



Weathering Around the World: Discovering new market opportunities for organic coatings.

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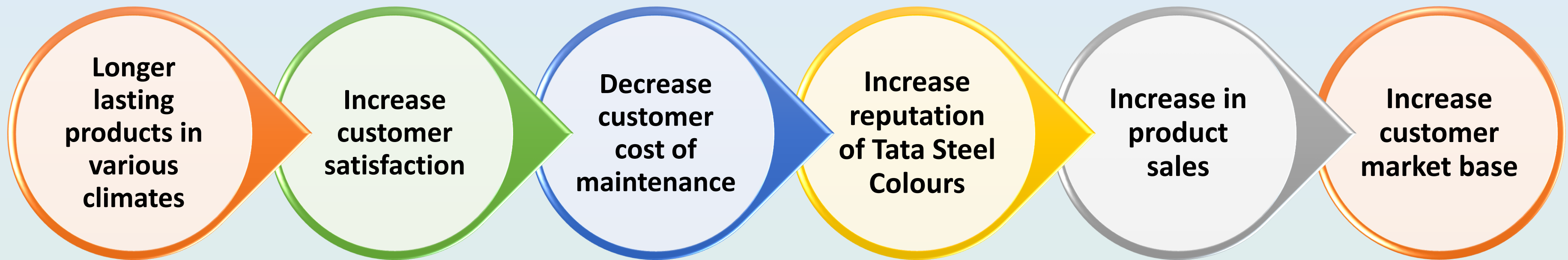
EngD Year 2

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Introduction

Tata Steel Colours is one of the largest producers of pre-painted steel in Europe, producing top of the range organically coated products which are primarily used in the construction industry. The construction industry represents 44% of sales for Tata Steel in the UK. To maintain this position, Tata Steel Colours are continuously seeking to improve the current product range and explore new market opportunities and expand their market base outside of Europe. Therefore, an investigation is required to determine the polymer performance of the organic coatings, which will include factoring the climatic conditions in these new markets, to determine the working lifespan of the coatings to identify how the product can withstand varied climates whilst maintaining the desired properties.



Weathering

- Exposure to the radiant energy present in sunlight, in combination with heat (temperature cycling) and water, in various states such as humidity, dew and rain, can cause changes to the properties of organic coatings.
- The coating can deteriorate over time which ultimately leads to losing its aesthetic appearance, crack/peel or oxidise, thereby ultimately losing its strength.

