TATA STEEL

TATA

Tata Steel Colors supporting report to the consultation of Strontium Chromate for the prioritisation inclusion into Annex XIV EC 232-142-6 CAS 7789-06-2

Date: 19th September 2012

Introduction

The purpose of this paper is to clarify and provide additional information of the use of strontium chromate in the coil coating industry in Europe and specifically Tata Steel Colors. This substance is used in coil coating industry throughout Europe and in fact the world, mainly in anticorrosive paint primers during the painting of a metallic substrate (mostly steel or aluminium). Strontium chromate is also used in anticorrosive primer paints in other industry sectors such as Aerospace however the coil coating industry holds approximately 90% share of the market where aerospace is 10%. The other aim of this document is to support the consultation response to raise awareness of the need to continue to use such substances until validated alternatives are available using real science and real life testing.

Coil coating is an efficient industrial process for painting sheet metal within a factory environment. The process differs from other finishing techniques because in coil coating the sheet metal is painted as a flat surface prior to forming or fabrication. Strontium chromate is used as an integral part of a anticorrosive paint primer of the metal surface prior to main colour painting, whereas other types of chromium (VI) substances such as chromium trioxide / chromic acid are used in the pre-treatment process prior to the painting. Both processes compliment each other and this point was raised during the consultation response to the chromium trioxide 3rd prioritisation procedure last year.

Chromates (substances containing hexavalent chromium, chromium (VI)) are known to have harmful effects and are categorised as carcinogens. Due to this categorisation, there has been much emphasis over the years on safe use of these substances and in many cases where safe use could not be established they have been eliminated. However, some chromate substances have excellent anticorrosive and adhesion properties and where their use could be carried out safely with zero or minimal exposure/emission they have continued to be used, as their downstream user benefits are valuable to the consumer and far outweigh the risk due to high level technology used to eliminate exposure. One such industry is the coil coating industry, where dichromium tris (chromate), chromium trioxide and/or chromic acid are used as conversion coatings to ensure adhesion of paint to metal and again to enhance corrosion protection of the base metal and then Strontium chromate is used in anticorrosive primers to further improve the durability of the coated metal.

Coil coating industry / Tata Steel

Coil coating represents the most efficient, the most reliable and the most environmentally friendly means of applying a high quality paint finish to metal surfaces. Coil coating applies paints and films to strip metal in a continuous process, providing the highest possible level of quality, uniformity and reproducibility.

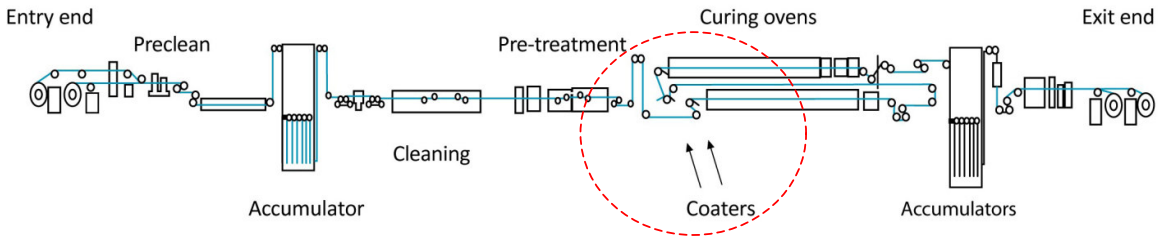
The coil coating industry has more than 60 years of history in Europe, with an annual output now around 1,500 million m^2 of coated metal. The coil coating industry was severely hit by the financial crisis of 2009 and an increasing rate of imports, with European output reduced by 20% to around 1,200 million m^2, but through 2010 this has recovered somewhat, as the benefits of coil coated products have never been so relevant. In 2009 the estimated turnover of the coil coating industry was around € 4 bn. Meanwhile, from information provided in the 2010 ECCA (European Coil Coating Association) survey of members, the industry is continuing to invest in the future with a reported reinvestment rate of 1.9% of total turnover – an important component in the financial sustainability of our approach and our industry. As stated above in the introduction the coil coating industry is thought to purchase approximately 90% of the strontium chromate sold in Europe. This supply chain is not just important to the coil coating industry but also to the other main user, the aerospace sector. Without the use from coil coating aerospace would be forced away from using strontium chromate in their safety critical applications where strontium chromate provides superior anticorrosive protection in its use in primer paints.

