Fiber Finish New Product Development for the Diaper/Hygiene Market

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Agenda

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- Brief Introduction of Pulcra for those who are not familiar with my organization.
- Description of Fiber Finish and how it impacts fiber and nonwoven process.
- Review Test Methods Used
- Discuss data for improved durable hydrophilic spun bond finish for Hygiene end use.
- Discuss product development on a sustainable, skin friendly new surfactant component for durable hydrophilic end use.
- Summary

HISTORY – IT ALL STARTED WITH HENKEL

1876
Henkel

1879
Adolf Theodor Böhme
(Later: Dr. Th. Böhme)

1906 – 1935
Heinrich Böhme
(Later: Böhme Fettchemie)

1941 – 1986
Pulcra: (latin) pure (both physically and spiritually), clean

1999 – 2007
Cognis

2007 – 2008
Foundation & independence of Pulcra group

2010
01. April takeover
Dr. Th. Böhme production facility in Geretsried and today's headquarters

2015
5th anniversary
in Geretsried

2017
10th anniversary
Pulcra Group

Facts and Figures

Pulcra Chemicals
The solution specialist

2.000
Over 2.000 customers: fiber and non-woven producers, textile and yarn mills, tanneries

1.000
Over 1.000 products

13
Present in 13 countries

800
Around 800 employees globally with around 300 engineers and chemists

Facts and Figures

Pulcra Chemicals provides added value for its customers by creating solutions that determine the look, touch/ feel and functionality to our customers' materials. Delivered by our team of 300 engineers from our 13 locations across the globe. We have more than 140 years of experience and partnering with customers.

Facts and Figures

Pulcra Chemicals is headquartered in Geretsried (Munich), Germany.

Facts and Figures

TEXTILE

Auxiliaries for manufacturing of yarns and textile fabrics for pretreatment, dyeing, printing, softening, coating and finishing

FIBER

Auxiliaries for the manufacturing and processing of man-made fibers

LEATHER

Leather auxiliaries for all processes in the leather and fur industries

PERFORMANCE

Performance products for a wide variety of end-markets

Fiber Finish

APPAREL

FLOORCOVERINGS

TECHNICAL TEXTILES

NONWOVENS

Topically applied solution or emulsion to assist in the optimization of fiber manufacturing processes at the Fiber Producer and / or the downstream processes used to make the desired end product. (yarn, fabric, carpet, nonwoven … etc …)

- Finish Add on Levels range from 0.1% to 5% OWF (on weight of fiber)
  FOY (finish on yarn level)
- Finish level and Composition varies with respect to the Fiber Type and the Fiber process/product
- An acceptable finish will optimize F/M, F/F friction, static and bundle cohesion for fiber production

Fiber Finish

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Primary Components

- Lubricant
- Emulsifier
- Anti-static Agent

Secondary Components

- Cohesion Agents
- Boundary Lubricants
- Anti-Oxidants
- Anti-Corrosion
- Viscosity Modifiers
- Wetting Agents
- Biocides
- pH adjustment agents

All Components and finish formulations must comply with TSCA, Health ,Safety, Environmental and in some cases FDA regulations and Reach regulations.

Fiber Finish (for Nonwovens)

<u>Staple Fiber</u>

Finish is applied to facilitate the processing of the fiber as it is made and then converted to a nonwoven by a dry lay or air lay web formation. (ex. Carding, rando…)

The resulting nonwoven web will typically go through a downstream bonding process

- Heat
- Water Entanglement
- Chemical

Depending on the process, additional finish may be post applied for the specific end use.

Fiber Finish

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Spun Bond or Melt Blown

For Spun Bond / Melt Blown or any combination there of, finish is applied, when needed, to facilitate the end use performance.

- Hydrophilic
- Hydrophobic
- Oil Repellent
- Alcohol Repellent
- Static Protection
- Flame Retardant
- Softener……..etc..

Fiber Finish

For the discussion today, we will review the finish development of a durable hydrophilic formula for predominately hygiene end use.

A hygiene finish must meet the following general parameters:

- Application as an aqueous emulsion by kiss roll or a spray.
- Uniform wetting of the kiss roll and the web to ensure consistent application of the finish.
- Allow emulsion concentrations of 6% – 8 %
- With resulting spin finish levels in range of 0.25 % – 1.4 %
- Low migration/absorption of the spin finish into the polymer

Fiber Finish (for hygiene continued)

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A hygiene finish must meet the following general parameters:

- Provide durable hydrophilic properties on nonwoven, as measured by:
  - Single Strike Through
  - Multiple Strike Through
  - Optimum Run Off properties
  - Minimal Rewet

- Excellent skin compatibility

Test Methods To Be Discussed

- Spray Application
- Strike Through*
- Re Wet *
- Multiple Strike Through *
- Run Off *

* WSP Standard Test Methods

Spray Application of Finish

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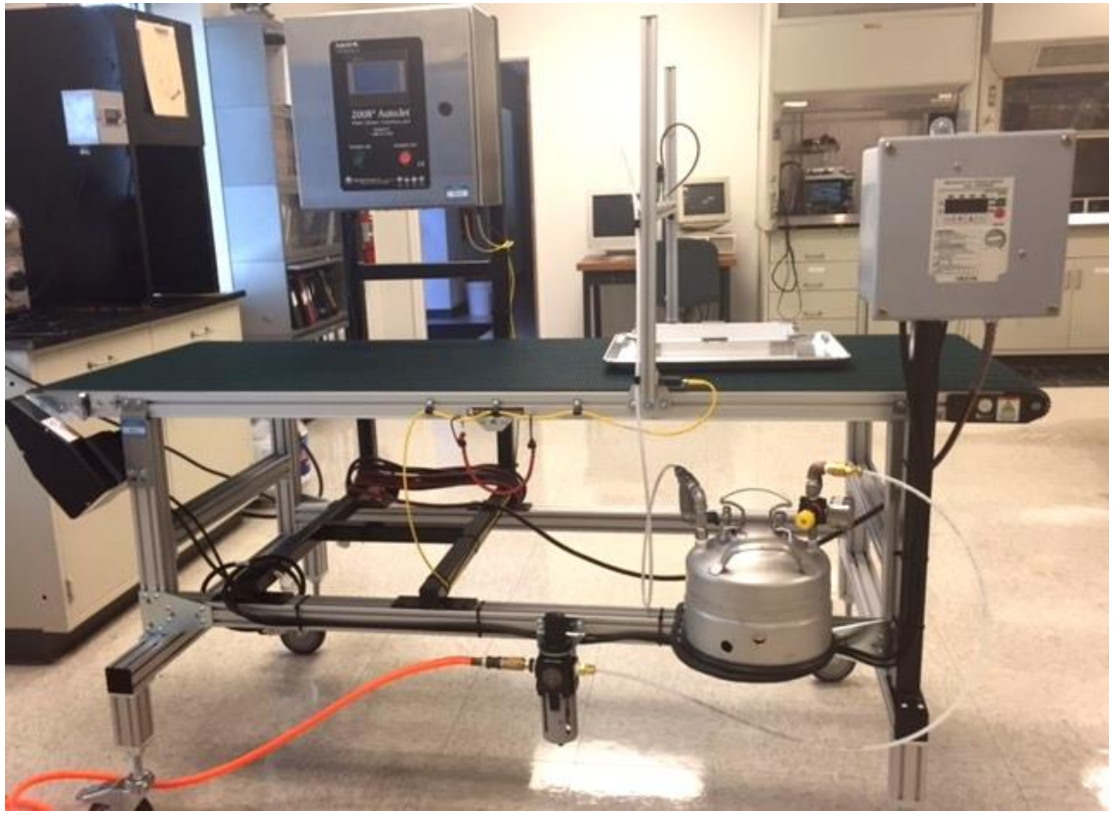
- Need to attain consistent finish application for small scale lab trials to assure that performance results are due to finish chemistry, not variation in finish level.
- SD of +/- 0.05
- Uniform droplet size
- One side application to compare to typical kiss roll production application of finish to nonwovens.

Spray Application Equipment



- Spray Angle – 80 to 95 degree
- Conveyor – 2 ft wide x 6 feet long
- Variable Speed 0 – 140 ft/min

- Consistent Application Level
- Optimum Sample size 9” x 13”
- Can Vary Length, as needed

Spray Micro Nozzle

Spray Pattern

- Small Droplet Size
- Uniform Application
- SD +/- 0.05

Spray Pattern

After 30 seconds, coalesce to larger droplet size to better visualize the uniform application

Strike Through and Multiple Strike Through

STANDARD TEST: WSP 70.3 (05)
Standard Test Method for Nonwoven Coverstock Liquid Strike-Through Time Using Simulated Urine

Principle
A specified quantity of simulated urine is discharged at a prescribed rate under specified conditions onto a test specimen of nonwoven, which is superimposed on a reference absorbent pad. The time taken for the entire liquid dose to penetrate the nonwoven is measured electronically.

STANDARD TEST: WSP 70.7 (05)
Standard Test Method for Nonwoven Coverstock Multiple Liquid Strike-Through time using simulated urine

Principle
Three subsequent doses of simulated urine are discharged at a prescribed rate, and under specified conditions, onto a test piece of nonwoven which is placed on a reference absorbent pad. The time taken for each of the liquid doses to penetrate the nonwoven is measured electronically, using conductometric detection. The absorbent pad remains unchanged and wet between the doses.

Re-Wet

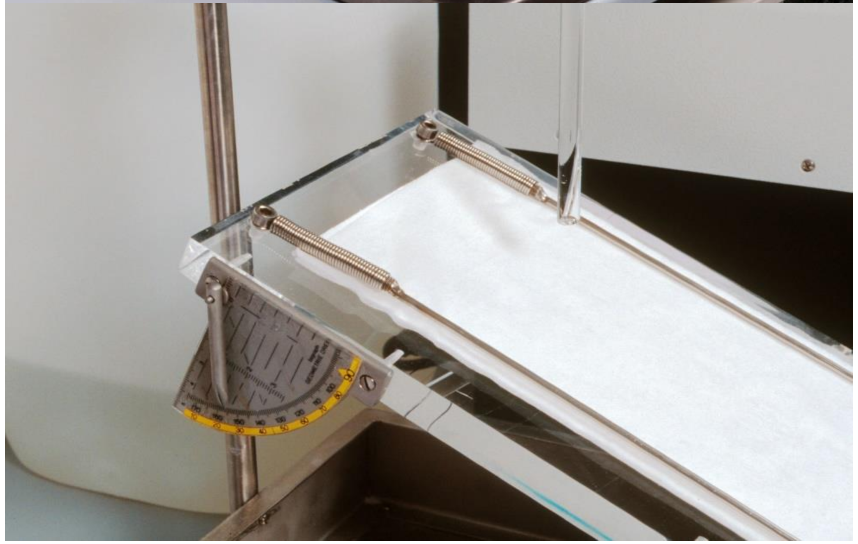
STANDARD TEST: WSP 80.10 (05)

Standard Test Method for Nonwovens Coverstock Re-Wet

Principle

A coverstock is placed over a standard absorbent medium which is then loaded with a specific quantity of simulated urine. A standard weight is placed onto the coverstock and absorbent medium to ensure even spreading of the liquid. A pre-weighed pick up (blotter) paper is then placed on the coverstock and the weight is again placed on top. The mass of absorbed liquid by the pick up (blotter) paper is weighed and defined as wetback.

Run Off



STANDARD TEST: WSP 80.9 (05)

Standard Test Method for Nonwoven Run-Off

Principle

A specified quantity of simulated urine is discharged at a prescribed rate under specified conditions onto a test specimen of nonwoven which is superimposed on a standard absorbent medium and placed on an inclined table. Any excess liquid that runs down the test specimen is collected by a standard receiver pad placed below the lower end of the nonwoven test specimen. The run-off measures the mass of liquid collected by the standard receiver pad.

Durable Hydrophilic Spun Bond Finish Development For Improved Performance

- Targeted for our Customer‘s New Product Development
- Lab Development trials to determine the optimum modified finish formula to maintain consistent finish level on surface of web over a longer time period.

