ExxonMobil

Imperial

11 June 2024

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[If applicable, insert document # here]

Efficient and Effective Test Parameters to Identify Best Performing Binders

Special thanks to Marcel Hildebrand, Rezwan Quddus, and the Imperial Oil asphalt lab technologists for their efforts on this initiative

Disclaimer

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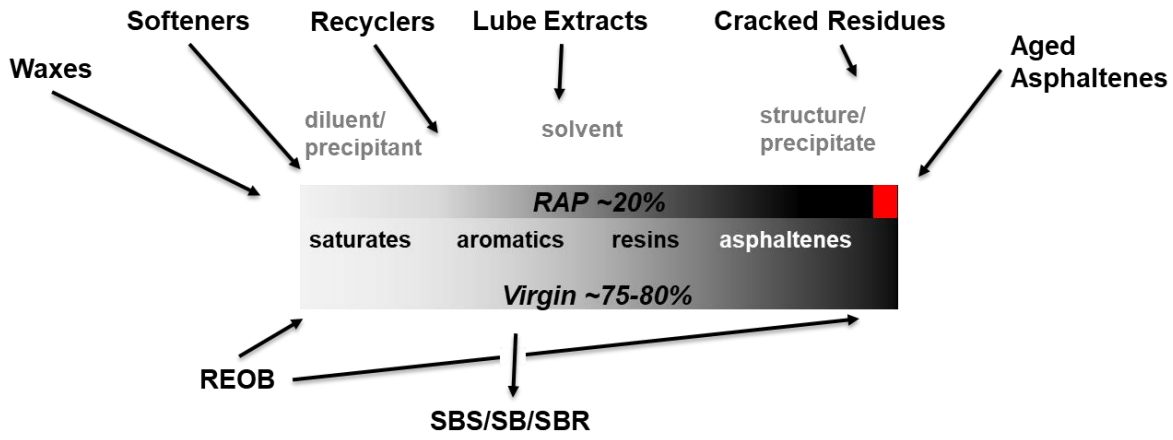
Where Are We and How'd We Get Here?

- Superpave™ system developed based on straight-run binders from 1980/90s
- Chemistry of today's binders has changed, not all additive effects captured well
- Proliferation of new specifications to combat perceived shortfalls
  - exBBR & DENT
  - DeltaTc (20 & 40 h)
  - LAS
  - NCHRP 9-59/60
- What do we want to capture?



And many other additives: Bio, Plastics, Acids, WMA, Antistrips, Scavengers…

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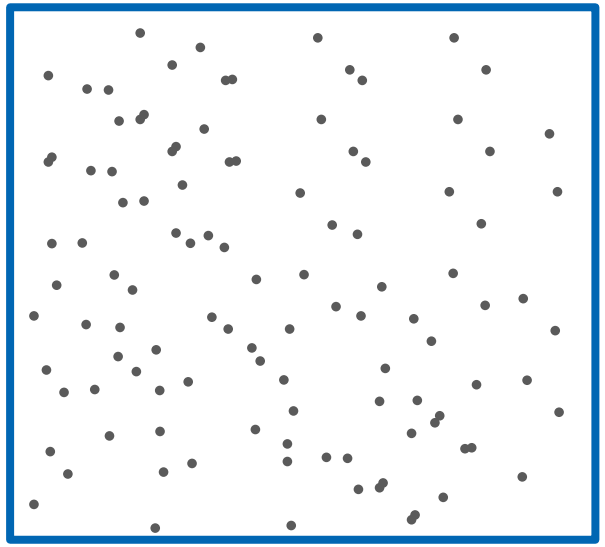
Superpave is a trademark of the Strategic Highway Research Program

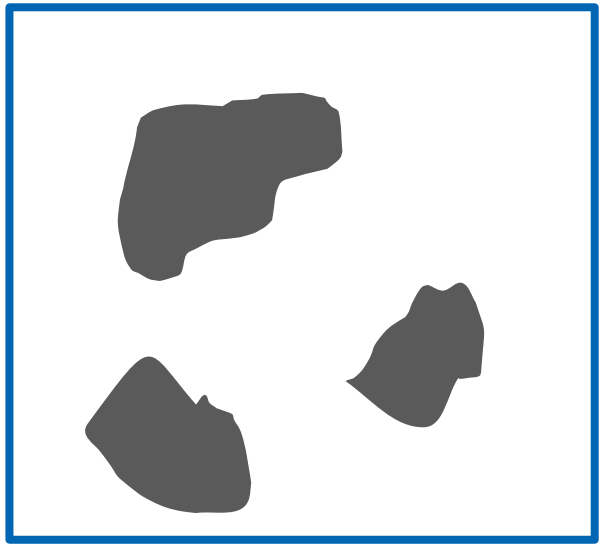
Colloidal Stability Key to Cracking Resistance

Stable
Asphaltenes Well-Dispersed



High Surface Area
Lower Maltene Viscosity at Given PG
Smaller Failure Interface
Lower Aging Rate
Faster Relaxation

Unstable
Asphaltenes Poorly Dispersed



Low Surface Area
Higher Maltene Viscosity at Given PG
Larger Failure Interface
Higher Aging Rate
Slower Relaxation

Colloidal Instability Index described by Gaestel (Esso France) in 1960s:

$$\mathrm{CII} = \frac{[Saturates] + [Asphaltenes]}{[Resins] + [Aromatics]}$$

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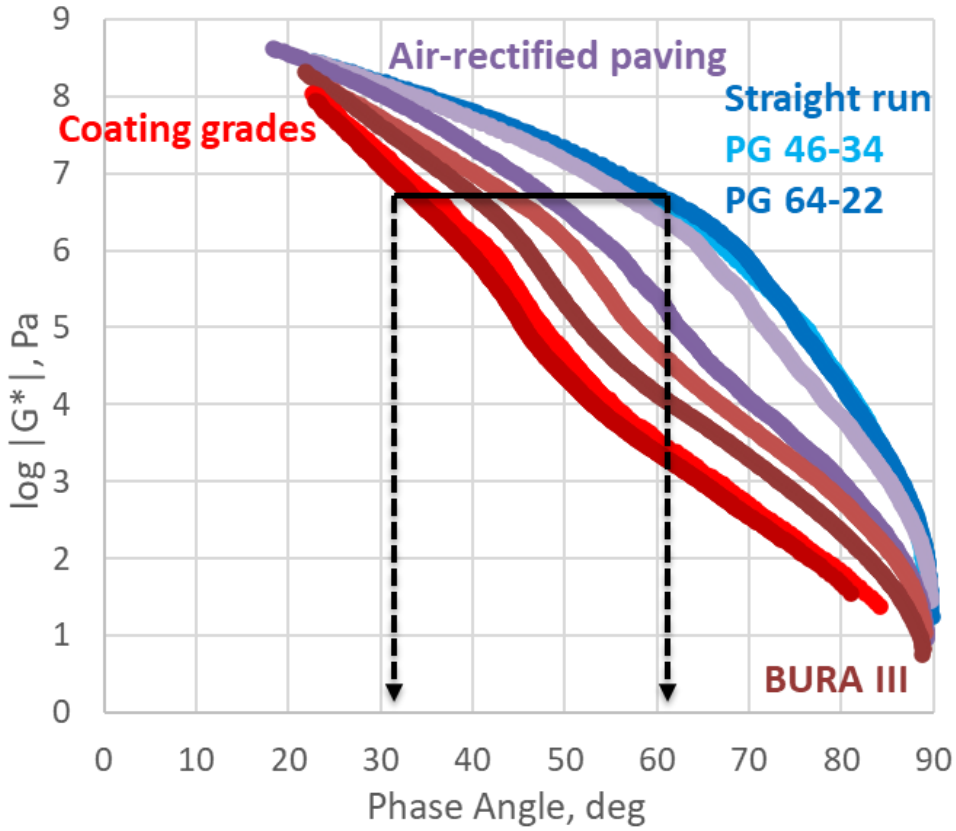
What is an Ideal Cracking Specification?

