The Dispersion Triangle for Carbon Black Pigments

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FAMILIAR BONDS

COMPOUND KNOWLEDGE

MICRO MATTERS

BEYOND DURABLE

CHALLENGE TESTED

Table of Contents

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Introduction

- Today we will be discussing the concept of the performance triangle.
- In turn we will cover
  - Pigment selection
  - Formulation
  - Dispersion

Pigment Selection

- For carbon blacks there are four fundamental properties that help determine the end performance
  - Particle size distribution
  - Aggregate size and shape distribution
  - Pore size distribution
  - Surface chemistry distribution

Surface Area (Particle size) is the primary determinant of color performance.

- Solvated CAB Formulation.
- Dispersion via chipping on 2 roll mill
- The chip approach ensures a high level of dispersion

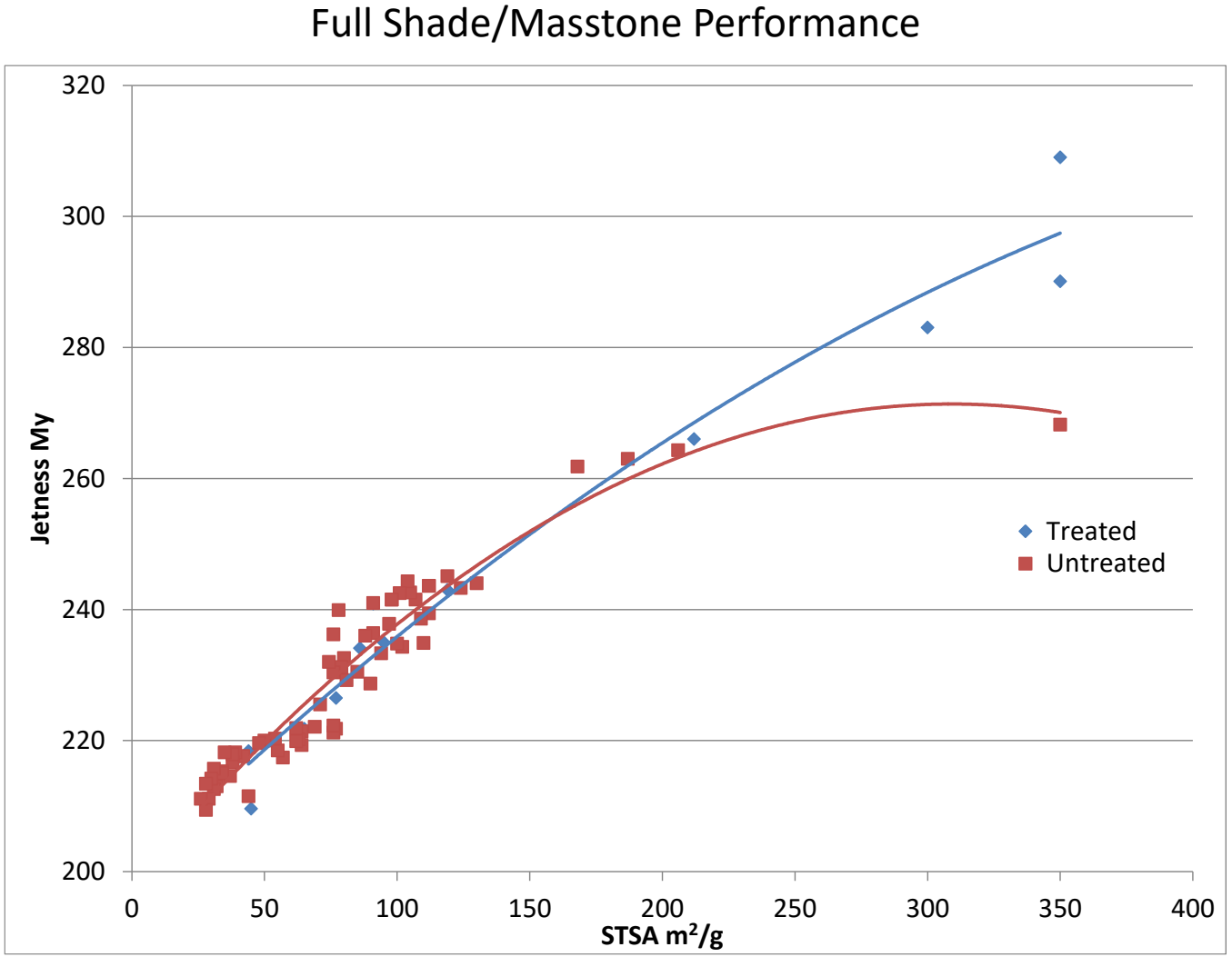
15 g CAB chip (15-40%CB)