Durable Spun Bond Finishes

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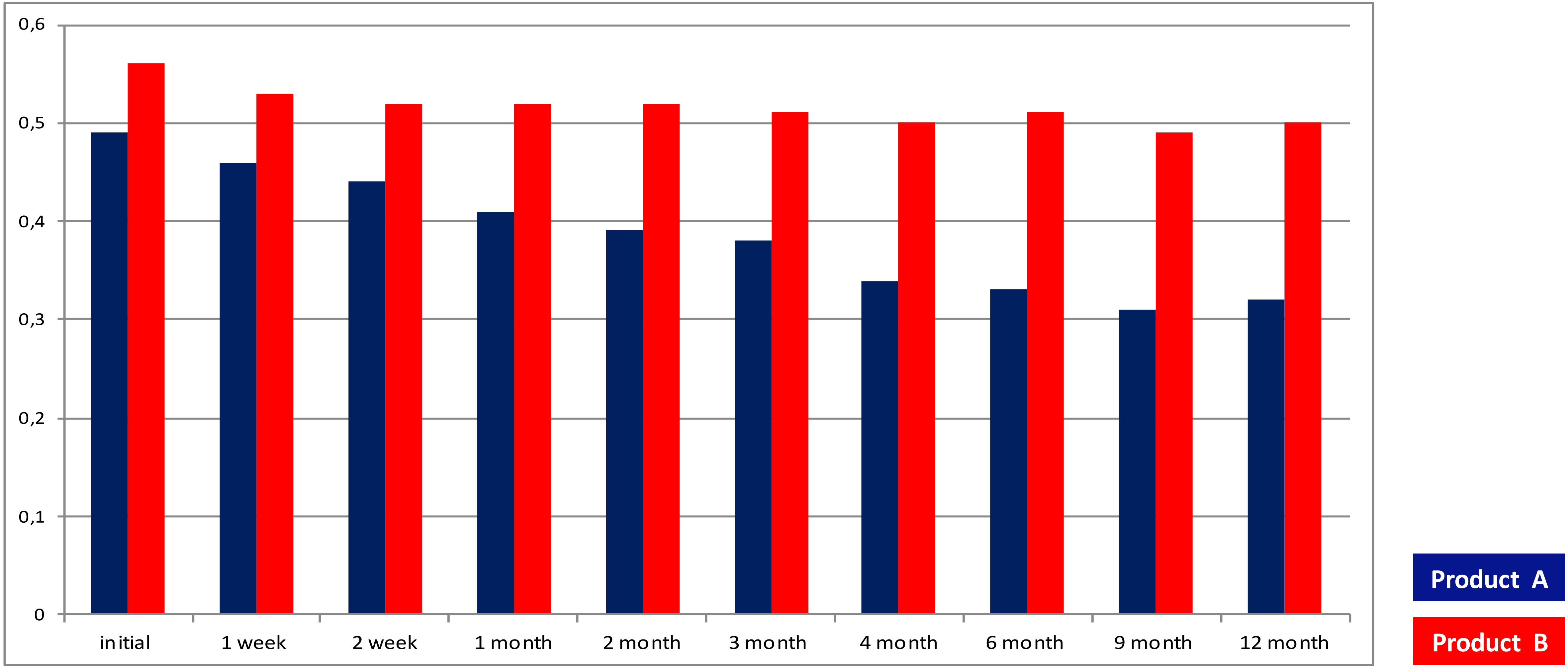
New and Improved Performance Aging Study

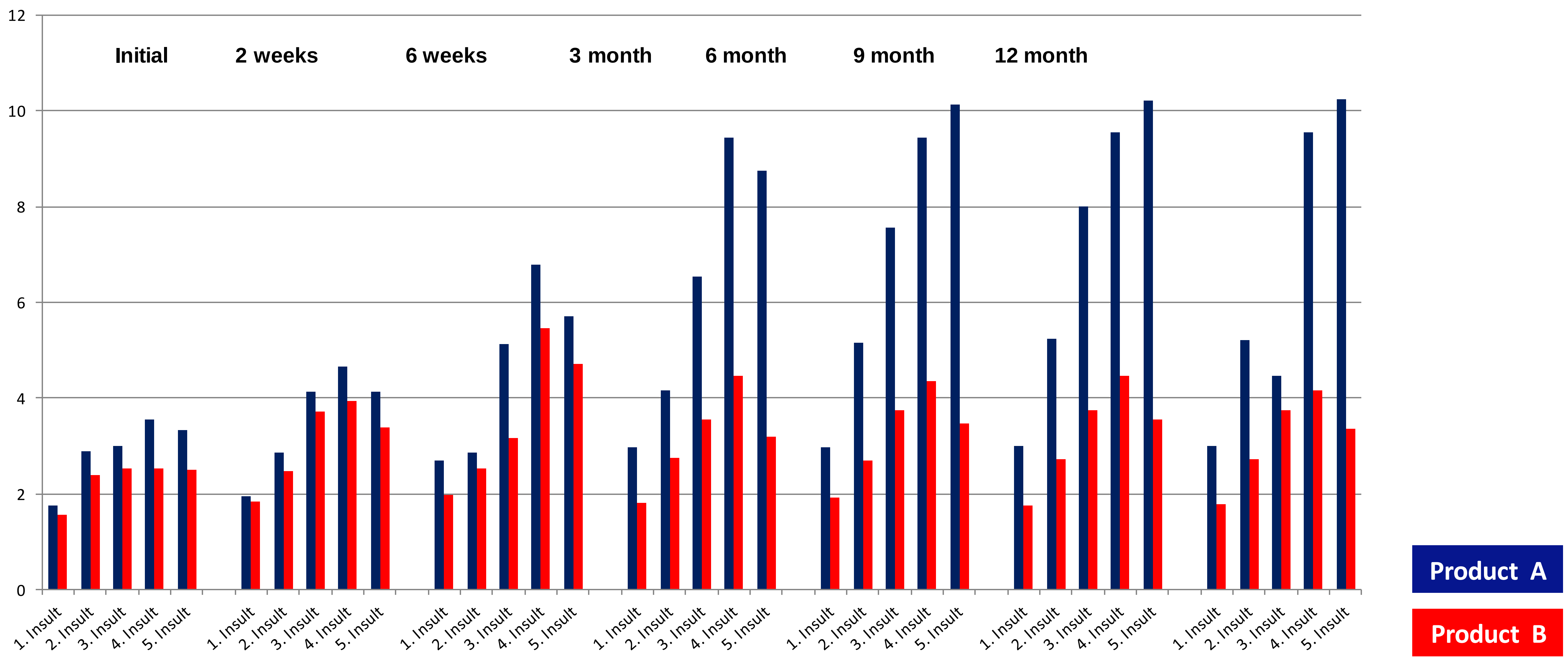
Stantex S 6327 Stantex S 6887

- Reicofil Spun Bond Pilot Line
- 15 gsm PP
- 0.5% Finish Level on weight of the web, via kiss roll application
- Measuring of the Finish Level initially and over time by cold IPA extraction
- Measuring of performance data according WSP test methods
  - Multiple Strike Through
  - Run Off
  - Re-Wet

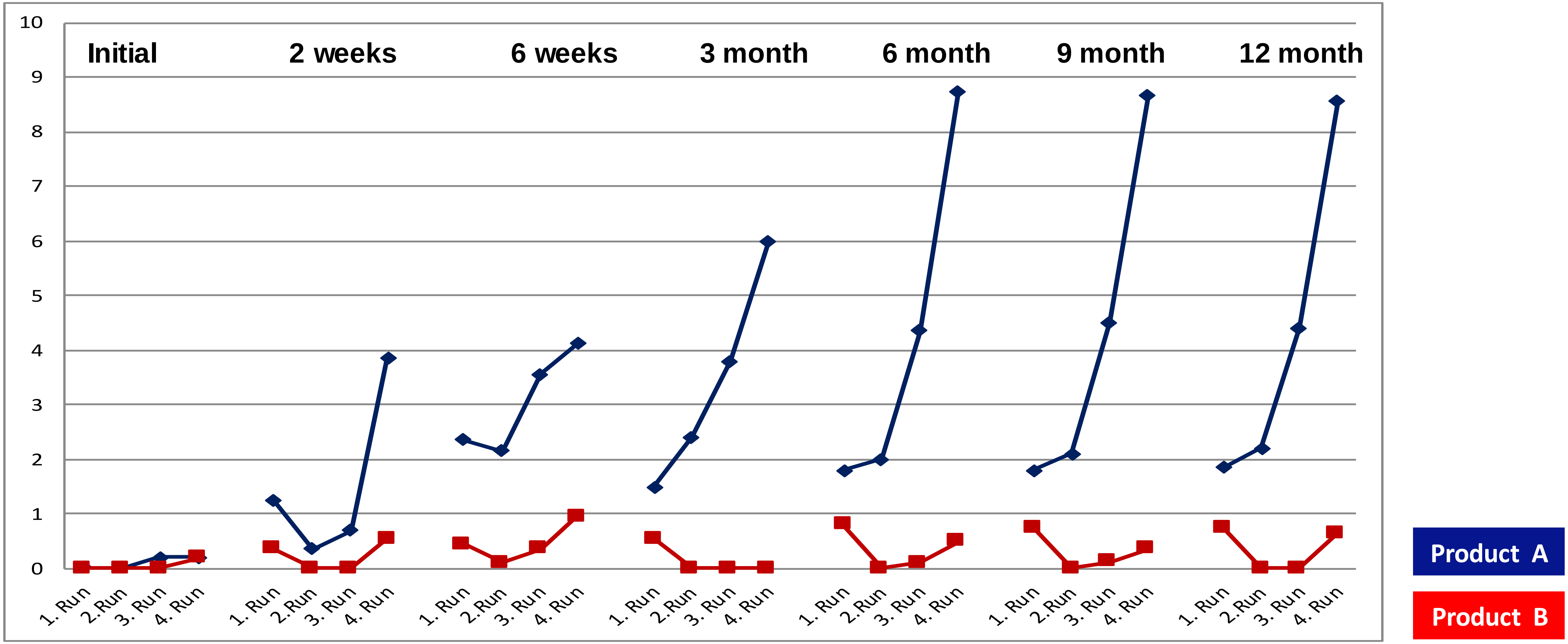
Finish Level Vs. Time



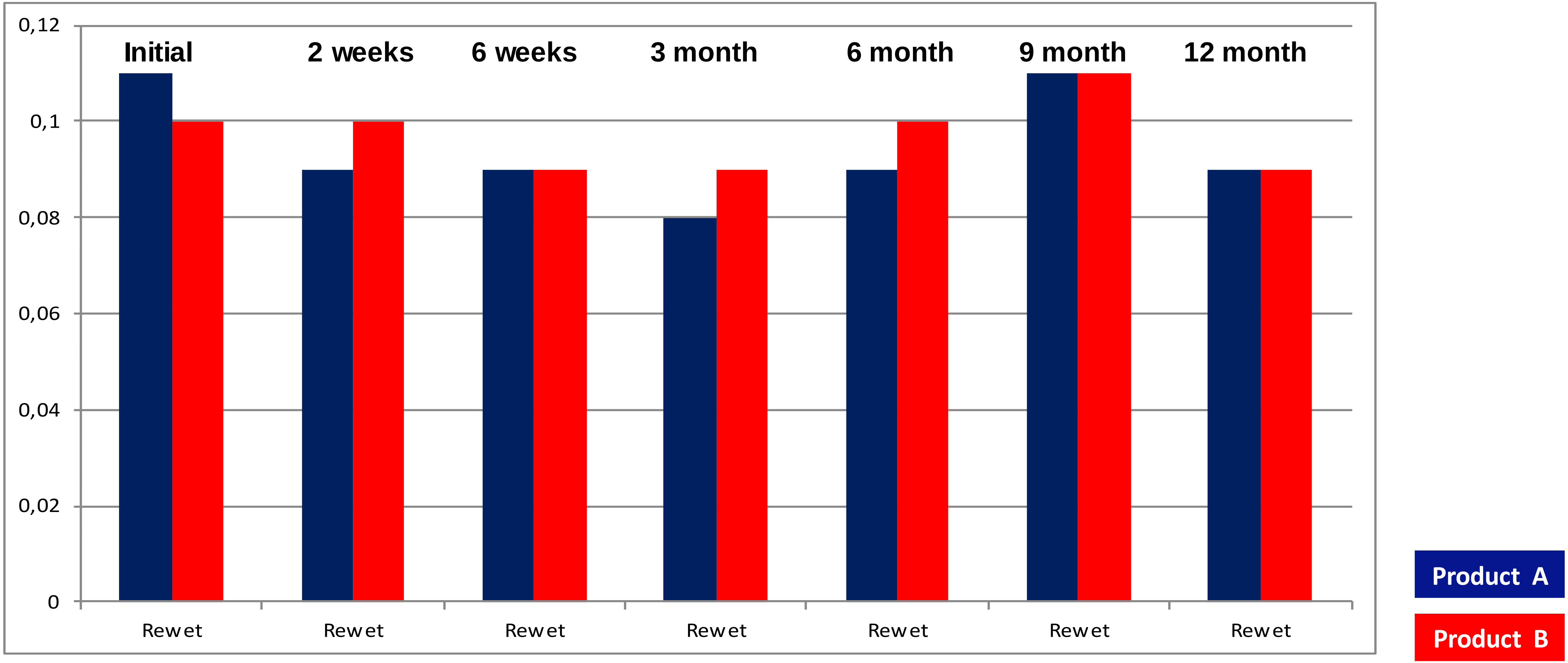
Multiple Strike Through Vs. Time



Run-Off Vs. Time



Re-Wet Vs. Time



Summary of Aging Study

The improved formula provides increased consistency over time.