Tata Steel Colors is a major producer of coated coil within Europe and around the World. With a large customer based ranging from many applications we manufacture 240,000 Tonnes or 55,000,000m^2 per year.

The largest single use of pre-painted metal (also referred to as coil coated, pre-coated, or pre-finished metal) is in the construction industry where the highly durable finishes coupled with the excellent physical properties of steel and aluminium to give superior cladding and roofing products. This provides a product that is aesthetically pleasing, very durable and inherently recyclable at end of life. However, pre-painted metal is also used in many other applications where the benefits of a uniform, high quality paint film pre-applied to sheet metal can be appreciated. This includes manufactured goods and furniture amongst other sectors.

Coil coating process

Coil coating is an enclosed and tightly controlled continuous process of applying up to three separate coating layers onto one or both sides of a steel strip substrate. The process incorporates a series of discreet, largely enclosed sub-processes designed to maximize coating efficiency, to minimize exposure to workers, emissions and waste to environment. Coil coating lines vary greatly in size, with rated outputs between 3,000 tonnes per annum and 200,000 tonnes per annum of coated metal, maximum widths up to 2650mm and speeds from 20 metres per minute to 300 metres per minute. However, all coil-coating lines share the same basic process steps: cleaning and **pre-treatment**, coating the strip (**primer**, topcoat(s) and/or laminating), and recoiling for shipment.



Cleaning and Pre-treatment

To ensure a high quality of finish, it is essential that the surface of the substrate to be coated has a good level of cleanliness. Acid or alkali cleaning can be used to prepare the surface of the strip.

Once the surface is clean, a chemical pre-treatment must be applied to ensure good adhesion between the metal surface and the paint or film. The pre-treatment can be applied either through a wet (bath or spray) process or by the use of roller-coating, but there is increasing use of the latter due to the efficiency of this technique and the fact it produces no waste water. This technique is used at Tata Steel. The pre-treatment contributes to the overall corrosion protection of the final product and gives an excellent adhesion between coating and substrate, especially in safety relevant areas.

Coating

Most coil coating lines have two main coating stations for the application of a 2-coat paint system, often referred to as primer and topcoat. Roller-coating is used to apply paint to the moving strip surface. A combination of rolls is used to pick paint up from a tray and apply it to the strip. Close control of roll speeds and gaps between the rolls allows specific paint thickness to be applied uniformly across the surface, within very tight tolerances and at line-speeds of up to 200 metres per minute. The wet-paint coated strip is fed through ovens, which dry and cure the paint. Close control of oven temperatures produces a highly uniform paint finish. Solvents driven off by the ovens are collected and in most cases are treated in thermal oxidisers.

The strip is quenched on exit from the ovens to allow re-coiling. In the case of film coatings, a base-coat and/or adhesive is applied at the coater head and the film is laminated onto the still-hot surface after the ovens.

TATA STEEL

TATA

Chrome (VI) in coil coating

Coil coating process

As stated above Strontium chromate is used in their anticorrosion primer paints on the metal surface in coil coating process. The anticorrosion primer coating stage has little or no exposure to workers and releases to the environment are managed virtually to zero. In no-rinse systems a roll coater, squeeze or squeegee rollers apply the pre-treatment products to the strip surface. Without any rinsing the wet film is dried in place using hot air. No-rinse systems have the advantage of resulting in no chromate-containing effluents, very small amount of wastewater, and significantly lower overall water usage. No-rinse is the dominant system in coil coating industry today bringing the benefits of minimal exposure and reduced process waste compared to the spray and dip systems. This system is used in Tata Steel Colors over the below method.

