Himadri

Himadri Speciality Chemical Ltd

Carbon Black Market Dynamics &
Fine-tuning of carbon black selection in
inks and coatings applications

Introducing COLORX and BARONX Specialty Carbon Blacks
For Inks and Coatings

Inks and Coatings Presentation Abstract;

North American Carbon Black Domestic Manufacturing Dynamics and Choosing The Right Carbon Black Pigment For The Future

The North American Carbon Black Pigment landscape has changed dramatically over the past 10 years, with EPA constraints on production in the US, the cost of oil feedstock increasing, the demand for carbon blacks overreaching the supply in the US, and the manufacturing of carbon black pigments seeing cost increase pressures.

This pressure has forced users of carbon black pigments to look at alternative suppliers to protect their supply chains and keep strategic carbon black pigment suppliers close. However, the "me too" carbon black pigment selection approach we have used for decades here in North America has led to many labs across the country forgetting that they can choose different carbon blacks to create varying functionality in their formulas. Remember, no carbon black pigment is the same, so why keep using the "me too" or "we have always used this pigment" mentality?

Questions like, how do we choose the proper structure of a carbon black pigment? Which DBP or oil absorption should we select for our formulas now, and what end properties do our customers want in their technical application? As ink and paint companies look for a competitive advantage, a "me too" formulation strategy might not work anymore. We will no longer be able to meet our customers' ever-changing demands by formulating black inks and coatings in the same manner as we used to. The old way of formulating black inks and coatings will no longer be able to meet these demands.

We, as formulators, need to be able to remember how we can use the structure of a carbon black pigment, the surface area, volatile content, its nanometer pigment size, or even its oil absorption values to design an ink or coating our customers need - to help them with their end applications.

It's time to think out of the box again and use the chemistry and physics of carbon black pigments already at your fingertips to create a competitive advantage in an ever-changing and competitive market.

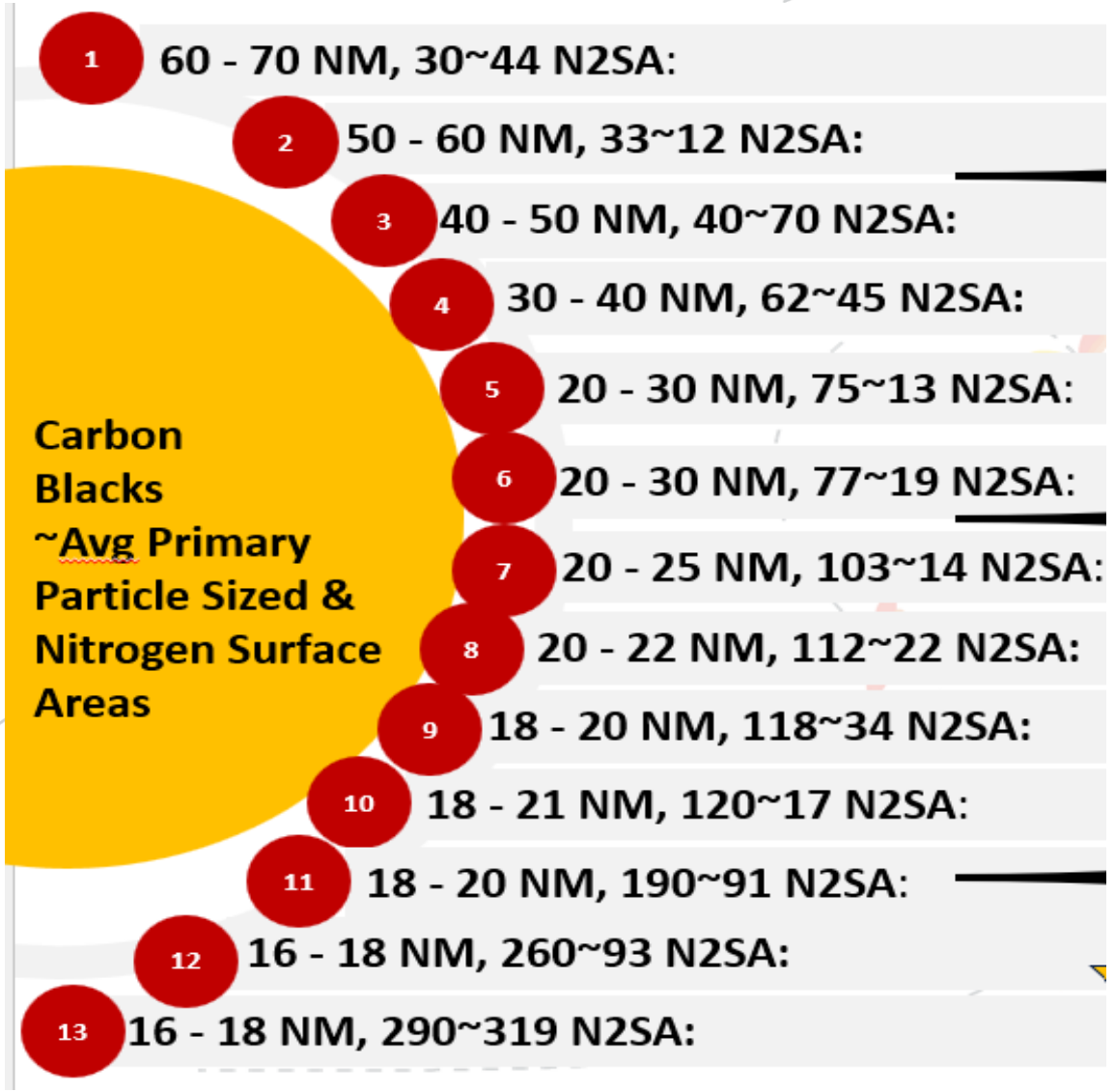
Quick Quiz

Key Definition;

- NM = Average Primary Particle Size

Questions;

- Which carbon black nanometer size to the left is one of the most common in the ink and coatings industry?
- Which would have the highest viscosity at the same pigment loading in your formulas?
- Which grade has the best tinting power in your tinted or architectural colorants?
- Which grade would have the highest blackness or jettness?



Introduction to Himadri

Fundamentals of Carbon Black

Carbon Black in Inks

Carbon Black in Coatings

Carbon Black Division

State of the Art Integrated Carbon Black Plant

About Himadri

- 3 Decades of Leadership with a Market Capitalization of $1.3 Bn
- Integrated Carbon Corporation based in Kolkata, India, with market leadership across multiple segments and presence across 40+ countries.
- Recognized for Cutting edge R&D Capabilities & Innovation
- 8 ‘Zero Discharge’ World Class Manufacturing Facilities across India & China
- Largest Integrated Carbon Black Production Unit in India.

Sustainable Growth in Core Business through Value-added products

EcoVadis Rating : Silver Medal

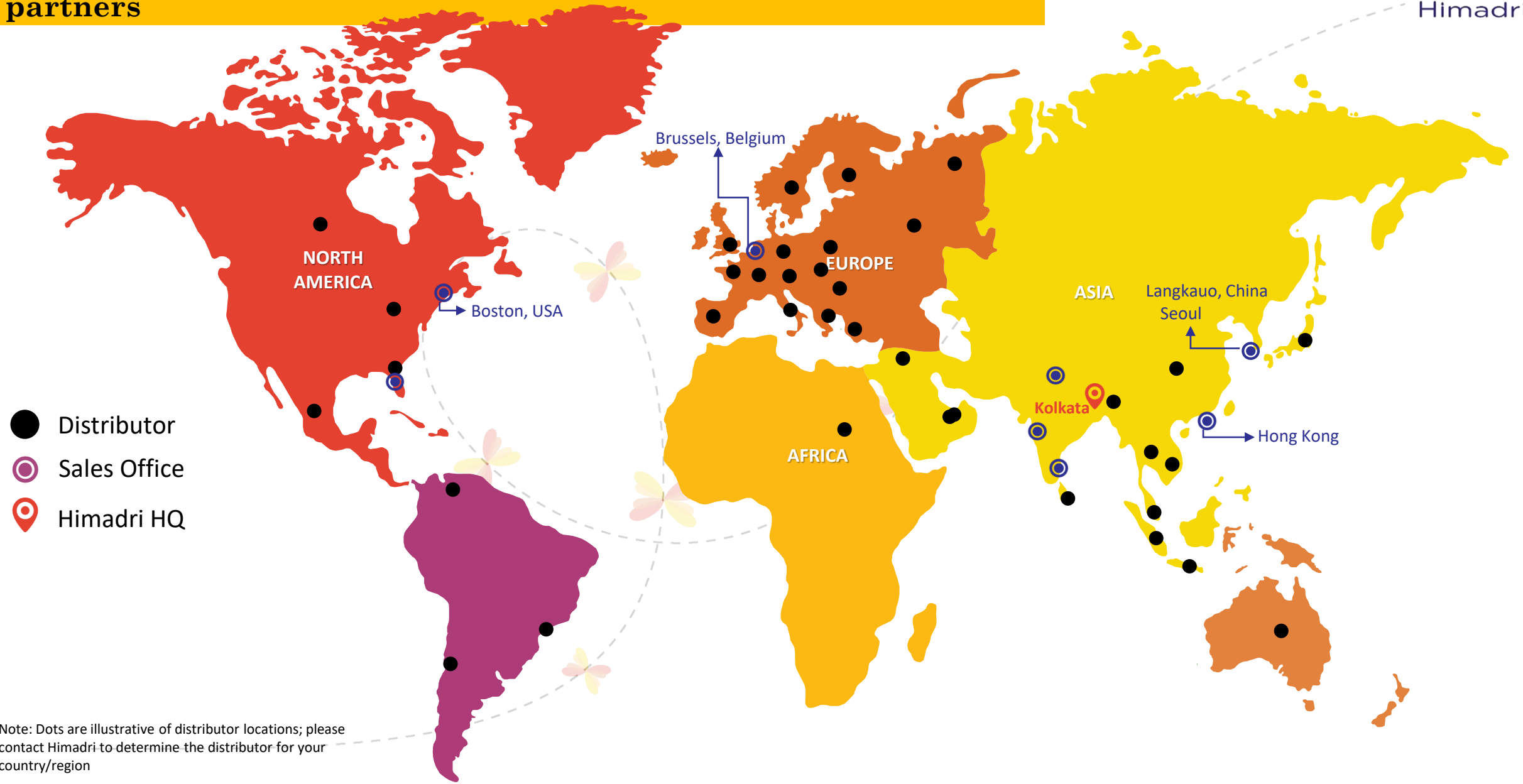
We are fully committed to manage our operation efficiently by preserving best in class workplace, and natural resources at large.