- Finish remains on the surface of the polymer, as measured by cold extraction.

Resulting in :

- More Consistent Multiple Strike Through
- More Consistent Run Off

- No increase in Re-Wet

New Product Development of Sustainable, Skin Friendly Finish

Objective of this work was to determine the feasibility of making a new surfactant that can be chemically varied to optimize performance with skin friendly attributes.

- Varied the Weight Ratios of the reactants to determine optimum ratio for Strike Through and Re-Wet
- Web Substrates Evaluated : majority of work on PP with some examples on PLA
- Measured Typical Frictional Properties to determine fitness for use in staple fiber processing.
- Measured Typical Component properties to determine fitness for use.
- Evaluated a range of components from the investigation for HRIPT(Human Repeated Insult Patch Test)

HRIPT (Human Repeated Insult Patch Test)

- Consumer Product Testing Company
- Testing completed on 20% active solutions
- Direct skin contact
- The result: NO potential for dermal irritation or allergic contact sensitization for any of the samples

Reactant Weight Ratio Variation

Reactant A + Reactant B ⟶ Surfactant C

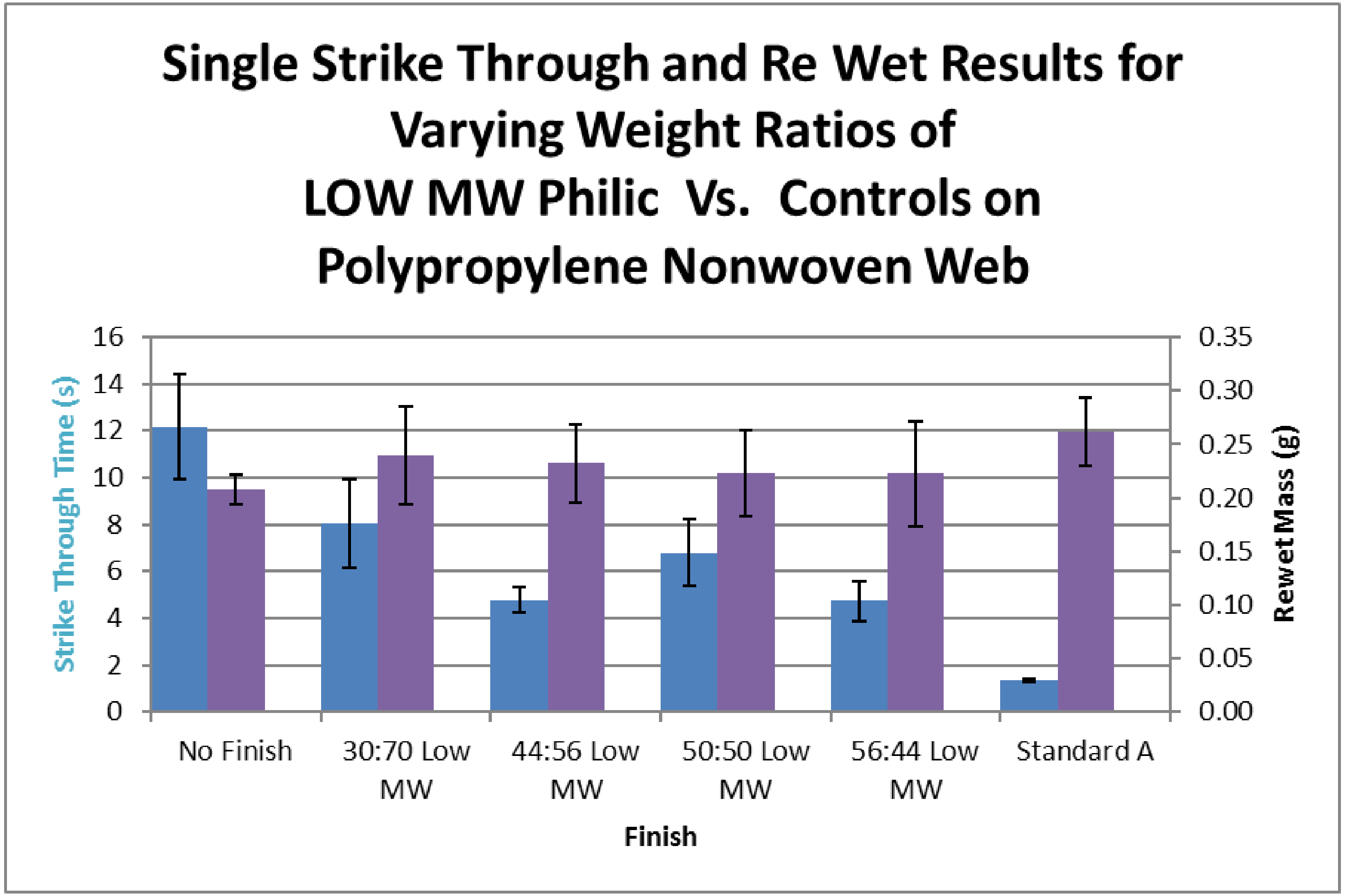
Weight Ratio
Variations

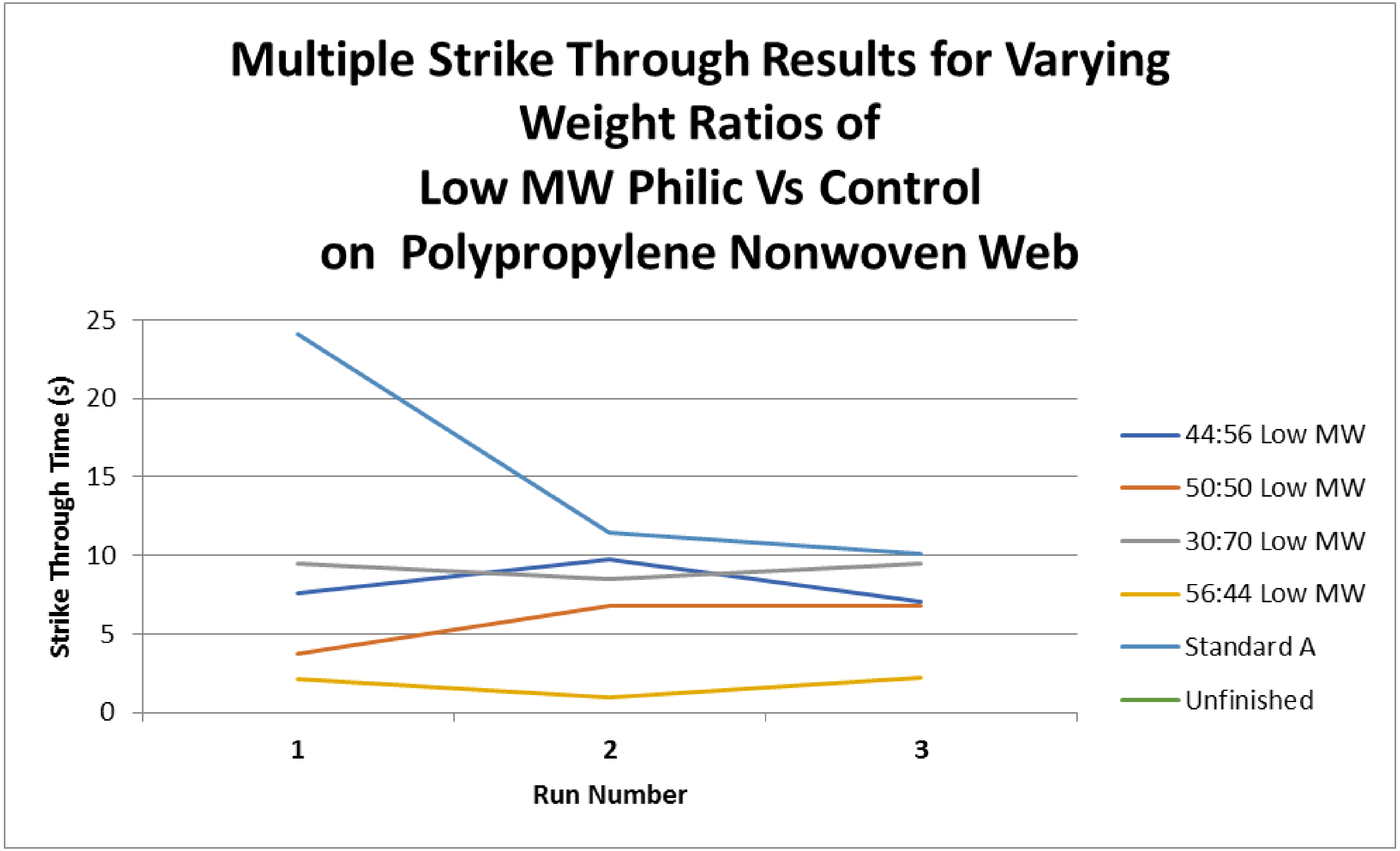
30:70
44:56
50:50
56:44

Hydrophobic end remained constant : MW varied on the Hydrophilic ⟶

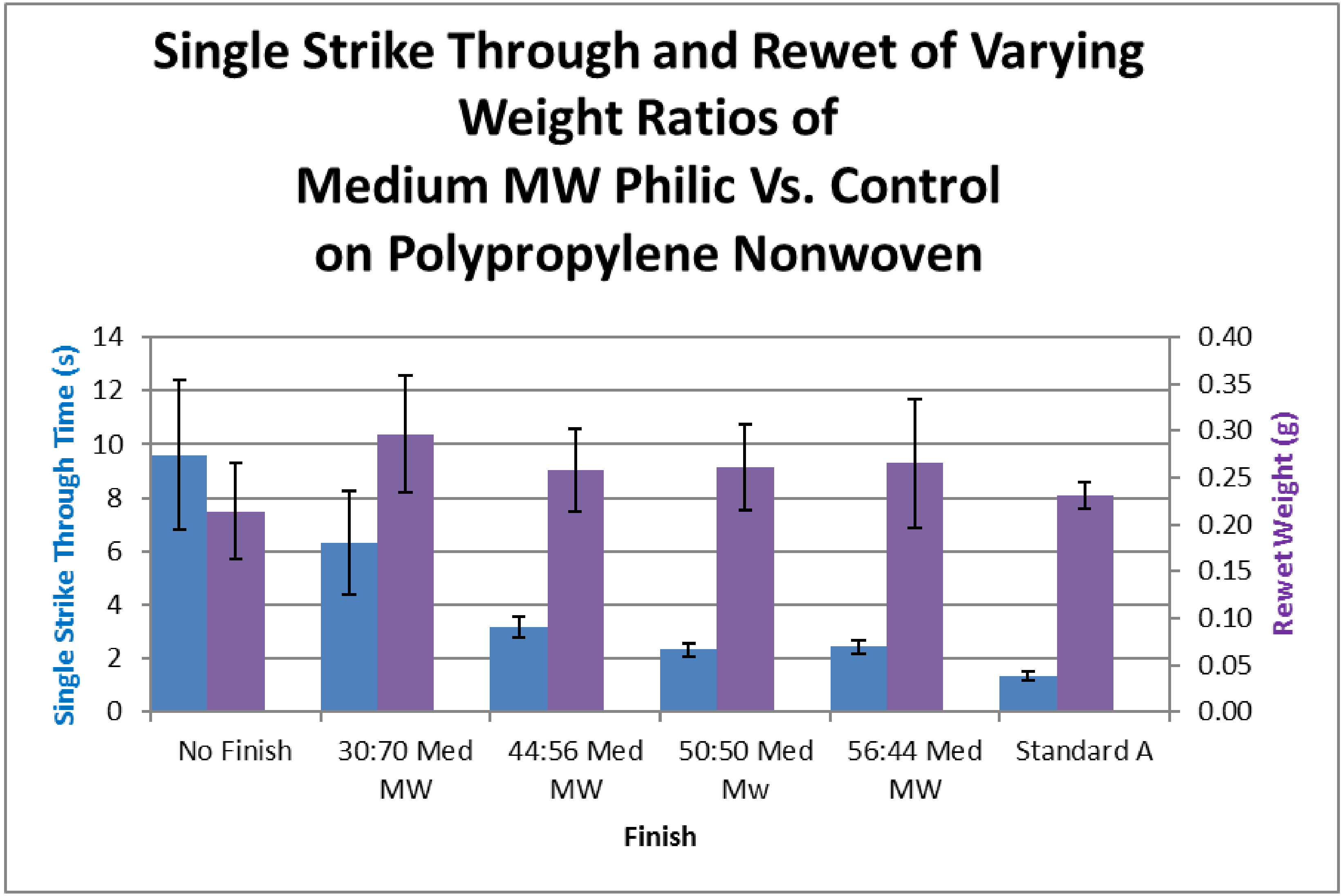
Resulting in a homologous series of increasing MW component

