Formulating a Sustainable Waterborne Tint Base

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FAMILIAR BONDS

COMPOUND KNOWLEDGE

MICRO MATTERS

BEYOND DURABLE

CHALLENGE TESTED

Dr. RICHARD ABBOTT

- Principal Scientist (Coatings) with over 20 years of working with carbon black in a variety of liquid systems.
- Based at Birla Carbon headquarters & technical center since 2003.
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Outlook

- Introduction
- Ecofriendly, Sustainable and Circular
- Starting Formulation
  - Mixing procedure
  - Pigment Selection
- First set of results and key lesson
- Adjust – Test – Learn – Adjust loop
- Current Status
- Conclusion

Introduction

Sustainability is an essential part of the over all strategy for coatings companies and suppliers to the industry.

The journey to a sustainable future can begin with a few small steps, substituting an ingredient here, lowering the energy costs there, steady and incremental.

Introduction

Or it can be done in more immediately effective manner by changing a complete tint base to a fully sustainable one, a much more significant step

This is of course much more challenging

The resin system for the final coating is an additional area for large scale improvement in the overall sustainability

Ecofriendly, Sustainable and Circular

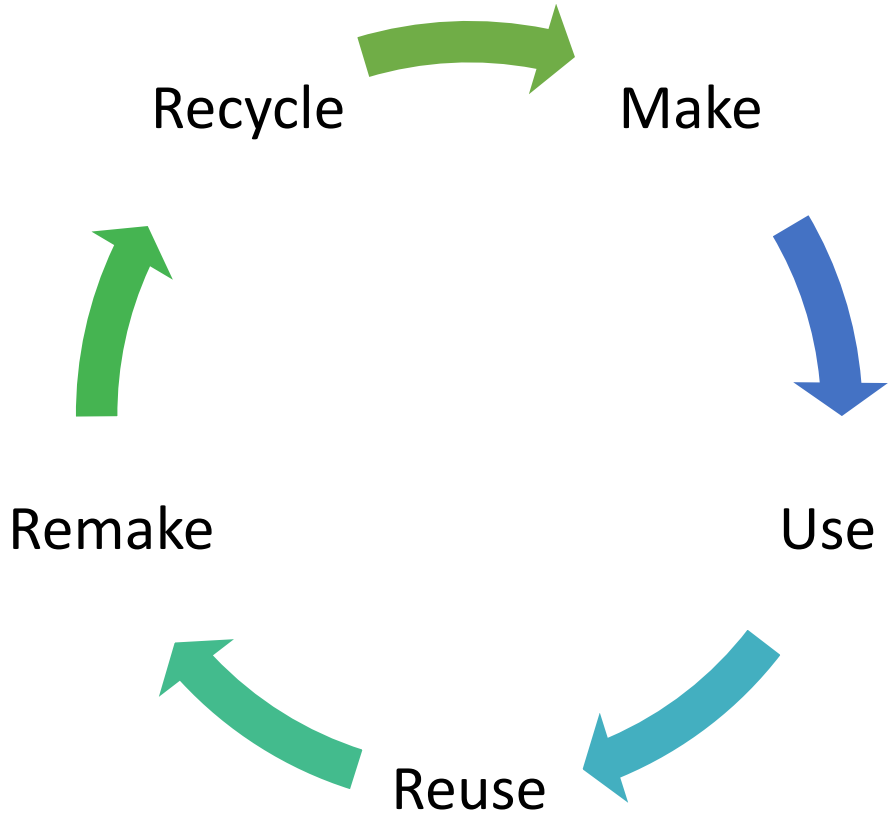
- These are not the same thing
- Eco-friendly or Green – lower environmental impact, such as a lower VOC, or reducing the overall toxicity of the product or formulation
- Sustainable, starts with ecofriendly ingredients, but also includes manufacturing and end-use activities
- Circularity is step beyond the sustainable concept and requires a much more progressive approach

Linear Economy “Take, Make, Waste”

- The traditional economy has been very linear

- Take the feedstock materials
- Make the product
- Use the product
- Dispose of the product

Circular Economy



Basic formulation start point

- We have two formulations that we considered for the starting points for this project, both using traditional carbon blacks

Ingredient	Medium Color Pigment	Tinting Pigment
Carbon Black	25.0%	35.0%
Dispersant (50% active)	15.6%	7.0%
Defoamer	0.2%	0.2 %
Water	59.2%	57.8%
Dispersant % SOP	31.2%	10 %

