The Tio2 Killer – How to take Global Consumption from 50% to 17%

Titanium Dioxide [Tio2] equals Carbon Dioxide [Co2]. This simple relation in cause and effect is actually the most acute of corners, and the coatings industry has painted itself into it full steam ahead! But some are looking back for a way out.

Since 1921, Tio2 remains the immutable material in paints & coatings. Naturally occurring, finite and without a synthetic substitute, its opacifying effects are irreplaceable [whiteness & refractive index value]. Paradoxically, these same benefits produce negative outcomes in both economy & environment through high cost in formula & footprint intensity. Rooted in traditional formulaic solutions unable to control the diminishing returns that it inherently yields, chemists can only load so much before the benefit to cost ratio becomes untenable.

In 2013, the Dow Chemical Company was awarded the U.S. Presidential Green Chemistry Award for its pre-composite polymer technology *EVOQUE.* Joan Schuller of the Coatings Materials division highlights "Tio2 has been stretched to its limits, both in terms of hiding efficiency and supply." After a decade of being sold as an offset, formulators realistically achieve a lateral move in performance for better input costs through an average of a 5-10% reduction in Tio2 and mitigated exposure to, as Schuller describes, a high "energy footprint that comes from mining, processing and transporting…" More substantially, this begins the conversation where stakeholders realize the incongruity between our dependency on the white pigment and its true legacy for an entire industry and its customers. "The Corner."

The International Journal of Chemical Engineering and Applications from October 2015 published a report entitled *"Low Carbon Footprint Tio2 Substitutes in Paint"* by Matthew J. Ruszala, working in partnership with Akzo Nobel. It concludes "Tio2 due to its costs, dwindling resources, and environmental impact…an alternative is required…however, none of the current alternatives are comparable…" As this notion begins to gain momentum even key personnel at the material supply tier start to take notice of the obvious route towards the solution.

Dr. Michael Diebold, a former Research & Technical Fellow at Dupont and Chemours, emphasizes the inherent truth in an article from PCI January 7, 2022 "…the opacity benefit of Tio2 decreases as Tio2 levels increase, and there is an upper limit where adding too much Tio2 can even become detrimental to the overall light scattering power of the paint. In such cases, the only way to achieve complete opacity is to increase the thickness of the paint film".

Moving contrary to functionality, economy and environment, the Titanium Dioxide Manufacturers Association [TDMA] promotes "High quality paints formulated with high Tio2 content have the lowest environmental footprint as…fewer layers of paint are required to achieve the desired result." Not only is this out of touch with the chemical performance of the material itself, as increasing load percentage has proven not to reduce layers, but it encourages mindless extraction at the source where the utmost damage to Earth occurs.

A new sustainable technology in advanced light scattering and optimization, generates a novel universal coatings system for multiple substrates and market segments that resolves the dilemma. Coined 'Self-Build Technology™' this method maximizes efficiency to the core utility of paints & coatings [opacity] under which all sub – utilities and benefits reside. It uses an exclusive 'mechanism of action' at point of

standard application wherein paint molecules compound onto themselves like magnetic anchors in real-time, yielding equivalent or better film build [and all typical required results] of multiple coats from traditional coatings, but without ever the need of a primer or a second coat.

While traditional coatings are good at and focus on adhesion to a surface for improved core performance, they shift, move and wash around before drying to an incomplete finish. This is followed by layering additional coats, repeating the application process until unconditional opacity is achieved wherein all peripheral benefits of a full system then fall effortlessly in line [sheen, texture, color & durability]. This is the convention of using coatings. Important to note that the only ***uncontrollable*** component of a coating's purpose is ***opacity,*** and this is because it cannot be tamed in formulation using current methods.

Concept & The System Profile

The concept asks the question – *"if conclusive opacity [the hallmark of knowing when to stop painting] is realized through a user's typical labor - multiple coats layered onto each other but over the time of a traditional coating's application process, [painting and drying, painting and drying, cont'd etc…], how can these layers and therefore complete results be achieved in real time?"*

An extension of the originating thought experiment was to refer to the optical behavior of sodium chloride [NaCl] under purposeful manipulation. In its static position, NaCl maintains a refractive index of 1.54, which when observed through even the most basic objective lens of a microscope would clearly display its true transparent nature. But when many grains of NaCl are clumped together [mechanism of action] the material is now opaque. So much so that placed on top a drastic color base, light cannot penetrate through the sodium particles to the underlying color and scatters the same way it does through sufficient film build from opacity on a substrate. More impressively, the latter is using Tio2 that maintains a refractive index of 2.61 and yet still requires multiple coats to perform using traditional approaches.