Low MW		less hydrophilic
Medium MW		
High MW 1		
High MW 2		most hydrophilic

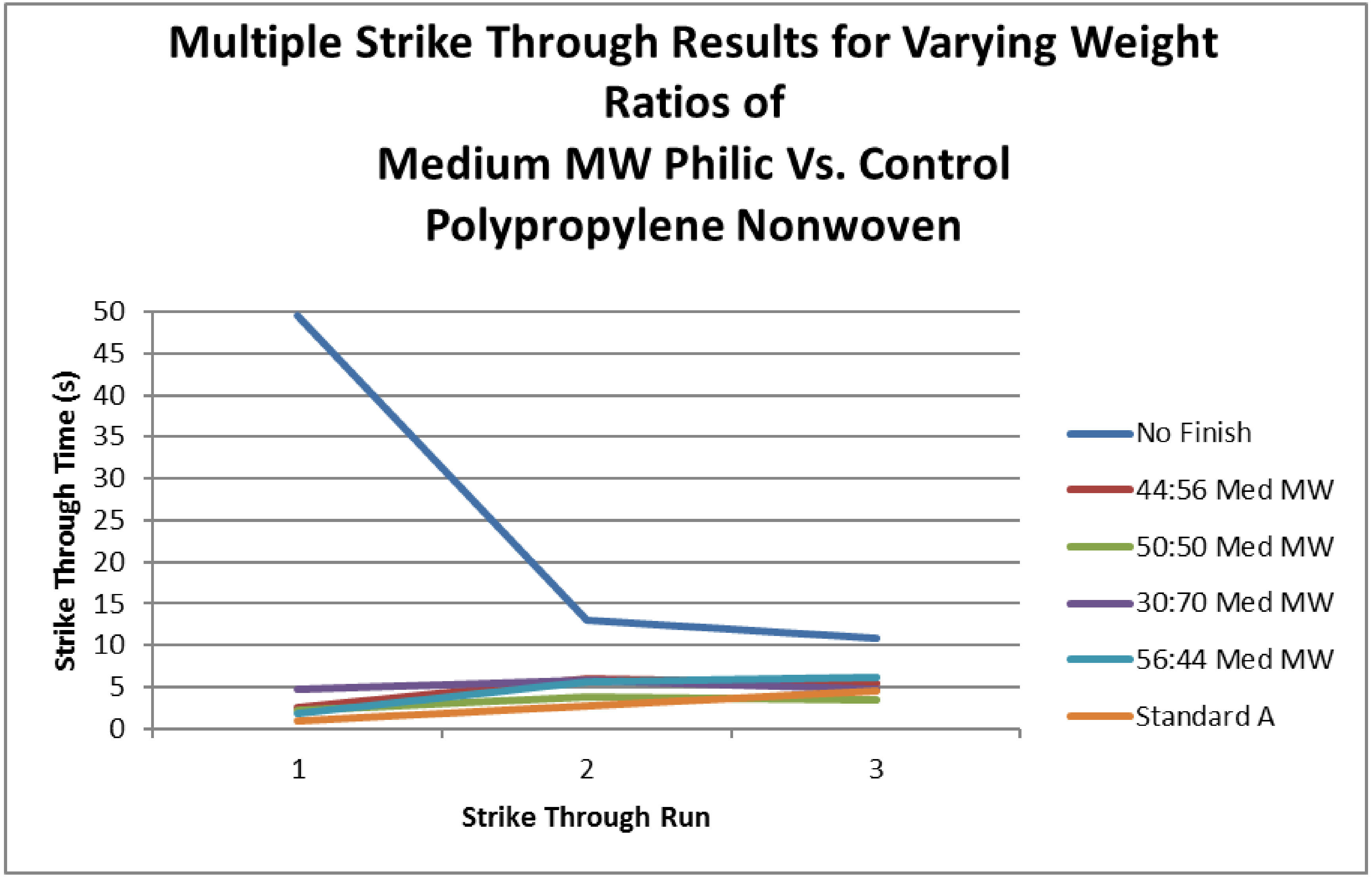

Single Strike Through and Re Wet Results for Varying Weight Ratios of LOW MW Philic Vs. Controls on Polypropylene Nonwoven Web
Strike Through Time (s)
0
2
4
6
8
10
12
14
16
Rewet Mass (g)
0.00
0.05
0.10
0.15
0.20
0.25
0.30
0.35
No Finish
30:70 Low MW
44:56 Low MW
50:50 Low MW
56:44 Low MW
Standard A
Finish



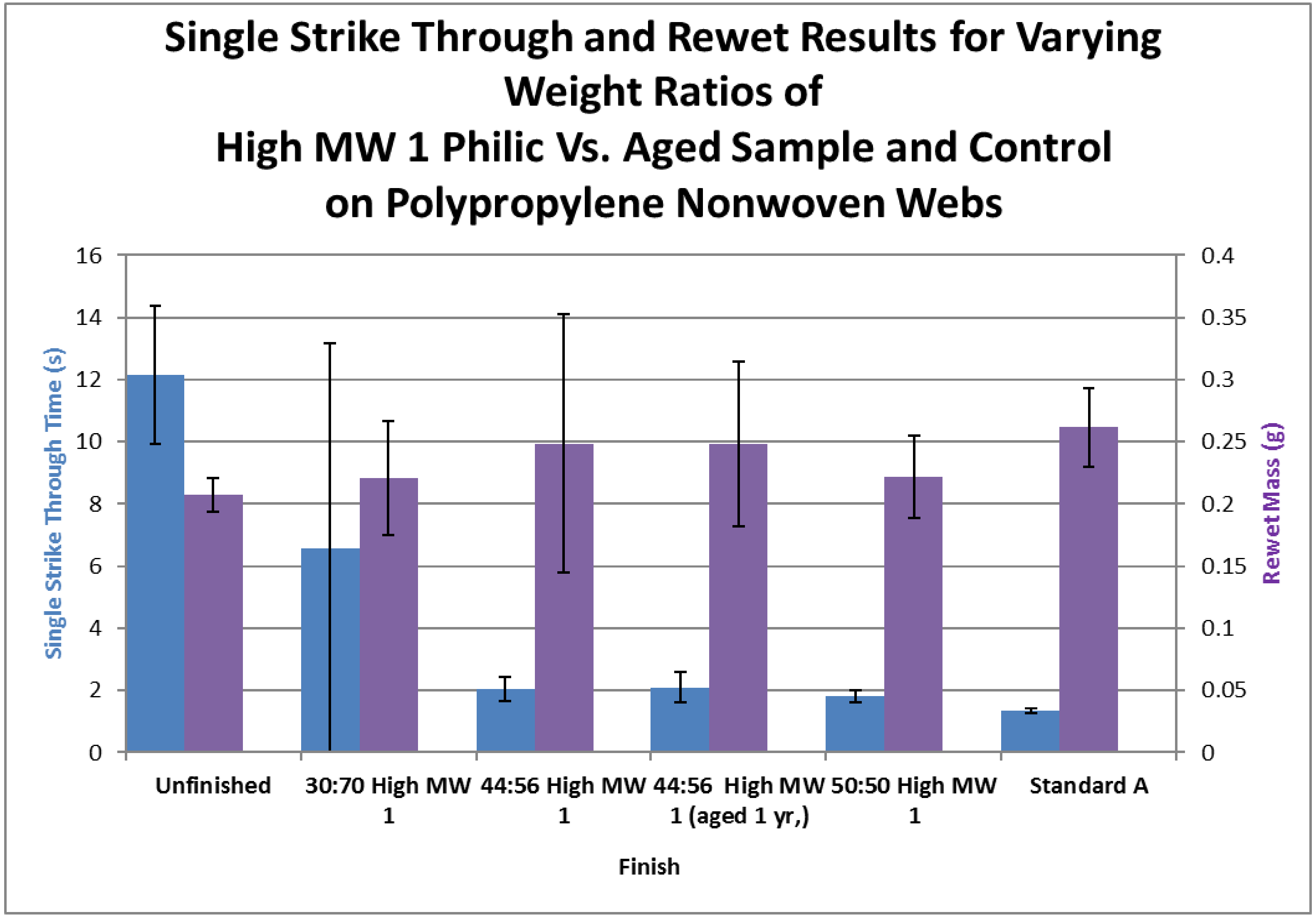
Multiple Strike Through Results for Varying Weight Ratios of
Low MW Philic Vs Control
on Polypropylene Nonwoven Web
Strike Through Time (s)
25
20
15
10
5
0
1
2
3
Run Number
44:56 Low MW
50:50 Low MW
30:70 Low MW
56:44 Low MW
Standard A
Unfinished



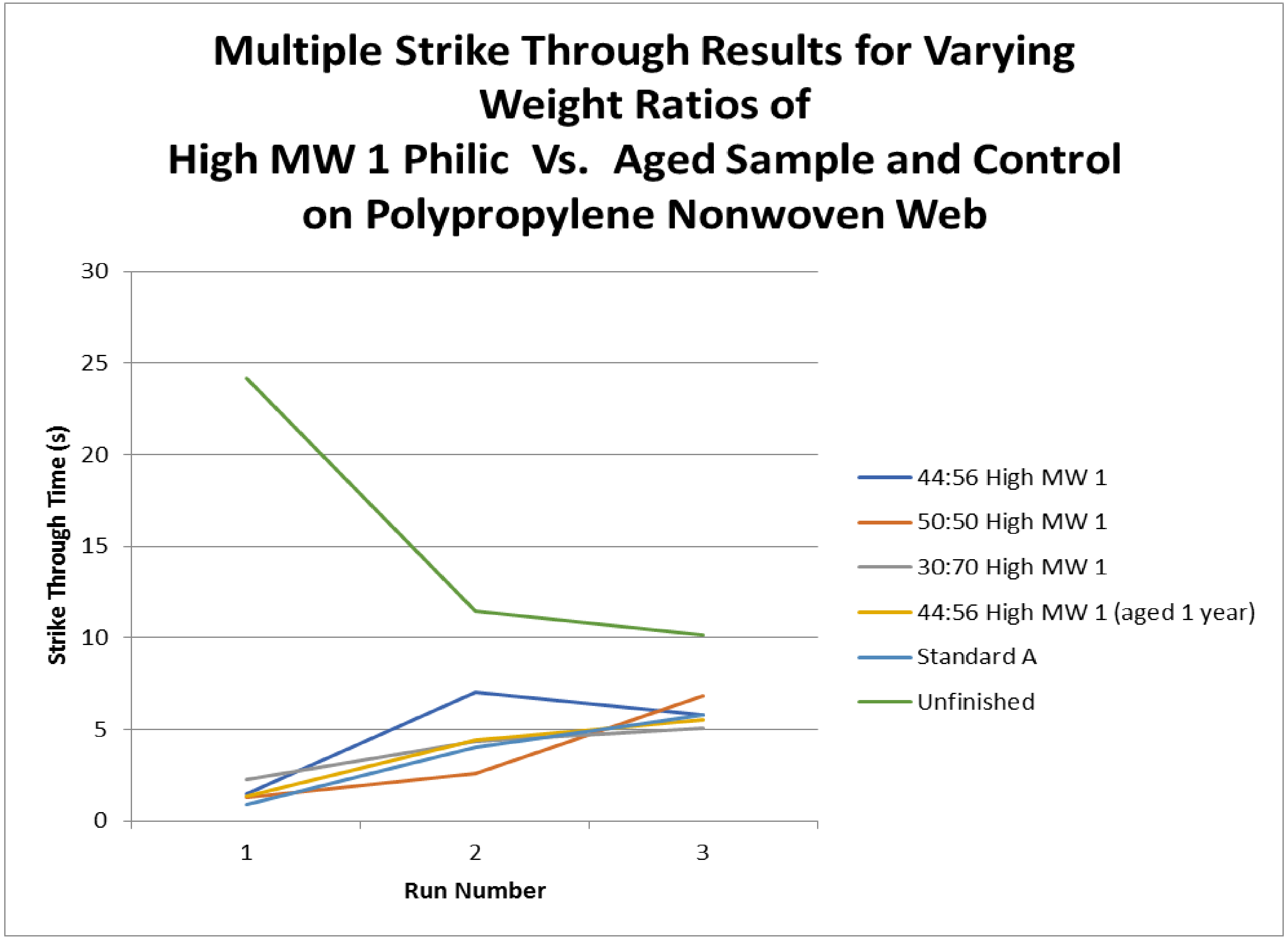
Single Strike Through and Rewet of Varying Weight Ratios of Medium MW Philic Vs. Control on Polypropylene Nonwoven
Single Strike Through Time (s)
Rewet Weight (g)
14
12
10
8
6
4
2
0
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
No Finish
30:70 Med MW
44:56 Med MW
50:50 Med Mw
56:44 Med MW
Standard A
Finish