We are fully alligned with BRSR Framework initiated by Govt.of India and UNGC - SDGs

EcoVadis is one of the world's largest and most trusted providers of business sustainability ratings, based on international standards. It assesses companies' actions and practices on their corporate social responsibility around four main themes: the environment, ethics, labor & human rights, and sustainable procurement.

Himadri Speciality Chemical Ltd. has recently been awarded with EcoVadis Silver medal. This recognition ranks Himadri in the top 23% of the highest-rated companies in the world amongst more than 100,000+ rated companies.

Himadri has a global footprint supported by our key distribution partners



Note: Dots are illustrative of distributor locations; please contact Himadri to determine the distributor for your country/region

North American Market Dynamics
Find A New Source Soon

The North American Carbon Black Market was valued at USD $16.1Bn in 2021, registering a CAGR of 4.54% during the forecast period (2023-2030), and it is projected to be worth USD $23.19 Bn by 2030.

- Key Players: Domestic; Cabot, Orion, Birla, Tokai, Continental Carbon; And stocking importers like Himadri
- The EPA has capped NA Carbon Black Capacity; nobody can expand carbon black production in the US unless it is for the support of conductive grades for battery production
- For ASTM grades and even specialty clean grades for the ink, coatings, rubber, tire, or plastics markets – nobody can expand production capacity
- Compounding the problem, the NA carbon black producers have worked to transition current capacity towards specialty grades, away from many of the grades you use today. This is also why you see more delays and allocations on many of your common grades.
- Consider this, if they can make grades towards the battery industry and away from the inks, coatings, and plastic industry – they will leave you needing grades for your current formulations
- With continued growth from all industries like the tire, rubber, plastics, inks and coatings, the CAGR growth expectations are exceeding the United States ability to support the markets with volume demand. Thus, current capacity is at or below the US demand – TODAY
- The tire industry steers the market, which is why all tire manufacturers have taken the strategy to find partners like Himadri to help fill the GAP and provide volumes that will support their growth objectives – NA Domestic Carbon Black Producers cannot support further
- All users of carbon black should work to protect their supply of carbon black by strategizing with partners like Himadri
- Action, partner now, or be stuck without options

Sources; https://www.linkedin.com/pulse/north-america-carbon-black-market-size/

Market Overview & Himadri's Position

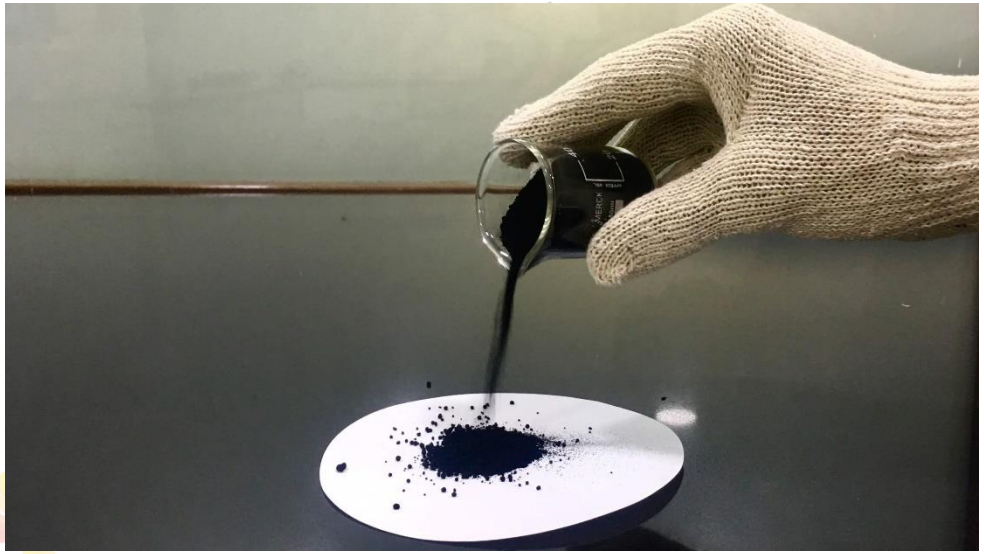
Fundamentals of Carbon Black

Carbon Black in Inks

Carbon Black in Coatings

What is Carbon Black?

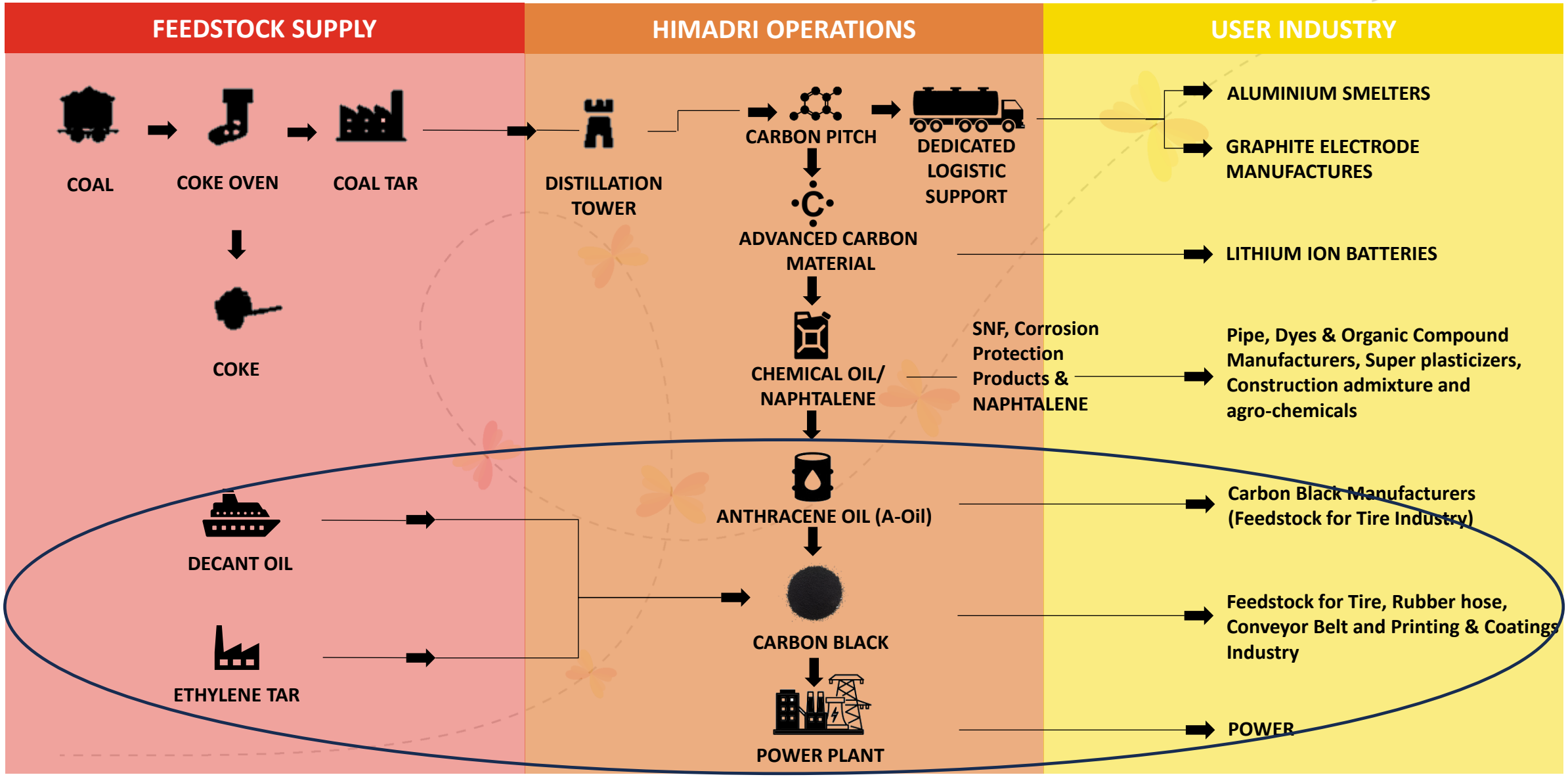
- Carbon black is virtually pure elemental carbon in the form of colloidal particles that are produced by partial combustion or thermal decomposition of gaseous or liquid hydrocarbons under controlled conditions
- Its physical appearance is that of a black, finely divided pellet or powder
- Carbon black is principally used for the reinforcement of rubber, as a black pigment **for colorant purposes** and also because of its electrically conductive properties