This innovative method uses thin film building to achieve opacity by not only adhering to the surface but also to itself through an exploitation of outdated surface tension techniques. Achieved in production through a shearing effect, paint molecules become 'magnetized' by a distinct treatment and sequencing of raw materials relative to each chemical packet [additives, pigments, water, binders/resins] that abrade with sensitive but proven mixing processes. Despite this exclusive result, 90% of all raw materials in the system are used by manufacturers around the world with typical equipment requirements both in production and lab. This method uses two thirds less Tio2 yet achieves two - and three-times opacity of any traditional architectural coating system. This is because the mechanism of action at point of application acts as a counterpoint to the absence of excess Tio2.

To maintain and improve performance, the method had to be adaptable to industry's current infrastructure by way of how manufacturers produce and how users consume paints & coatings for it to be adopted. The system profile can be described as a common water based single component, but with extreme durability and scrub counts approaching 10,000 on the ASTM D2486. It is a non-viscous product in the 85-90ku range with ease of flow and application despite approaching solids of 70%. It is no odor with very low voc and non spatter that can be produced in multiple sheens. Most intriguing is the tint system. There is one base that can be tinted white down to deep medium tones [85 – 90% of all color sales] and there is a base for accent colors. The method accepts any tints and matches any color. Compared to the sku matrix and costly proprietary tint systems of any other product line, some up to 7 bases, this simplification is further evidence towards real practical sustainability through the supply value chain. Self-Build Technology has been transferred into seven architectural coatings serving their specific market segments.

These product systems range from interior and exterior decorative, new construction, industrial and commercial coatings. More recently, through possibly the largest field test in history, over 150,000 gallons were produced, marketed, and sold through traditional channels in North America and internationally. With over 15,000 unique end users, the system has proven successful in a wide range of geography, user type and practical real life requirements.

These measures de-risk the technology and provide social proof that large scale market sized batches can be produced. That the raw materials can be sourced with consistency and most importantly that the varied customer base of traditional coatings through distribution, retail and end user type not only welcome these results but have come to expect them. The technology continues to be transferred into additional product systems, growing the platform to serve additional market segments. What's more, a push towards the only next best improvement has commenced – ***Zero Tio2*****.** A full technical report is being prepared for international trade presentations as Tio2 is the cornerstone of the entire $235B USD annual market value responsible for 50% global inventory consumption.

But can we significantly reduce our dependency while maintaining or even increasing market value?

Tio2 Alone Controls Sustainability

In October 2017, at the outset of the European attempt to classify Tio2 as a Carcinogenic Category 1B, the EC Journal published '*Titanium Dioxide: Ruling opacity out of existence?'* A seminal article of a theoretical study performed by chemists at Akzo Nobel on industry's reliance. They demonstrated this by using Zinc, which is considered the next best material. The result required many more coats or layers to achieve equivalency.

This study further illustrates the standard formulaic approaches, many through industry collaboration that have not succeeded in optimizing the potential of Tio2 for opacity. Including such traditional attempts as adjusting viscosity, rheology, dry time, increased solids, 2k systems, saturated tints used at point of sale, particle sizing and spacing, synthetic polymers that in fact provide similar or worse opacity.

Optimization has long been a salient conversation. What began as discussion among those in the trade on technique at the raw material level, is now inclusive of varied stakeholders with a vested interest in the practical influences of Tio2 through the supply value chain. This is where the novel method has its real impact as it brings with it the opportunity to offset as much Tio2 in coatings as is currently possible. This simple shift in system approach can solve the economic and arguably more important, the sustainability vision of an entire industry that cannot formulate around its effects. Chemours, a leading producer of Tio2, found in a recent poll that "…63 percent of coatings professionals identify balancing sustainability and cost as their greatest challenge to advancing sustainability in their coatings design". While industry admits the end game, achieving it with such dependency looming over its head is seemingly impossible.