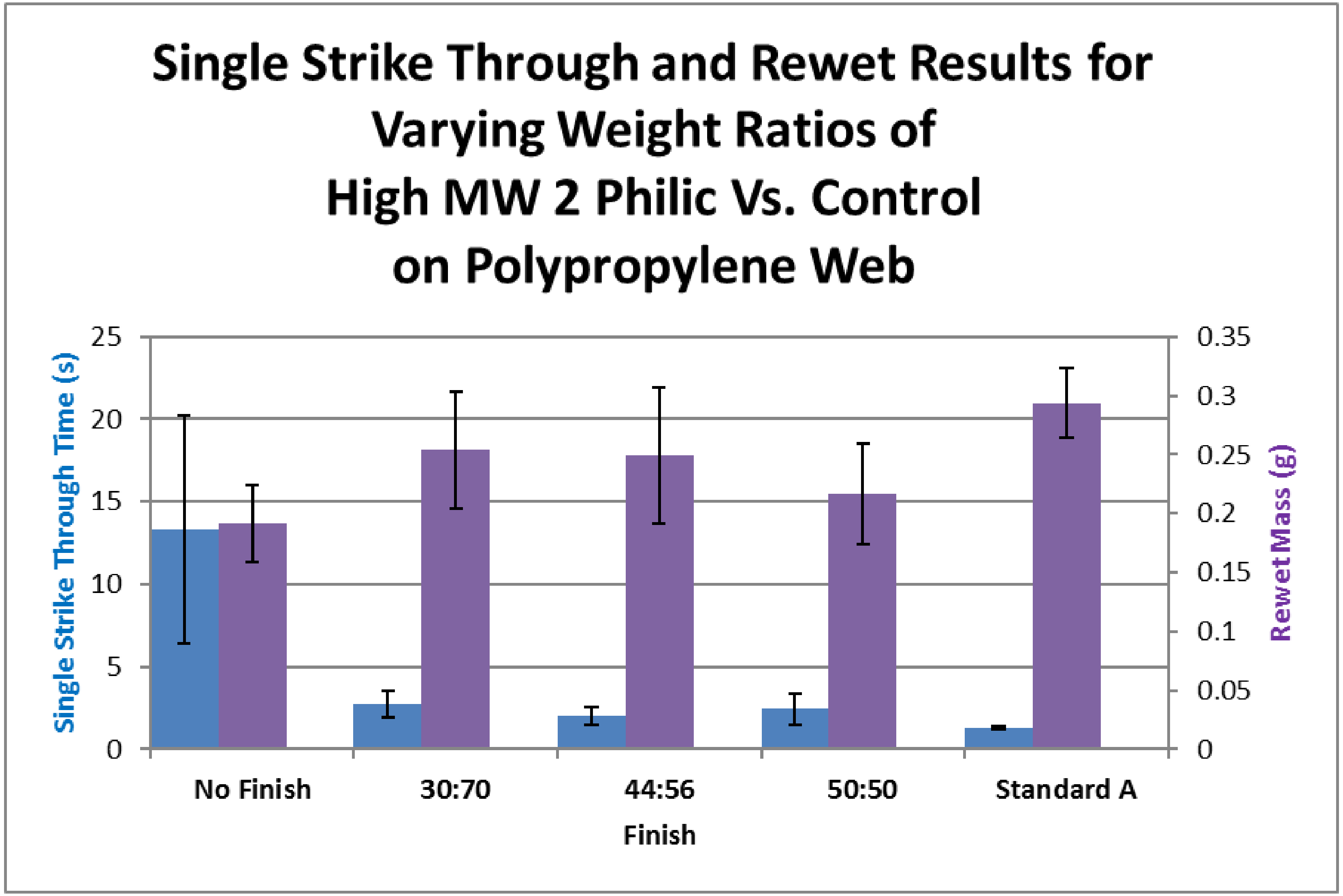
Multiple Strike Through Results for Varying Weight Ratios of
Medium MW Philic Vs. Control
Polypropylene Nonwoven
Strike Through Time (s)
50
45
40
35
30
25
20
15
10
5
0
1
2
3
Strike Through Run
No Finish
44:56 Med MW
50:50 Med MW
30:70 Med MW
56:44 Med MW
Standard A

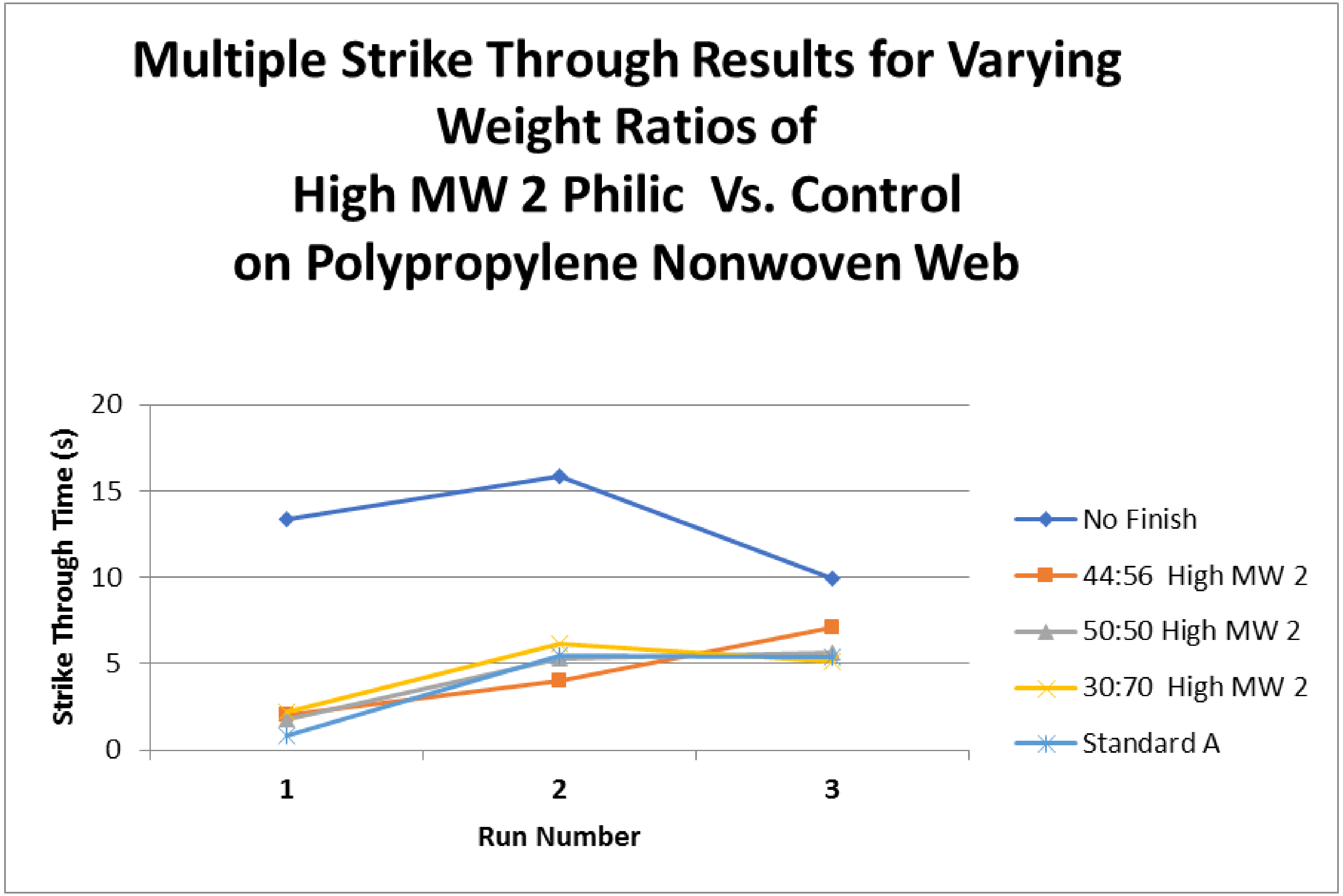


Single Strike Through and Rewet Results for Varying Weight Ratios of
High MW 1 Philic Vs. Aged Sample and Control
on Polypropylene Nonwoven Webs
Single Strike Through Time (s)
Rewet Mass (g)
16
14
12
10
8
6
4
2
0
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Unfinished
30:70 High MW 1
44:56 High MW 1
44:56 High MW 1 (aged 1 yr,)
50:50 High MW 1
Standard A
Finish



Multiple Strike Through Results for Varying Weight Ratios of
High MW 1 Philic Vs. Aged Sample and Control on Polypropylene Nonwoven Web
30
25
20
15
10
5
0
Strike Through Time (s)
1
2
3
Run Number
44:56 High MW 1
50:50 High MW 1
30:70 High MW 1
44:56 High MW 1 (aged 1 year)
Standard A
Unfinished


Single Strike Through and Rewet Results for Varying Weight Ratios of High MW 2 Philic Vs. Control on Polypropylene Web
Single Strike Through Time (s)
Rewet Mass (g)
25
20
15
10
5
0
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
No Finish
30:70
44:56
50:50
Standard A
Finish


Multiple Strike Through Results for Varying Weight Ratios of
High MW 2 Philic Vs. Control
on Polypropylene Nonwoven Web
Strike Through Time (s)
20
15
10
5
0
1
2
3
Run Number
No Finish
44:56 High MW 2
50:50 High MW 2
30:70 High MW 2
Standard A

Summary of Component Weight Ratio Study

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PP Spun Bond

The 50:50 weight ratio generally exhibited optimum over all performance with respect to Re-Wet and Strike Through.

The new chemistry exhibited either comparable or lower re wet as compared to the standard.

The higher MW 1 and 2 exhibited the lowest Strike Through and Re-Wet combination as compared to the Standard.

Next Steps

Blends of the varying weight ratio components to
Determine any synergistic relationships to further reduce re-wet.

Evaluate further increase of the Philic end MW

Evaluate other reactants for effect on re-wet.

