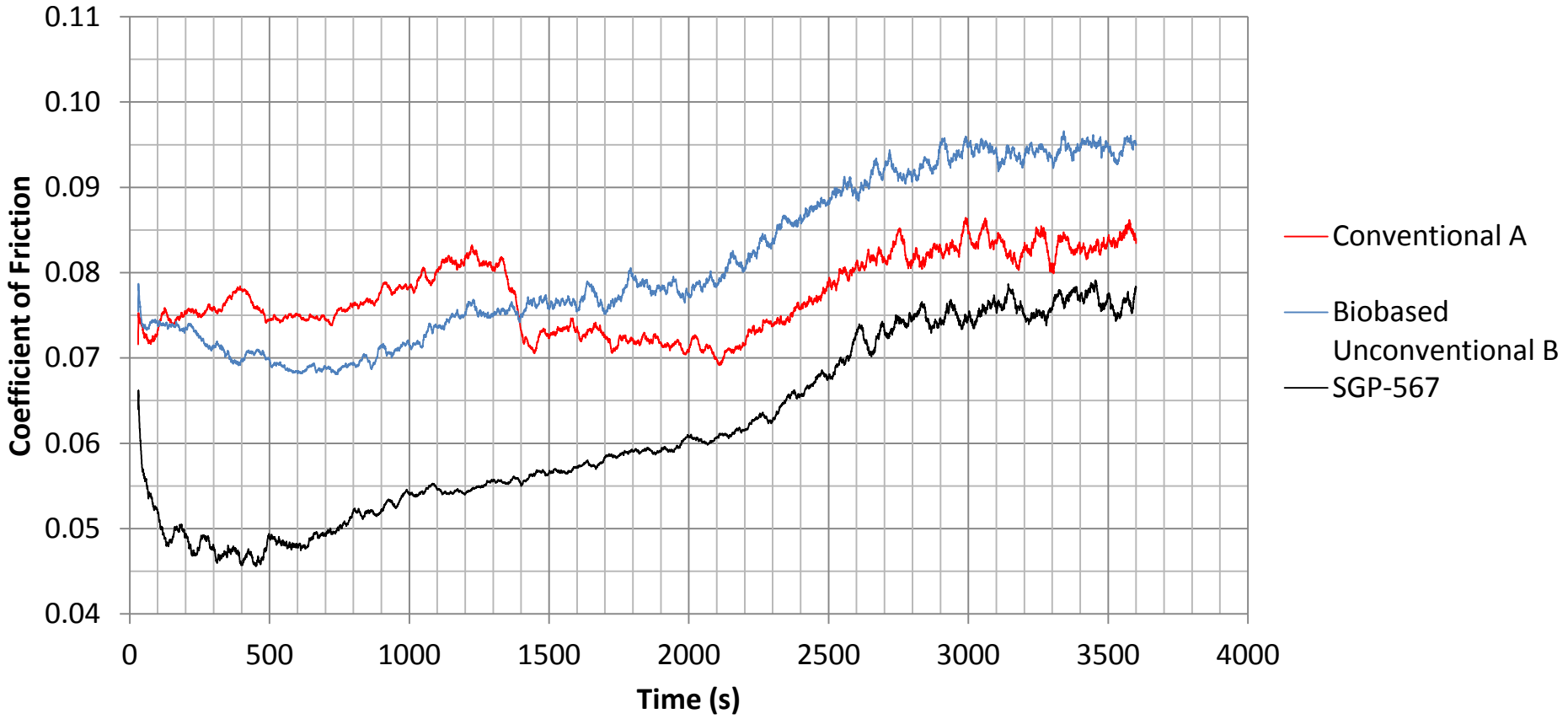
As the number of asperities on the surface increases, the CoF increases

Less force is required to overcome the applied load when the CoF is lower

Ramp Up and Staged Load Test

Sample Discription	ISO Grade	Relative Tack	Total Wt. Loss	
Conventional A	150	Tacky (62)	.029 g	
Biobased Unconventional B	150	Tacky (57)	.008 g	
SGP-567 in Canola Oil	150	Tacky (59)	.001 g	Averge of weight loss of Canola oil based formulas with SGP-567 is statistically zero
SGP-567 in Canola Oil	150	Very Tacky (67)	.000 g	
SGP-567 in Canola Oil	150	Exceptionally Tacky (98)	.000 g	