Mixing procedure

- Liquid ingredients were preblended before pigment addition
- 250 ml double wall vessel on a high speed disperser

- 3 cm mixing blade at 1000 rpm during pigment addition

- Ramp up to 3250 rpm (tip speed 5.1 m/s) during dispersion (30 min)
- pH checked after 10 min and if necessary adjusted with DMEA

Pigment Selection

- Being a carbon black company, obviously choosing a black sustainable pigment was the first step

- The pigment is a Sustainable Carbonaceous Material derived from end of life tires. On plots this is labeled as SCM

- Due to the credits from the steel and oil recovered in the process the pigment is a net negative CO_{2eq} pigment*

*Per Life Cycle Analysis under ISO14040 and ISO 14044

Pigment Selection

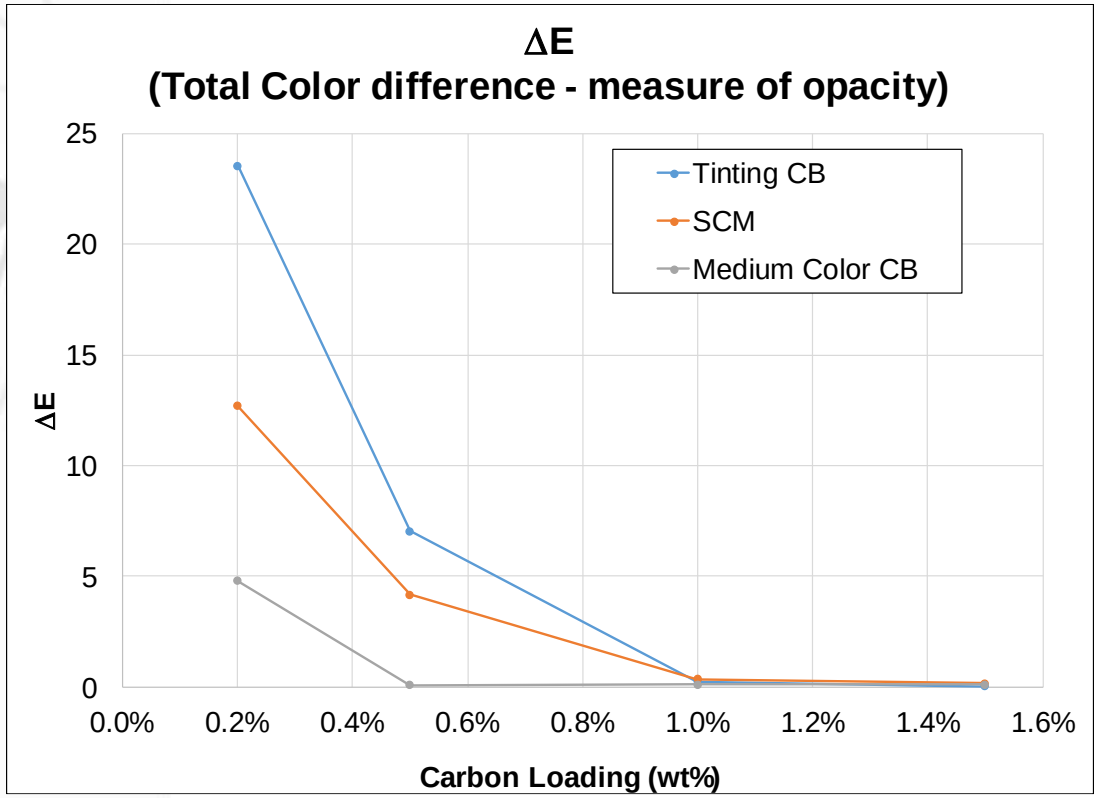
- For comparison purposes two benchmark carbon black pigments were used:
  - The first is a general purpose, medium color product – this is labelled as Medium Color Carbon Black (Medium Color CB) on plots
  - The second is a lower surface area product typically used for tinting purposes – this is labelled as Tinting Carbon Black (Tinting CB) on plots

- The SCM and Tinting CB were run using the 35% loaded recipe
- The Medium Color CB was run using the 25% loaded recipe

- All samples were used in powder form (no beads)

First Results:

