

NEW COATINGS TECHNOLOGY

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ABSTRACT

The continual process of research and development into coatings raw materials is giving formulators better options to meet the needs of a time and cost driven construction industry; whilst at the same time also improving the application, durability and aesthetic qualities of the latest generation of coatings and systems.

Proprietary formulations using these improved raw materials allow for rapid recoat times even in the cold winter climates, with some formulations allowing topcoating in 2 hours at 2°C. Local formulations of finish coats deliver the best colour and gloss retention in New Zealand's harsh UV environment. Costs are maintained or improved through the use of high solids formulations which have better (higher) spreading rates.

Introduction

Contracting timeline pressures require that projects are finished faster but still within budget. Coatings applicators are under increased pressure to deliver their work within these new timelines. The Christchurch rebuild requires this even in the depths of winter. Coatings formulators and manufacturers need to meet the practical requirements of the construction market. New coatings technology is able to deliver fast-cure, high-performance (as well as decorative systems) in cold atmospheric climates.

The majority of coating science involves the continuous improvement of existing raw material technology as well as the use of them in proprietary formulations. The basic categories of the raw materials used in coatings include resins (plus converter in the case of 2-pack products) solvents, pigments, additives and extenders.

Epoxy

Background

There have till the recent past been four main epoxy resin / binder types used:

- Polyamide cured epoxy
- Polyamine cured epoxy
- Phenolic cured epoxy
- Novolac cured epoxy.

Polyamide cured epoxies are normally the most economic (\$/m²) with the least chemical resistance of the four binder / resin types, whilst novolac cured epoxies are the most expensive (\$/m²) but the most chemical resistant.

Phenalkamine Technology

The new generic epoxy type is known as phenalkamine cured epoxy. It is positioned in between polyamide

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cured epoxies and polyamine cured epoxies in terms of cost (\$/m²) and chemical resistance. Phenalkamine curing agents are based on cashew nutshell liquid (CSNL) which is a reddish brown viscous liquid extracted from a soft honeycomb structure inside the cashew nutshell. Cardinal is then extracted from the CSNL via decarboxylate and distillation processes, and forms the primary building block for phenalkamine curing agents (www.cardolite.com).

As cardinal is a derivative of the CSNL, it forms what can be termed 'green technology' as it is natural, is not part of the food chain, and is an annually renewable resource. The key advantages of phenalkamine cured epoxies include:

- Low temperature cure (in some cases as low as minus 18°C)
- Good chemical resistance
- Rapid cure
- Highly hydrophobic, giving excellent moisture tolerance during application
- Excellent early water and salt water immersion resistance
- Good surface tolerance and adhesion
- Resistance to amine blooming

Using the properties of the phenalkamine curing agents, different types of epoxies can be formulated with unique and specific features. Two examples of proprietary formulated phenalkamine epoxies include:

Epoxy A

- Low temperature cure down to -7°C
- Excellent surface tolerance and adhesion
- Moisture tolerance during application – humidity up to 95%
- Immersion in water and salt water one hour after application (at 25°C)
- Dry film thickness (DFT) range – 150 to 500µm

The key design drivers for this epoxy are surface tolerance and adhesion, moisture tolerance and high build. This produces a product that is ideally suited to maintenance situations where the surface preparation and the environment is less than ideal.

Epoxy B

- Low temperature cure down to -7°C
- Rapid low temperature cure – topcoat in 2 hours at 2°C
- Extended recoat window – up to six months with an epoxy
- Low stressing epoxy
- Dry film thickness (DFT) range – 100 to 150µm

The key drivers for Epoxy B are rapid cure even in cold temperatures, extended recoat times and a low stressing film. As a result of the speed of cure and the need for the solvent to be able to get out of the film, design DFT's are limited to between 100µm to 150µm. This technology lends itself to high producing blast and paint shops.

Ultra-Violet Resistant Coatings

Background

New Zealand has uniquely high levels of UV exposure due to the ozone hole over the country and very clean atmosphere. This requires local proprietary coatings formulations using high quality raw materials to deliver optimum colour and gloss retention. There are three primary lines of defense against UV attack – the resin system, using UV resistant tinters and UV resistant absorbent additives.

There are there are three main generic classes of UV resistant coatings used in the heavy-duty, high-performance coatings industry.

Isocyanate-free coatings

Catalysed Acrylics

The formulation of catalysed acrylics is strongly acrylic with the actual binder or resin more UV transparent than polyurethane coatings (PUR). As a result the pigment is exposed to more UV degradation and colour shift occurs more readily. The [performance of catalysed acrylics varies](#) significantly depending on the [proprietary](#) formulation and raw [material](#) used, but it is generally recognised that the UV resistance of these coatings is not equal to that of PUR coatings.