Differentiates good binders from poor-performing binders

1. Established on Scientific Fundamentals
2. Cost Effective (Time & Resources)
3. Reproducible
4. Simple & Accessible
5. Field Validated

Shape Parameters

- Tell us about the shape of the mastercurve
- Shape of the mastercurve is tied to chemistry
  - Composition
  - Modification
  - Oxidation / Aging
- Can tell us about a binder's capacity to relax stress in the stiffness regions where cracking occur



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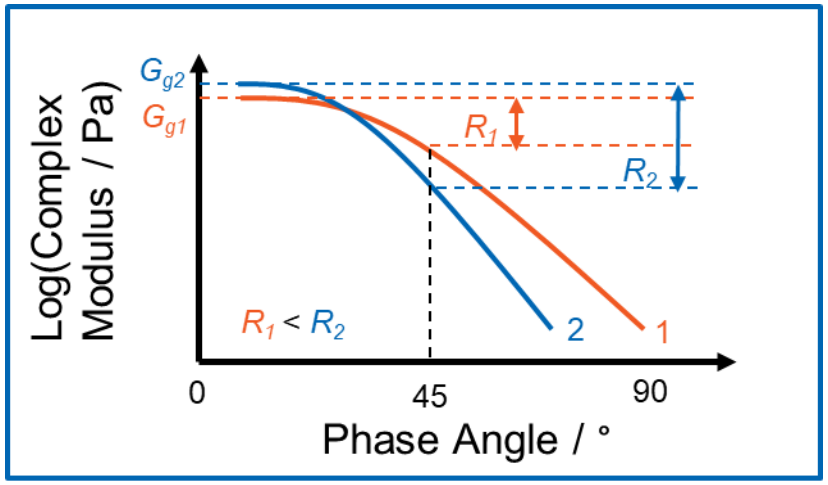
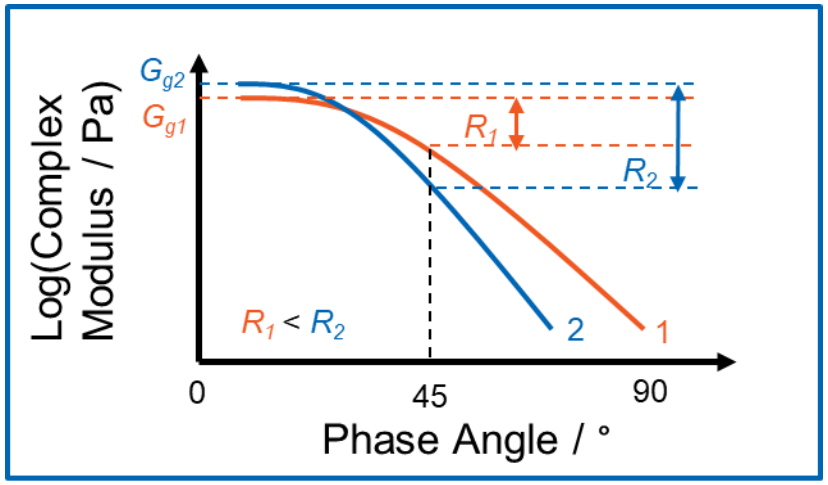
Example Shape Parameters



R-Value

- Mastercurve
- BBR (NCHRP 9-59)

Example Shape Parameters



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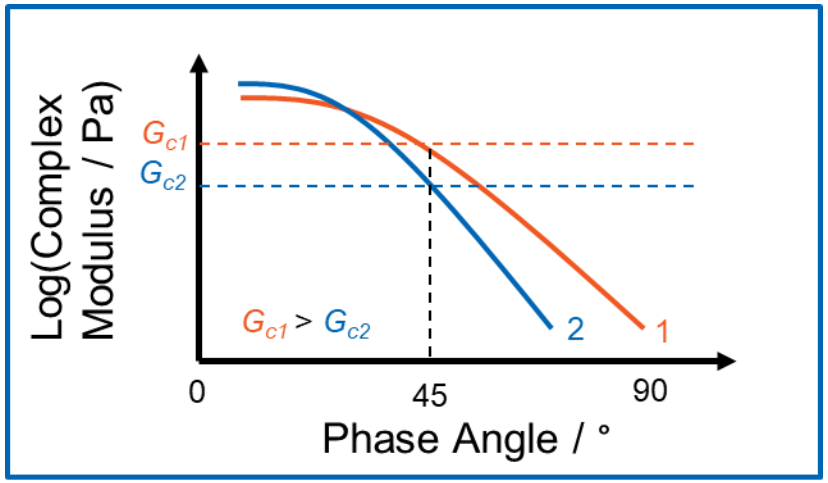

Crossover Modulus
- Mastercurve
- DSRp

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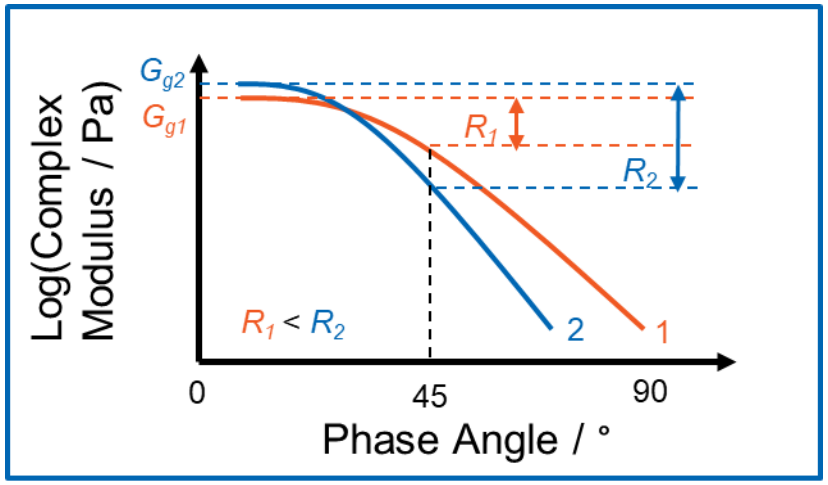
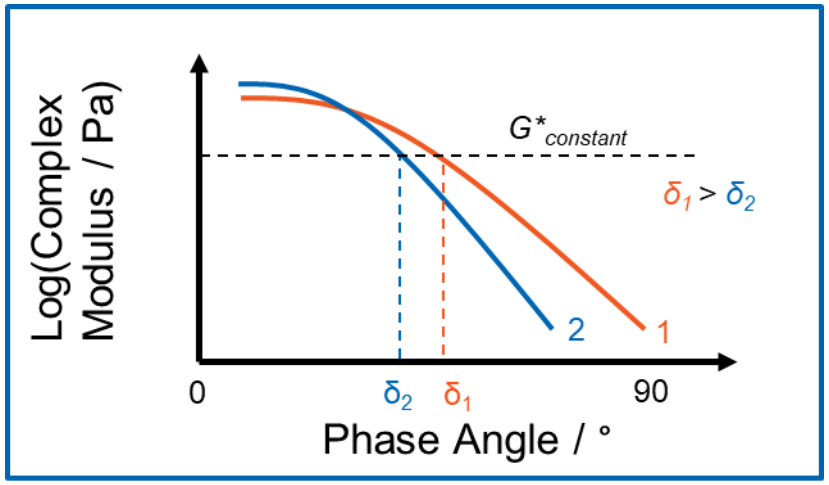
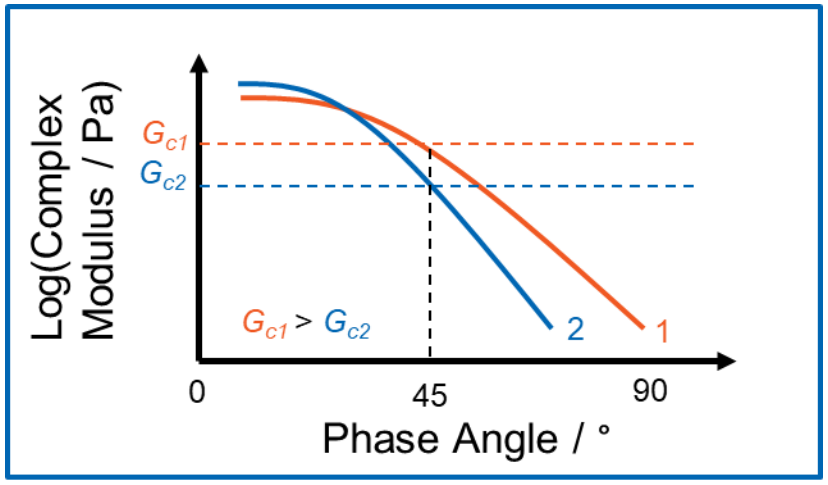
Example Shape Parameters