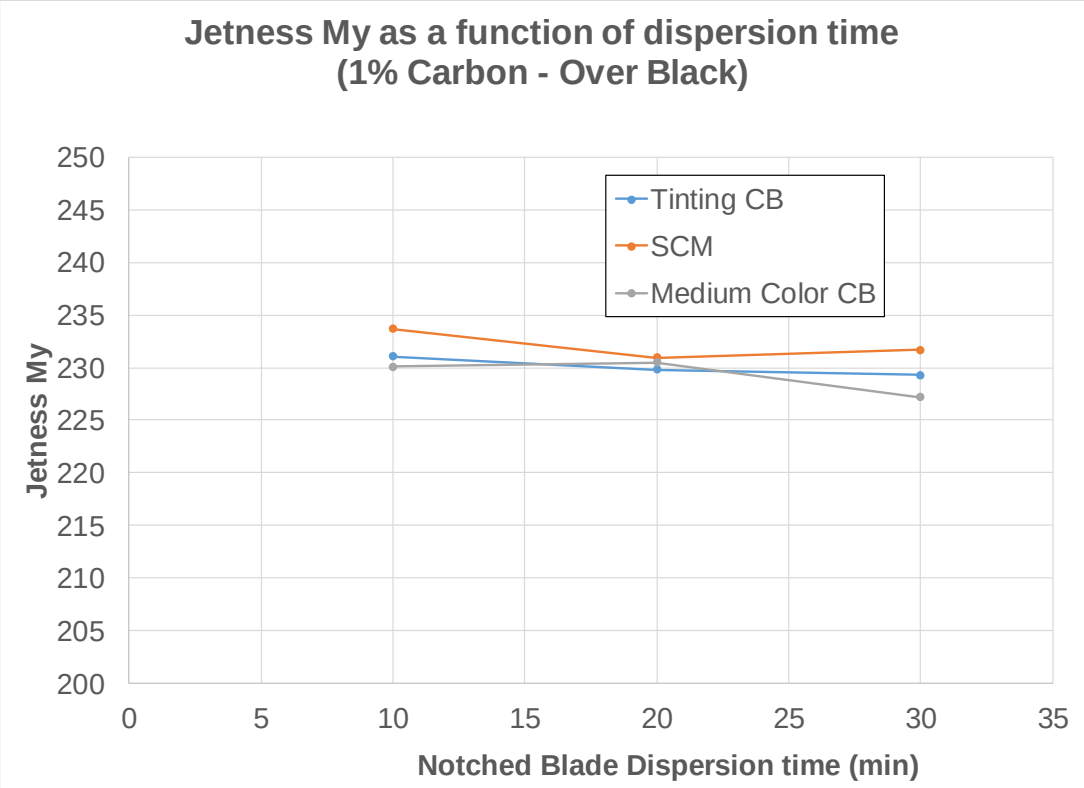
Masstone opacity better than tinting carbon black



- Measured the drawdowns over both the white and black portions of a standard opacity card
- Compared the total color difference to gauge the opacity

First Results

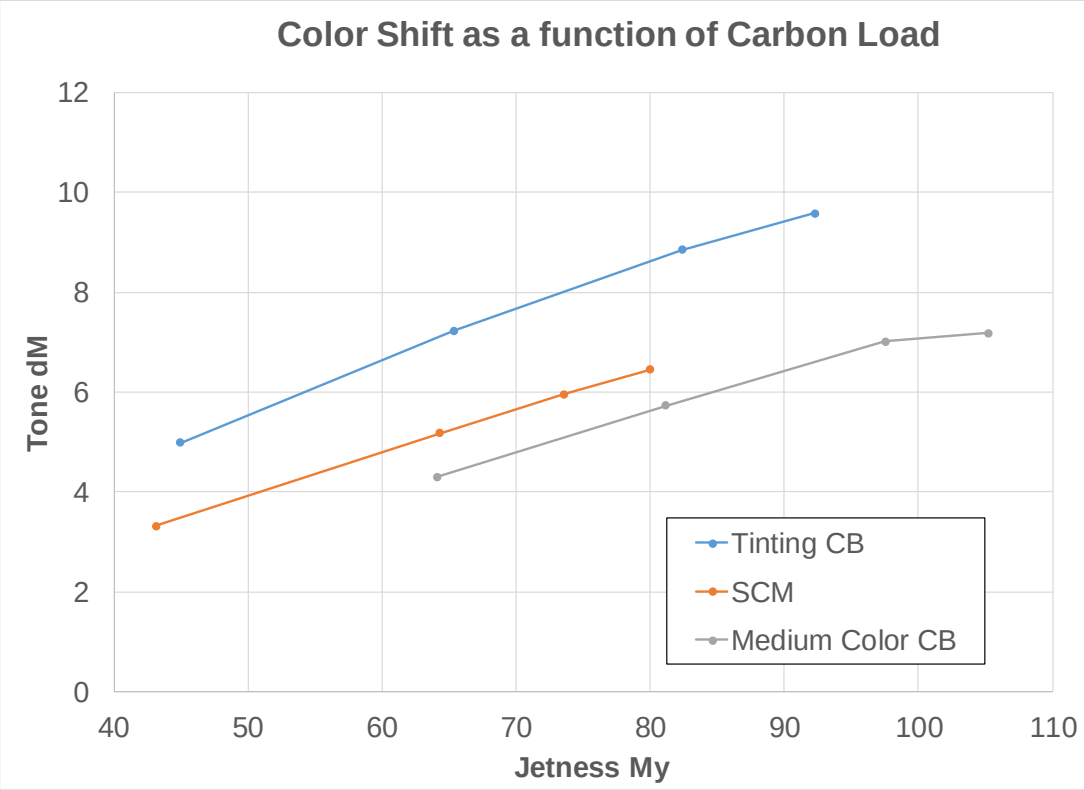
Promising full shade development with dispersion time