Polysiloxane

It is not the intention of this paper to discuss the performance of this technology except to say that it is still under significant development with some very mixed results. UV resistance of polysiloxane coatings is generally accepted as not yet equal to that of the top quality PUR coatings although better than that of catalysed acrylics.

Isocyanate catalysed coatings

Polyurethane

Polyurethane polymers are formed by reacting an isocyanate containing two or more isocyanate groups per molecule with a polyol containing an average of two or more hydroxyl groups per molecule in the presence of a catalyst. Polyurethanes can be [split](#) into two generic classes:

- [Aromatic](#) (Toluene Diisocyanate – TDI) which has the lower chemical resistance and lowest UV resistance and are therefore not used much in coatings .
- Aliphatic (Hexamethalene Diisocyanate – HDI) which has the best weathering resistance (including UV resistance) and chemical [resistance](#). As a result aliphatic polyurethanes are used in heavy-duty, high-[performance coatings](#).

Gloss Retention Testing

Local New Zealand formulations for UV resistant coatings have produced some excellent results with regards to gloss retention when compared to industry recognised brands that have been formulated for the northern hemisphere environment. Aside from extensive atmospheric exposure testing, [empirical](#) data has also been obtained through accelerated testing in QUV Accelerated Testing Cabinets, with panels being exposed to QUV-A light. Gloss retention testing is undertaken using a gloss meter which fires white light at the surface and records the scatter of the reflected light, measured in gloss units (ASTM D4587-11; AS 3894.8-2002). The results recorded below were for light fired at an angle of 60° to the surface being tested.

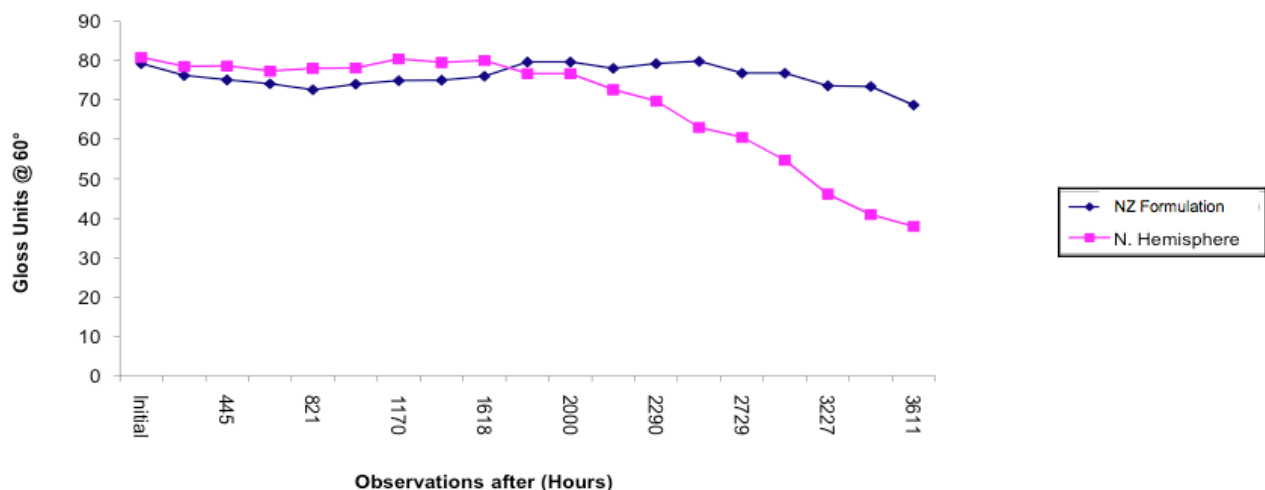


Figure 1. Catalysed Acrylic: QUV-A exposure, NZ formulation versus northern hemisphere product ([Altex Coatings Limited, 2012](#)).

[Noticeable](#) difference in gloss levels of the two catalysed acrylic coatings were recorded after approximately 1800 hours exposure. After approx 3600 hours the difference between the two coatings was so significant (almost 35 gloss units) that the exposure trial was terminated. The northern hemisphere catalysed acrylic had

a gloss loss of approx 40 gloss units or 50%. The New Zealand formulation was little change with a gloss loss of only 5 gloss units or 6%.