60 g N-butyl acetate

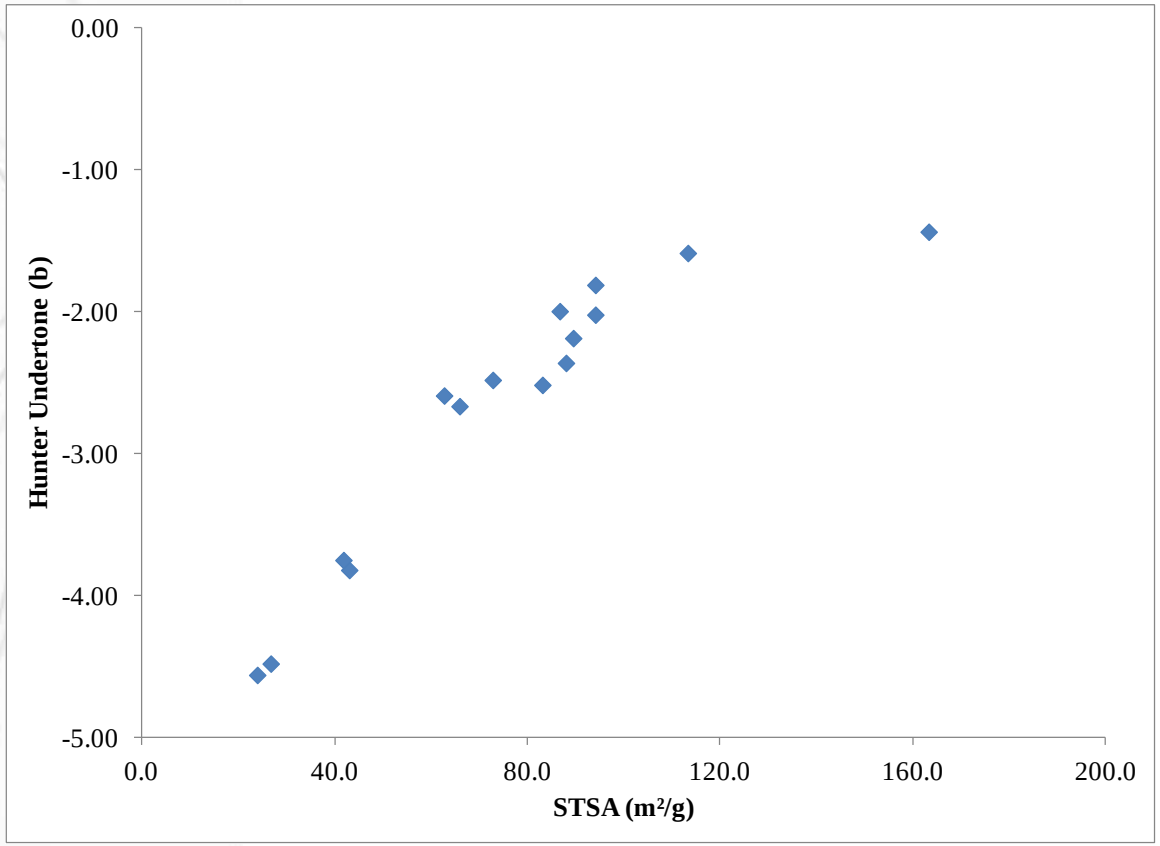
75 g 3/32 steel shot

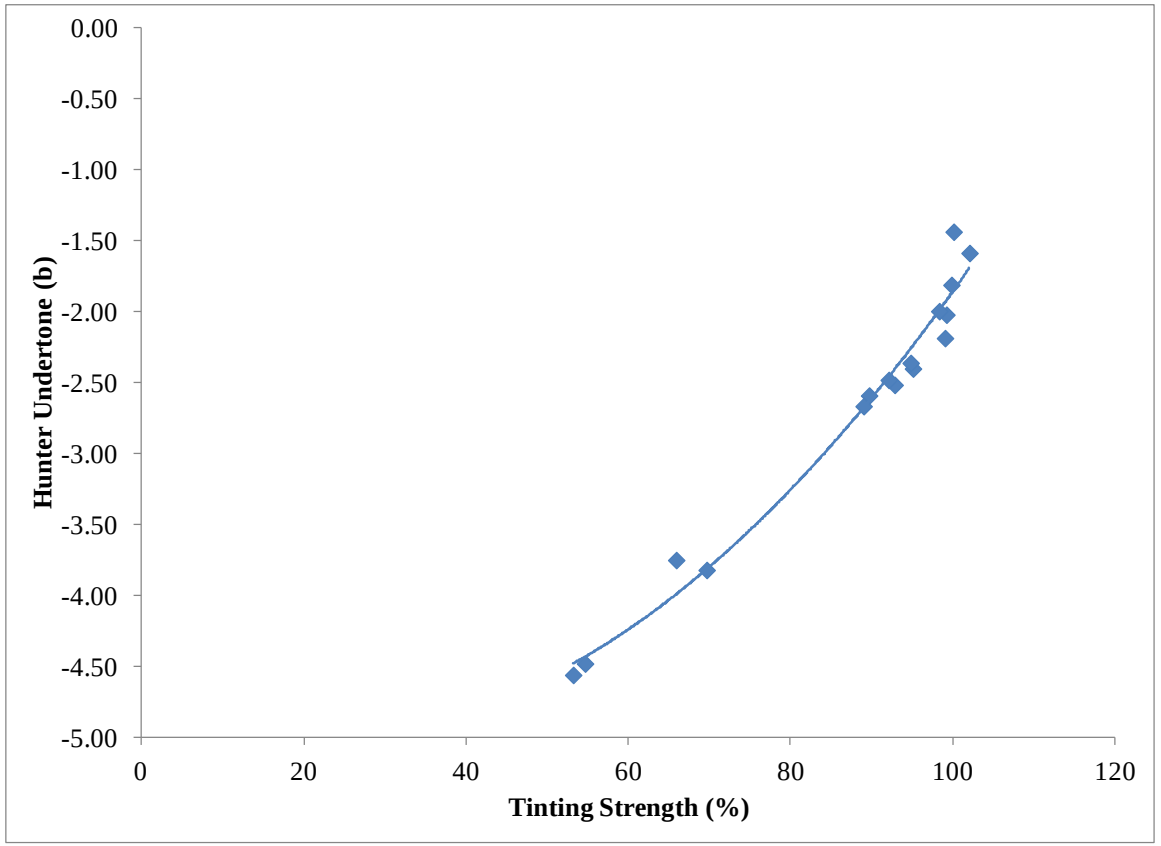
1 hour shake time

- Higher surface area gives higher Jetness.
- Solventborne formulation, so the effect of treatment becomes very apparent at high surface area.



Tinting Product Selection Involves Trading Off Strength and Tone





Pigment Selection Additional Criteria

- Aggregate size and shape distribution

  Higher structure carbon blacks will create a higher viscosity, as well as providing an easier dispersion. This will usually come at a minor cost in color performance.

- Pore size distribution

  Outside of conductive coatings, this is not normally an important parameter