Function of the primer

The primer coating applied to the metal strip in the coil coating process is a thin layer, so the total quantity of chromates used in this function is relatively small and diluted. However, the primer coating plays a crucial role in the functioning of a pre-painted metal product. The main function of chromates used in primer coatings is to improve the corrosion protection offered to the underlying substrate and adhesion to the topcoat, which acts as both a barrier and aesthetic coating. This is especially necessary when the final coating is a bonding system used for metal to paint, rubber, or plastic. The requirement for corrosion protection depends on the prevailing atmosphere in which it is to be used. Corrosion of steel in particular is promoted by the presence of water (humidity), air and salts. In many parts of the world this combination of factors is commonly found and in this case, it is important to protect the underlying metal substrate from corrosion.

Modern pre-painted metal products can provide excellent corrosion protection in even the harshest of climates. This is partly because of the use of chromates in the primer and pre-treatments of these products. In some cases, pre-painted metal for outdoor exposure can be offered with guarantees against corrosion, even at cut edges, up to 40 years. Although some patents of alternative chromate free products mention the same capability, and although chromate free systems have been supplied, there is currently no proof of such performance against the most demanding requirements in the most aggressive environments. The guarantees used for chromate products are based on decades of experience and data of real outdoor exposure. Laboratory testing can never totally imitate the real life conditions. Tata Steel Colors wishes to emphasise this point as we are not against chrome free in principal but there is a need to technically validate such products, which is not achievable in the short-term.

Exposure Controls / Examples

Chromium (VI) contents in all the raw materials used in the coil coating process are either water borne (surface treatment) or solvent borne (liquid paint). To eliminate or reduce exposure to a minimum a series of controls have been implemented in our coil coating lines. Such controls are the redesign of lines from spray to roller coating, which reduces aerosol production and therefore any potential aerosol exposure to operators. A key design to reduce mist production is to carefully apply primer paint onto the roller instead of a quicker flow, thus adequately coating the roll without excess use.

Where necessary, the use of specifically designed local exhaust ventilation systems are installed to remove any possible aerosol at source, thus reducing any possible risk further. The pre-treatment areas are also sparsely manned via procedural controls and design of the system that does not require operators to be present during normal operations.

Other controls, such as health surveillance, have also been implemented historically to monitor exposure. In recent years this has diminished, as exposure is controlled and at such a minimum that it is not required to that extent anymore. The regular occupational hygiene monitoring of the work environment also provides valuable data on the adequacy on the control measures in place and the design of the system itself. As a last resort

adequate personal protection, education and qualification to prevent inhalation (in case of spray coating) and skin contact is also made available to operators most importantly maintenance operators.

Waste management in the coil coating process

Metal surface

Generally all process scrap metal can be recycled or reused. The amount of scrap metal produced during the process will largely depend on the width and gauge of the substrate being used, and hence is not normally directly correlated to the paint system being manufactured. Recycling is generally conducted by charging scrap metal, including coated strip, into the basic oxygen steel-making vessel as a raw material. The coating generates energy in return when the steel/aluminium strip is re-melted.

Liquid waste of coating chemicals

The main source of wastewater on the coil coating line arises from the degreasing and degreasing rinsing section and the conventional conversion application and rinsing. Water remediation is used to reach an acceptable standard prior to discharge. Treatment usually requires the pH to be adjusted, reduction of chromium (VI) to chrome (III) and any metal, paint or oil contamination to be removed. As all paint systems require rinsing and quenching, there are no differences in the quantities of wastewater generated for the different paint systems, but there may be slight differences in the actual level/types of contaminants.

In today's world no-rinse systems are the state of the art and used in an increasing number of coil coating lines. Waste produced from no-rinse systems is significantly lower than from spray or dip systems.