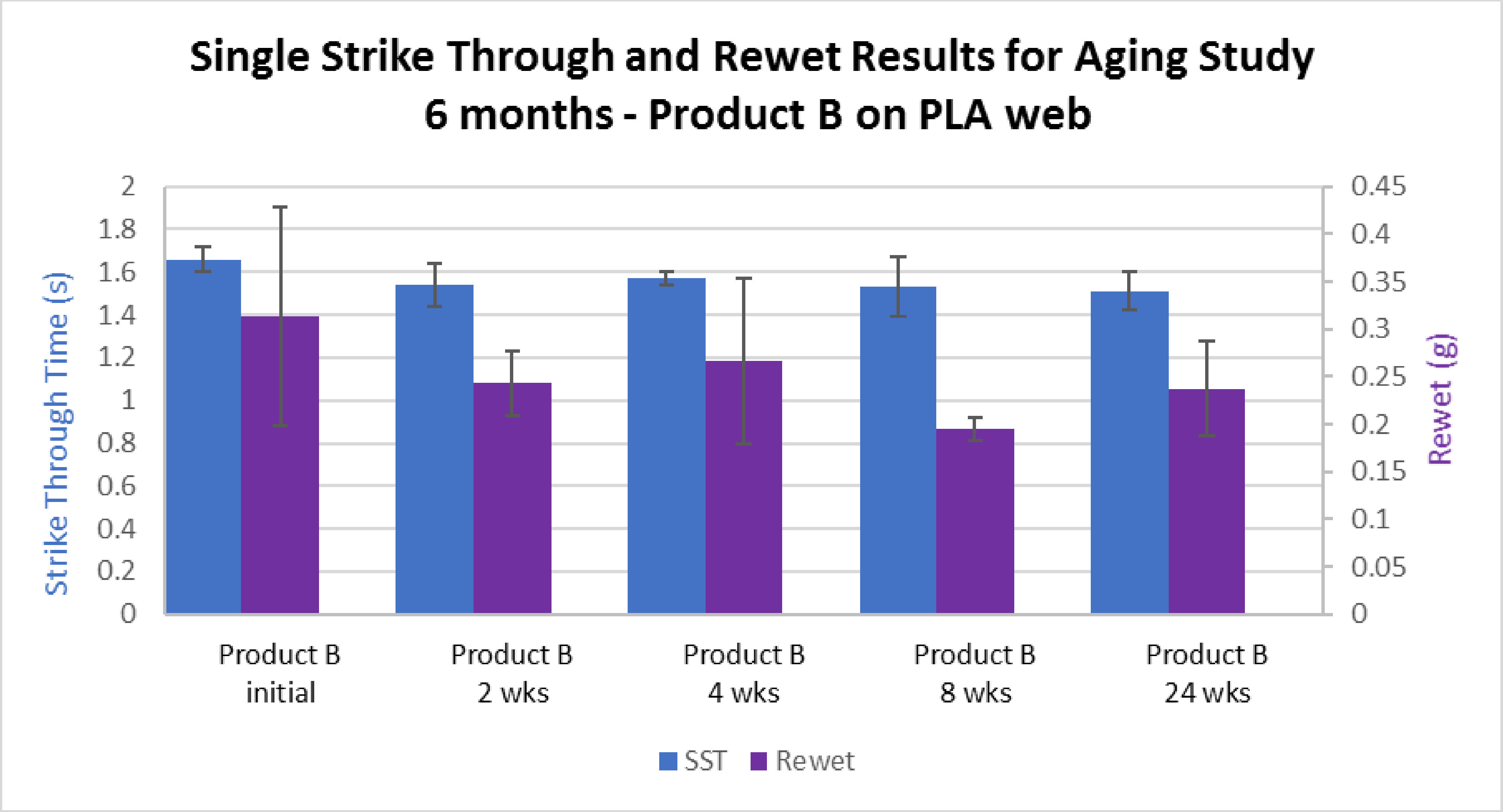
Evaluate on other web types.(limited data on PLA to date)