- Surface chemistry distribution

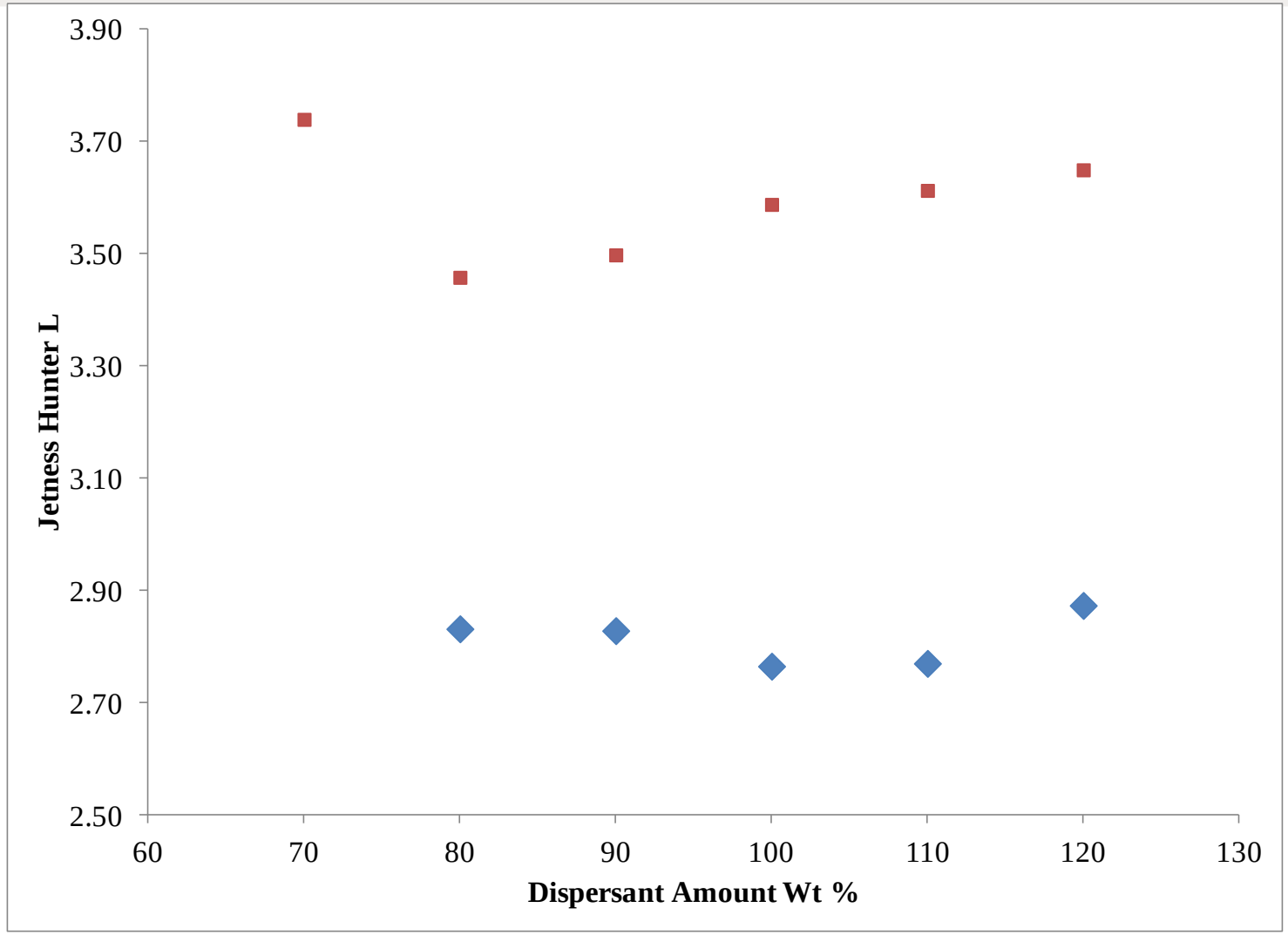
  Post-treated carbon blacks have an acidic surface. This is important in how the pigment interacts with other formulation ingredients

Formulation

- The formulation chosen has a major effect on the performance of the carbon black
- Some general comments
  - Ensure adequate levels of dispersant (in terms of %SOP)
  - Check dispersant/resin compatibility
  - In solventborne applications, post-treated/acidic products tend to perform better than untreated products
- Good color/dispersion in a concentrate/grind doesn't necessarily mean good color in a final coating.