End of life – recycling of Steel

Recycling takes place both in integrated steelworks, which make use of process scrap generated by the steel industry and its immediate customers, and in EAF (Electric Arc Furnace) plants, which use mostly market scrap. Coil coated steel is handled in the same recycling route as most of the rest of steel scrap. The paint is combusted in the furnace and the minimal residual chromium (VI) present is converted into the chromium (III) form with the action of the very high temperature (1600 ℃). Therefore, all the potential chromium (VI) present is removed in the recycling process.

Alternatives to chrome (VI) in coil coating

Strontium chromate primers are applied on the metallic strip by roller coating and subsequently cured on convection ovens before the final aesthetic topcoat is applied and cured. The strontium chromate based primers are delivered to the line and any waste primer collected and returned to the paint supplier. There are non-strontium chromate based primers available to the coil coating industry. These are suitable for many applications and markets in Europe, but not for all and certainly not for the most demanding outdoor and indoor building applications. In certain coastal and other industrialised areas having a very corrosive environment there are no substitutes to strontium chromate that would match the performance of chromates in corrosion protection.

Tata Steel Colors as a business are committed to developing Cr-free pre-finished steel products and have had for many years' active research & development programmes to achieve this goal. Throughout the various Tata Steel Colors manufacturing sites, many primers have been Cr-free for several years and where legislation dictates (consumer goods etc) all products are totally Cr-free. It is only for the longer life performing products and sales into harsh environments where the proven product performance is key in providing these long-term guarantees. This long-term performance has been achieved using Cr (VI) based technology and many years (> 10 years) natural weathering and real life buildings to substantiate these claims. The individual product guarantees of up to 30 and 40 years have been independently verified by industry wide bodies such as the British Board of Agreement. The mode and time of failure is relatively well known for Cr (VI) based technology

on buildings in UK and European climates and Tata Steel have extensive experience of the performance of our products throughout the main markets world wide. The earliest Confidex guarantee buildings are approximately 20 years old.

Existing alternatives for coil coating applications

Some alternatives to chromates for conversion coating in the coil coating process do exist. There are technologies such as those based on zinc phosphates and other non-chromate corrosion inhibitors, but these do not provide the benefits of strontium chromate based primers. In recent years, many new chromate free solutions have been developed which may give comparable performance, but this is as-yet unproven in harsh climates and the solutions tend to be more expensive. In our experience and to the best of our knowledge there is still no accelerated corrosion test that would reliably predict the performance of a coating system in real world conditions. Consequently, extensive natural weathering testing is required in order to validate the level of both corrosion protection and paint adhesion of a certain paint system. Moreover, each combination of substrate, pre-treatment, and paint is unique and no universal conclusions can be drawn based on testing of one system. All paint system combinations have to be evaluated in different climates, which can induce different failure mechanisms.

The active research and development programs in the European coil coating industry are pursuing chromium (VI) free primers for the long guarantee products. The chromate free primers are based on zinc phosphate or similar corrosion inhibitor technology. These non-chromate corrosion inhibitors only act as a cathodic inhibitor and lack the mobile ability of the chromium (VI) species to move to an active corrosion site and therefore act as both a cathodic and anodic inhibitor. Not only do chromate species act this way, they provide excellent adhesion between the metallic surface and topcoat paint system, which is stable over a wide range of different environments. In each case there is some commercial experience with these products but not for long-life products where extensive testing programs are mandatory.

The active research & development programs within Tata Steel and our suppliers are pursuing both Cr(VI) free pre-treatments and primers for the long guarantee products. The Cr-free primers tend to be based on phosphate or alternative Cr-free corrosion inhibitor technologies. The Cr-free primers have anti corrosive inhibitors, which typically act as cathodic inhibitors. In each case there is some commercial experience with these products but only for commodity / low performance requirements where there is no need for extensive testing programs. To the best of Tata Steel knowledge no European pre-finished steel is using full Cr(VI) free technology (both pre-treatment and primer) that is equivalent to our long term performing products or full Cr(VI) free products in marine or demanding environments.