Sustainability used to be about voc control and that took a generation to trickle down before the end user began to understand its value. Today, the environmental conversation hinges on CO2 footprint and wastes and does so among the most educated and awake consumer base in history as it pertains to aligning environmental goals with the paints & coatings they purchase.

Synonymous with how manufacturers maintain their public relations, top producers like Hempel base their entire message on concepts like ***"Detaching growth from our environmental footprint".*** And while this notion supports the reality that the most environmentally friendly coating can only be the one you use the least of, there isn't a palette of products in the market that supports their distant future desire.

A precursor to modern day marketing for the "greenest image money can buy" is what governments used to promote as the Extended Producers Responsibility System or EPRS. In its infancy it was an attempt to curb post-consumer wastes, which grew to become an initiative by manufacturers to run the costly and fledgling reuse and recycling system using a consumer financed model of eco-fees. But when looked at through the lens of Self-Build Technology and its controls over Tio2 and therefore the industry's entire CO2 footprint, EPRS can revive a somewhat forgotten inclination to not only control wastes after end user consumption but before it, from the starting point of raw material extraction.

The influence of this control over the systemic hyper problem that is Tio2 goes well beyond a single raw material. For if we control it then we control all materials that orbit around this core ingredient. Like the planets in our solar system around its sun. By reducing it to the minimum required, the simplification of the supply chain occurs naturally, and all input costs, peripheral materials and necessary key resources in additives, resin, water, fillers, energy, transport with its emissions and containers with its packaging, automatically reduce to their minimum. That is the power of this particular control. That it can actually shrink supply chain consumption in all excesses, including ***time and labor*** to market, and prevent maximum life-cycle wastes before they begin.

As important then are the sustainable repercussions for all adjacent industries, like construction, as customers of paints & coatings. By giving them the gift of a minimized eco-footprint as added incentive, we can approach environmental stewardship unlike the past. We cannot expect customers to pay more to be eco-friendly but should rather reclaim the responsibility of achieving this on their behalf. This is the only way forward for sustainability, by actually connecting it with innovation sincerely.

The Path to *REAL ESG* – The Industry's Choice

How do we effect real quantifiable change for our environment? Planting a tree? Convincing employees to ride their bikes to work? These in principle feel good and are aesthetically correct but are reactionary notions and benign of any significant consequence. In short, they don't move the needle. If the industry is as frantic as it seems, then consider the impact of every producer on Earth adopting this novel system. After all, we've spent a generation consuming marketing ads telling us it's okay to push for fewer coats and that it's just common sense, regardless that this was not/is not possible using any current market products. What would happen?

To start, Tio2 consumption would be cut from 50% of global feedstocks to 17% and this in turn would dictate maximum peripheral resource preservation and minimize the CO2 footprint and all excess input costs through the entire supply value chain forever. This in turn creates climate tech coatings, the path to real ESG, solving the global megatrends of sustainability. A path rooted not in a manufacturer's self-marketing and image but in its core purpose – ***its production.***

What's encouraging. is reading that many established industries are moving to relieve Tio2 such as Ystral dispersion equipment in Germany who engineers mixing solutions. Their machines help producers towards maximum efficiency in material resources. More incredibly, Chemours has been actively engaging their customer base by promoting the idea that using less Tio2 is better for the environment even at their expense. And Akzo Nobel, partnered with the SusInkCoat Initiative, a Dutch research program, is exploring how to make inks and coatings more sustainable.

As it stands, all stakeholders are seemingly held hostage by their obligation for Tio2 while at the same time being challenged by consumers and environmental agencies. But unless the industry can hedge

against it using a real life substitute that offers this double incentive solution in economy and environment, the challenge will be met with impediment. The simple fact is that architectural coatings, with the exception of the move from oil to latex in the 1950's, hasn't fundamentally changed in a century. No coincidence that this is a timeline shared with the advent of Tio2 refinement and mainstream use.

In closing I echo the sentiments in the paper *"Transformational Thinking: Innovating for the Future"* by George Pilcher of the ChemQuest Group, wherein he strengthens the ideal that for the industry to truly innovate, it must not do so gradually but rather act on a spark through transformational thinking that has the power to change how we look at coatings and processes forever. In doing so we can recalibrate the relationship between people, paint and now, even the environment.

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