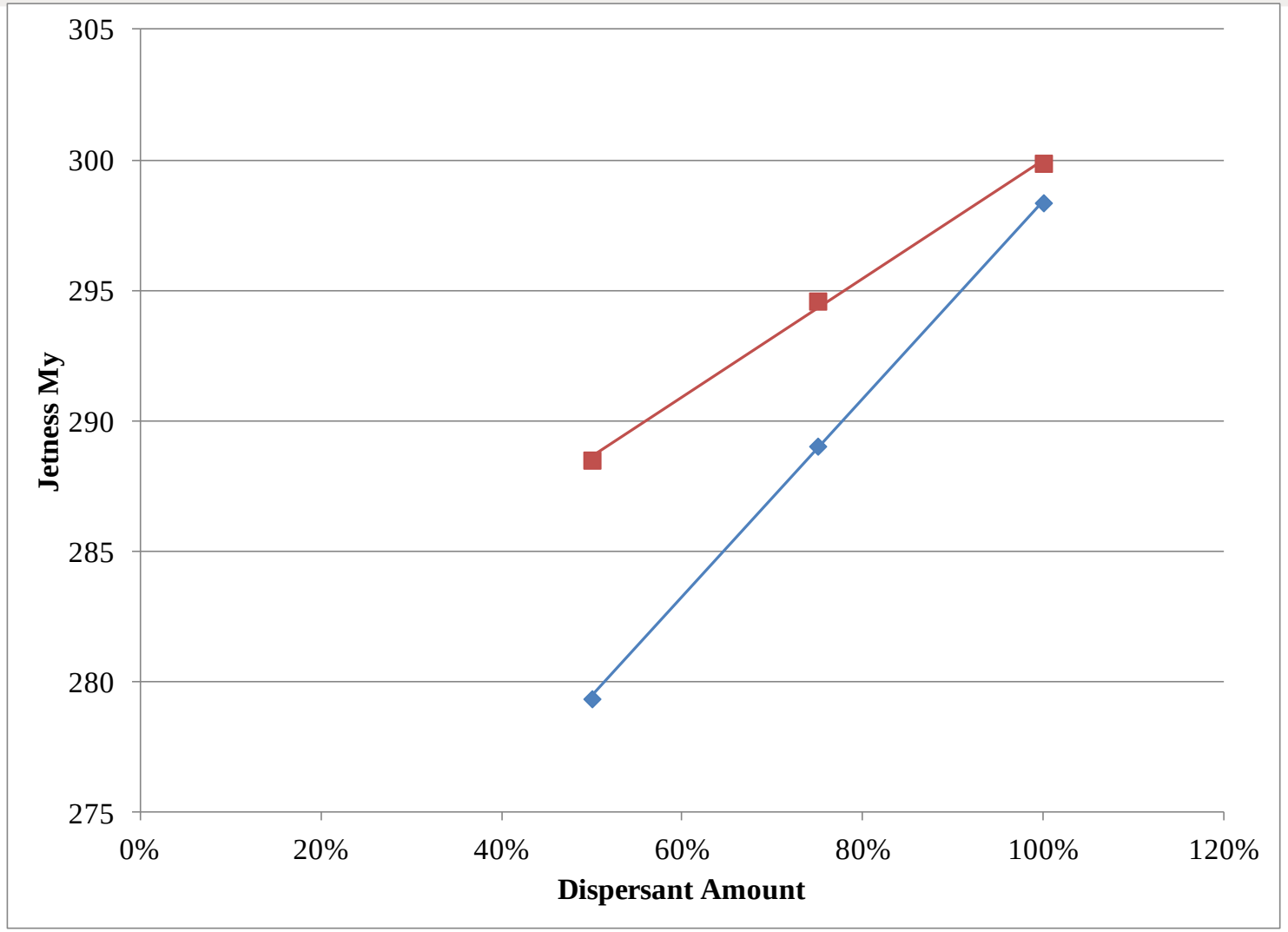
High Color Carbon Blacks:

Waterborne Ladder study shows expected high dispersant demand for optimum performance