Comparative testing

In the standard suite of accelerated tests (1000 hours salt spray, prohesion, humidity, water soak and Kesternich) full chromate free systems can give equivalent performance to chromate containing products. However, the true longevity of performance of these products can only truly be assessed via natural weathering exposures. There is no accelerated test method available that would be able to accurately predict the durability of coil coated metal. It is impossible to predict at what point the bond between the chromate free pre-treatment and primer is hydrolysed leading to adhesion failure or how fast the corrosion inhibitors in the primer will be consumed. The only reliable way of assessing the lifetime performance of coil coated metal is to use it in the targeted environment as long as it is expected to last. Totally chromate free products have been developed for 20 years. Therefore, there is no experience of the performance of chromate free systems for harsh climates for long-term (lifetime of 20-40 years) applications.

An extensive program of natural weathering at the main climatic zones throughout the world has been on-going and supported by fundamental mechanistic research. The objectives of these research and development programs is to design a Cr (VI) free pre-painted metal that can achieve equivalent performance to Cr (VI) products to avoid European producers being at a competitive disadvantage (importers will continue to offer chromate containing products) both within Europe and just as importantly in export markets. As customers will

be able to import coated coil from outside the EU with no REACH obligations whatsoever.

Extensive test programmes to replace chromates in all types of products are on-going, but long-term durability testing has not yet proven the required level of performance in the most demanding applications.

Life Cycle Assessment / Sustainability perspective

The long-life products produced by Tata Steel Colors are expected to give the customer what is needed in terms of a long life of a building, which is protected against corrosion from adverse weather conditions. There has been extensive work carried out internally to assess the best techniques and products that can be made available to make sure this is achieved but also to focus on the life cycle especially the consumer use of the product. End points taken into account focus on the possible negative aspects of lesser performing alternative products such as climate change, energy use, disposal.

For High Performance building markets where the lifetime expectations are up to 40-50 years, chromates are still vital in order to be able to guarantee the desired performance both in terms of corrosion resistance and adhesion of the paint layers. *The longer life cycle time of the strontium chromate based branded products produced by Tata Steel have been shown to have a lesser carbon dioxide footprint compared to lesser performing pre-finshed steel products that require replacing or overpainting after 10 to 20 years of in service performance.* The standard Colorcoat Prisma® colour range which is produced with a strontium chromate based primer has been rigorously tested by the Water Quality Centre and conforms to the requirements of The Water Supply Regulations 1999 and BS 6920:2000. Colorcoat Prisma® has been independently certified in accordance with the Water Regulations Advisory Scheme (WRAS) as being suitable for use in contact with drinking water, as it does not adversely affect the quality of the wholesome (drinking) water.

To put things into perspective if you take the total production of coated coil in Europe (ECCA figures) and use the BRE approach (The Green Guide to Specification 4th edition, IHS BRE Press) for calculating replacement building assuming 10% of coated coil is the long life chrome 6 products these are the results you get when looking at equivalent carbon dioxide. So to re-clad buildings early would result in a possible 535,832 tonnes of carbon dioxide emitted into the atmosphere or to look at it another way, 195,559 equivalent number of extra cars travelling 20,000 km/year each.

New Product Sustainability Assessment tool

Tata Steel in Europe has also developed an internal Sustainability Assessment Tool (SAT) to assess the relative sustainability of New Product Developments (NPD) against the current industry benchmark for that product. The SAT has been produced to assess all NPD in a standardised way and provide a sustainability rating based the strategic priorities of the company and therefore highlight which NPD have the potential to be promoted as sustainable products in the future. The SAT is independent to any of the NPD being assessed as the weightings remain constant throughout and has been internally validated.

The SAT considers seven key sustainability principles, which cover social, economic and environmental issues, namely Climate Change and Energy, Water Consumption, Emissions and Hazardous Substances, Resource Usage and Waste Minimisation, Service Life, Reuse and Recycling, Social and Ethical Value as well as Economics. These principles are assessed over four key life cycle stages Manufacture, Fabrication, Use Phase and End-of-life.