R-Value
- Mastercurve
- BBR (NCHRP 9-59)

Phase Angle at Constant Modulus
- Mastercurve
- DSRp





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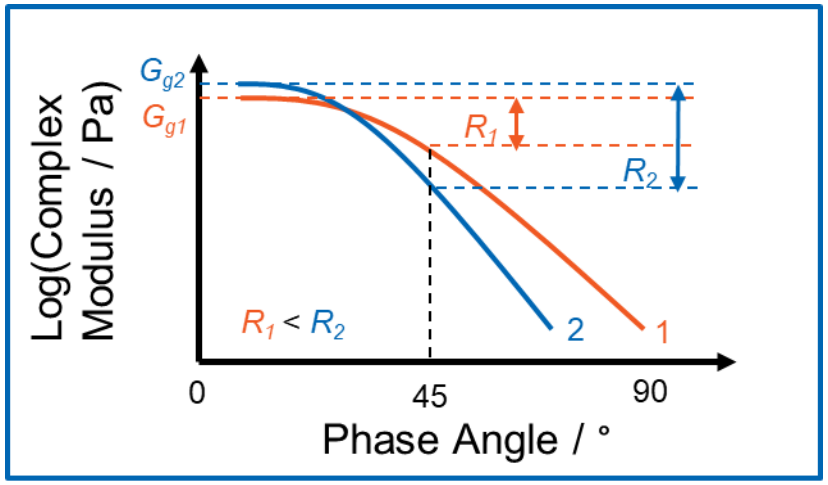

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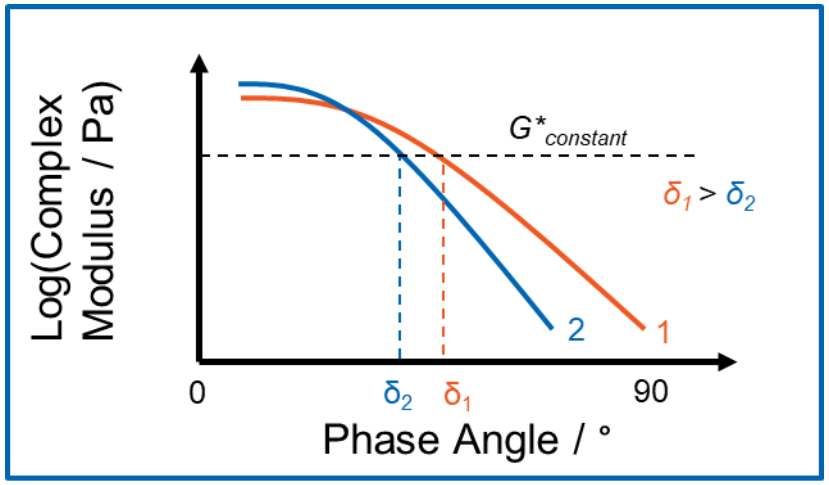

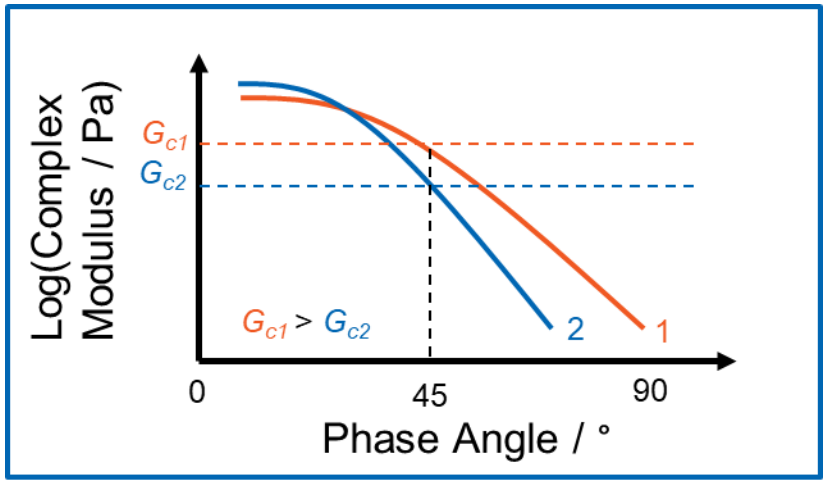

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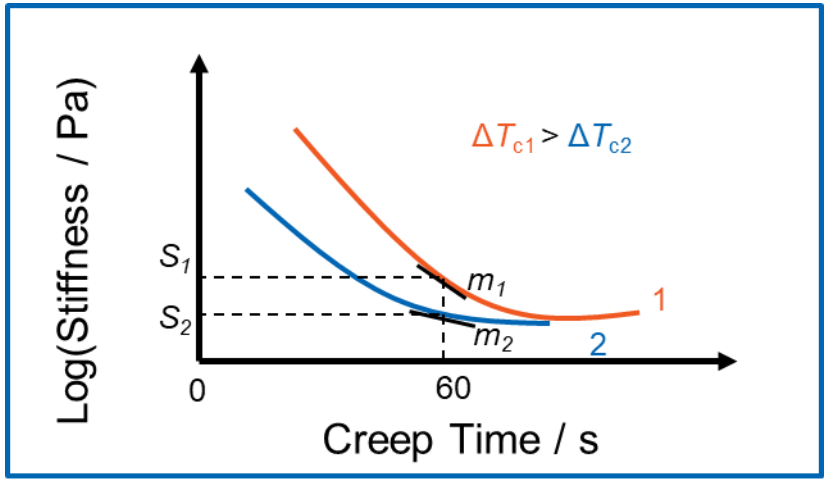