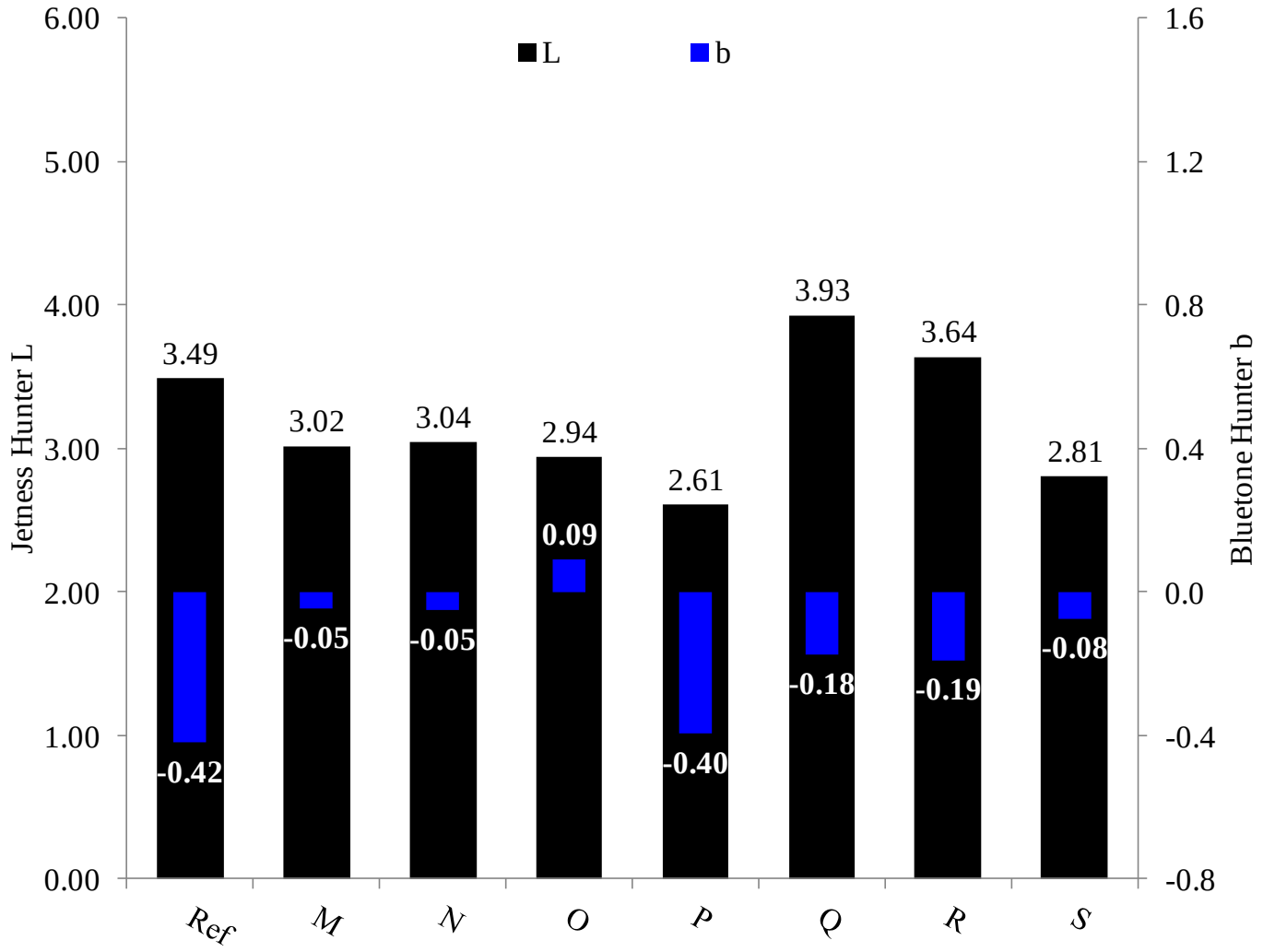
Solventborne Automotive:

Fall off in performance at different loadings reflects different surface characteristics



