Tema: Proteção das Estruturas – Corrosão e Incêndio (com Sustentabilidade)

High Performance Green Coating

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Abstract
Steel fabrication has many types like prefabricated buildings, pre-engineered buildings, general steel structures, offshore structures, vessels, tanks etc.

There are emerging demands for Environmentally-friendly coating systems which has less impact on environment, more safer for users and meet green legislation or building rating systems like LEED.

For many years people believe that waterborne coatings are not as good as solvent born when it comes to application property, corrosion protection and durability. The current waterborne technology has reached high level of quality, ease of application and longer durability in comparison with solvent borne protective coatings.

This paper will highlight the new generation of Green Coatings that meet steel fabricators needs for speed, ease of application and meeting sustainability requirements.

Considering the different steel fabrication process, surface preparation, coating and quality control are a cost driver and time consuming. We will propose few coating technologies which can save time by reducing application time; minimize QC time and faster to dispatch coated steel for erection. Those systems are either complete waterborne or hybrid systems for corrosion protection, fire proofing and aesthetical needs. All proposed coating systems are conforming to major regulation when it comes to Health, safety and Environment. In addition they meet the needs of most commonly used building rating systems like LEED v3 and v4.

Keywords: Coatings; Green Coatings; Fireproofing; LEED; Corrosion Protection; Corrosão; Incêndio; Sustentabilidade

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1 INTRODUCTION

Jotun A/S – Performance Coatings Division decided to develop a new water born complete system that meets Green Building Rating Standards; LEED was selected as the most widely used in the countries where Jotun has factories and sales offices.

Three labs joint efforts to develop full solution to Steel structures Fabrication Industry; Anticorrosive lab, Topcoat Lab and Intumescent Coating lab.

The project started approximately 3 years ago and new products were launched during December 2013 to May 2014.

First product: 2 component waterborne epoxy primer (will name it in this paper 2CWB primer)
Second Product: 2 component HAP’s Free epoxy primer (will name it in this paper 2CSB primer)
Third Product: 1 component acrylic topcoat - LEED compliant (will name it in this paper 1CWB topcoat)
Fourth Product: 1 component waterborne intumescent fire proofing coating - LEED compliant (will name it in this paper 1CWB INTU)

2 MATERIAL AND METHODS

Anticorrosive Lab - Project No. 1: 2C WB primer

Growing demand on environmental-friendly coatings pushes protective coatings towards waterborne formulations. Waterborne coatings have low VOC and less hazard substances. Jotun’s more than 20 years’ experience with anticorrosive waterborne coatings proves that waterborne coatings are as good as solvent borne. As any technology waterborne coatings have benefits and challenges. And as any technology waterborne formulations can be adjusted to meet customer needs.

A recently launched two component (2C WB primer); anticorrosive waterborne epoxy primer/intermediate paint has properties typical for solvent-borne epoxies: good anticorrosive performance, good application properties, excellent adhesion to steel, non-ferric substrates and concrete, visible end of pot life. In addition to that it has VOC below 70 gr/ltr compare to 250 gr/ltr for a conversional solvent borne epoxy primer. It makes the new product a good supplement for a conversional solvent borne epoxy in markets looking for environmental-friendly products with protective properties.

Different combinations of raw materials have been tested in more than 20 formulations. The main focus of raw material screening was on anticorrosion performance of a primer and optimal formulation cost. In the first screening the most expensive formulations have been rejected.

The rest of formulations have been applied by airless spray on Sa2½ steel panels and used for accelerated corrosion tests like: Salt Spray (ISO 7253 and ASTM B117-97), Prohesion (ASTM G85-94), Humidity (BS 3900-part F2).
Anticorrosive Lab - Project No. 2: 2C SB primer

Develop a **2C SB primer**, curing down to 0 C, quick drying/ dry to handle. Reduces the emission of volatile organic compounds (VOC) to a minimum; reduces wastage and volume of paint required; less environmental impact and safer to use High solids primer/intermediate coat for protection of steel and other non-ferrous substrates in urban and industrial atmospheres, coastal areas with low/moderate salinity and where fast dry-to-recoat and/or dry-to-handle times are desired.

Product shall be VOC compliant, HAP’s Free and compatible with intumescent coatings.

Key features:

**Easy application**
Good flow and film formation combined with no sagging ensure wide flexibility for the applicators

**Wide DFT range**
Easy application with good flow and film formation combined with no sagging ensure wide flexibility in application (60 -250 µm DFT); tailored product variants to meet specific customer requirements i.e. zinc phosphate, MIO variants

**Fast drying**
Speeds up the process and improves efficiency for applicators, contractors and steel fabricators; reduces the need for space to dry painted steel structures; reduces the risk of damage during transport/handling; High build; saves application time - saves money Speeding up the production process - a coating system can be completed in a day

Topcoat Lab - Project No. 3: 1 C WB topcoat

The target was to develop a new 1C WB topcoat for use in selected Protective markets. The focus areas were to develop a glossy topcoat to be tinted on the MC Deco tinting machines. The product had to be good regards to application properties and in accordance to LEED requirements.