DeltaTc
- BBR

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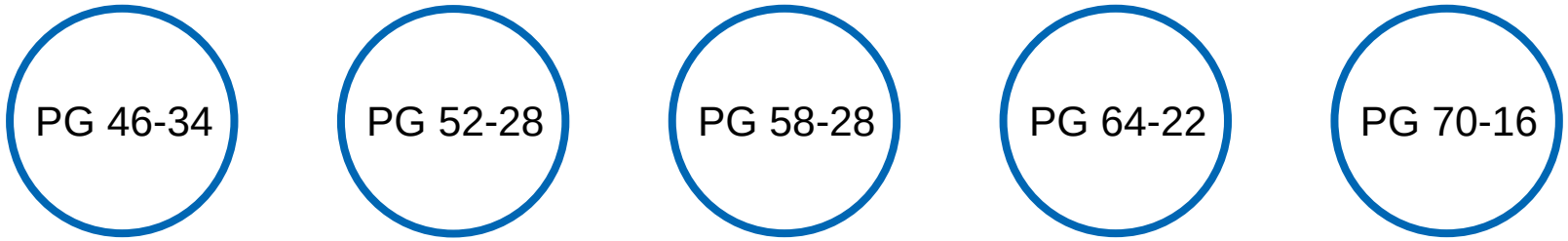
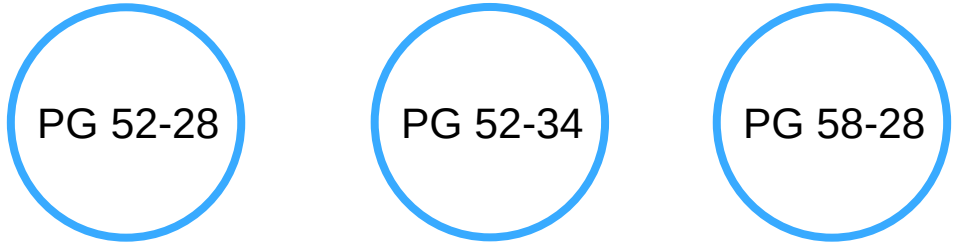
Sample Set

Base Binders:



Blended Binders:



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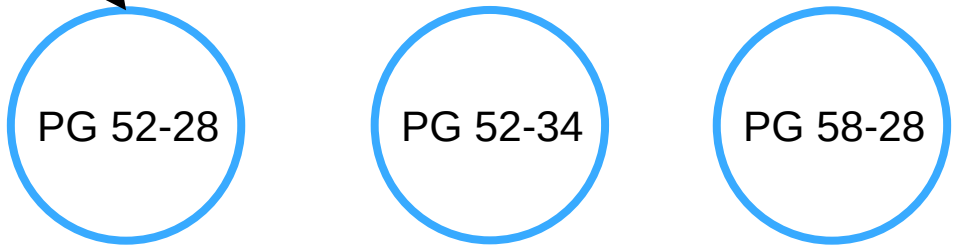
Sample Set

Base Binders:

Wax

Blended Binders:



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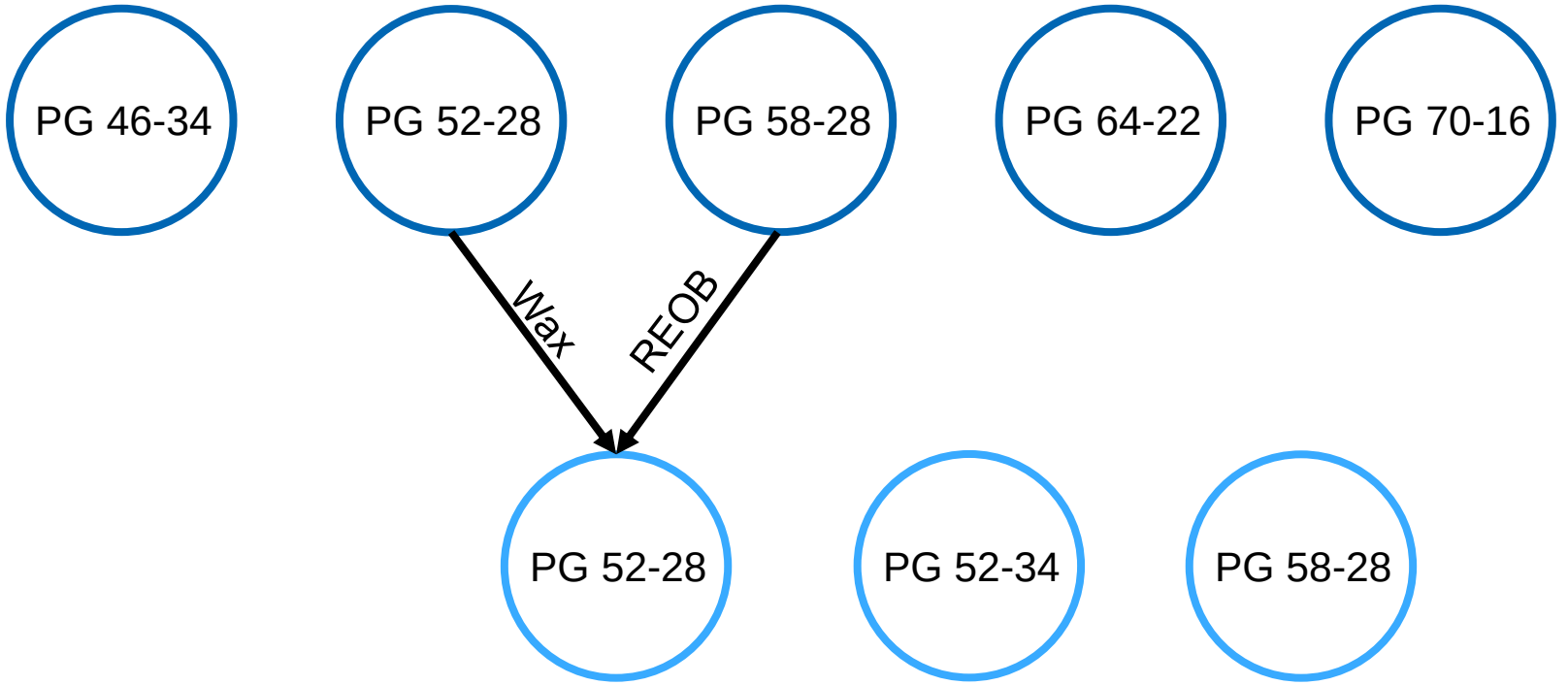
Sample Set

Base Binders:



Blended Binders:

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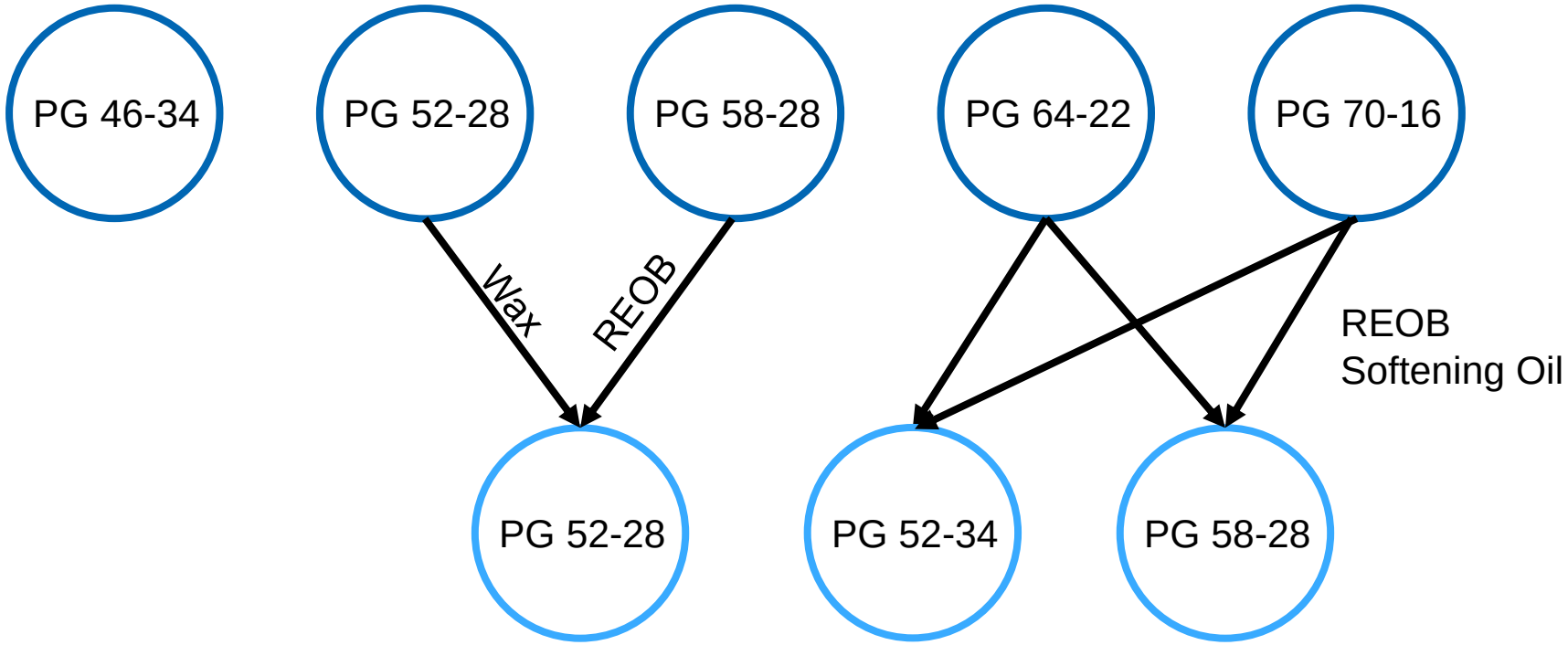
Sample Set

Base Binders:



Blended Binders:

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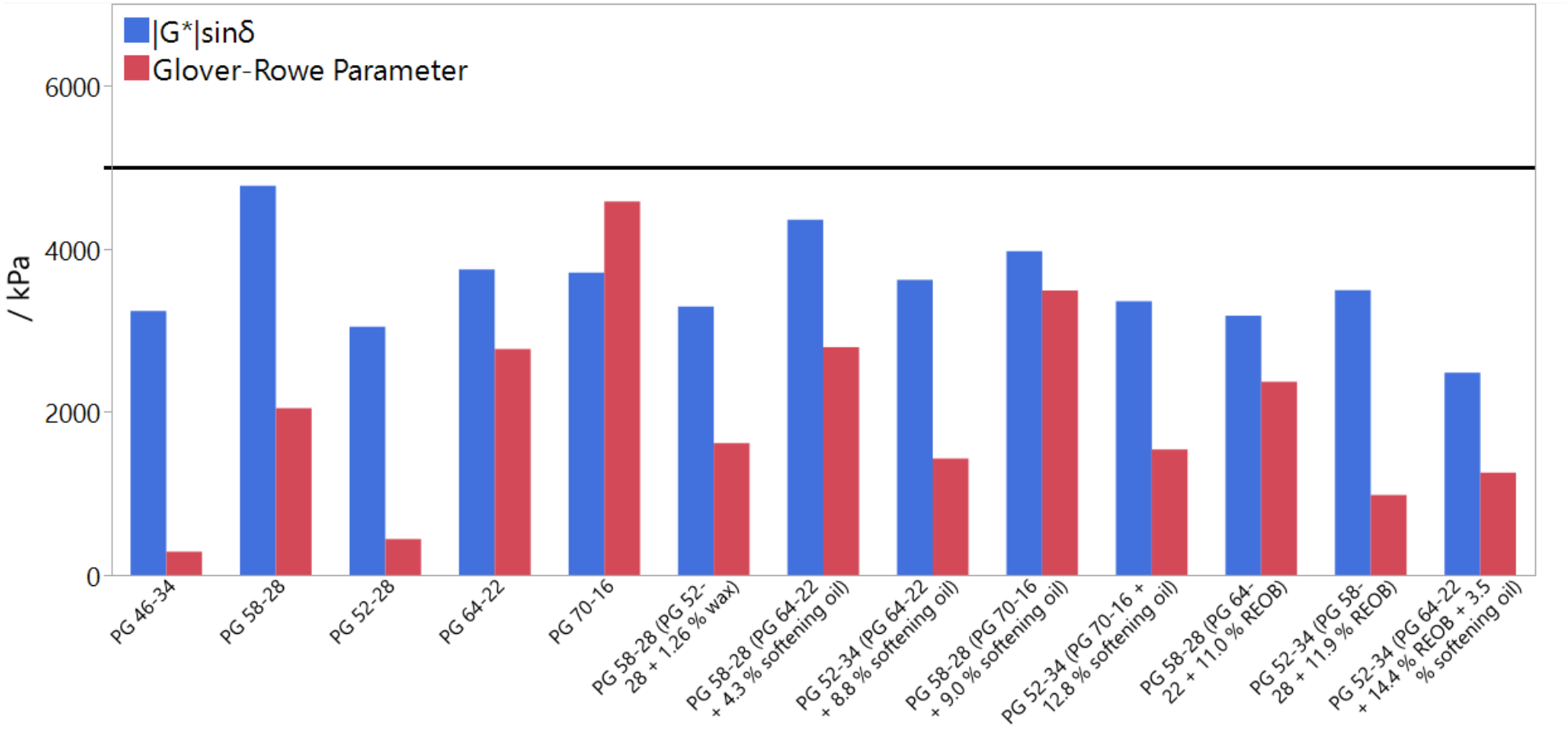
DSRp Doesn’t Identify Poor Performers…