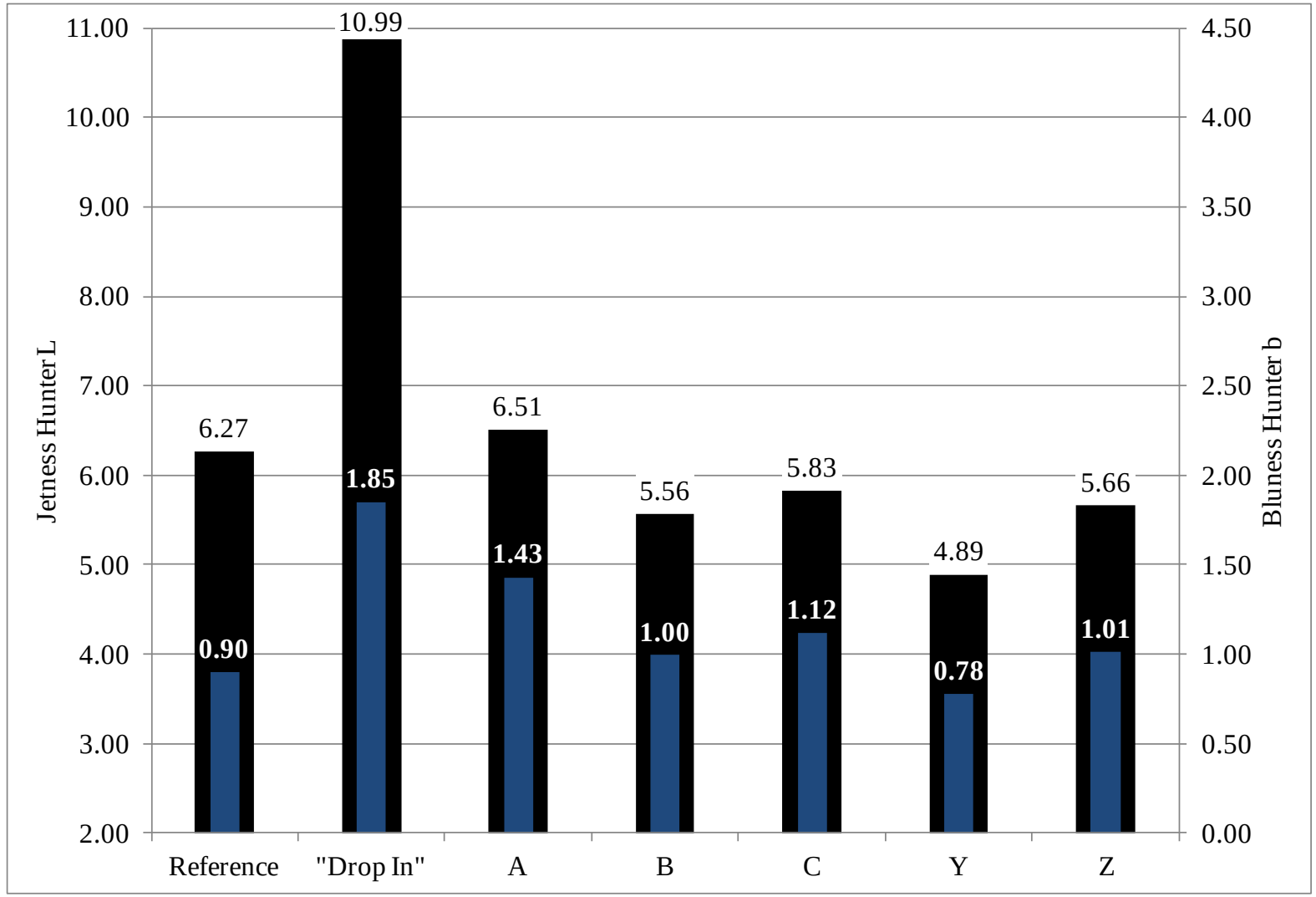
Effect of Dispersant Choice: WB Automotive

Large swings in both jetness and bluetone



Effect of Dispersant Choice : Leather Coating

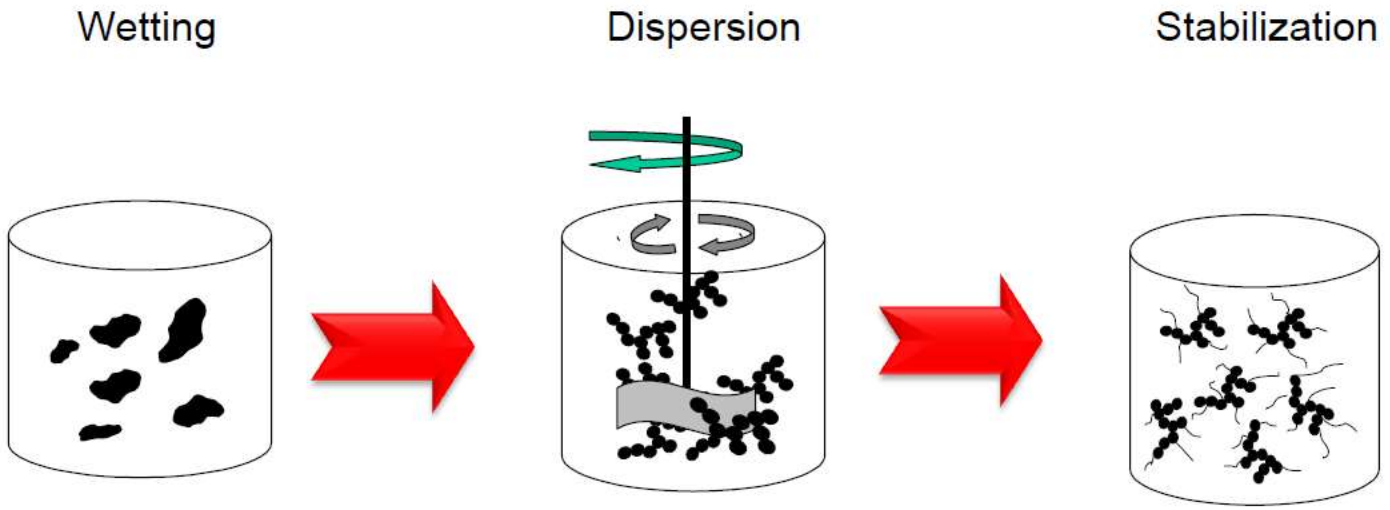
Predominantly a let down effect



Dispersion

- Dispersion covers
  - Pigment wetting
  - Dispersion process
  - Time/Energy
  - Media Size and density (if applicable)
  - Pre-mixing/bead breakdown (if applicable)