The coatings market is served by multiple carbon black technologies

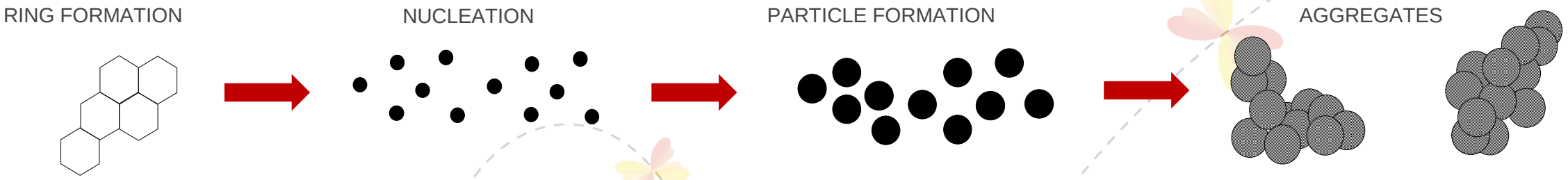
Process	Share	Overview	Coatings	Himadri
Furnace	85%	The furnace black process uses heavy aromatic oils and is burned in a reactor to separate black carbon from tail gas and made into pellets once it cools down and becomes dense.	✓	✓
Thermal Blacks	7%	Natural gas is injected into the hot refractory-lined furnace and, in the absence of air, the heat from the refractory material decomposes the natural gas into carbon black and hydrogen. The aerosol material stream is quenched with water sprays and filtered in a bag house	✓	
Acetylene	5%	Carbon black produced from acetylene gas instead of natural gas and not converted into pellets.		
Gas Blacks	2%	Produced from the Degussa gas process (technology is now with Orion) delivers unique surface properties ideal for coatings applications	✓	
Lamp blacks	1%	The oldest known process is the lampblack process, Carbon black was traditionally produced by collecting soot from oil lamps.	✓	
Channel Blacks	n/a	Thousands of small flames fed by natural gas from ceramic openings impinged upon the underside of water-cooled iron channels. Deposited Carbon black scraped off into funnel trough & collected in screw conveyors.	✓	FDA furnace black

Integrated Business Model



What Happens In A Furnace Reactor?

Carbon black is formed through incomplete combustion

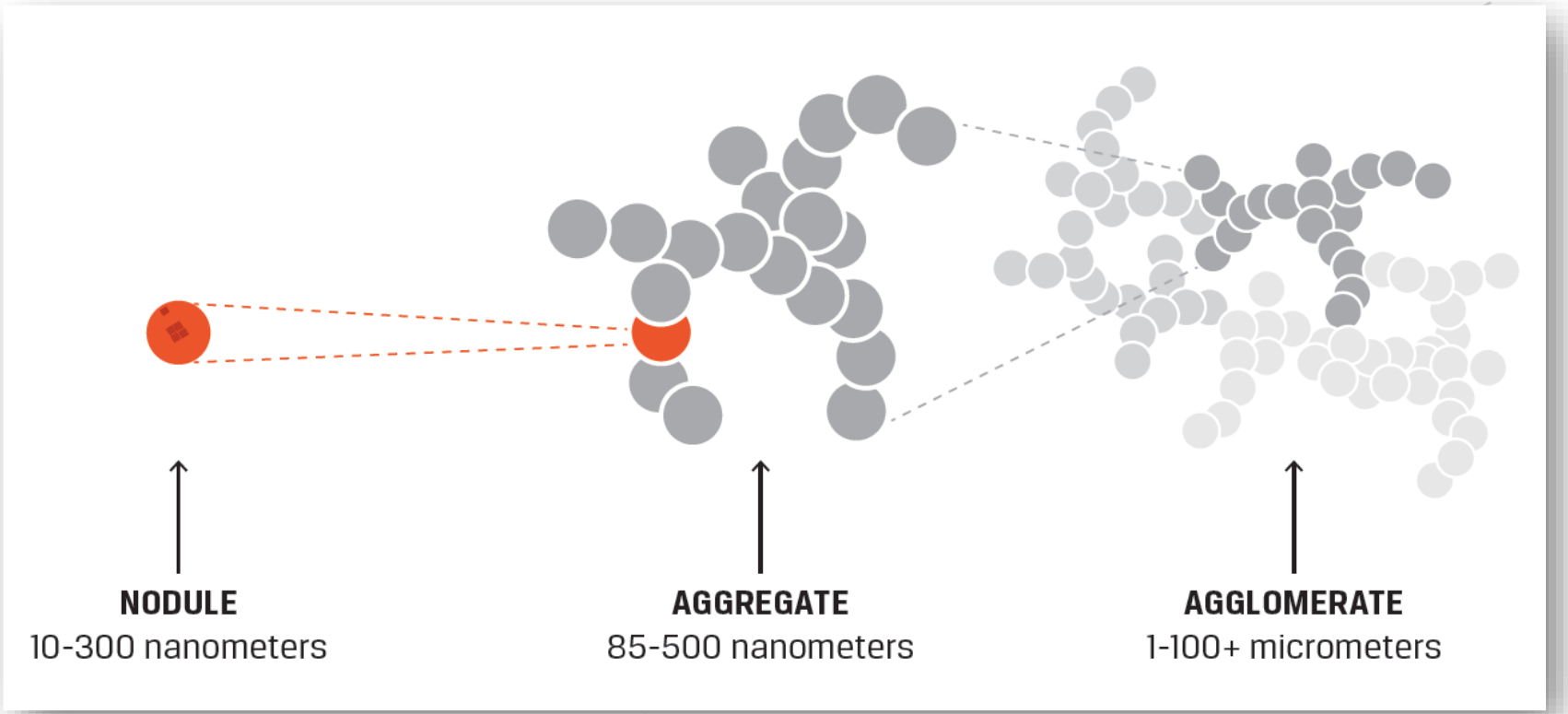


Liquid/gas phase

Solid phase

- In the furnace process all these steps are occurring in a very short time (from few to hundreds of milliseconds depending of grade type)
- Control of all inputs and process variable is key to assure product consistency and uniformity

Carbon black exhibits a hierarchy of morphological features



- The primary particles (conceptual in nature) never exist in isolation, but are strongly fused by covalent bonds into aggregates
- Aggregate is the functional unit of carbon black
- Individual aggregates join together by van der Waals forces to form agglomerates

Carbon black comes in two forms particularly relevant for inks & coatings

Functionality Discussion Points Terminology For Inks and Coatings

- Masstone
- Tinting
- Opacity
- Ink Density
- Conductivity
- Rheology
- Gloss
- Jettness
- Blue Undertone
- Beaded, Oxidized or Standard Powder

Properties	Powder	Beads
Dispersibility	✓	
Handling		✓
Dust Generation		✓
HIMADRI Brands	**COLORX, BARONX**	**JETEX, ONYX**

Surface area and structure are key determinants of end use performance

SURFACE AREA
(measured by N2SA)

Low (Larger Particle) ← **Surface Area** → **High** (Smaller particle)

Masstone / Full Color

LOW ←	Degree of Blackness	→ *HIGH*
BROWN ←	Hue	→ *BLUE*

Tinting / White Blend

HIGH ←	Tinting Strength	→ *LOW*
BLUE ←	Hue	→ *BROWN*

Transparency-Coloring

SLIGHTLY OPAQUE ←	Transparency	→ *BRILLIANT*
BROWN ←	Hue	→ *BROWN TO BROWN-RED*

Structure
(measured by OAN)

Low	**Structure**	**High**
Higher ←	Jetness	→ Lower
Blue ←	Hue	→ Brown
Lower ←	Viscosity	→ Higher
Higher ←	CB Loading	→ Lower
Difficult ←	Dispersibility	→ Easier
Lower ←	Conductivity	→ Higher
Higher ←	Gloss	→ Weaker

Note: Assumes equivalent level of dispersion
Carbon black comes in 2 forms
1. *Pellets or beads: easier to handle but requires more shear to break the pellets*
2. *Powder or fluffy: Very easy to disperse --- used in low shear applications*