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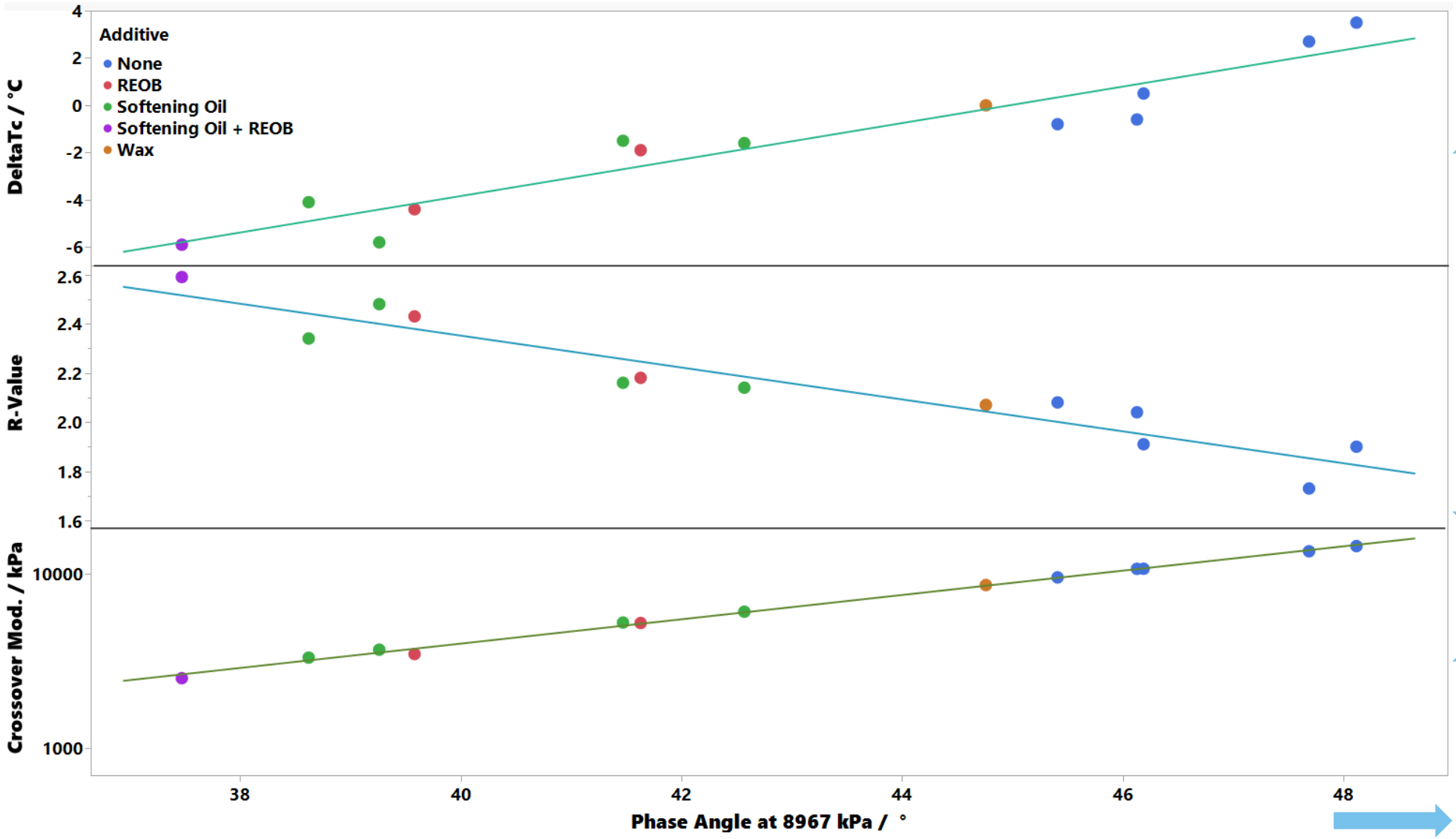
…But There are Effective Tests that Do



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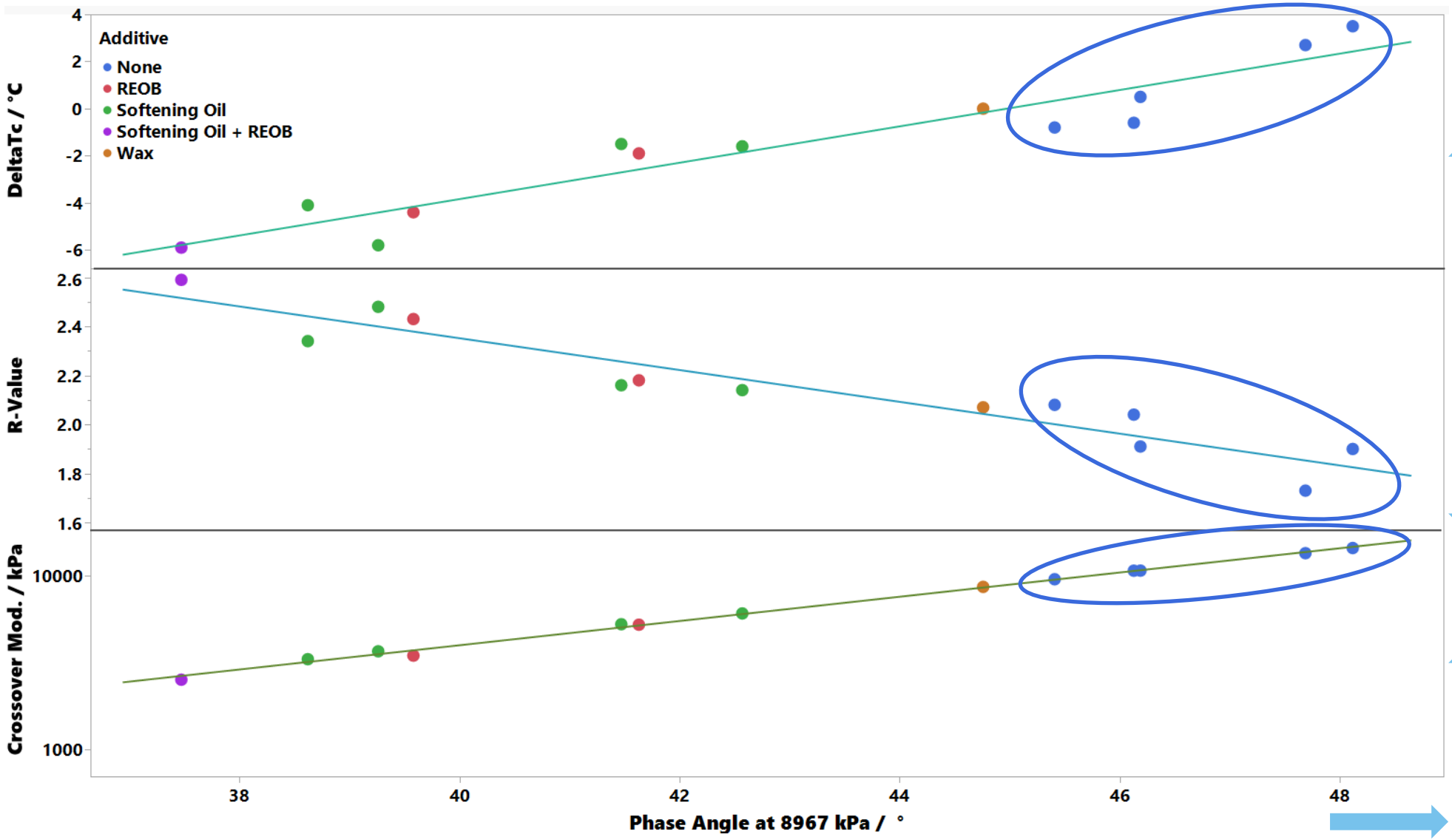