- With the powder products the dispersion is rapid after the initial incorporation
- The dispersion rating (not shown) and color development reflect this

First Results

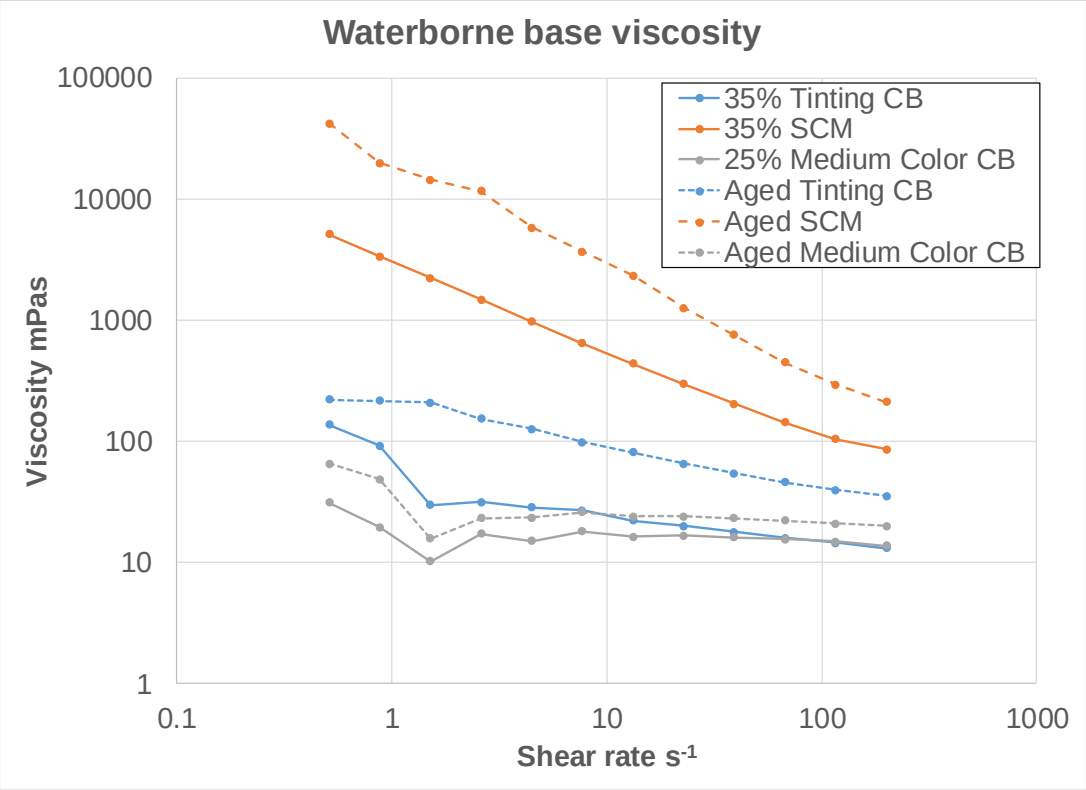
Tinting performance between the carbon black products