Surface Oxidation of Carbon Black and its effect on performance

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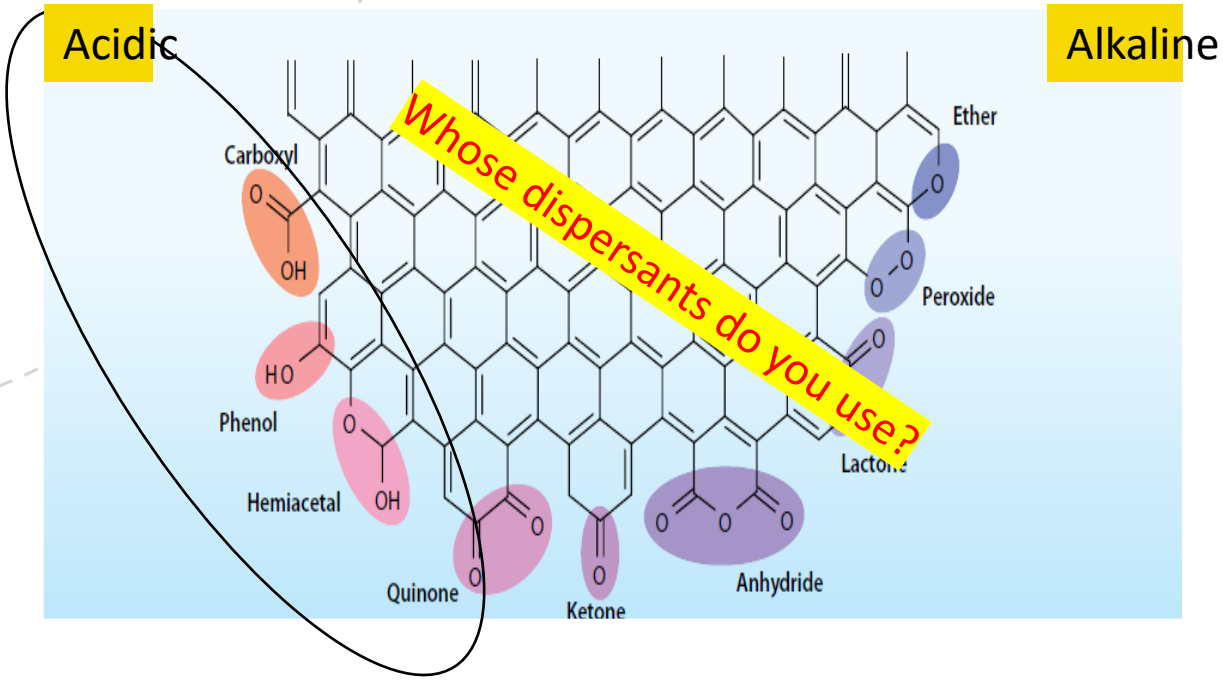
Surface oxides
(measured by Volatile Matter Content)

Not Oxidized	Surface oxides	Oxidized
Low	Jetness	High
Brown	Hue	Blue
High	Viscosity	Low
Low	CB Loading	High
Difficult	Dispersibility	Easier
Higher	Conductivity	Lower
Weaker	Gloss	Higher

Benefits of oxidization;

- Higher jettness, easier dispersibility, better gloss and leveling, higher pigment loading, better rheology
- Chemistry is more acidic, so asking which solvents, diluents, dispersants and resins are currently being used is important for oxidized systems



Importance of dispersion

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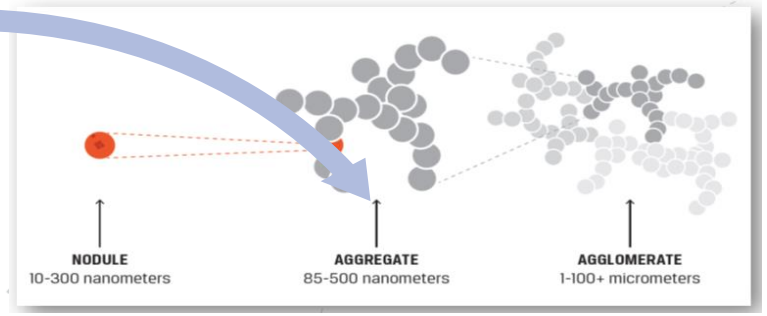
- **Initial Stages**
- Pre-Wetting in medium to higher boiling point solvents
- High-Speed Cowls Blending
- Dispersing resins

Agglomerates

Aggregates

- **Milling Stages;**
- Dispersants Needed For Optimum Performance (P:B)
- Viscosity Needs To Be Higher To Produce Friction & Energy
- Temperature Control Important
- Mills Types; Sand Mills, Ball Mills, Basket Mills, Media Mills



- **Finished Dispersion Stages;**
- Dispersants essential to keep stable
- Dispersing resins help reduce need for dispersants
- Oxidized pigments help reduce need for dispersants

Nodules, Semi Aggregate / Close To Primary Particle

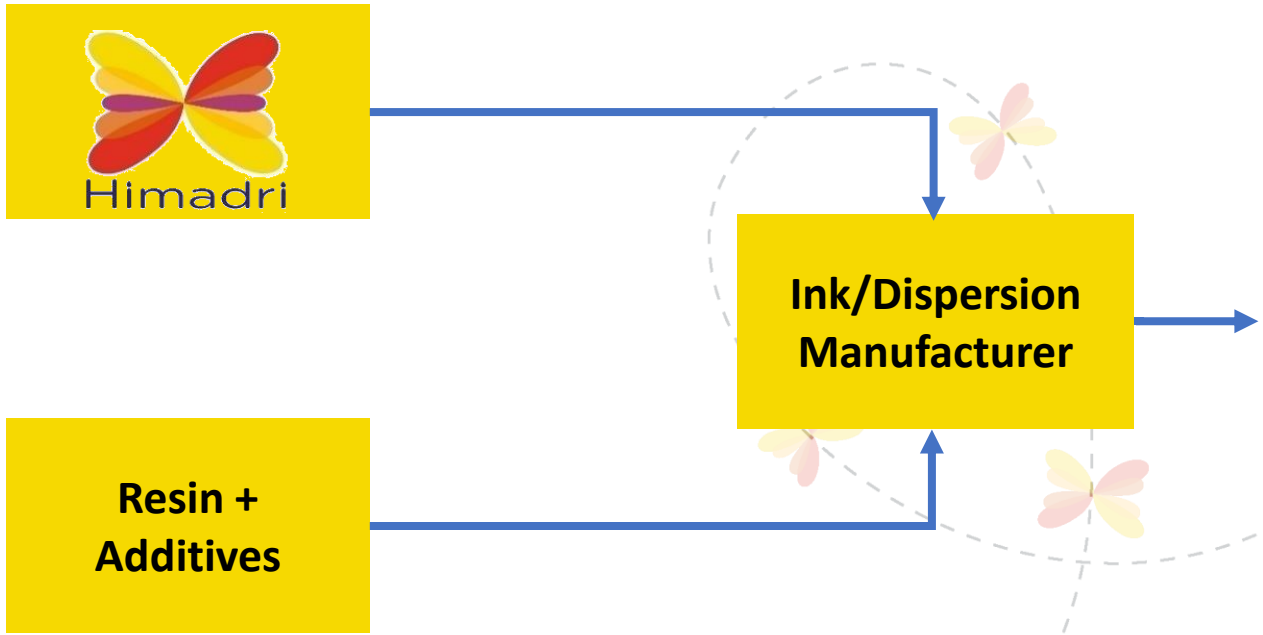
Specialty black's role in critical functions of inks

Why Ink Accounts Need Carbon Blacks

Function	Role of Carbon Black	Critical Performance Requirements	Example Applications
Coloring (Masstone/Tinting)	Absorbs visible light to different extent according to carbon black morphology and provide blackness with the appropriate undertone	• Achieve target blackness or tinting with good undertone • Particle size of carbon black governs the Jetness , Masstone and tinting strength of the ink • Increasing structure at same particle size enhances blue undertone of the ink	Blackness being the prime requirement of any ink can be applied to: a. Offset Lithographic b. Gravure printing c. Screen printing
Viscosity / Flowability	Carbon black used as Pigment in Ink formulation plays crucial role in viscosity or flow property controlling of the liquid phase. Viscosity is an crucial property in all printing techniques.	• Too thick/viscous solution of ink causes 'Smudge' in printing whereas too thin/fluid solution of ink results 'Strike through' • Carbon black structure controls the viscosity to considerable extent • Higher the structure higher will be viscosity of the solution	Classical examples of inks depending on viscosity are: a. Newspaper ink b. Flexographic ink c. Gravure printing
Dispersibility	Pigment dispersion in the resin phase is very important to ink manufacturers. Reduction in time of milling in three roll mill to obtain desired level of Hegmen Gauge dispersion is desired.	• Carbon black morphology plays crucial role in dispersion • Larger particles are always better dispersing than smaller particles • High structure improves dispersability compare to low structure carbon blacks.	Typical examples of inks include: a. Toner ink for cartridges b. Inks for letterpress c. Digital printing etc.