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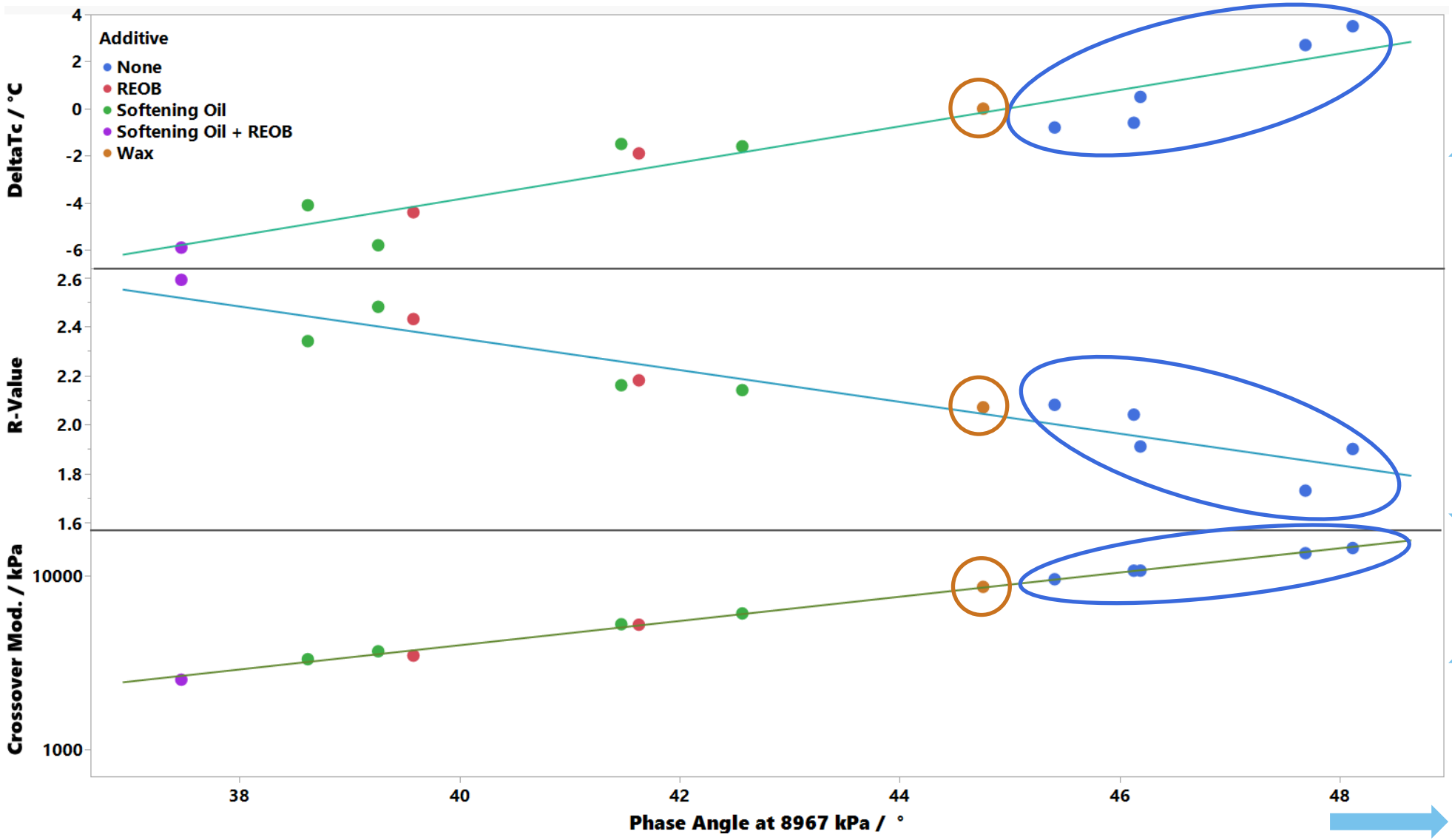

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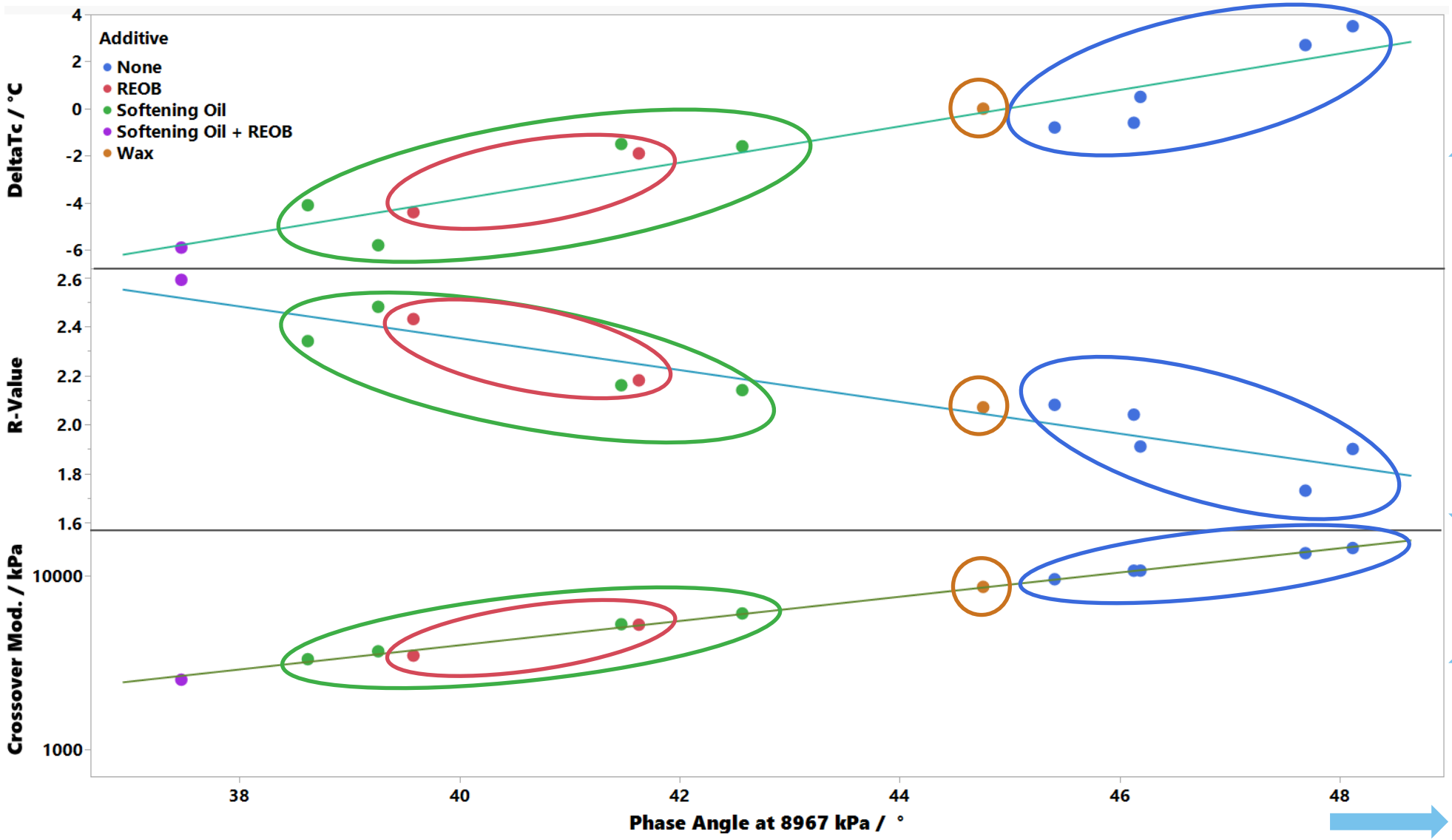