- 0.2, 0.5, 1.0 and 2.0% carbon dispersed in a commercially available white paint.
- More carbon within this range obviously gives a darker and bluer coating

First Results

Viscosity too high



- This is the key failure of the initial work
- Viscosity was simply far too high for the sustainable carbonaceous material, and it rose further on aging

Lessons Learned

- So let’s talk about what went wrong …
- Assumptions were made about how the pigment would interact with other ingredients in a similar way to traditional carbon black
- The dispersant loading was assumed, not tested

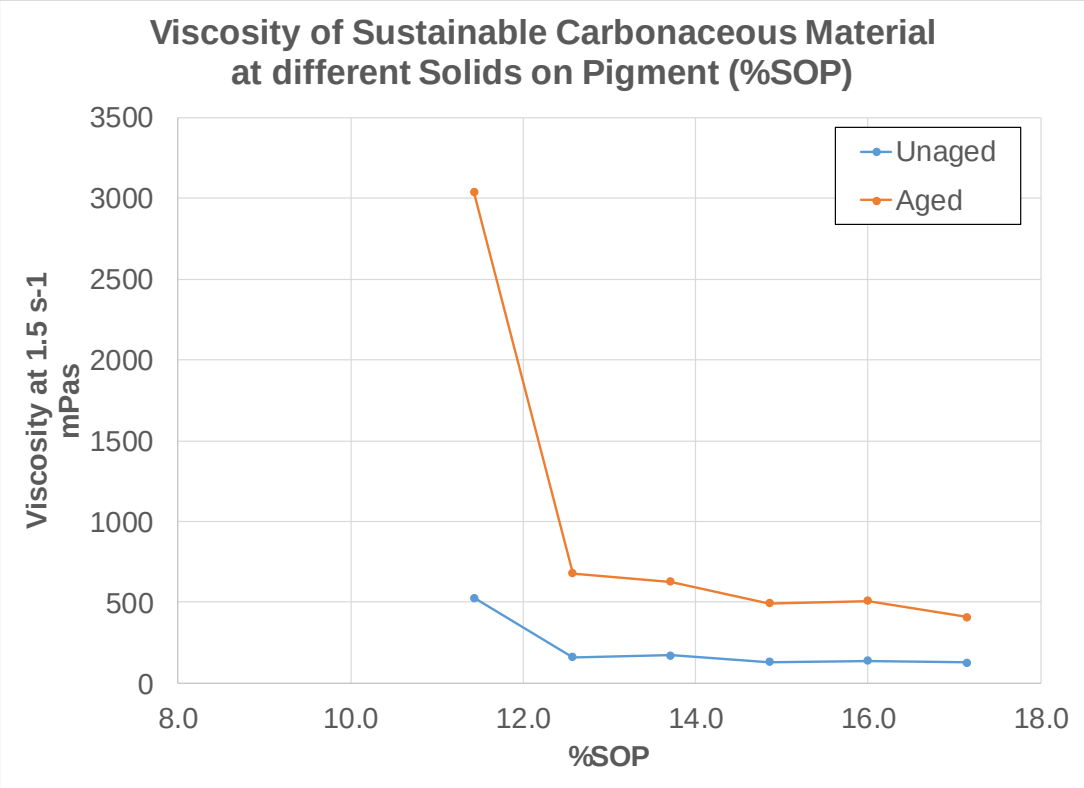
Adjust and test

- Full ladder for a dispersant known to be good (not sustainable) shows the dispersant SOP in the preliminary work lower than ideal loading

- Verified the SOP for the Sustainable Carbonaceous Material with a second, then a third, different non-sustainable dispersant known to work well with traditional carbon blacks.