Specialty blacks used in inks serves the market of different printing techniques

Simplified Value Chain



Application of Inks	Type of Printing	Chemistry Types
Packaging (e.g. Printing on plastic films and papers for product identification)	Lithographic Offset; Container Board, Commerical Ads	Oil Based Alkyds Inks
	Flexographic; High End, Low End GCMI Corrugated	Solvent Inks / UV Inks
	Gravure Printing; Container Board, Commercial Ads	Water Inks
Publishing (e.g. Books, newspapers, magazines etc)	Gravure Printing; Books, Magazines	Nitro Cellulose and Polyamide solvent systems & Water Based Acrylic Systems
	Lithographic Offset; Commercial Ads, Some Books	Oil based alkyd inks
	Coldset / Heatset; Newspaper & Magazines	Oil based alkyd inks

Carbon Black Colloidal Data Comparison

Non Oxidized Particle Size Selection Chart

Carbon Blacks ~Avg Primary Particle Sized & Nitrogen Surface Areas

1. 60 - 70 NM, 30~44 N2SA:
2. 50 - 60 NM, 33~12 N2SA:
3. 40 - 50 NM, 40~70 N2SA:
4. 30 - 40 NM, 62~45 N2SA:
5. 20 - 30 NM, 75~13 N2SA:
6. 20 - 30 NM, 77~19 N2SA:
7. 20 - 25 NM, 103~14 N2SA:
8. 20 - 22 NM, 112~22 N2SA:
9. 18 - 20 NM, 118~34 N2SA:
10. 18 - 21 NM, 120~17 N2SA:
11. 18 - 20 NM, 190~91 N2SA:
12. 16 - 18 NM, 260~93 N2SA:
13. 16 - 18 NM, 290~319 N2SA:

Tinting Grades, From High Tinting Value To Medium Tinting Value

Medium Jetness Grades, in masstones. Workhorse industrial blacks. These are from Medium to higher jetness/Medium to mid-lower particle size

Medium To High Jetness, Masstones

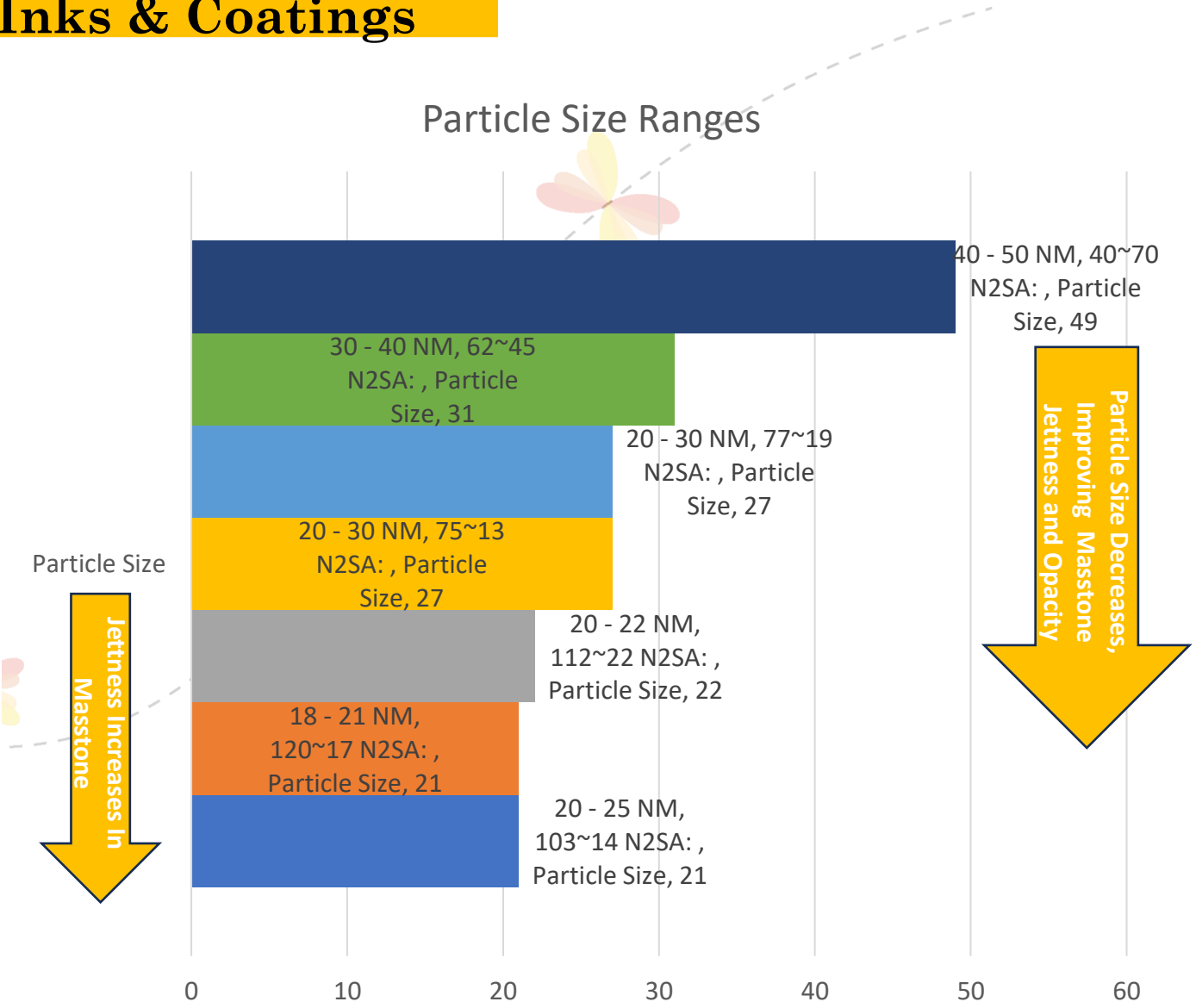
Application Example;
Architectural Coatings With Fillers, Gray Floor Coatings With Blue Undertone

Application Example;
General Industrial DTM Coatings, Without Fillers, Masstone. General Inks

Application Example;
General Industrial DTM Coatings, needing higher Jettness. Masstones

Conventional Powder Grades, CX; Key physical properties for speciality blacks for Inks & Coatings

Current Products	BET / NSA Surface Area (m2/gm) *ASTM D-6556*	OAN (ml/g) *ASTM D-2414*	Ash Content (%) *ASTM D-1506*	Sieve Residue @ 325 mesh (ppm) *ASTM D1514*	Tint (% R) *ASTM D 3265*
40 - 50 NM, 40~70 N2SA:	40	117	<0.3	<50	60
30 - 40 NM, 62~45 N2SA:	62	45	<0.3	<50	100
20 - 30 NM, 75~13 N2SA:	75	103	<0.3	<50	103
20 - 30 NM, 77~19 N2SA:	77	70	<0.3	<50	111
20 - 25 NM, 103~14 N2SA:	103	54	<0.3	<50	125
20 - 22 NM, 112~22 N2SA:	112	115	<0.3	<50	116
18 - 21 NM, 120~17 N2SA:	120	60	<0.3	<50	124



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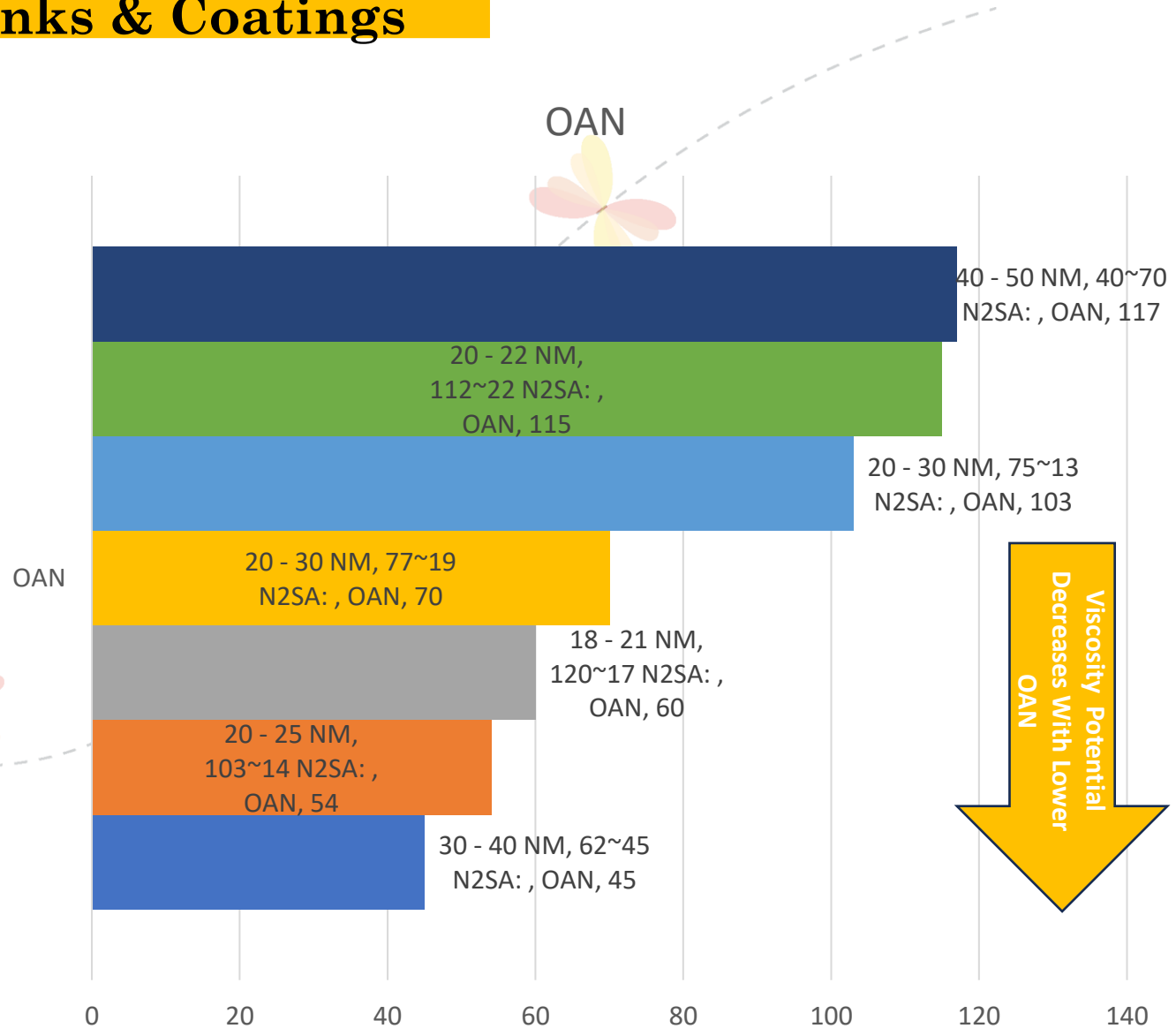