Ramp Up and Staged Load Test: ISO 150 Tacky Formulations



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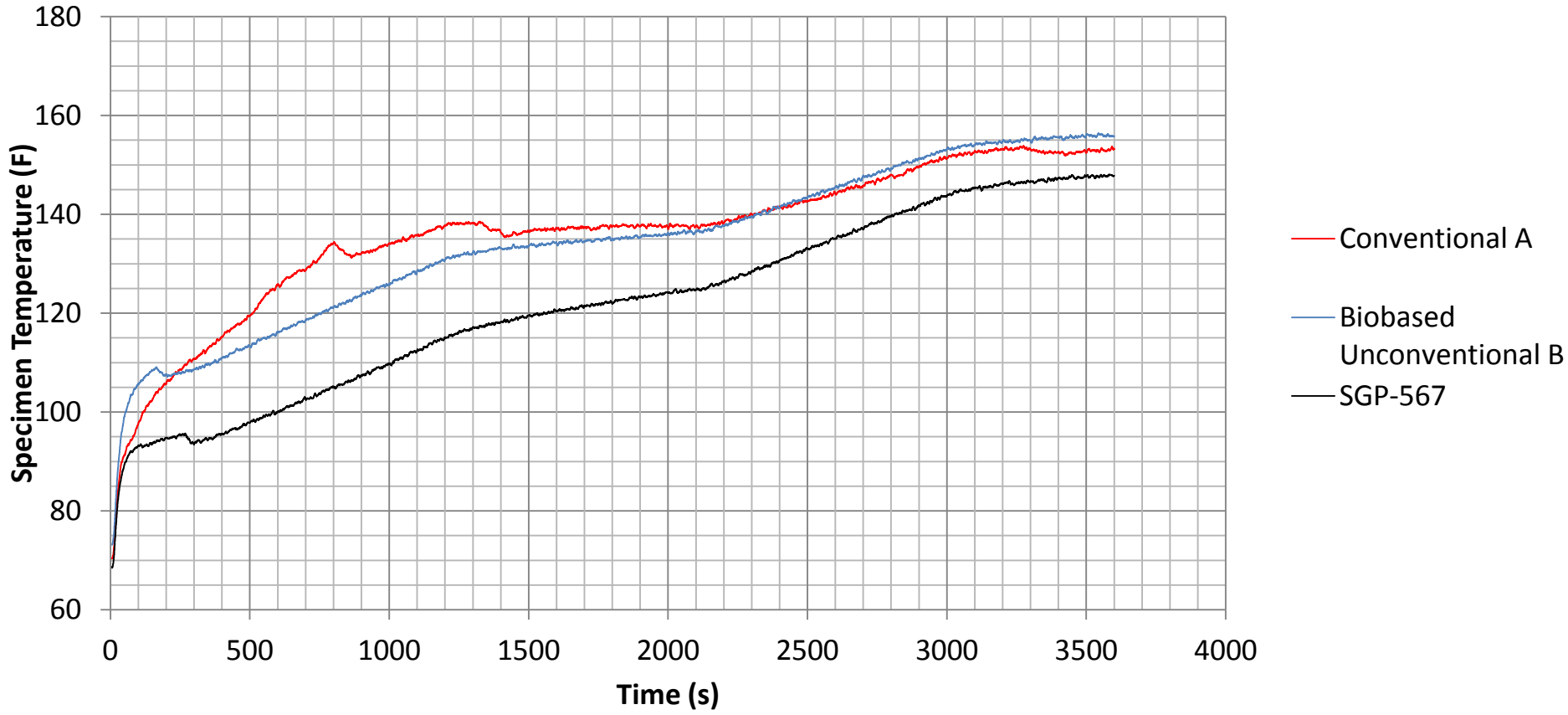
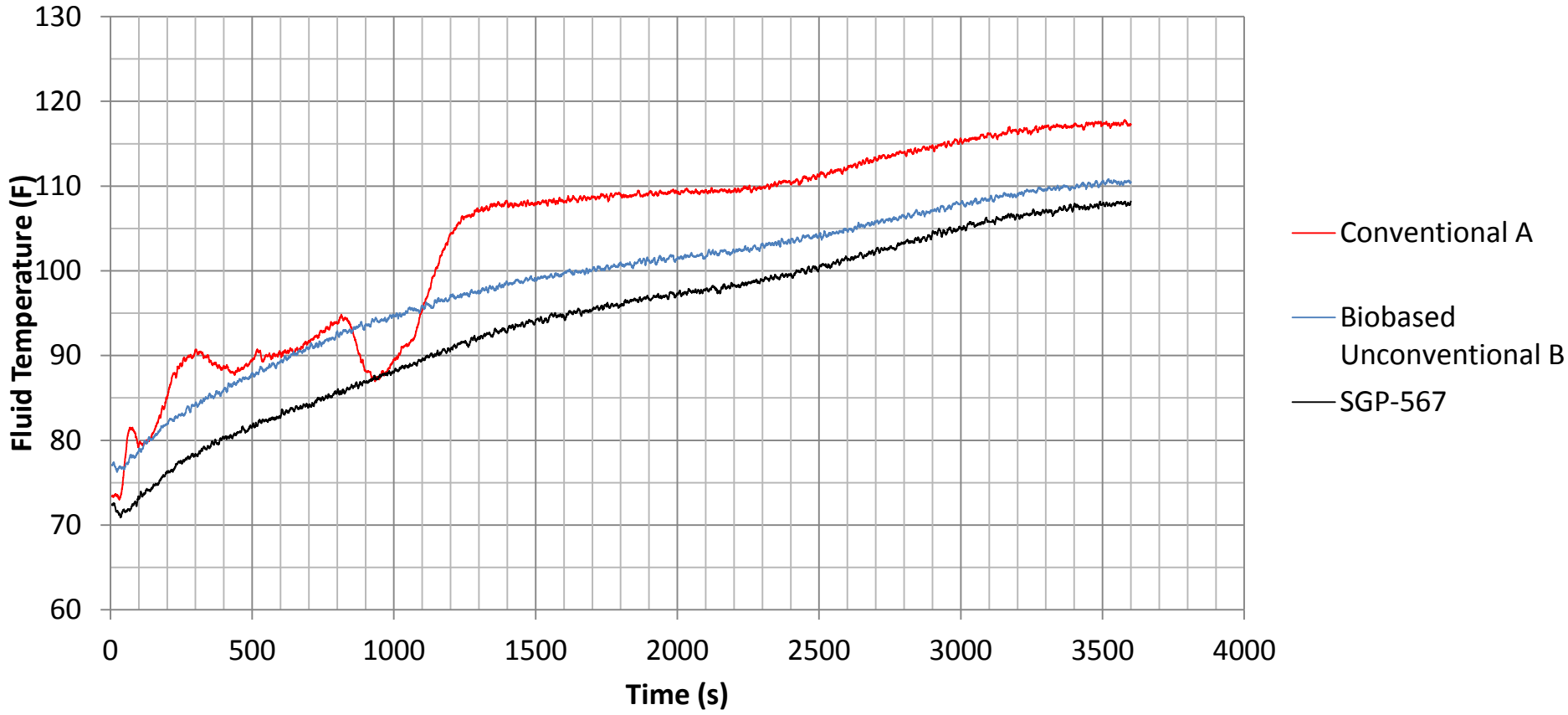
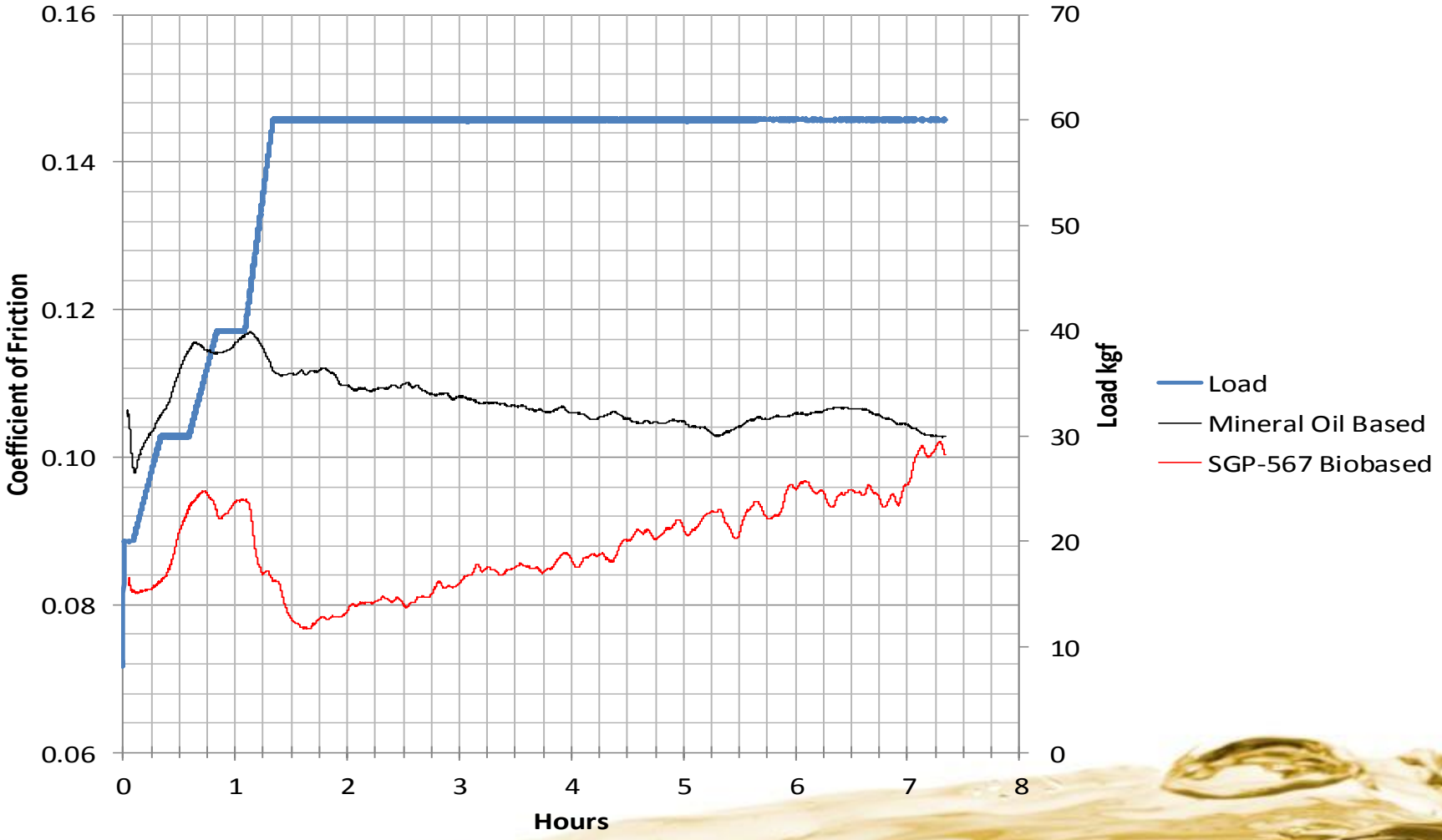


