Sustainability & Titanium Dioxide

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Agenda

- Cristal Company Overview
- Sustainability Introduction
- Focus on Carbon Footprint
  - ‘Footprint vs Performance’ balance
  - Use phase benefits enabled by titanium dioxide (TiO$_2$)
- Optimising TiO$_2$ levels to minimise carbon footprint
  - Lab study on Satin Paints below CPVC
  - Practical comparison of two Matt Paints from a DIY store
- Summary & Conclusions
Company ownership

Strategic ownership

TASNEC 66%  
Gulf Investment Corporation 33%  
Private investor 1%

CRISTAL

Mining  
Mineral sands

Pigments  
Titanium dioxide and titanium performance chemicals

Metals  
Titanium metal and alloy powders
Cristal locations

6 Mines, 7 TiO₂ Plants, 1 Titanium Metal Plant, 7 Technical Centres, 1 Slagger Plant & 11 Operational Offices
Sustainability - Not just about being green....

- Leading companies with Sustainability high on the agenda communicate a very consistent motive...
  - The strong belief that making their businesses more resilient to the pending stresses of the future is essential to maintain **Long Term Profitability & Survival**
Environment Sustainability

- Environmental Sustainability is only one part of the Sustainability agenda

- Within Environmental Sustainability there is currently a big focus on Carbon Footprint (CF)
  - Many major coatings manufacturers looking to evaluate and report Carbon Footprints of their operations and products
  - Some customers looking to set aggressive reduction goals
  - TiO$_2$ is the single largest contributor to the carbon footprint of Decorative paint manufacture

- Care needs to be taken not to look at CF in isolation, as the other Environmental impacts (eg waste, water etc), can be conflicting with CF.
The TDMA Carbon Footprint Project

- Titanium Dioxide Manufacturers Association (TDMA)
  - CEFIC Sector Group
  - Representation from all global major TiO$_2$ producers
- Carbon Footprint project launched in 2010
  - Product category rules (PCR) written and agreed
  - ‘Cradle to gate’ product carbon footprint
  - All members confidentially submit their data for aggregation to an industry average value
- Industry average carbon footprint - 5.2kg CO$_2$e/Kg (2010)
- Biannual update planned through - www.tdma.info
The Footprint vs Performance Balance
Do we really need TiO$_2$?
What Sustainability Benefits does it bring?

- TiO$_2$ is normally identified as a ‘hot spot’ within decorative coatings manufacture
- Prior to optimising the TiO$_2$ levels in paints, we should consider the two more basic questions....
  - Is there an effective alternative white pigment with a lower footprint that can be used instead?
  - What is so special about the white and lighter coloured coatings and would it be more sustainable if we chose darker colours instead?
Our Colour Choice

• Most people consider the brighter whiter environments enabled by TiO$_2$ as more aesthetically pleasing
  • Improving our feeling of ‘well-being’
  • Giving the impression of cleanliness and more space

• But the colour choice is not only about decoration
  • Light scattering (white) has demonstrable economic and environmental benefits over light absorption (darker colours)
Lower Lighting Requirements Inside Homes and Offices...

![Graph showing required lighting load as a function of wall colour]
White ‘Cool Roofs’ for Exteriors

- TiO$_2$ is a highly efficient reflector of infra-red radiation (sun/heat)
- Using white roofs and exteriors, can reduce air-conditioning needs
- White ‘cool roofs’ can also reduce the ‘urban heat island effect’
White - The ‘Greenest’ Colour?

• There are some compelling arguments why white or lighter colours should be the preferred colour choice for building interiors and exteriors

• These significant ‘use phase’ benefits should be included in any ‘full life cycle’ evaluations

• We can now consider the optimum TiO$_2$ loading for formulating these valuable white decorative coatings to minimise the carbon footprint
Optimising TiO$_2$ Loadings to Minimise Carbon Footprint in Decorative Coatings

Brilliance inspired by titanium

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Carbon Footprint Evaluation - Decorative Coatings

- Must take into consideration the coating’s performance
- Making any conclusions based only on the carbon footprint per litre of paint, is not uncommon, but is never valid
- As a minimum we must consider....
  - How much paint it will take to coat a given area - opacity
  - The expected life - scrub/wash resistance (for interiors)
Carbon Footprint Evaluation - Decorative Coatings

