

Blending VI Improvers For Greater Economics and Performance

Functional Products Inc.
October 7th 2019



- Mixed/hybrid VI improver blending
 - Motivation
 - Materials
 - Blending
- Comparison and analysis of mixed VII blends
 - Pour point vs. cost
 - VI vs. cost



- Many options for VI improver chemistry
- Often diminishing returns on using increasing amounts of one VI improver
 - VI can plateau beyond a certain wt%
 - Pour point can improve and then worsen
- What if we could use the high VI improvement from a PMA with the thickening efficiency of OCP?

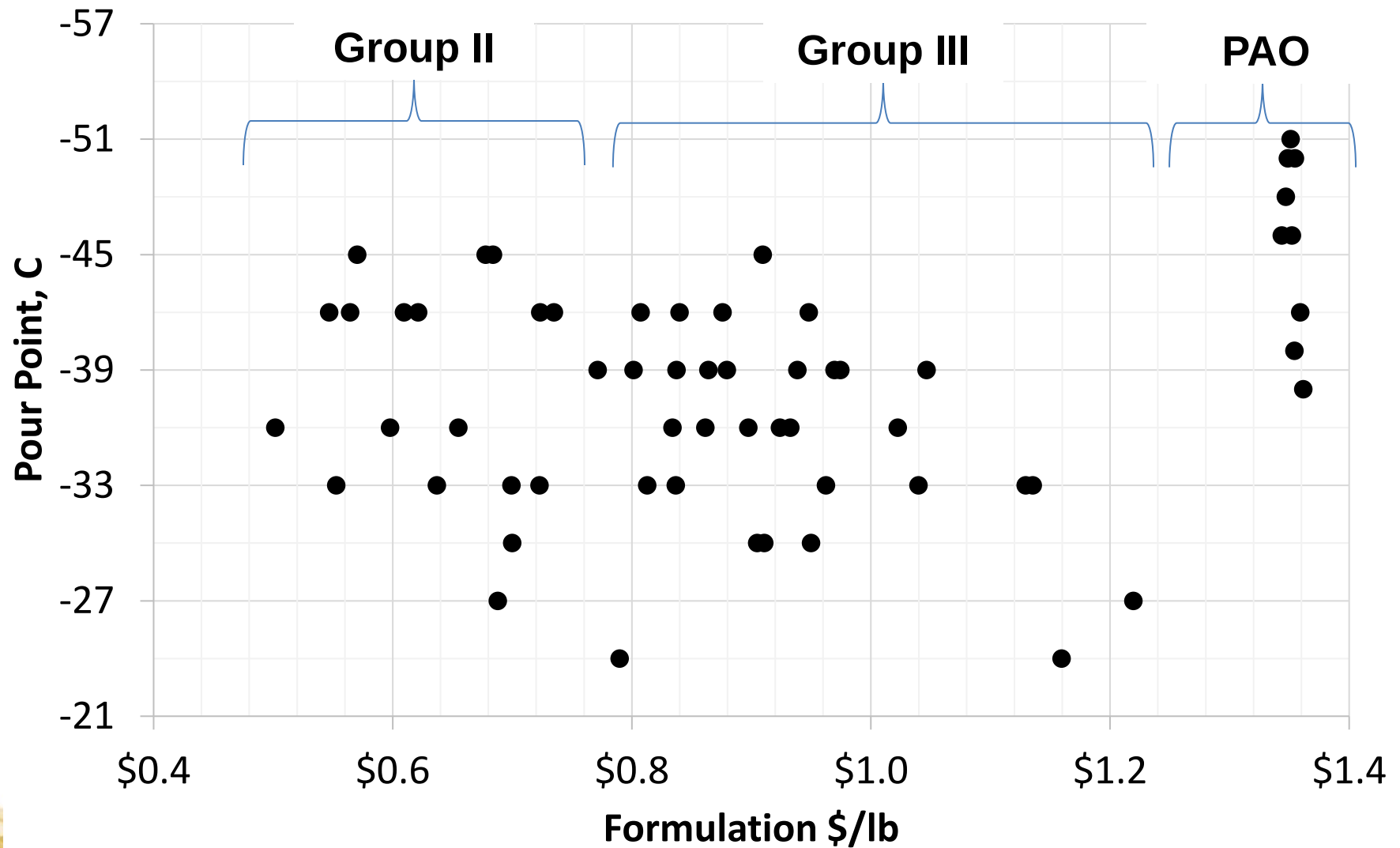


- Three base oils
 - 150N Gr. II (w/ 0.2wt% Gr. II PPD)
 - 4 cSt Group III (w/ 0.2wt% Gr. III PPD)
 - PAO6
- Three polymers:
 - MH-2000 – 1 SSI PMA
 - V-160F – 22 SSI OCP, concentrated liquid
 - 2200 MW polybutene (PB)
- No packages included to keep the study generic for HF, gear, engine, etc.
- Details in 2018 NLGI paper (Author Award winner)
 - “Viscometric and Low Temperature Behavior of Lubricants with Blended VI Improvers”