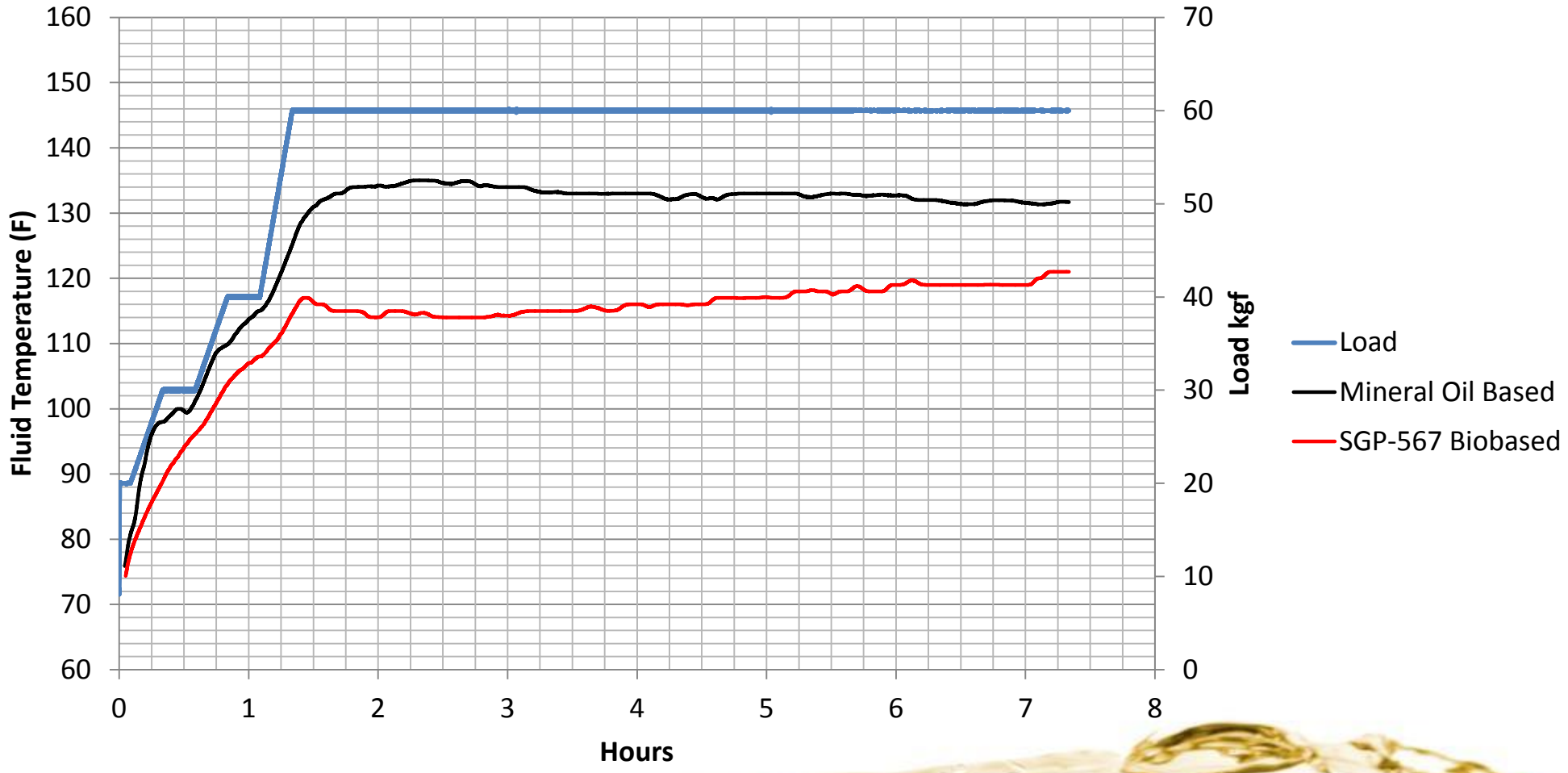
Ramp Up and Staged Load Test: ISO 150 Tacky Formulations