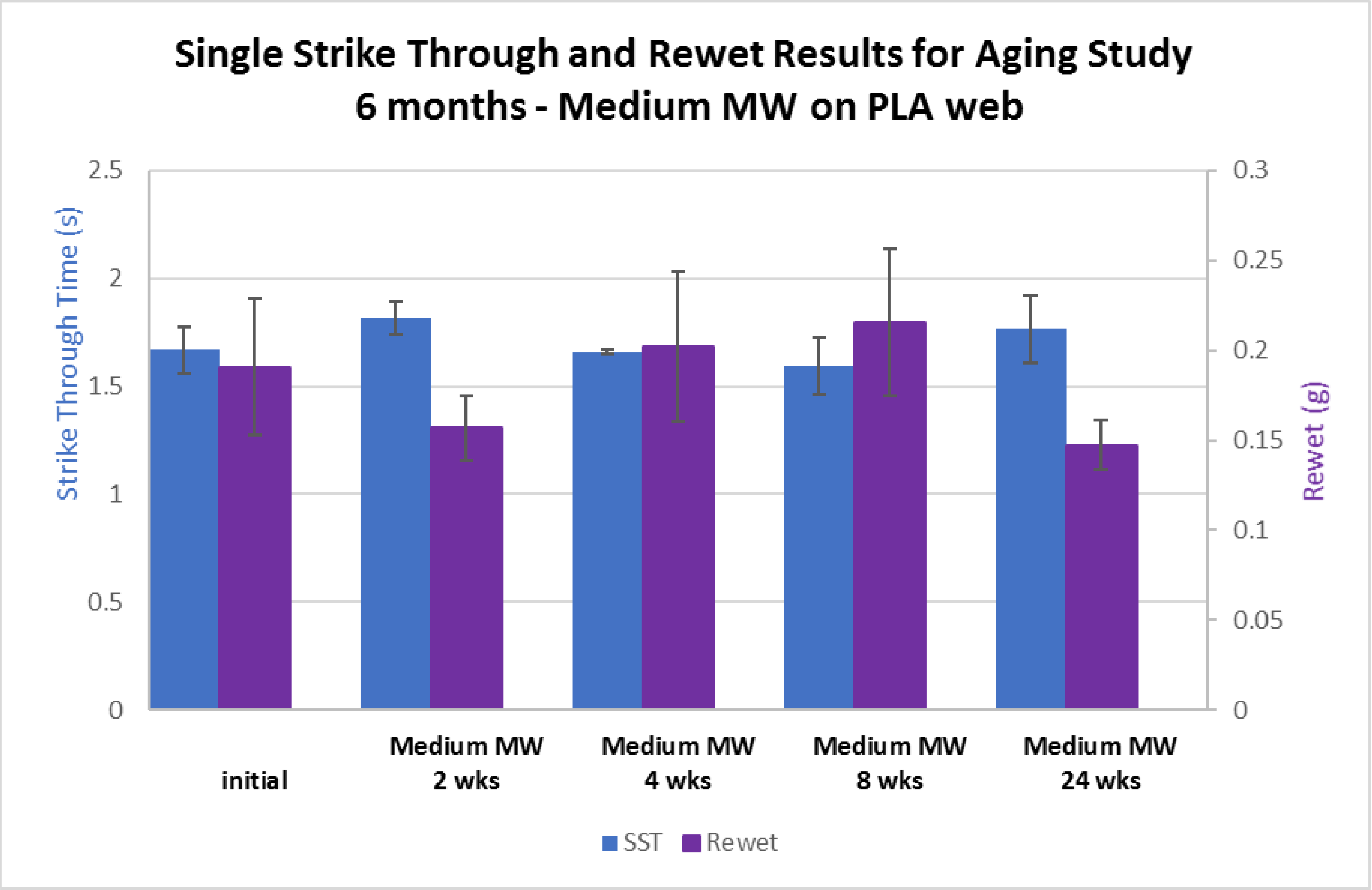
Performance on PLA Webs

15 gsm

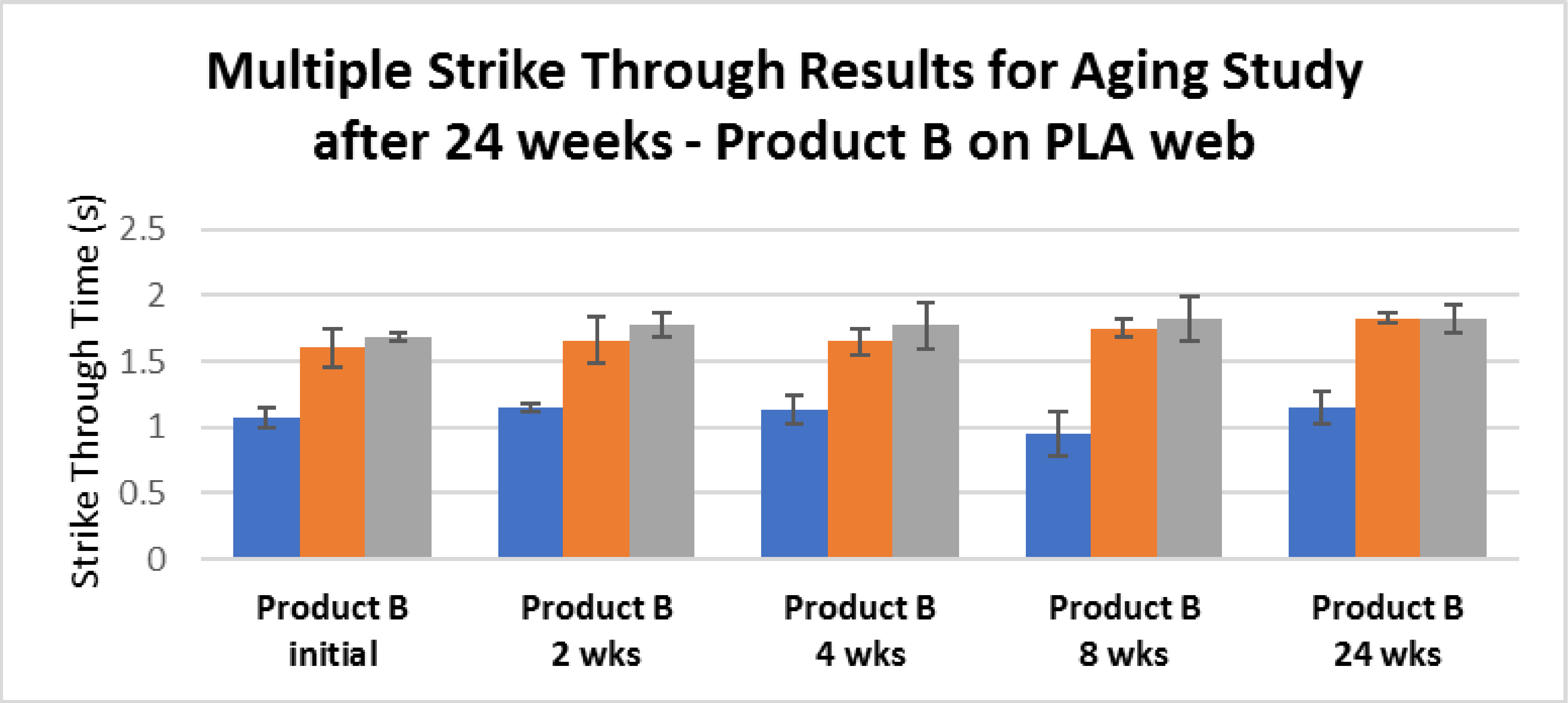
Aging Study – Performance over 24 weeks

Product B and the 50:50 Medium MW new chemistry

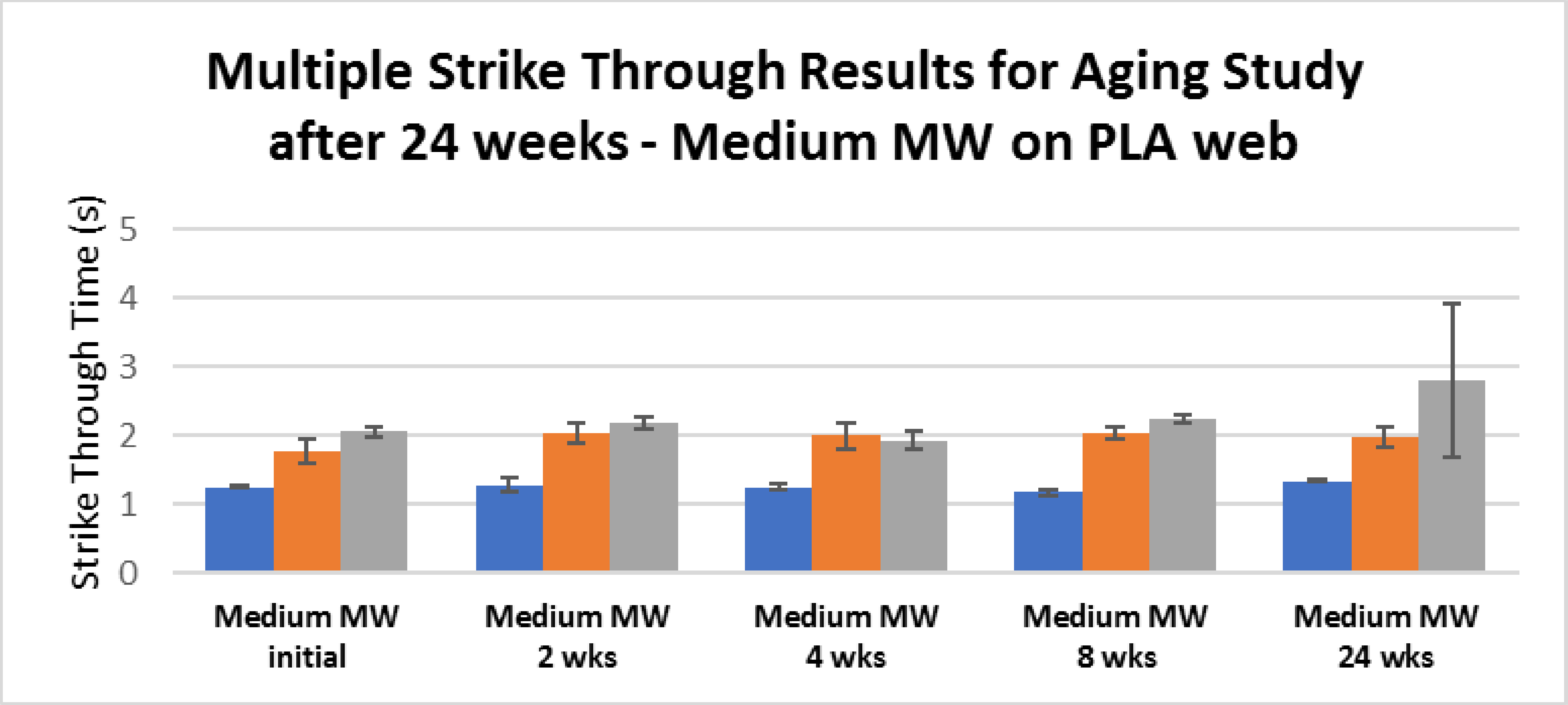

Single Strike Through and Rewet Results for Aging Study
6 months - Product B on PLA web
Strike Through Time (s)
Rewet (g)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Product B initial
Product B 2 wks
Product B 4 wks
Product B 8 wks
Product B 24 wks
SST
Rewet



Single Strike Through and Rewet Results for Aging Study
6 months - Medium MW on PLA web
Strike Through Time (s)
Rewet (g)
2.5
2
1.5
1
0.5
0
0.3
0.25
0.2
0.15
0.1
0.05
0
initial
Medium MW 2 wks
Medium MW 4 wks
Medium MW 8 wks
Medium MW 24 wks
SST
Rewet



Multiple Strike Through Results for Aging Study after 24 weeks - Product B on PLA web
Strike Through Time (s)
2.5
2
1.5
1
0.5
0
Product B initial
Product B 2 wks
Product B 4 wks
Product B 8 wks
Product B 24 wks

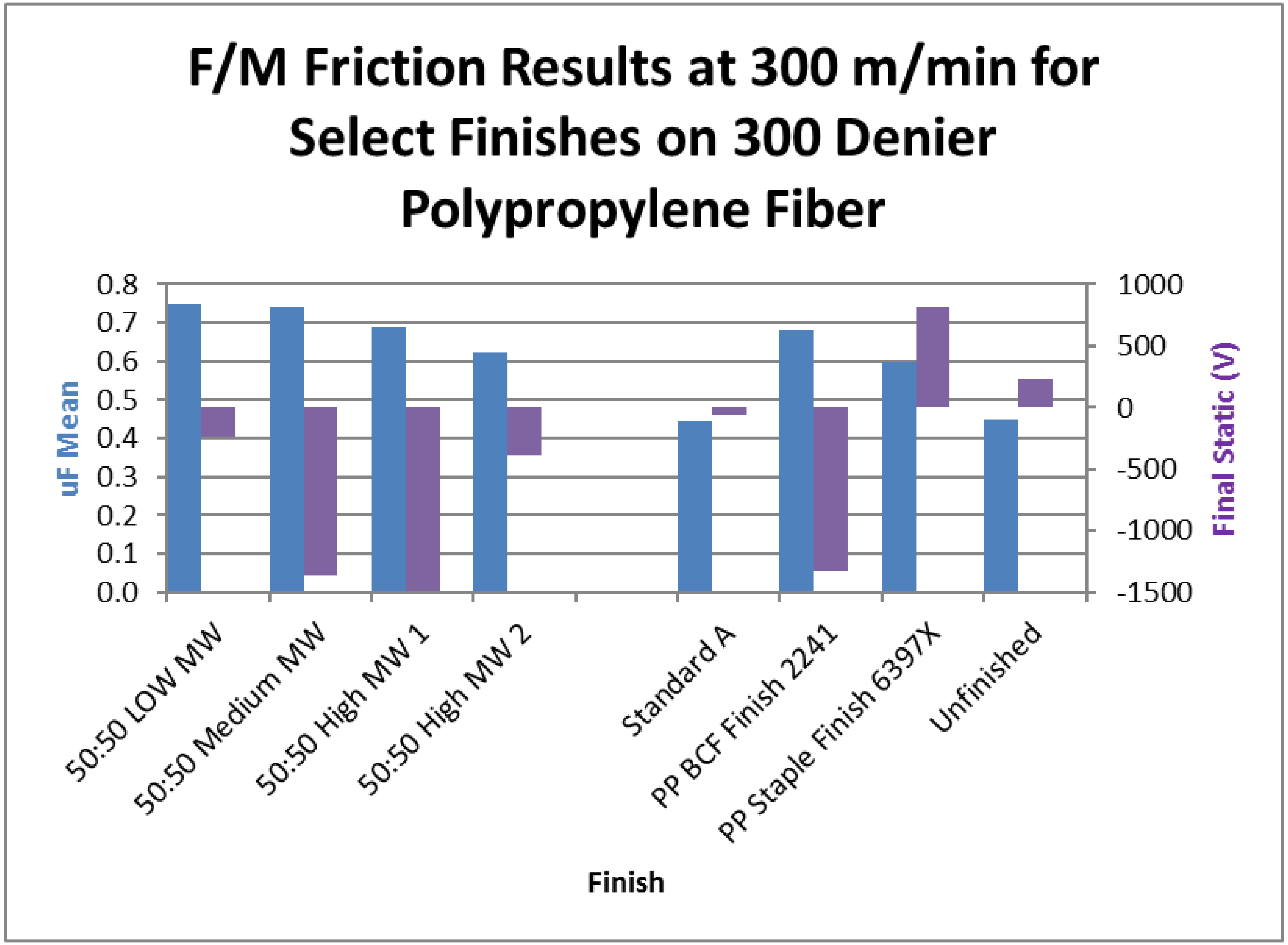

Multiple Strike Through Results for Aging Study after 24 weeks - Medium MW on PLA web
Strike Through Time (s)
0
1
2
3
4
5
Medium MW initial
Medium MW 2 wks
Medium MW 4 wks
Medium MW 8 wks
Medium MW 24 wks

Summary of PLA Web Study

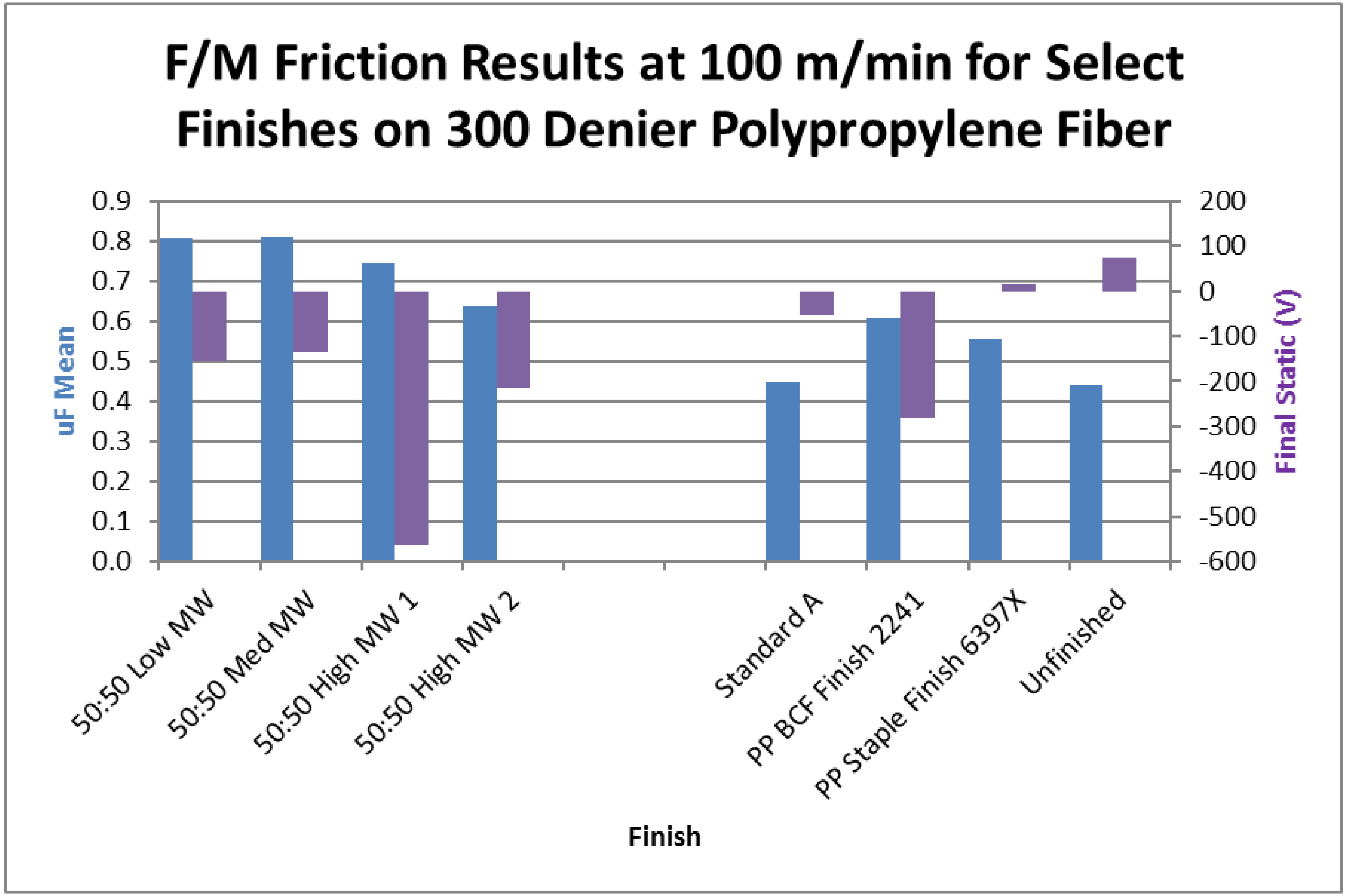
Both Product B and the 50:50 Medium MW exhibited Consistent performance over time on PLA.