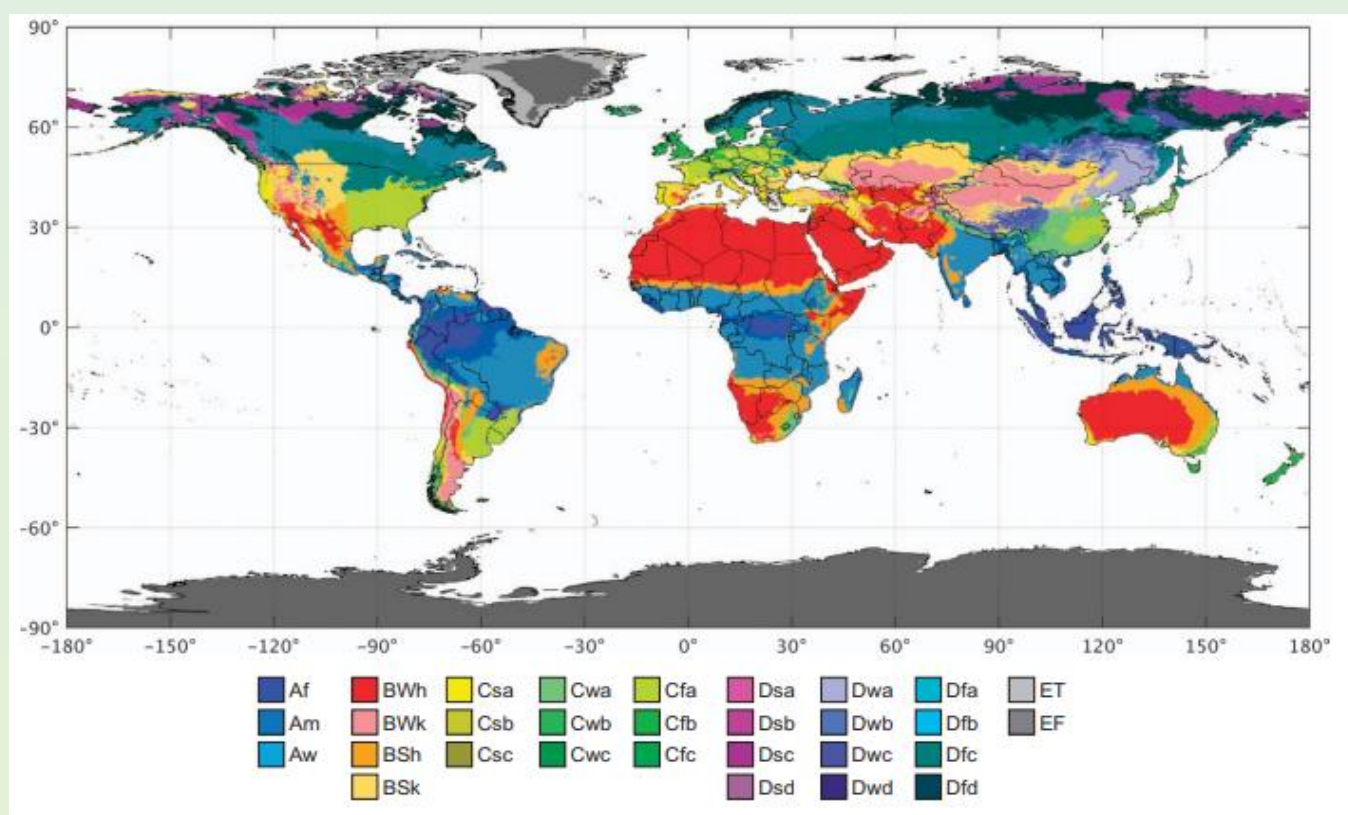


Figure 1: The Koppen Guigar Climate Classification system [1].

- Natural weather conditions vary greatly from one geographical region to another, so to be able to provide a service life guarantee on the coated products it is important to first understand how they will react in such conditions.

Initial Results

Physical Test

Gloss retention is calculated as a percentage change of the weathered sample compared with the un-weathered sample. Graph 1 details samples weathered in Florida and Dubai, with the greatest gloss loss occurring within the first 2 years of weathering.

Colour change measurements are calculated using CIE76 calculation for ΔE :

$$\Delta E = \sqrt{(L_1 - L_0)^2 + (a_1 - a_0)^2 + (b_1 - b_0)^2}$$

Graph 2 illustrates how the colour of sample Flint 10KR023 changed at a similar rate until year 5. The images of the samples visualise how the colour sample in Florida was destroyed by year 10 but was virtually undamaged in Dubai during the same weathering period. Further FTIR analysis may be able to explain the differences visible.