Extended Ramp Up and Staged Load Test: ISO 150 Tacky Formulations



Extended Ramp Up and Staged Load Test: ISO 150 Tacky Formulations



SGP-567 Biobased Saw Guide Oil Results

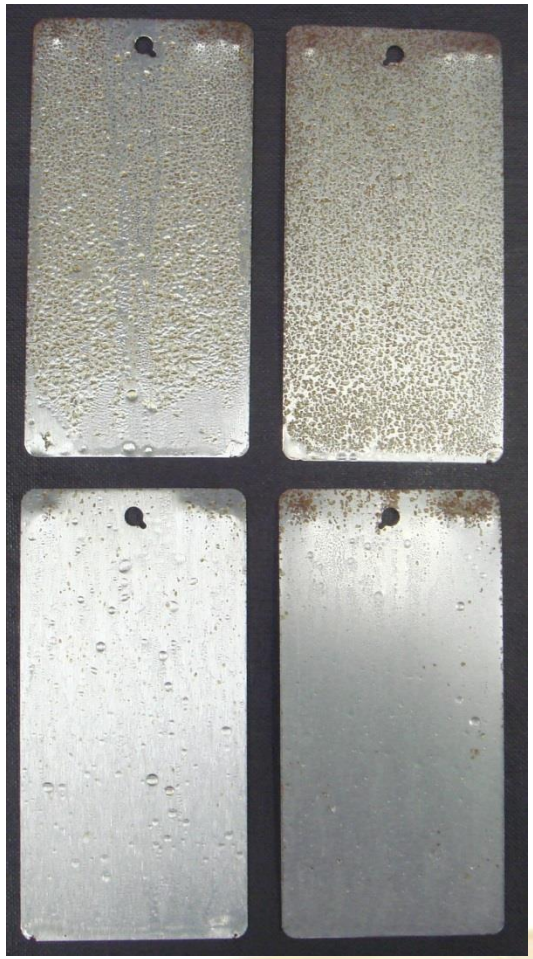
- >14% Coefficient of Friction improvement
  - Provides power and energy savings
  - Improves cutting efficiency
- Reductions in both saw and fluid temperatures
- Designed to be environmentally friendly
- Renewable resource platform, (> 90 % non-petroleum derived)

ASTM B117 Salt Fog: 2.5 Hours Exposure

Polished ***Matte***

Biobased ISO 150 Tacky SGP-567

Biobased ISO 150 Tacky SGP-567 XRP



ASTM D1748 Humidity Cabinet: Testing in Progress

Formulation	Hours to Failure
Conventional A ISO 150 Tacky	1176
SGP-567 ISO 150 Tacky	>2712
SGP-567 XRP ISO 150 Tacky	>2712

Biobased Chain Oil

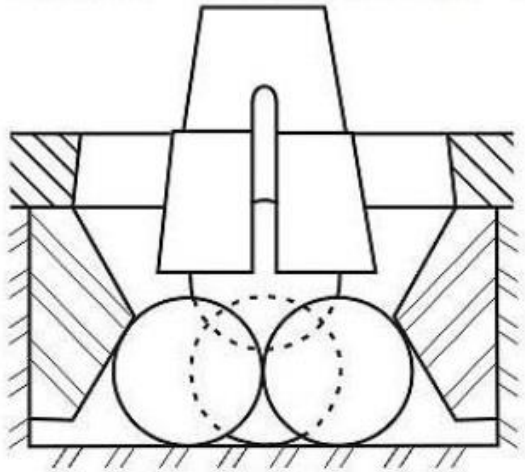
Benefits of Biobased Chain Oils over Conventional Formulations	
Excellent tackiness	Equivalent tack in biobased formulation using V-584 and conventional formulations
Low friction	Coefficient of friction lower in biobased formulations
Single viscosity grade	ISO 46 can be met using V-584
Good rust protection	Good ASTM D665 A/B performance
Excellent wetting	Added synthetic ester for enhanced wetting
AW characteristics	Comparable wear scar in both biobased and conventional
Low temperature handling	Pour point of -30°C in canola oil with added pour point depressant
EP characteristics	Biobased performs better under high load conditions