Second Round

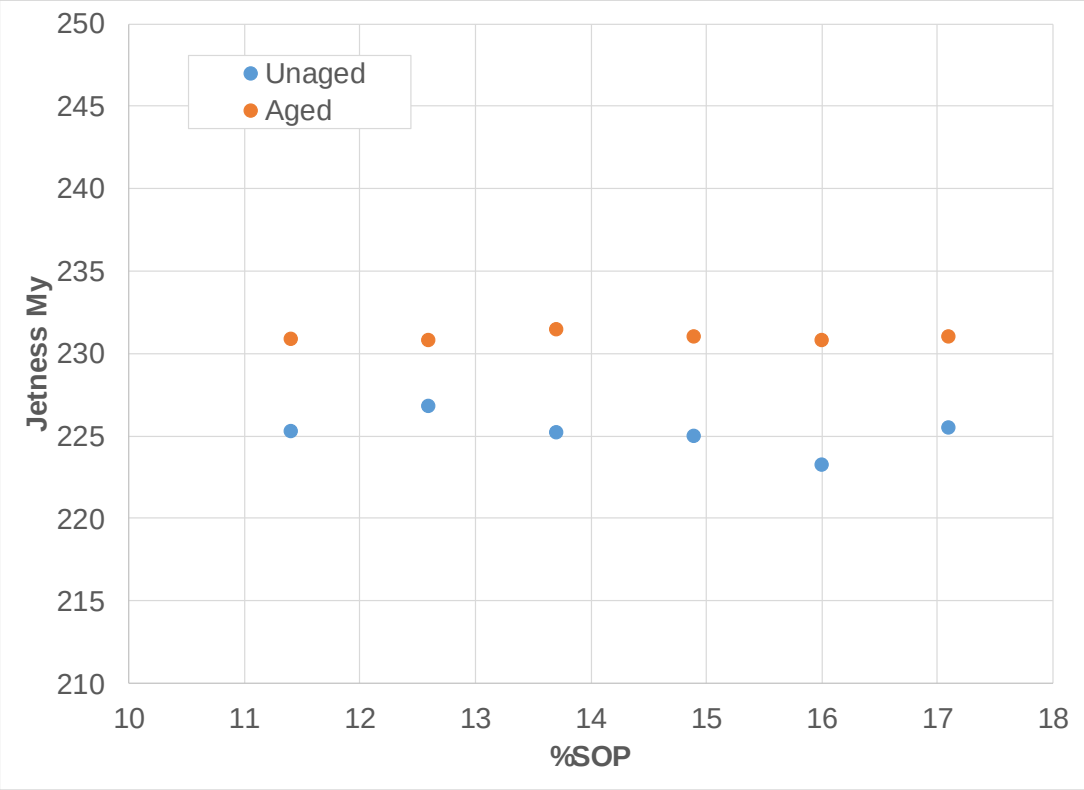
Viscosity of Optimized system is great

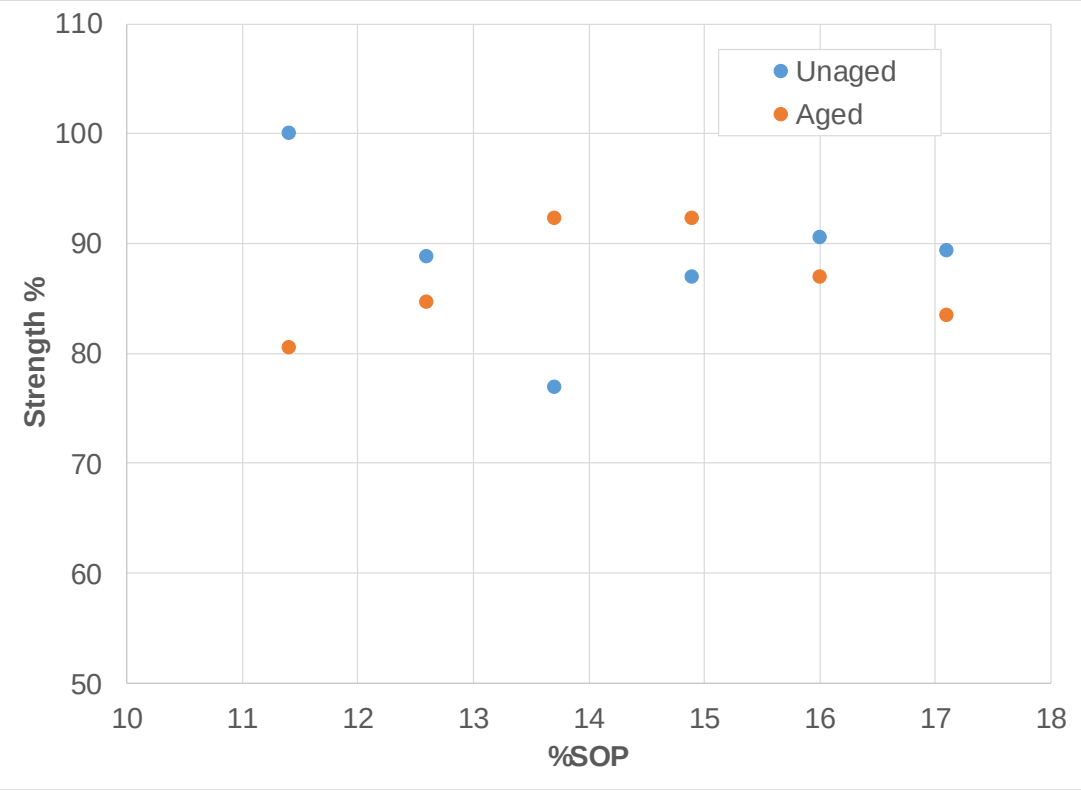


- The previous work if you recall was at 10% SOP
- This was quite a way away from the ideal level with this dispersant