Stages of Dispersion Process



Premixing

Deagglomeration

Depends on

- Premixing
- Deagglomeration
- Letdown

Premix Equipment

- Wetting is the first step in the dispersion process
- Breakdown of beads and agglomerates in to smaller fractions
- Removal of entrained air from the surface of the carbon black and replacing it with liquid vehicle
- Millbase viscosity and equipment geometry is important
  - Geometry should promote rolling laminar flow (Doughnut Effect)
  - High peripheral speed generates shear within liquid
  - Viscosity too low = splashing, aeration and bubbles
  - Viscosity too high = lack of movement, low transmission of mechanical energy

Low & Medium Viscosity Milling Equipment

- Bead or shot mills spin pegs or disks at high speed in a cylindrical chamber partially filled with small beads or shot
- Small dense beads provide a degree of impact as well as shear
- Ball mills use larger tumbling balls to crush the pigment
- Ball mills are older, batch technology but still very effective
- Attritors fall mid way between the two techniques

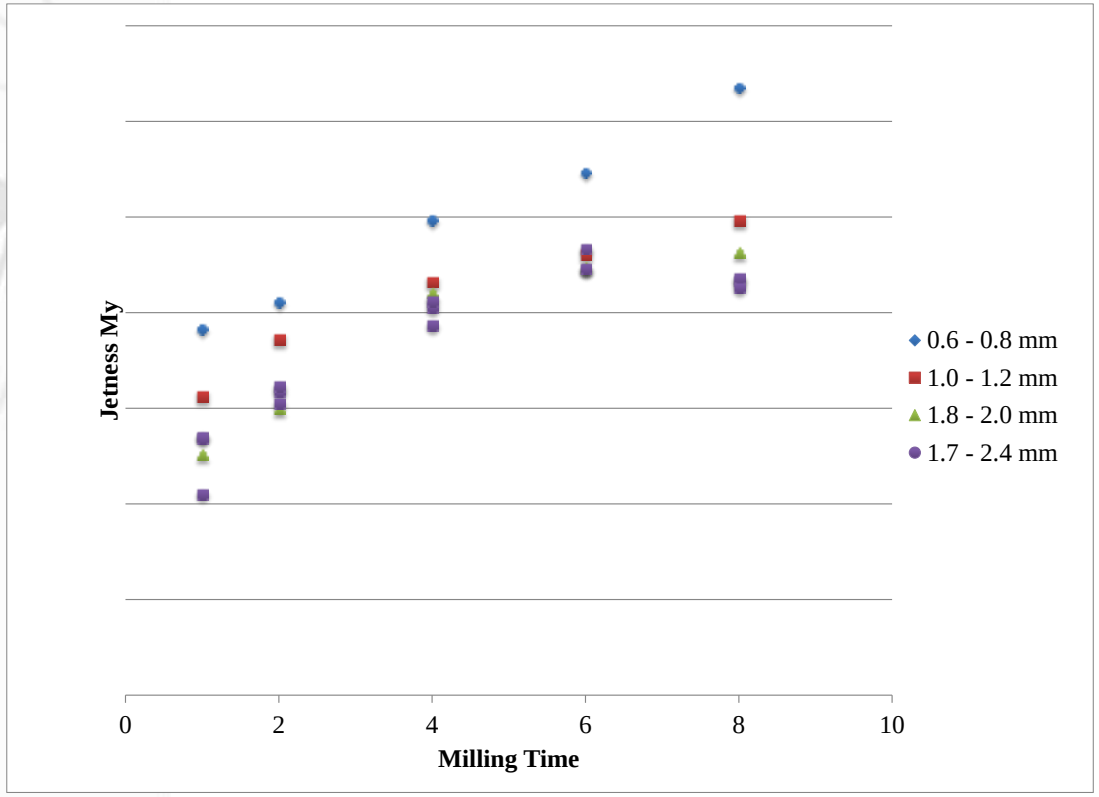
Bead Milling

Selection Considerations for high color milling

- Energy density
  - Usually dictated by cooling capability, a smaller chamber will allow for higher energy densities, which is a significant help to dispersing higher color pigments
- Hydraulic packing
  - How is the mill preventing hydraulic packing of the media, close fitting blades, back flow pumping or other characteristics
- Screen size
- Single/multiple pass versus recirculation