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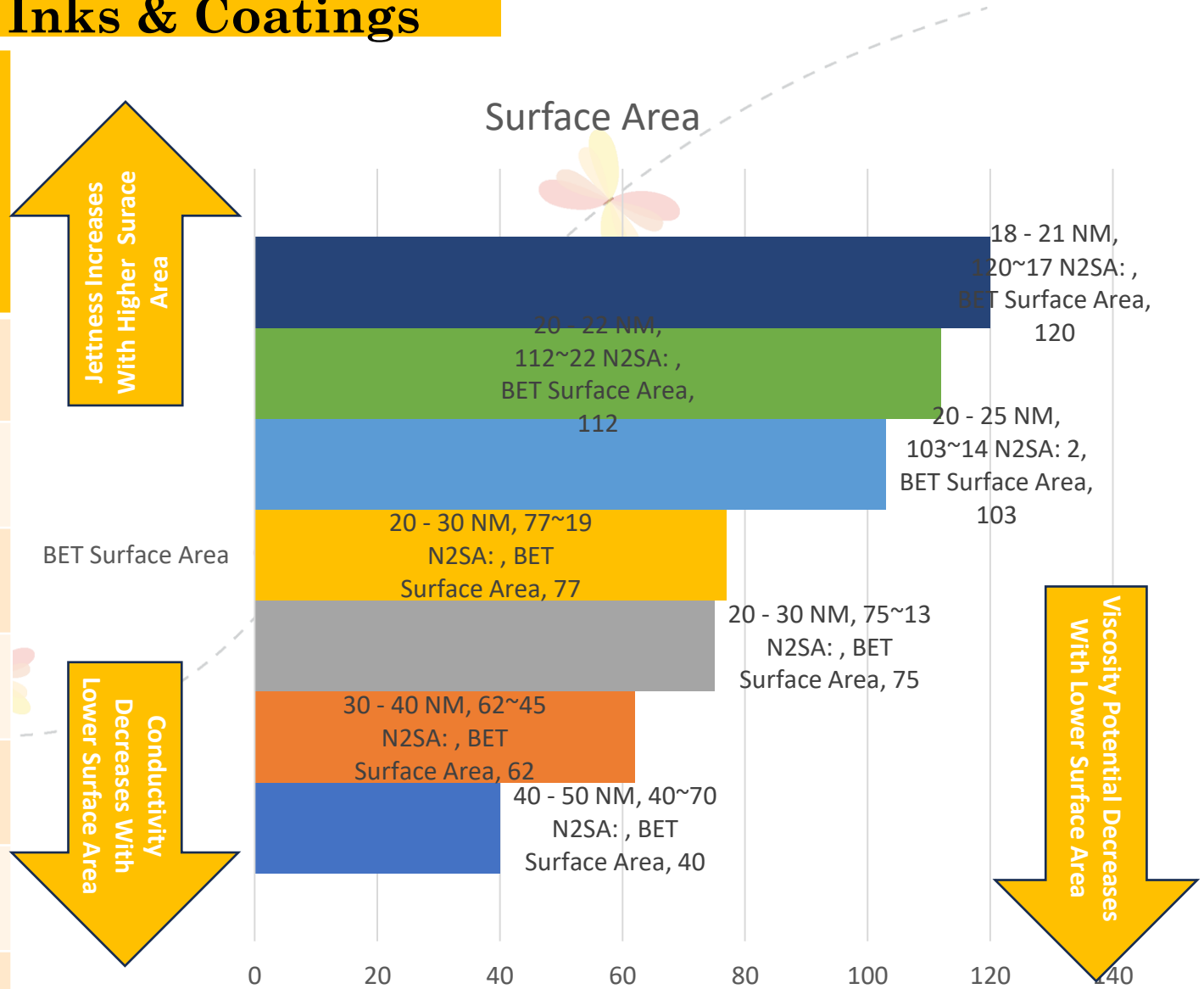
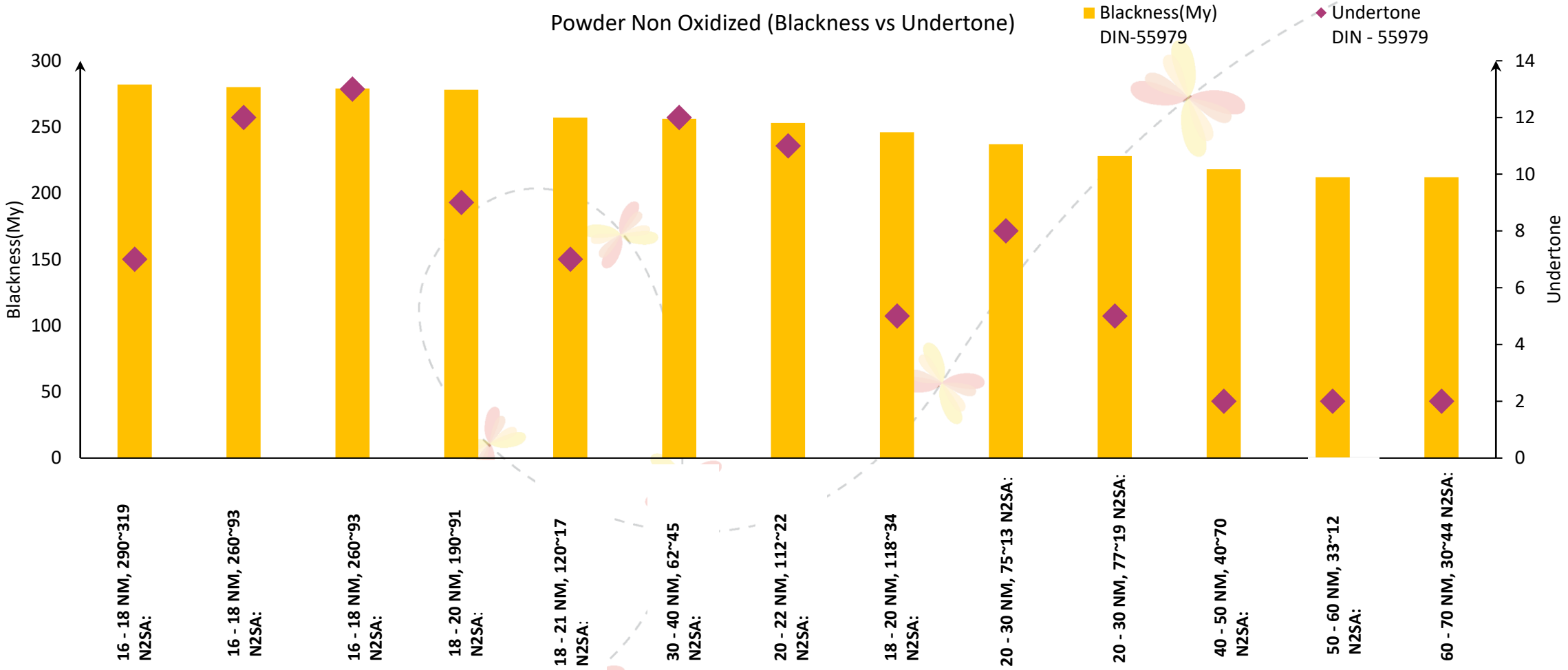


Blackness (My) vs. Drawdown | COLORX



** Tested as per DIN standard DIN-55979

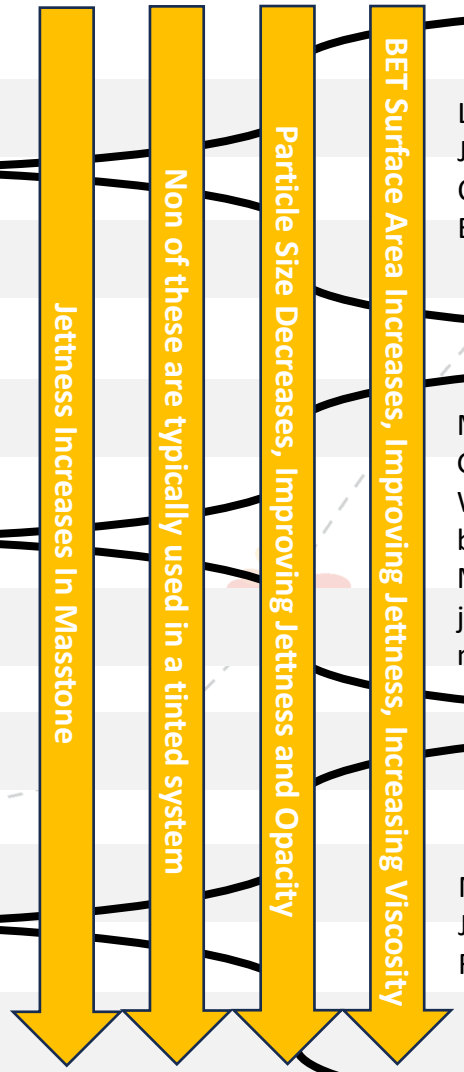
Possible Dispersant Recommendations:

- EFKA 5207 was effectively used by a customer for Architectural tinting applications, like the 60 - 70 NM (CX44)
- CLIQ alternative; Need intel from Ravago

(OXIDIZED Surface Treated)

Carbon Blacks ~Avg Primary Particle Sized & Nitrogen Surface Areas

1. **50 - 55 NM, 35~12 N2SA, <3OX:**
2. **31 - 35 NM, 65~45 N2SA, <2OX:**
3. **25 - 30 NM, 95~37 N2SA, <5OX:**
4. **25 - 27 NM, 100~09, <5OX:**
5. **20 - 25 NM, 107~10, <2OX:**
6. **20 - 25 NM, 180~32, <8OX:**
7. **16 - 18 NM, 600~55, <8OX:**



Low To Medium Jettness Industrial Coatings and Higher End UV Inks

Medium Jettness Grades, in masstones. Workhorse industrial blacks. These are from Medium to higher jettness/Medium to mid-lower particle size

Medium To High Jettness, Automotive Refinish

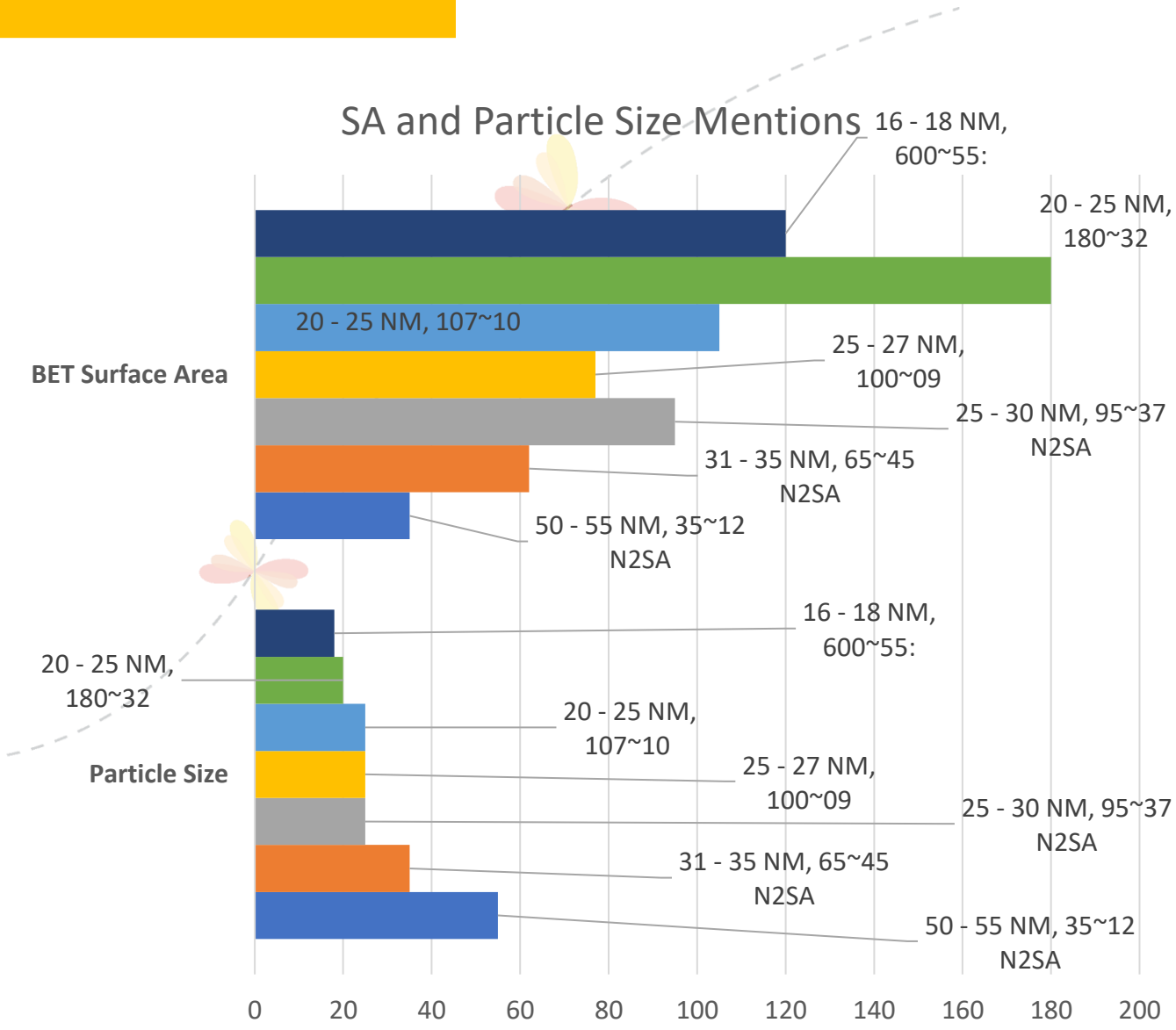
Application Example;
General Industrial DTM Coatings, Without Fillers, Masstone

Application Example;
General Industrial DTM Coatings, Without Fillers, Masstone

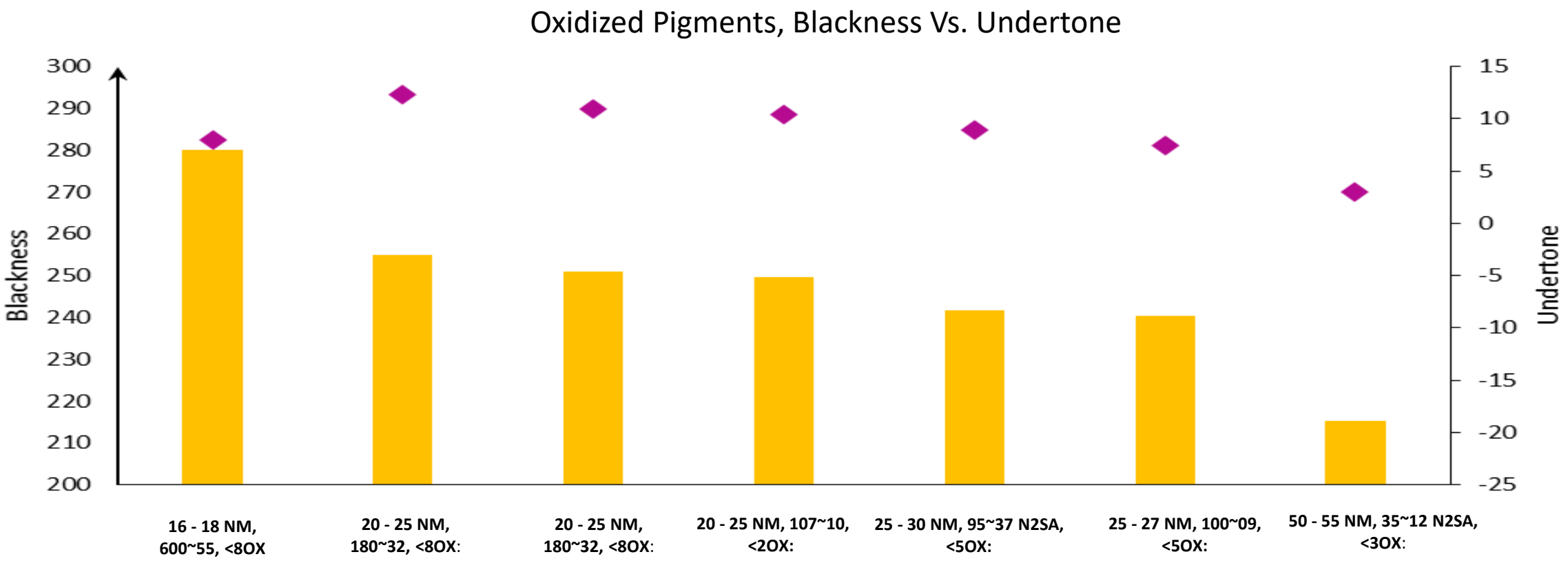
Application Example;
Higher End Industrial Coatings, Workhorse Automotive Refinish.