• For formulation areas (below CPVC) with no dry hiding, the evaluation is relatively simple...
  • It is only necessary to consider the opacity performance
  • Scrub resistance and life expectancy can be shown to be constant across a full range of viable TiO$_2$ loadings

• So a simple pigment ladder can be used to show relationship between TiO$_2$ loading and Carbon Footprint
Satin Wall Paint - Carbon Footprint per Litre

![Graph showing the carbon footprint of Satin Wall Paint per litre as a function of TiO₂ content (g/L)].

- **Kg CO₂e per litre paint**
- **TiO₂ (g/L):**
  - 57
  - 118
  - 183
  - 256
  - 335
  - 420

The graph illustrates the increase in carbon footprint as the TiO₂ content increases from 57 g/L to 420 g/L.
Opacity Performance

Spreading Rate (m²/litre) to Achieve 98% Contrast Ratio

![Graph showing spreading rate (m²/litre) vs TiO₂ concentration (g/L) to achieve 98% contrast ratio.](image)

- TiO₂ (g/L): 57, 118, 183, 256, 335, 420
- Spreading rate (m²/litre): 3.0, 4.0, 5.0, 7.0, 8.0, 9.0
Carbon Footprint to Coat a Square Metre
Satin Water-based Wall Paint

Optimum CF achieved by paint with 250g/L TiO$_2$ applied at 7.8m$^2$/L
Total Carbon Footprint to Coat a Given Area

Commercial Satin Wall Paint Evaluation

![Graph showing the relationship between TiO₂ (g/L) and Kg CO₂e/m² @ 98% CR for different commercial satin paints. The graph indicates that lower TiO₂ concentrations result in lower carbon footprints.](image_url)
Comparisons of Matt paints above CPVC

- Largest volume formulation area in decorative coatings
- More complex as utilises dry hiding to as an alternative source of light scattering opacity
- Dry Hiding is a ‘Low Carbon’ source of opacity
- But air voids in the dry film significantly reduce the durability / wash resistance of the film and this should be taken into account
Carbon Footprint - Value vs Branded DIY Matts

• The paints were analysed for their composition
• The two paints contained very different TiO2 levels
• The wet opacity performance was predictably different
• The Carbon Footprint of the two formulations could be calculated from the composition using standard data.....
Carbon Footprint - Value vs Branded DIY Matts

- On a ‘per litre’ basis the Quality Matt has a carbon footprint 4x higher than the Value Matt
- The Dry Opacity of the Value Matt is closer to the Quality Matt after drying due to dry hiding from air voids
- How much paint is needed to coat a surface can be calculated using the hiding power (m2 per ltr @98%CR)
- On this basis the two paints are much closer on a Carbon Footprint per M2 basis, but the Value Matt is still lower
Carbon Footprint - Value vs Branded DIY Matts

• But the dry hiding utilised by the value matt paint give a film with almost no scrub resistance

• The impact of this on life expectancy now needs to be taken into account in the comparison

• For **walls** we can estimate an impact of coating life expectancy and calculate the CF per m2 per year

• For **ceilings** there is an argument that the value matt is the lower CF **but** this data doesn’t account for additional labour, packaging and transport required!
Summary

• TiO$_2$ is critical in enabling the formulation of white and light coloured decorative coatings

• These coatings are important as they offer sustainability benefits above their simple decorative effect

• Accounting for differences in opacity and life expectancy is critical to enable truly sustainable formulation and marketing

• The results suggest that higher quality paints represent more sustainable options than ‘value’ branded alternatives for the vast majority of applications
Conclusions

• High performance materials such as TiO$_2$ might initially be targeted as ‘hot spots’ for reduction
• But when studied with a correct methodology, simple reductions are likely to be counter-productive
• Coatings manufacturers should carefully consider the validity of carbon footprint reduction goals based on simple ‘total’ or ‘per litre’ metrics
• Pressure around such metrics with limited performance safeguards, can lead to a reduction in product quality with an overall negative impact on sustainability