Media Size and Density

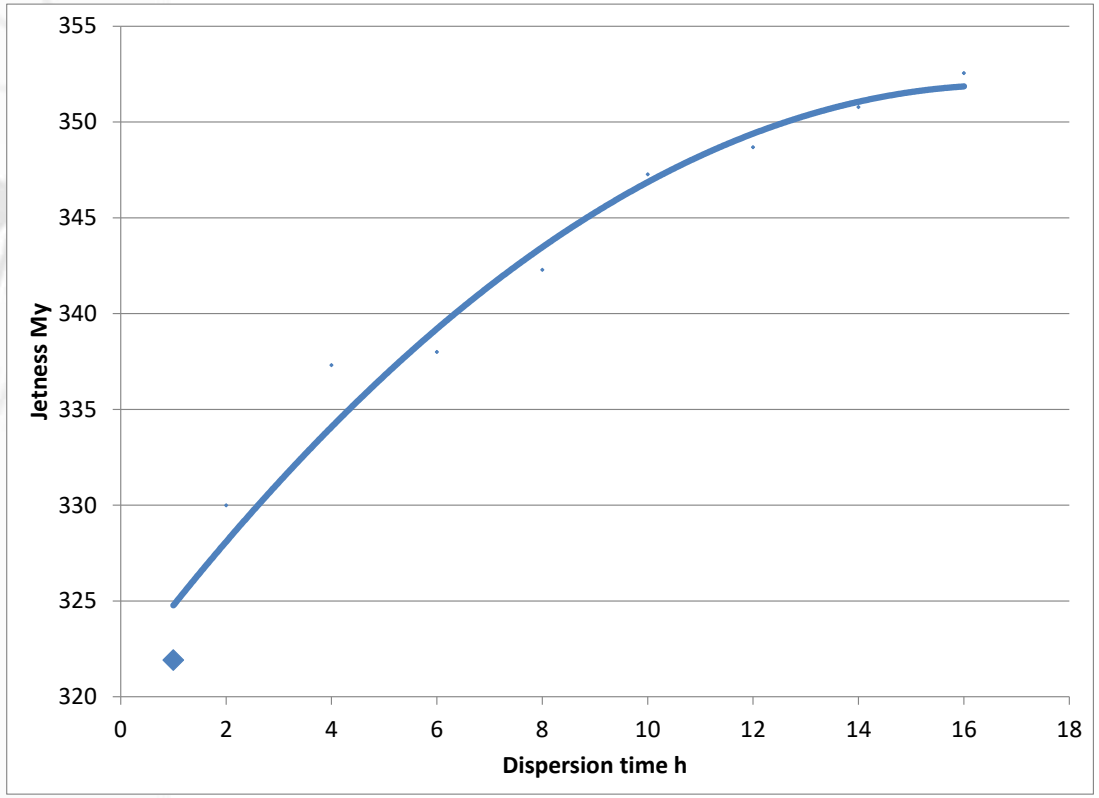
Media type has significant impact on color development



- Standard Laboratory Shaker
- Finer media gives rise to a jetter coating
- Beaded products will need to be broken down before grinding with fine media
- Finer media has higher risk of hydraulic packing

High Color Carbon Blacks

Take a lot of time/energy to disperse fully



- Standard Laboratory Shaker
- 0.6 - 0.8 mm Zirconia beads

- With a well matched dispersant even 16 hours of shaking has not reached the ultimate level of performance

- For production efficiency there will be a time/energy and performance balance that will be particular to any given location and product

Summary

- We discussed the concept of the performance triangle.
- Covering in turn
  - Pigment selection
  - Formulation
  - Dispersion

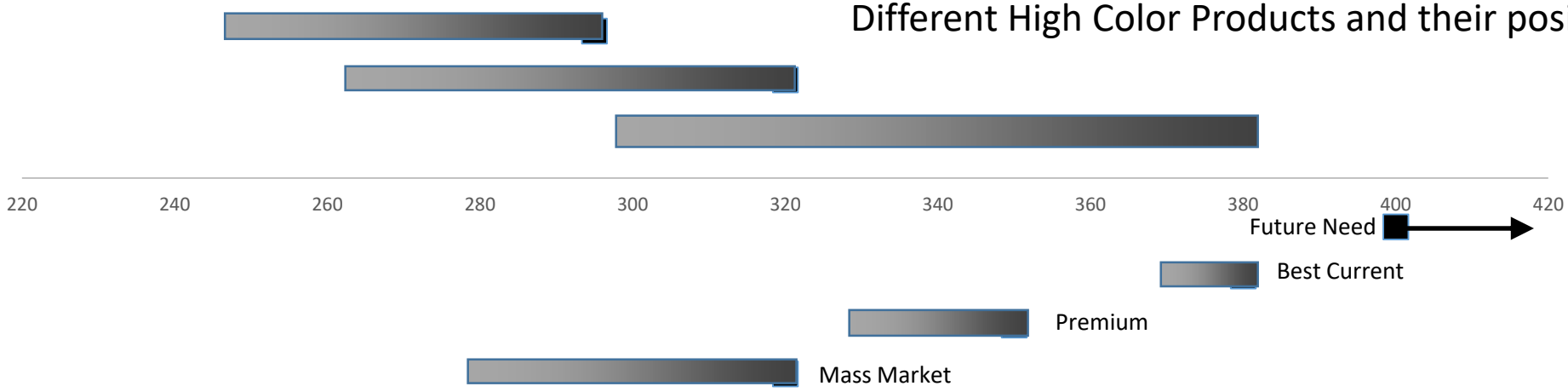
- But why this concept, why tie them together ?

Considering all parts of the triangle

Enables proper product selection for any given application

My Color Space	Market
280 – 320	Mass Market Black
330 - 350	Premium Black
370 – 380	Best Current
400 +	Future Need

Different High Color Products and their positioning



What about constraints ?

- As a formulator, constraints are common. You must use pigment X, or the production time is limited so you can only disperse for Y time

- Ultimate example – Military paint
  - Pigment and formulation specified
  - Performance range also specified.

Thank you and Any Questions ?

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