Oxidized Grades, Key physical properties for specialty blacks

Current Products	BET Surface Area (m2/gm) *ASTM D-6556*	OAN (ml/g) *ASTM D-2414*	Ash Content (%) *ASTM D-1506*	Sieve Residue @ 325 mesh (ppm) *ASTM D1514*	Tint (% R) *ASTM D 3265*
50 - 60 NM, ~12 VOL<3%	35	90	<0.3	<50	65
30 - 40 N, ~45 VOL <2%	62	50	<0.3	<50	100
20 - 30 NM, ~37 VOL <5%	95	110	<0.3	<50	112
20 - 30 NM, ~09 VOL <5%	77	70	<0.3	<50	111
20 - 30 NM, ~10 VOL <2.5%	105	100	<0.3	<50	125
20 - 22 NM, ~32, VOL 10-15%	180	115	<0.3	<50	105
18 - 21 NM, ~55 VOL <13%	120	60	<0.3	<50	124



Blackness (My) vs. Drawdown | BARONX



** Tested as per DIN standard DIN-55979

Possible Dispersant Recommendations;
- Nuosperse FA 196 was effectively used by a customer with the 16 - 18 NM (BX55,OX)
- CLIQ's alternative; CLiQSPERSE HK

Much Like Ink / Coating Tech Service

Carbon Black Technical Service Is About Asking Questions and understanding the customer's needs

Quick Quiz

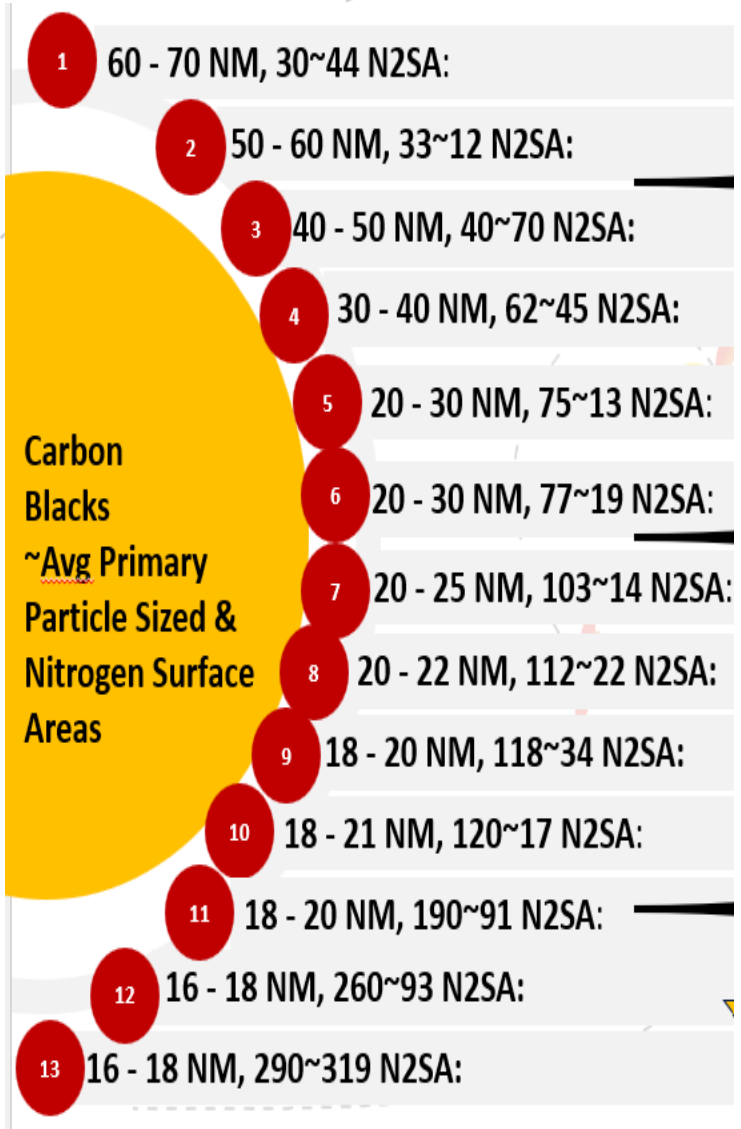
Questions;

- Which carbon black nanometer size to the left is one of the most common in the ink and coatings industry?
  - #6; This grade is one of the more highly used carbon blacks in the ink industry, yet its not the jettest.

- Which would have the highest viscosity at the same pigment loading in your formulas?
  - #13; The lower particle sized carbon blacks typically have the highest structure, which equates to the viscosity building in your vehicles or resins

- Which grade has the best tinting power in your tinted / architectural colorants?
  - #1 has the highest particle size, and due to a tinted color like a gray having other fillers, the tinting power of a higher particle sized carbon actually tints with more power and will cause a bluer undertone.

- Which grade would have the highest blackness or jettness?
  - #13, in a masstone system, the smaller the particle sized carbon black, typically has a higher surface area, both of which lead to better jettness and blue undertone in a masstone system



Important: *No Carbon Black Is The Same*

We Are Similar, Nobody is Exact

No carbon blacks are exactly the same.

No carbon blacks even though slated as a similar alternative; none are exactly the same

Carbon blacks will always vary slightly in Particle size, OAN, Surface Area, and Oxidization Volatiles.

Where are you now with your current pigment – and what do you need or want it to do differently?

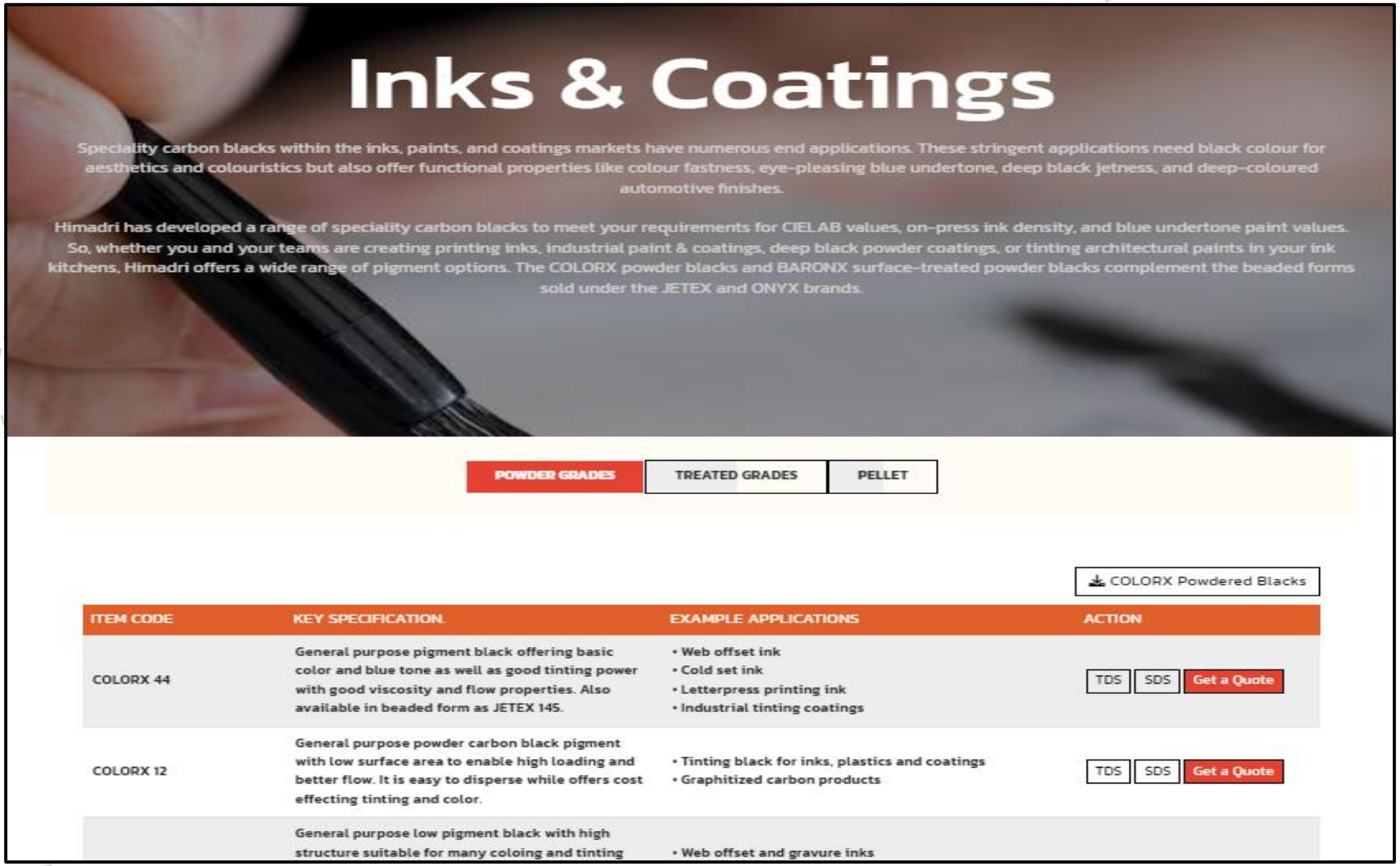
What is your current pigment doing for you now? What would you like it to do differently? What performance attributes are important to you?

What advantages are you looking for in a carbon black pigment supplier?

- Security of supply?
- 2nd Sourcing?
- Technical Service?
- Better Jettness?
- Different viscosity?

Himadri Website

Use The Himadri Website
Review specific products for powder, treated or pellet/beaded grades
Find literature for specific markets
Grab a specific TDS
Grab an SDS
Review who and what Himadri stands for



THANK YOU

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