The topcoat was to be made on WB acrylic technology. The development was based on knowledge and experience from our long existing WB topcoat on the market and from our decorative division colleagues. A screening was done on a range of acrylic resin, and they were tested for critical criteria’s as gloss level, hardness development, color compatibility, appearance by airless spray e.g.

The most promising acrylic resin was then tested and optimized to match the criteria of the product: Application properties, durability, flexibility, appearance, hardness, drying times e.g. The selecting of raw materials was based on: Health profile of the
raw materials, preferably raw materials already registered in our systems and worldwide accessibility and cost.

The WB topcoat is produced in both, Barcelona, Spain and in, Abu Dhabi, UAE. The paint has been sent to several of our regional labs; Dubai, China, Malaysia e.g. for testing.

The WB topcoat has been tested by an external company and passed LEEDv4 requirement regards VOC content and VOC emission. It has passed the low flame spread test, IMO 2010 FTPC and it is also approved to C3 according to ISO 12944.

**Global Intumescent Centre - Project No.4: 1 C WB INTU**

Develop a new 120 minute water borne intumescent coating for the infrastructure market which is both competitive and environment friendly. Conform to Green Seal standard (Formaldehyde, APEO and Phthalate free) and LEED v3 & v4

### 3 RESULTS AND DISCUSSION

**Project No. 1: 2C WB primer**

Coating performance is a sum of formulation design and careful raw material choice. This is truer for waterborne coatings than for any other coatings. Raw materials for waterborne coatings are costly. Economical formulation design requires deep understanding of paint chemistry and extensive knowledge of existing raw materials. It took 4 years of development work and testing to make a final formulation of the 2C WB primer waterborne epoxy primer with balanced properties and formulation cost.

Extensive accelerated corrosion testing according to ISO 12944 proved that this primer combined in waterborne or hybrid systems can be used from C2 to C5 corrosion environments. Salt Spray (ISO 7253 and ASTM B117-97), Prohesion (ASTM G85-94), and Humidity (BS 3900-part F2) test results confirm that the 2C WB primer waterborne epoxy can compete with solvent borne epoxy in anticorrosive performance.

Due to visible end of pot life applicator does not need stopwatch for each tin with mixed paint. Convenient mixing ratio (2:1 by volume) and good workability make it easy to work with.

Low VOC improves quality of the working area due to low solvent smell and less hazard during the application.

Drying time of waterborne coatings is very dependent on the environmental conditions. The fact that low humidity (30-50%RH) and high temperatures (over 30ºC) significantly reduce drying time makes waterborne coatings very attractive for markets with controlled application/drying environment (like steel pre-fabrication and EMI) and
countries with warm climates. However, carefully formulated WG version of this new primer secures good drying speed down to 5°C.

First trial application in Dubai (40%RH, air temperature 45°C, steel temperature on sun site 55°C) confirmed good workability, excellent sag resistance (600 mic WFT) and short drying time of the new 2K waterborne epoxy primer/intermediate. Application has been done by airless spray on 5a2½ steel sheets of size 2x6m and concrete samples of size 50x50cm. Good adhesion between primer and substrate was measured both on steel and concrete. The primer has excellent compatibility with different concrete sealers (WB, SB, and SF).

Second trial application has been performed in China (55%RH, air temperature 18°C, steel temperature 17,5°C). Application has been done on boiler steel pillars (difficult geometry which is not easy to prepare for painting). The product showed excellent robustness to the surface preparation, making smooth film with good adhesion to substrate, excellent sag-resistance and no sign of flush-rust.

Achievement:

- **2C WB primer** epoxy primer/intermediate paint which cures down to 5 °C
- Contains active corrosion protective pigments and flash rusting inhibitors
- Available in standard and WG (cold climate) versions
- Standard for temperatures from 15 °C to 40 °C
- WG for temperatures from 5 °C to 23 °C
- For steel, aluminium, galvanized steel, stainless steel and concrete in atmospheric conditions
- For paint systems with zinc primers and water-borne acrylics, water-borne epoxy and suitable solvent-borne coatings and topcoats

**Corrosion protection**

**ISO 12944 C3, C4 and C5**

Corrosion protection testing

- C3 High : Water condensation 240h / Salt spray* 480h
- C4 High : Water condensation 480h / Salt spray* 720h
- C5 High : Water condensation 720h / Salt spray* 1440h

