Case Study

The Humber Bridge

Alternative coating strategies for maintenance painting

Functional excellence and environmental protection are guiding principles for the European solvents industry. As part of its commitment to environmental care the industry continuously explores opportunities to reduce impacts such as emissions and conserve resources by providing ever more efficient solutions for its customers. One area of focus is VOC reduction as part of Europe's broad commitment to reduce ground-level ozone peaks, a component of summertime smog.

However, the enormous array of applications and processes which rely on solvents means that it is impossible to generalise on how best progress can be made on the VOC agenda. The European Solvents Industry Group (ESIG) is a strong advocate of a flexible approach to VOC reduction. True understanding of the performance requirements, constraints, costs and environmental issues requires the expertise of those who actually operate an individual process. This case study goes some way towards explaining this opinion. It describes work by ESIG and colleagues in the paint making and using industries.

Alternative coating strategies for maintenance painting have been considered. The results reinforce the need to take an integrated view of environmental impact and highlight the complexity of the issues; the most environmentally friendly solution in this example is not a low solvent based system as a simplistic review may lead some to assume.

Background

Life cycle analysis has been used to examine the options for maintaining the Humber Bridge and similar structures. It allows users to consider which paint system - from a growing range including low solvents options - provides the best long-term environmental option.

The 'cradle-to-grave' life cycle assessment (LCA) provides comprehensive data that informs the debate for maintenance painting.

The options assessed are:

Option 1: current solvent based system (or a similar high-solid, compatible system)

Option 2: high-solid system not compatible with existing paint

Option 3: water-based system

Key findings

The best option is to continue with the existing paint system (solvent borne rubber based) which can be over-painted and does not require repainting.

The next best alternative would be a high-solids-solvent-borne system which is not compatible with the existing paint.

Water-based paints would require repainting at five year intervals with complete removal of the current coating and, as such, are the least environmentally favourable option in the case studied.

The study showed that three factors were key in maintaining low environmental impact. They are:

- Coating compatibility with existing system
- Coating durability
- Coating ease of repair

Methodology

Painting methods considered by the study:

- Patching: repairing a small area of damaged paint, working the new paint over the old
- Stripping: total removal of paint
- Repainting: painting the structure after stripping
- Over-coating: painting a whole coat over existing paint to maintain appearance and performance

In order to make a comparison of the options, it is necessary to define what is known as the functional unit.

This must properly express the job being done. In this case, protecting the surface area of the bridge for the next 15 years.

Case Study The Humber Bridge

A 1.0m^2 area of the bridge was selected for the study. It represents the typical surface area combining surface exposed to normal levels of corrosion and including welds and weld coverplates because these have the highest corrosion rate.

Options

A careful life cycle inventory analysis has been done which identifies the areas of concern and the best available options relating to coating strategies for maintenance painting.

Comparing the raw material and energy consumption, the study identified a wide range of emissions for the three options:

Option 1: current system

The Humber Bridge is currently using a low solids high solvent rubber based six-coat system. The key technical advantage of this system is that it allows easy over-painting. This is because solvent content helps the new 'patch' to attach itself onto the old paint. The repairs are done on small areas at a time, on only the areas which need maintenance, with paint being manually removed and repainting done by brush.

Due to weather erosion a new surface coat needs to be applied over the old paint approximately every 12 years. This is done by spray application.

However, the Humber Bridge Board considers the current state of repair to be sufficiently good not to require repainting (of the whole six coats) in the foreseeable future and through patching a small proportion of the structure each year, it can be continuously maintained at a cost of some £100,000 per annum.

A virtually identical environmental profile results from a solvent based high solids paint, provided it is able to patch the existing paint.

Option 2: high-solid system not compatible with existing paint

A high-solid system which can be patched indefinitely but is not compatible with the old paint, and, therefore, requires a one-time full repaint.

Option 3: water-based system not compatible with existing paint

The water-based systems available cannot provide the Humber Bridge Board with the required performance characteristics. However, in light of claims concerning reduced environmental impact, water-based systems have been compared in this study. The adhesion and repainting performance of the water-based system are inferior to solvent-based maintenance systems and would result in a re-paint every five years to guarantee structural integrity. So in the time period of this bridge study (15 years) the bridge would have to be stripped and repainted 3 times if a water-based system was used (obviously a longer time frame would involve further future repaints).

Results

Taking all emissions into account the current system used by the Humber Bridge Board (option 1) is environmentally and economically better than alternatives (options 2, high-solid system, or option 3, water-based system).

This is a consequence of the following key performance factors:

- compatibility: this avoids stripping in order to change paint systems. Stripping involves large grit usage, resulting in loss to the environment
- durability: provides good surface adhesion
- patching: due to a high-solvent content which ensures a good inter-coat adhesion the bridge can be patched successfully providing a repair mechanism with the best environmental profile

Due to these factors (compatibility, durability and patching) only 0.83 kg/m^2 of paint is required with the current paint system, in comparison to 1.7 kg/m^2 for option 2 and 6.6kg/m^2 for Option 3.

Although the current solvent based system (option 1) has the highest VOC paint content 'in the can' it contributes the lowest VOC emissions 'on the job' because less total paint is required.

This result emphasises the significant environmental importance of coating lifetime (durability) and performance which go hand in hand with financial benefits.

Conclusions

The study teaches us that, in this particular case:

- the best option for the environment (option 1) is also the lowest cost option;
- continuing patching with the existing paint, which indefinitely postpones stripping and repainting, leads to much lower emissions not just for VOC but across a wide range of other environmental impacts;
- compatibility, durability and patchability are the key factors in identifying the best maintenance paint system for the environment;
- stripping and repainting the bridge produces a range of environmental burdens.

These conclusions for paint system selection apply not only to the Humber Bridge but also more widely in the maintenance paint sector. Generalising beyond this cannot be done. Other factors and quite different technology options apply in different solvent applications. What is clear, however, is that one needs specialist knowledge on the process and an open mind, to assess complex technical options. The final choice is application specific. Inevitably it must combine performance, quality, cost and environmental concerns. This work reinforces our belief that a flexible approach is required in framing VOC regulations.

For further information on solvents, please visit our website at www.esig.org or contact Pierre de Kettenis, European Solvents Industry Group, CEFIC, Avenue E. Van Nieuwenhuyse 4, bte. 2, B-1160 Brussels. Tel: 32 (0) 2 676 72 64 Fax: 32 (0) 2 676 72 16 e-mail: pdk@cefic.be