References

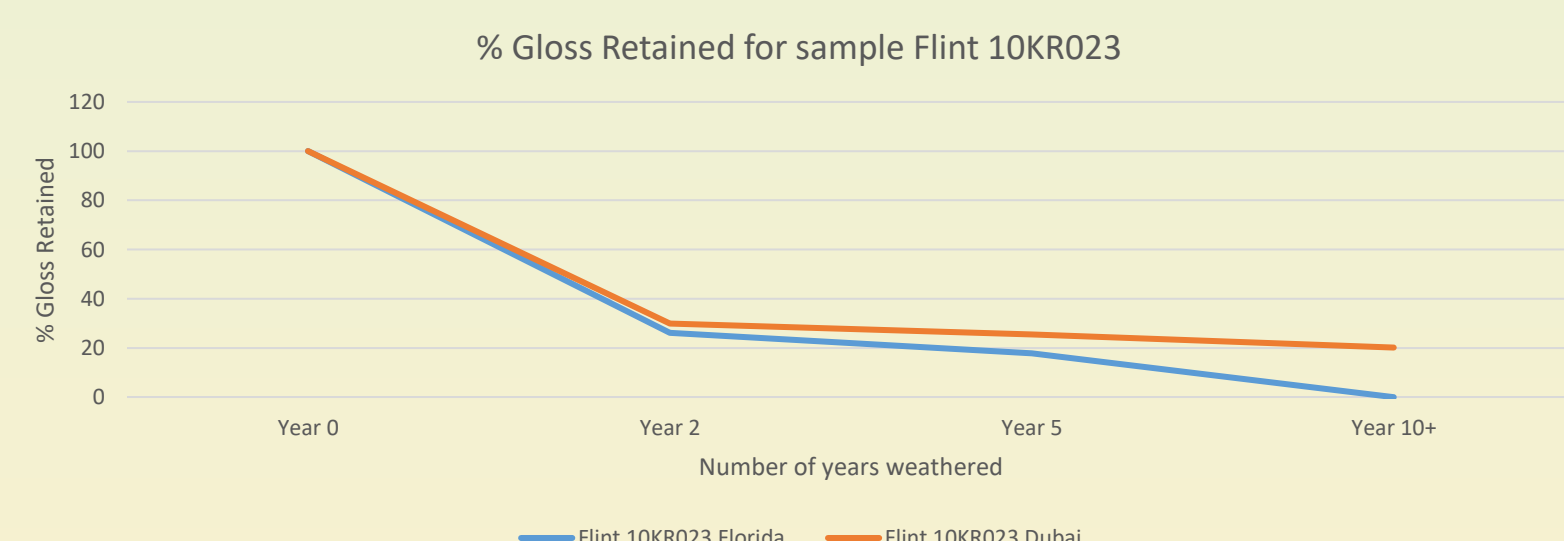
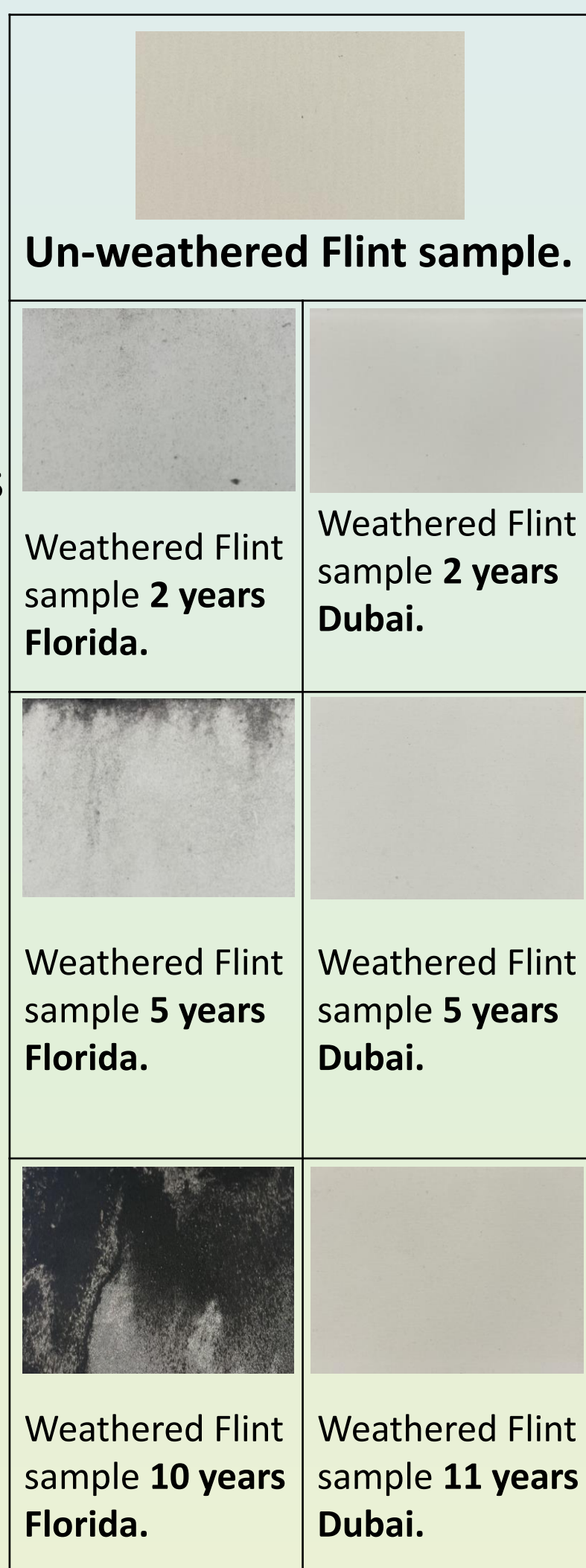
[1] 'Koppen climate classification | Definition, System, & Map | Britannica', Apr. 07, 2023. <https://www.britannica.com/science/Koppen-climate-classification> (accessed May 11, 2023).