Starting Point Formula: CO-545 ISO 46 Biobased Chain Oil

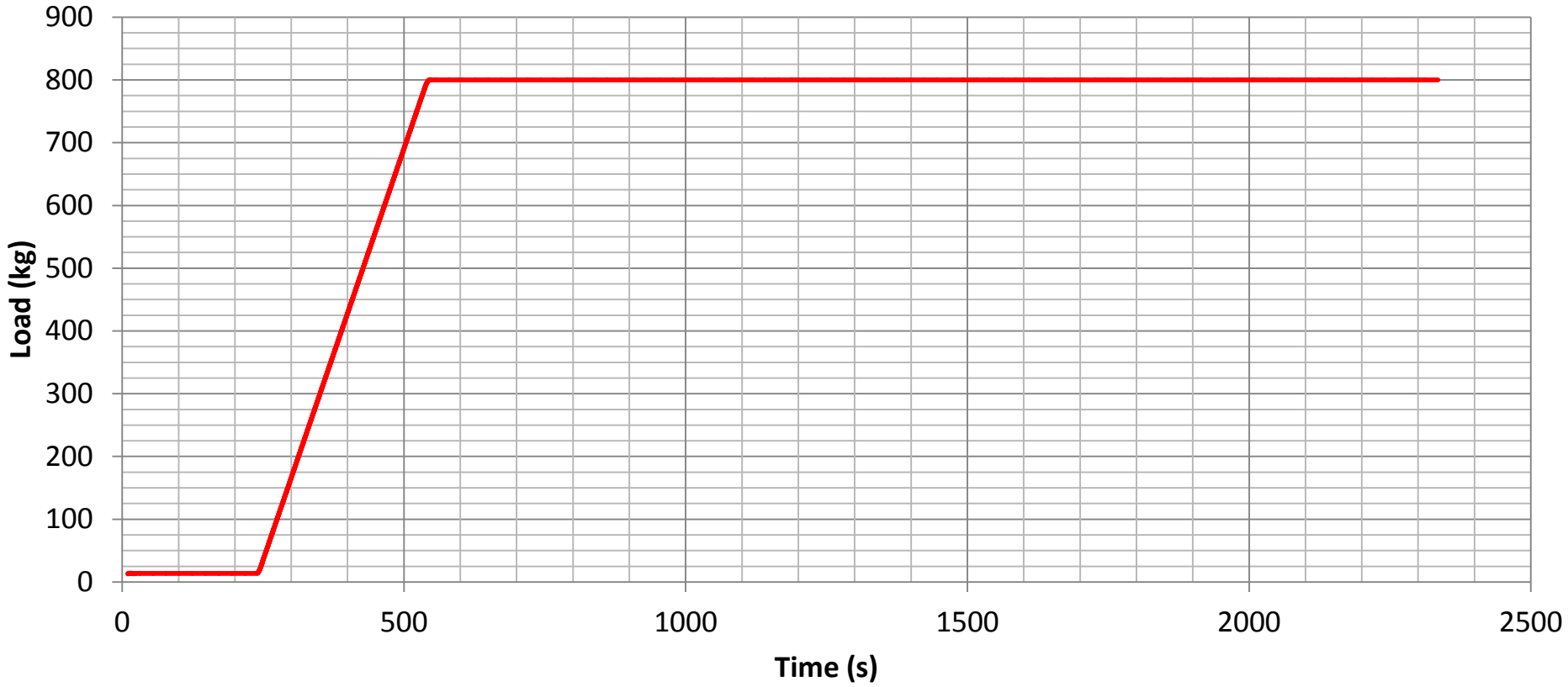
Component	Name	Treat Rate (%)
Tackifier and Thickener	Functional V-584	3-5
Pour Point Depressant	Functional PD-590	0.3-1.0
Performance Additive Package	Functional CO-545	1-2
Base Fluid	Canola Oil/Synthetic Ester Blend	Balance