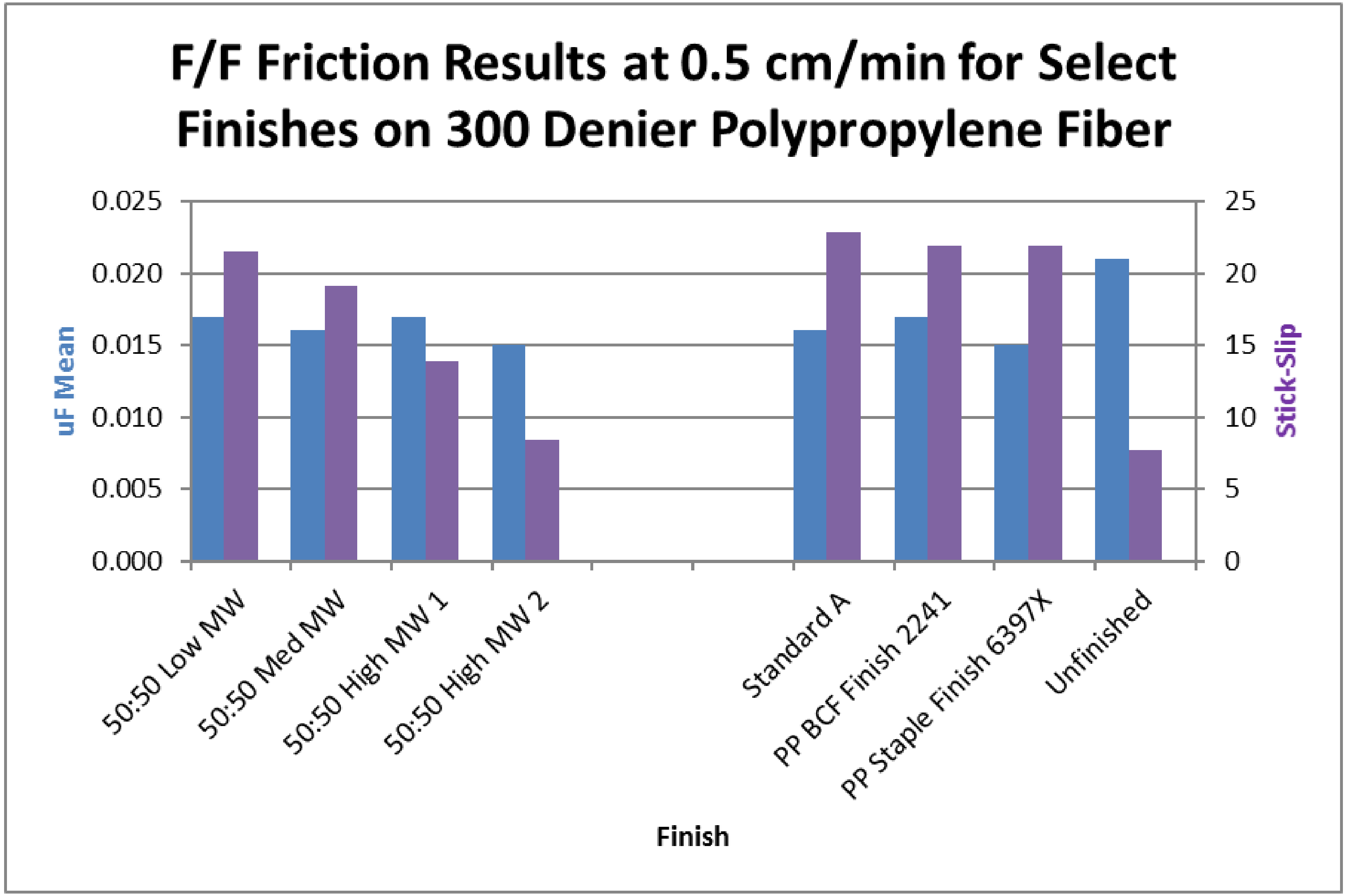
General Lab Test Comparisons of the New Chemistry Vs. Known Performance Standards

- Fiber Friction
- Foaming
- pH
- Specific Gravity
- Viscosity



F/M Friction Results at 300 m/min for Select Finishes on 300 Denier Polypropylene Fiber
uF Mean
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Final Static (V)
1000
500
0
-500
-1000
-1500
50:50 LOW MW
50:50 Medium MW
50:50 High MW 1
50:50 High MW 2
Standard A
PP BCF Finish 2241
PP Staple Finish 6397X
Unfinished
Finish


F/M Friction Results at 100 m/min for Select Finishes on 300 Denier Polypropylene Fiber
uF Mean
Final Static (V)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
200
100
0
-100
-200
-300
-400
-500
-600
50:50 Low MW
50:50 Med MW
50:50 High MW 1
50:50 High MW 2
Standard A
PP BCF Finish 2241
PP Staple Finish 6397X
Unfinished
Finish



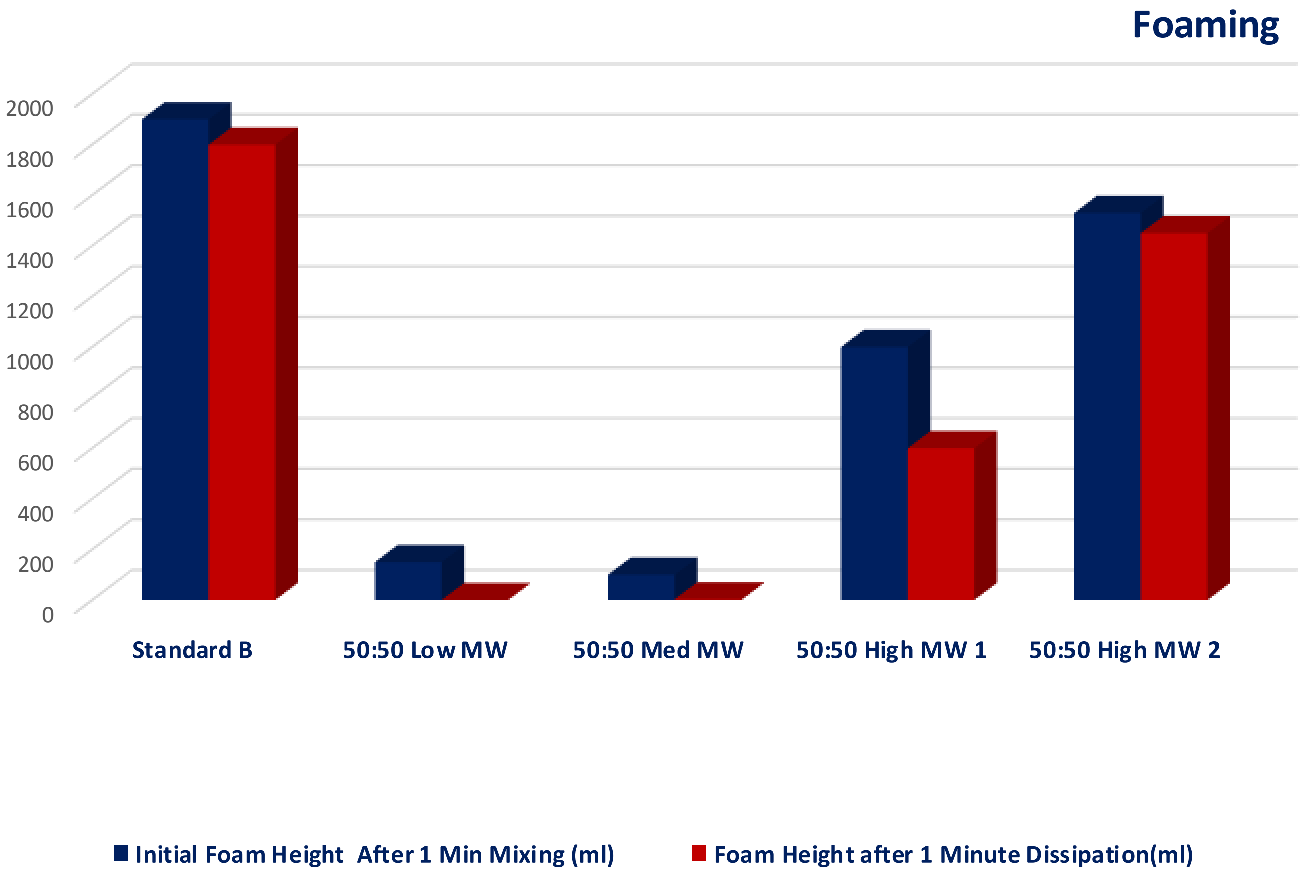
F/F Friction Results at 0.5 cm/min for Select Finishes on 300 Denier Polypropylene Fiber
uF Mean
Stick-Slip
0.025
0.020
0.015
0.010
0.005
0.000
25
20
15
10
5
0
50:50 Low MW
50:50 Med MW
50:50 High MW 1
50:50 High MW 2
Standard A
PP BCF Finish 2241
PP Staple Finish 6397X
Unfinished
Finish

General Comparative Characteristics

Foaming

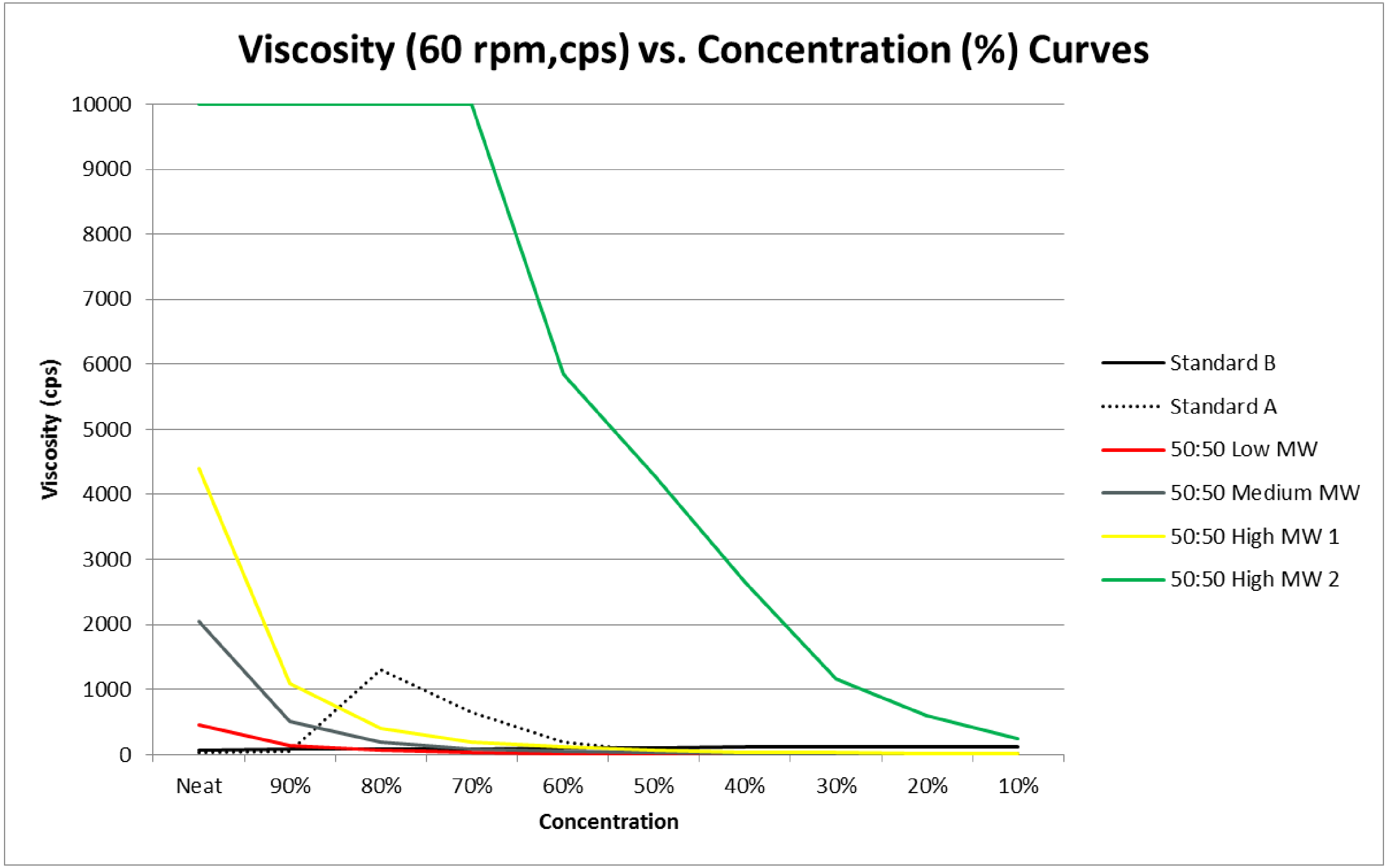
pH

Specific Gravity



Product Name	5% pH in D.I. Water	Specific Gravity (25C)
Standard A	5.5 - 7.0	0.97464
Standard B	3.5 - 6.0	1.03644
50 : 50 Low MW	3.93	1.19424
50 : 50 Med MW	3.44	1.19364
50 : 50 High MW 1	3.16	1.19268
50 : 50 High MW 2	2.92	1.19952

General Comparative Characteristics



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General Characteristics Comparison

New Chemistry exhibits:

- Acceptable Friction Characteristics for potential use in staple fiber production.
- Low Foaming for the Low and Medium MW options.
- Acceptable Viscosity Range for use in current fiber and nonwovens processes.
- Low pH in range to provide web pH in range of 5 – 6.

Next Steps

Customer Trials

- With the optimum new component known, to date
- With the new improved durable hydrophilic finish Stantex S 6887

Continue investigation of the new component

- Blends
- Philic Higher MW Investigation
- Expand into Fiber Trials
- Evaluate larger series on PLA web

Thank you for your attention