The SAT contains a set of standard questions, which are answered by technical and commercial experts involved with the NPD being assessed with the process facilitated by an expert in sustainability assessments. The questions can only be answered as better, worse or no change and the SAT scores the answers to the questions to reflect the impact on the different sustainability principles and the life cycle stage.

The results of the SAT are displayed both in a matrix format where the relative benefit or impact can be seen for each sustainability principle and life cycle stage and in a single value that classifies the NPD into a level of sustainability which weights the individual matrix cells with the predefined priorities of the company. The highest weighting is applied to climate change benefit or impact in the use phase of a product.

One NPD to be assessed was the use of Cr (VI) free branded Organically Coated Steel (OCS) versus conventional branded OCS using chromium based compounds in pre-treatments, primers and backing coats for use in construction.

From the attached summary of the assessment it can clearly be seen that over the full life cycle the product has the advantage of not requiring the chromate treatment in manufacture. However, the poor durability means a lower quality product, which requires more maintenance and has a shorter life. Life Cycle costs are also poor due to lower selling price and higher maintenance costs. Overall the NPD has a negative sustainability rating, which implies that the NPD is likely to be worse than the existing benchmark. This clearly shows from an overall viewpoint that the new product at this stage is not as good. The diagram overleaf shows the results page indicating the principles that is used in the assessment and provides a clear and informative answer. This results page was of a chrome free standard product vs. the chrome VI equivalent.

The tool is an internal tool that has been made by independent experts and it not bias in any way to the old product range. In fact the tool is generally used to show the benefits of new products over older ones but in the case of chrome it is actually the opposite results.

Product sustainability profile

Sector: Construction

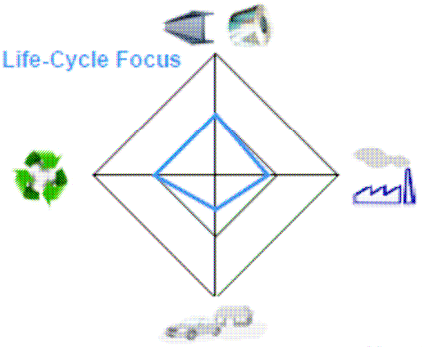
Cr(VI) free branded OCS

Sustainability Score **-21%**

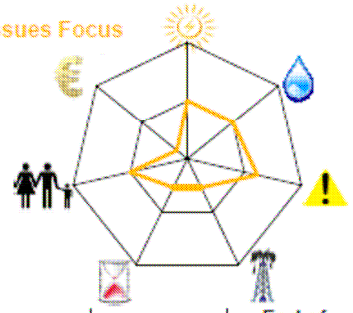
- >30% ECO-PREMIUM — Significant sustainability benefit over baseline
- 5 to 30% — Some sustainability benefit over baseline
- -5 to 5% — Little change in sustainability over baseline
- <-5% — **Lower sustainability than baseline**

Description of product: Cr(VI) free branded OCS
Baseline comparison: Conventional branded OCS using chromium based compounds in pretreatments, primers and backing coats.
Description of advantages & opportunities: Removal of Cr(VI) which will become a restricted substance. Note that this assessment assumes a legislative requirement to offer a Cr free product in 2015/16, which (because of the need for long term testing) will make it unlikely that the business can offer the current 30 and 40 year gurantees on wall and roof products respectively. Similar performance products are forecast to be available by at worst 2020 and the business must manage the market until this point.
Date of Assessment: 7th July 2011 NPD Pipeline: Development Stage (TRL:6.0)
Assessors: Mark Collinson, Nick Coleman, Pete Barker,

Life-Cycle Focus



Issues Focus



	Manufacture	Fabrication	Use Phase	End of Life
Energy & Climate Change				
Water Consumption				
Emissions & Hazardous Substances				
Resource Usage & Waste Minimization				
Service Life, Reuse & Recycling				
Social & Ethical				
Economics				

Expected benefit against baseline
No difference from baseline
Expected deficiency against baseline