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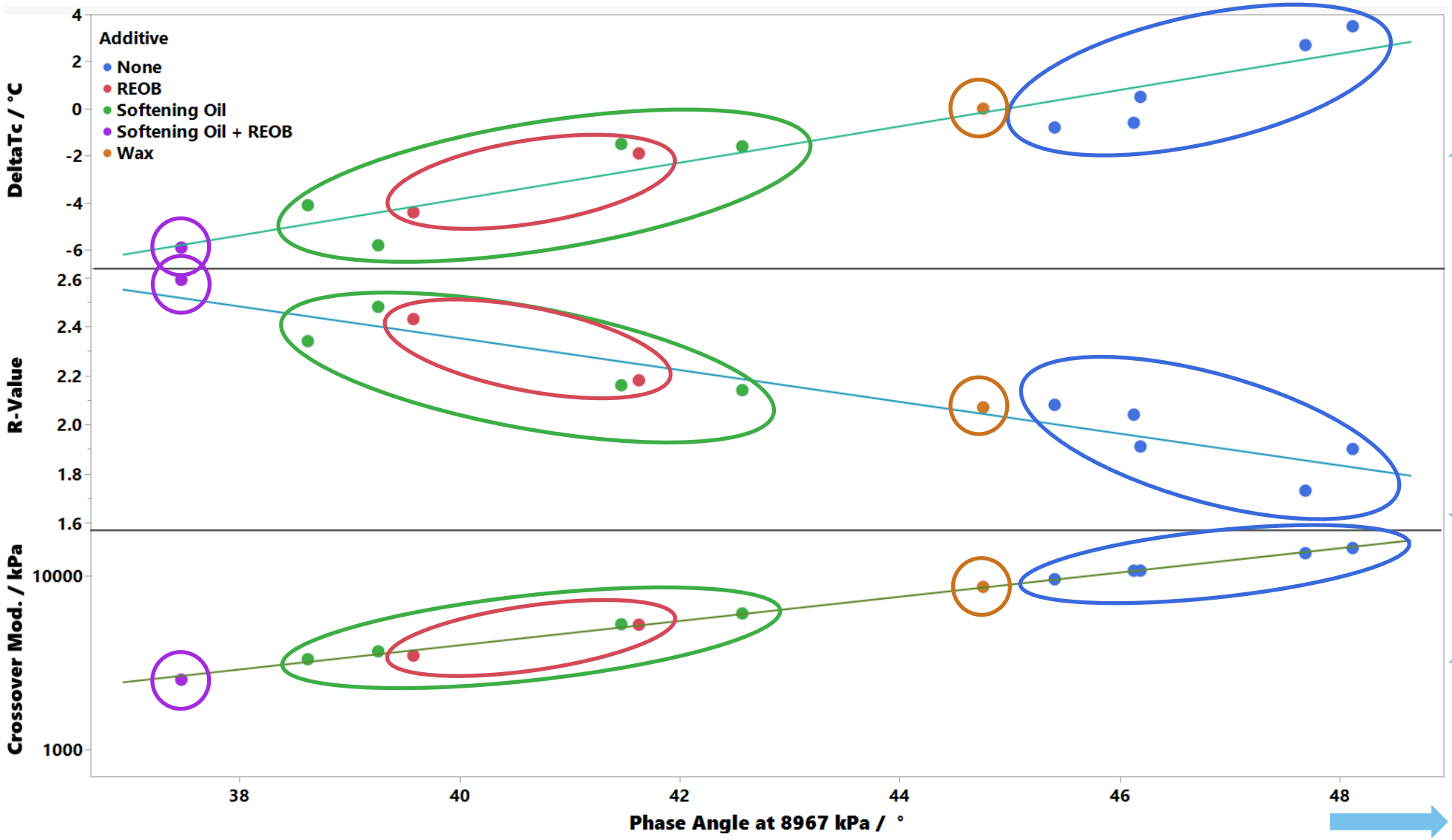
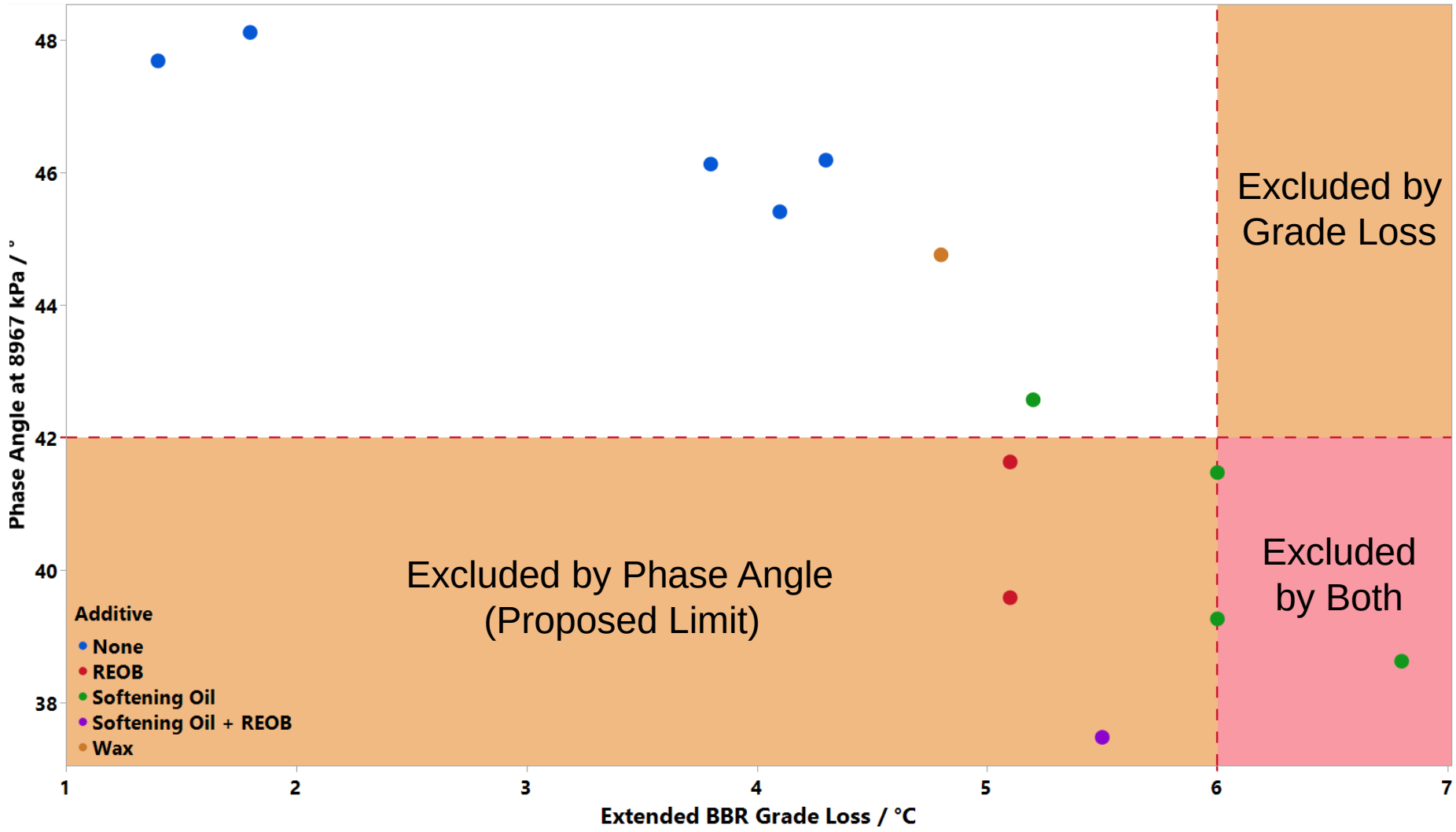


Same (Better?) Differentiation, Much Less Time than eBBR



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Summary

- Current fatigue cracking specification does not identify poor-performers
- exBBR can identify poorer-performers, but is logistically challenging as a spec
- A shape parameter such as phase angle at constant modulus, crossover modulus, R-value, or DeltaTc can provide equivalent or superior differentiation in much less time and with high repeatability