Second Round

Color Development is better and consistent across the SOP range





Learn, adapt and adjust again

- Knowing the “ideal “ dispersant SOP allows us to target with a tighter a ladder study using other dispersants.
- Each does have slightly different optima for the loading, but small ladders rather than expansive ones

- Build a baseline performance with only a single unknown before progressing further

- Then test sustainable dispersants

Current status

- Dispersant A – works well
- Dispersant B – works OK but not as well
- Dispersant C – works well (Can recommend either A or C)
- Dispersant D – cheaper ingredient, not as good but works

- Sustainable Dispersant X – Does not work (excessive foam)
- Sustainable Dispersant Y – Does not work (excessive foam)
- Sustainable Dispersant Z – Does not work (gels)

- Other formulations work well including solventborne, powder coatings

Next Steps

- Keep working with sustainable candidates for the dispersant
- Identify the sustainable additive package (defoamer especially) for the fully sustainable waterborne base
- Test in fully sustainable letdown systems

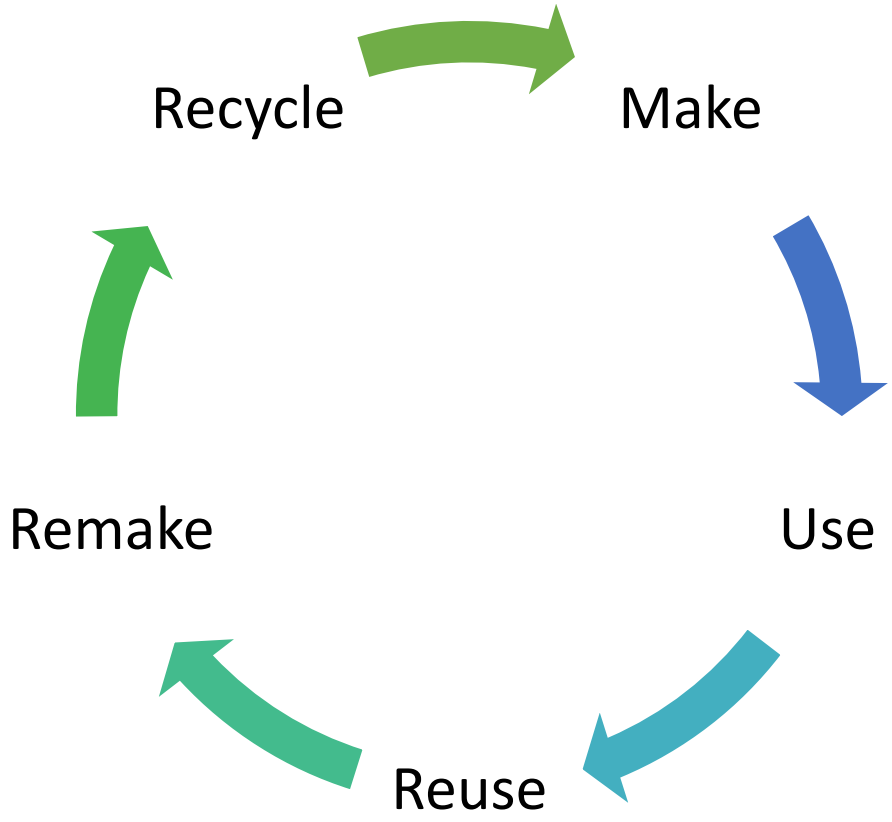
Conclusion

- Sustainable and circular materials come in many forms
- ISCC certified (mass balance approach etc) tend to be closer to a drop in replacement

- Novel materials are more of a challenge.
  - “Almost, but not quite, entirely unlike tea” – Douglas Adams

Final Thoughts

Will coatings ever be a Fully Circular ?



Thank you and Any Questions ?

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Thank You

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