Material

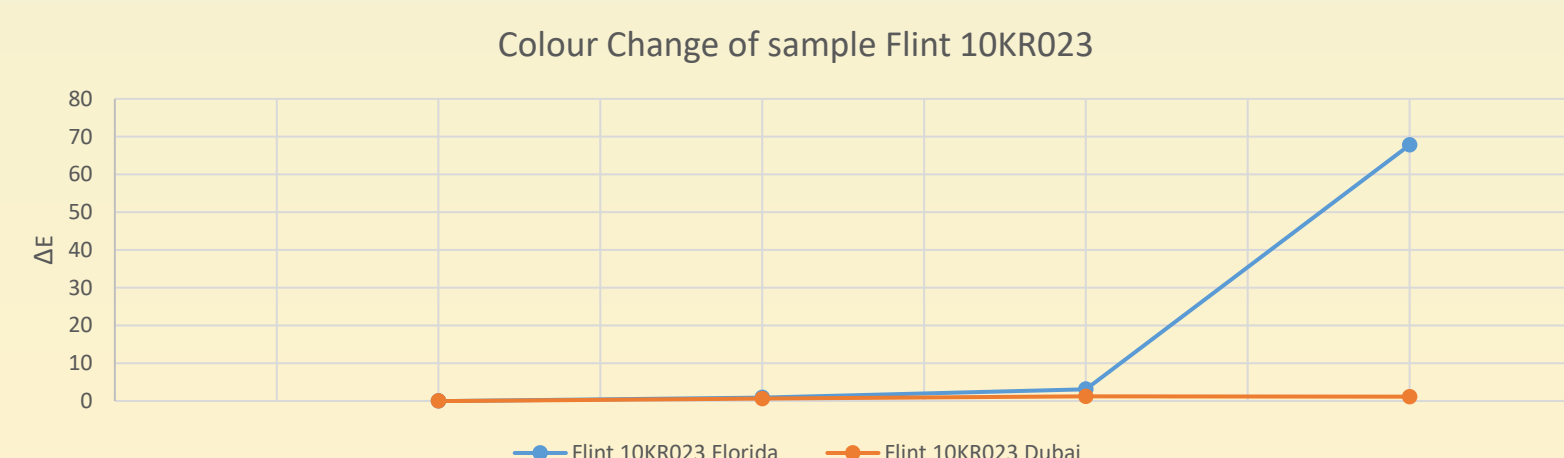
- A variation of two-layer polyurethane, plastisol and PVDF samples in a range of colours were naturally weathered at Florida and Dubai. Samples were exposed for a total of 10 years in Florida and 11 years in Dubai, with specimens being taken from the exposed samples at intervals of two and five years.
- Florida is classified as a sub-tropical environment with high UV exposure, high humidity and is located close to the Ocean.
- Dubai is classified as being an arid, hot-desert climate with high UV exposure and no precipitation.

Analytical Techniques

- Microscopy Techniques such as SEM will be used to assess changes to the surface topography and morphology.
- Physical Aesthetic Properties such as gloss and colour change measurements are taken to analyse changes to the aesthetic appearance of the coatings.
- Spectroscopy Techniques such as ATR-FTIR, Raman and UV-Vis will be utilised to understand chemical changes to the molecular structure of the coating



Graph1: Comparison of % Gloss retained at each weathering interval.



Graph2: Comparison of the degree of colour change of sample Flint 10KR023 per geographical region.