* Salt spray is not an applicable method for water-borne coatings
Adhesion comparison with older WB epoxy primer:

<table>
<thead>
<tr>
<th>Temperature</th>
<th>2C W</th>
<th>Old generation WB Primer</th>
</tr>
</thead>
<tbody>
<tr>
<td>40°C/70%RH</td>
<td>8,9</td>
<td>9,7</td>
</tr>
<tr>
<td>23°C/50%RH</td>
<td>9,8</td>
<td>11,6</td>
</tr>
<tr>
<td>10°C/80%RH</td>
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<td>7,9</td>
</tr>
<tr>
<td>5°C/85%RH</td>
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Flexibility - Conical mandrel

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Trail production / application
China:
Qatar application:

Project No. 2: 2C SB primer

Tests (lab and field): Low temp cure, application at low temp, recoating, VS% test, corrosion tests, condensation tests, abrasion, flexibility, adhesion on various substrates with various topcoats, adhesion of intumescent, fire tests etc.

The result is a versatile product meets all wanted features; easy to use providing protection to steel and other substrates in urban and industrial atmospheres, coastal areas with low/moderate salinity and where fast dry-to-recoat and/or dry-to-handle times are desired

Project No. 3; 1 C WB Topcoat:

ISO 12944: Test of paint system according to C3, Salt Spray Test and Condensation test.
**Dirt Pick up resistance:** The panels are exposed to carbon black slurry for testing of dirt pick up resistance of a paint film.

**Colour compatibility:** Selected MC tinters and critical colors are tested in all bases for colour compatibility.

Base White

Base 3 (Neutral)
**Application site: Customer in Norway.**  
- 2C WB Primer (100µ)  
- 1C WB Topcopat (50µ)

| Excellent coverage and application properties with airless spray and brush. | Fast drying and low odor. Nice edges when tape is removed while drying. | Very good sag-resistance. Application in too high WFTs may result in shrinking (e.g. >2 X max WFT). |

**Application site: Customer in China.**  
- 2C WB Primer (100µ)  
- 1C WB Topcopat (50µ)

| Excellent flow and coverage when applied with airless spray. Dries fast and has low odour. | Excellent levelling and coverage when applied with brush. | Two coats needed for full coverage when applied with roller. |
Global Intumescent Centre - Project No. 4: 1 C WB INTU

Tested to BS 476 (British Standard).

First part of the extensive testing was carried out internally with over 40 sections fire tested when an acceptable formulation was established. This program was devised to give us the best possible outlook on how to test externally, as testing can be the most difficult part of the product development process. The second part of the test was conducted externally with over 80 sections including 3 loaded beams, 4 tall columns, 1 loaded column and 6 cell beams. Over 1500 liters of paint was sprayed to achieve the thicknesses required.

The results obtained on these tests were very good, reaching up to 30% better loadings than the major global competitor at the 120 minutes target area. The product can also cover all time periods with some protection for up to 180 minutes on certain section sizes.

The direction of the global market is towards the use of materials with minimal environmental impact, this green product complying with LEED’s requirement for low VOC at only 24g/L.

Further testing in the future will be carried out on UL263 (USA and Canada), EN13381 (Europe) and BS476 for a full 3 hour range. There will also be testing carried out on GB14907 (China) and GOHST (Russia).

4 CONCLUSIONS

Jotun has completed a full New Generation of High Performance Green Coatings range for Steel fabricators; the system is FAST, Safe and Saving costs. The system provides anticorrosion, colourful topcoat and fire proofing for up to 3 hours if needed.

Thanks

Project No. 1: 2C SB primer: Thanks to Ms. Tatyana Strenalyuk
Project No. 2: 2C SB primer: Thanks to Mr. Victor Mascarenhas
Project No. 3: 1 C WB Topcoat: Thanks to Ms. Heidi Guren
Project No. 4: 1 C WB INTU: Thanks to Mr. Brett Bullough
REFERENCES (BIBLIOGRAPHY)

Ms. Tatyana Strenalyuk
PhD degree in chemistry from University of Oslo; work in Jotun R&D since July 2009; now R&D Senior Chemist Primer.

Mr. Victor Mascarenhas
He is Chemist work as Laboratory Manager - Protective coatings; Regional R&D Lab ME located in Dubai with 26 years of R&D experience.

Ms. Heidi Guren
She is Norwegian; here academic background is Senior R&D Chemist, MSc in Chemistry from NTNU in Trondheim - Trondheim- Norway, 2005; Started working in Jotun AS in 2007 and have worked since in the Topcoat group stated in Sandefjord, Norway.

Mr. Brett Bullough
Sr R&D Intumescent Chemist, Jotun UAE, Dubai.
Worked in fire protection for 16 years the last 2 being for Jotun