Chain Oil Bench Test Parameters

PTI Multi-Four Ball Machine (M-4) – variable load and ball speed

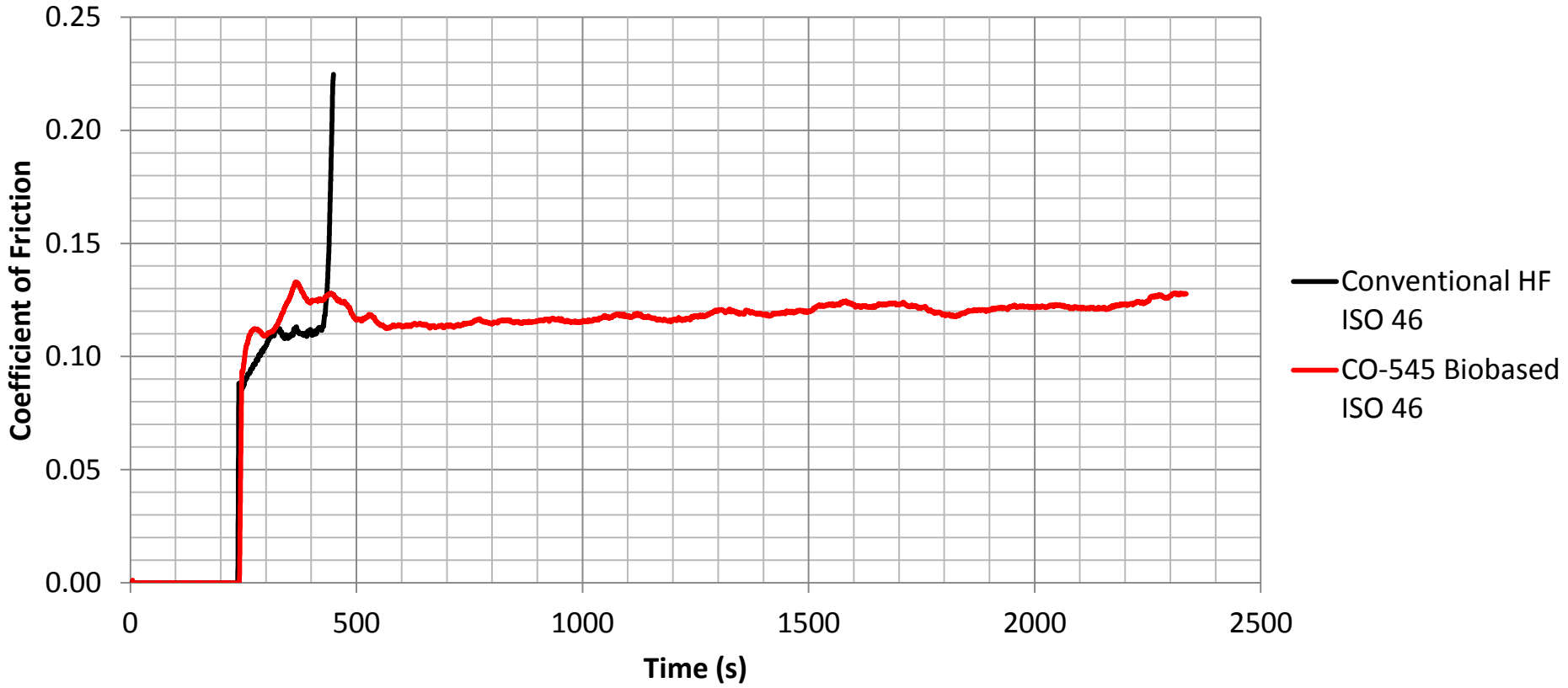


Chain Oil Bench Test Parameters



Speed: 10 rpm
5 min ramp up
30 min hold at 800 kg

Ramp Up and Staged Load Test: ISO 46 with CO-545



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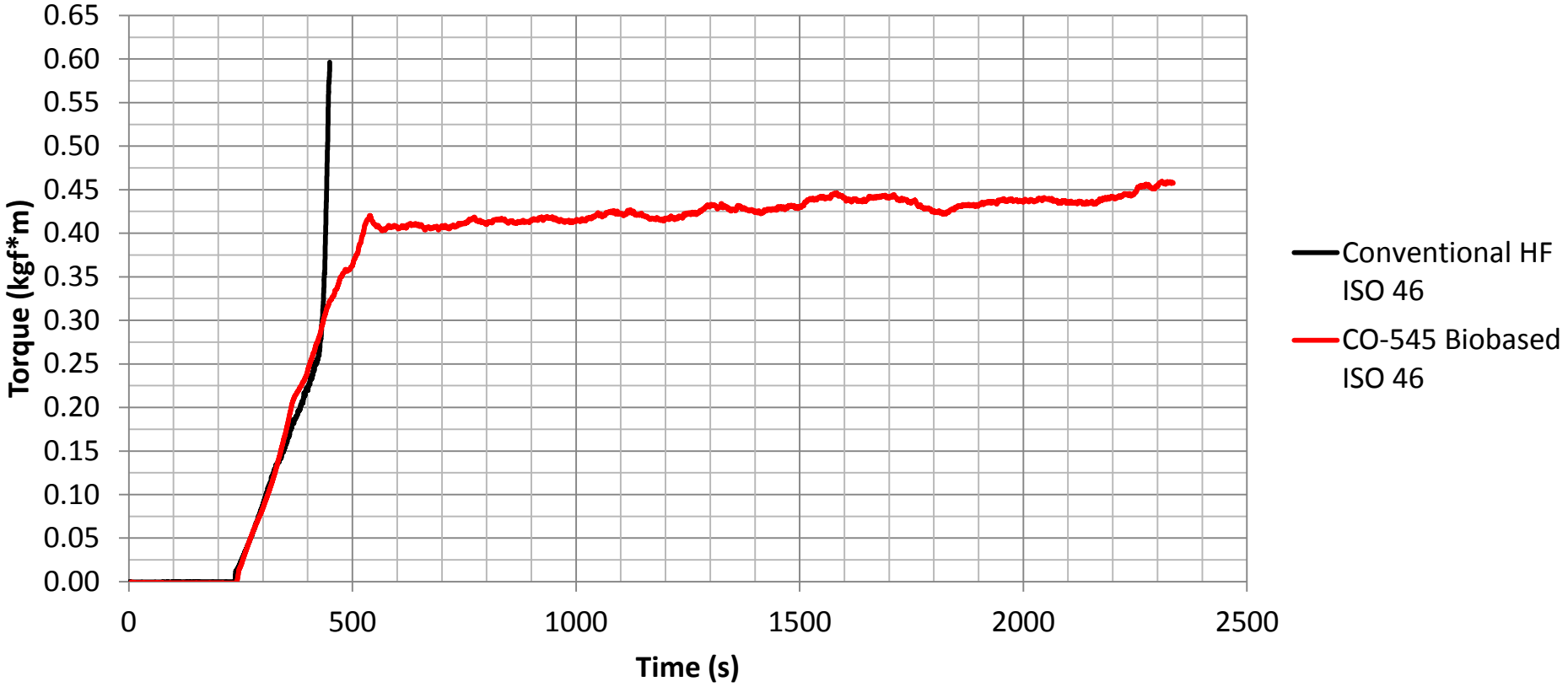
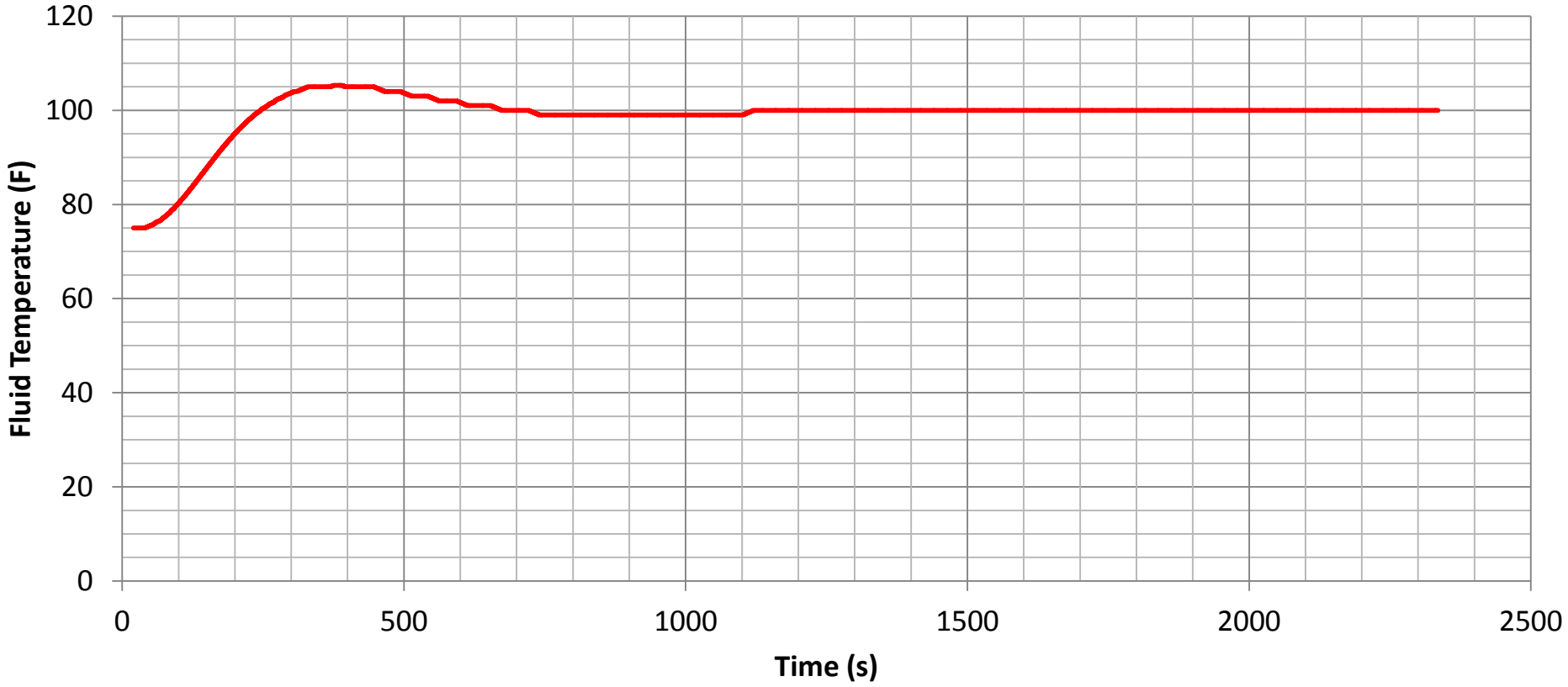


Ramp Up and Staged Load Test: ISO 46 with CO-545



CO-545 Biobased Chain Oil Results

- Coefficient of Friction improvement
  - Provides power and energy savings
- Stable fluid temperature
- Designed to be environmentally friendly
- Renewable resource platform, (> 90 % non-petroleum derived)

Advantages of SGP-567 and CO-545 Formulations over Conventional Oils

- Superior performance
  - Improved lubricity
- Lighter color than conventional formulations
- Safer for the environment
  - Renewable base fluids

Other Biobased Packages

- Functional Products also offers the following packages to formulate the following:
  - Hydraulic fluid – HF-580 or HF-546
  - Open gear oil – GA-502
  - Way oil – WA-64 or WA-60SF
  - Rock drill oil – RD-535 or RD-535CP

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