- Pairs of VI improvers blended using 5% / 10% / 20% of each VI
 - 5% PMA + 5% OCP
 - 5% PMA + 10% OCP
 - ...
 - 10% PMA + 5% OCP
 - ...
 - 20% PMA + 20% OCP
 - Then repeat in each base oil
- 81 formulations
 - Measured viscosity, VI, and pour point
 - Determined trends in VI and pour point behavior with VII



Pour Point vs. Cost

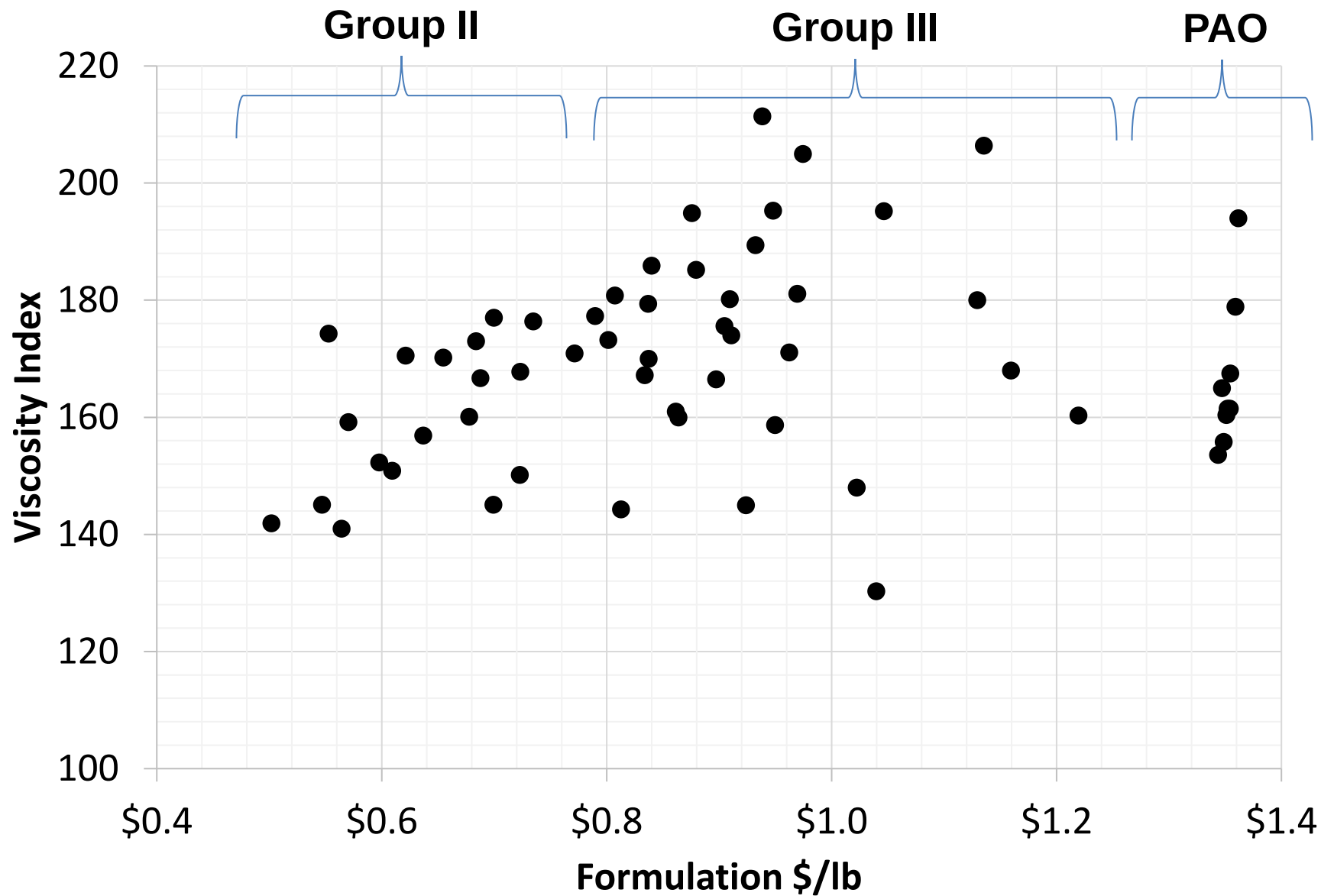




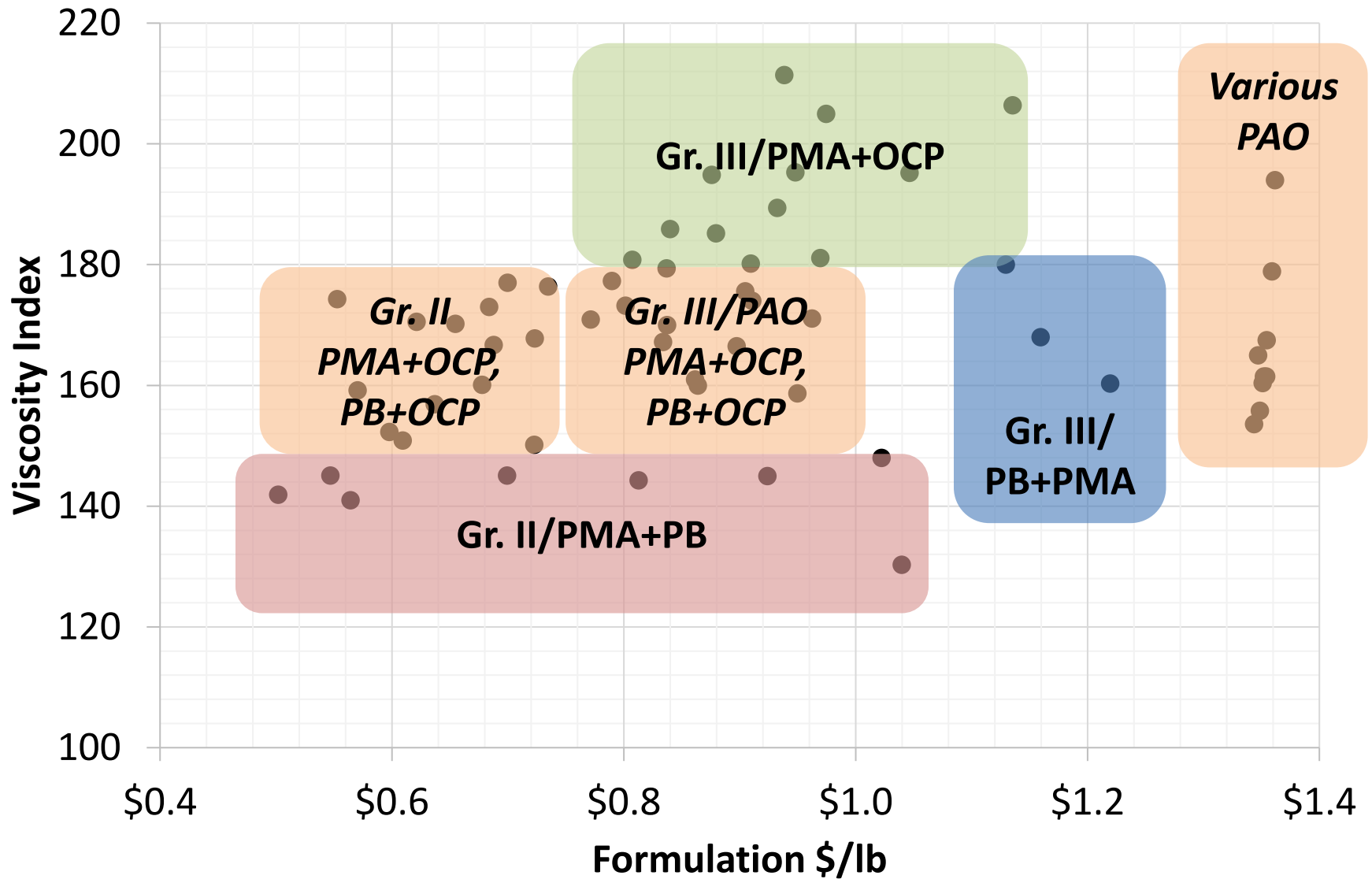
- Key findings:
 - PMA + OCP combination offers best pour point versus cost trend
 - Gr. II data shows better performance than Gr. III
 - Likely due to optimization of the PPD – both used a flat 0.2wt%
 - PAO offers lowest pour point but 130% and 50% more expensive than Gr. II and III
 - Worst cost vs. pour point was Group III with PMA + PB



VI vs. Cost



VII vs. VI and Cost



- Key findings:
 - Stand-out performance with Group III using PMA+OCP combo
 - VI 180 – 220 are feasible
 - VI from PB+OCP or PB+PMA fall in Gr. II / III / PAO are mostly similar
 - Worst performer is Group III with PB + PMA
 - Lower solvency Group III with high amounts of added PB will begin to affect clarity



- Mixed PMA+OCP VI improvers provide greater low temperature (PP) and VI than possible with PB+OCP or PB+PMA
 - Ideal for economic HF using the MH-2000 and V-160F
- PMA+OCP shows best synergy for high VI with Group III