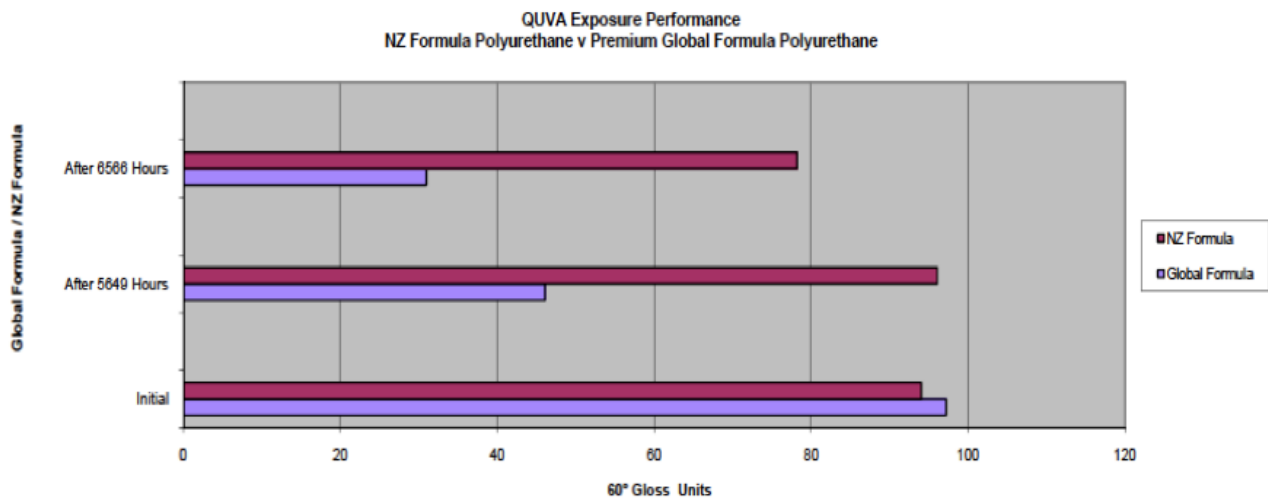


Figure 2. Polyurethane: QUV-A exposure, NZ formulation versus northern hemisphere product ([Altex Coatings Limited, 2012](#)).

Polyurethane coatings have a higher UV resistance than catalysed acrylics, therefore the QUV-A exposure time was longer (6566 hours). In the above exposure chart only three measurements were taken. However after 5649 hours the northern hemisphere polyurethane had experienced an approximately 50% gloss loss or what can be termed a catastrophic failure. At this point the New Zealand formulation had shown no appreciable change. The exposure trial was terminated after 6566 hours when finally a change in the New Zealand formulation was recorded (approximately 17 gloss units / 18% loss). At this stage the Northern Hemisphere polyurethane was at a point where it was a total failure with respect to gloss retention (66 gloss units / 67% loss).

System Time Charts

The overcoating time advantages of the new coatings [technology](#), is best understood and appreciated when compared to existing traditional products. To facilitate this, two [comparative](#) tables have been constructed using the systems [conforming](#) with PUR4 or PUR5 (AS/NZS 2312:2002).

Product	2°C	10°C	24°C
Inorganic zinc silicate (CO1)	56 hours	36 hours	20 hours
Polyamide epoxy (C13)	N/A	12 hours	4 hours
Polyurethane (C26)	50 hours	10 hours	4¼ hours
TOTAL TIME	N/A	86 hours	28¼ hours

Table 1. Standard coatings technology (AS/NZS 2312:2002)

Inorganic zinc silicate (IOS) primers are the best performing zinc in terms of corrosion resistance, but have significant overcoating challenges including speed of cure. IOS technology requires moisture to during the cure process, and therefore premature [overcoating](#) of IOS films will result in a partially cured film and a risk of premature failure of the system. Polyamide cured epoxy (C13) as referenced in the document AS/NZS 2312:2002 require a separate low-temperature convertor in temperatures below 10°C. These convertors have a high propensity to amine bloom which if undetected, can result in topcoat delamination. The polyurethane referenced in Table 1 (C26) above is designed to have a long wet window so as to have superior lay down properties resulting in a high gloss finish. Curing times are therefore extended.

Product	2°C	10°C	24°C
Epoxy zinc (CO2)	6 hours	2 hours	1½ hours
Phenalkamine epoxy (Epoxy B)	2 hours	1½ hours	¾ hours
Acrylic polyurethane (C26)	25 hours	2½ hours	2 hours
TOTAL TIME	33 hours	6 hours	4¼ hours

Table 2. Time saving new generation coatings technology (AS/NZS 2312:2002)

The use of epoxy based zinc primers has significantly changed the overcoating time of these primers. Phenalkamine cured epoxies like Epoxy B as [referred](#) to above, have excellent recoat times even at low temperatures and when combined with a fast curing acrylic polyurethane, can achieve some excellent production rates even in the middle of a South Island winter.

Caution

In an endeavour to speed up production, sufficient time must still be provided for the contractor to complete adequate and appropriate QC checks, and any necessary repairs. Third party inspection is recommended for critical performance areas.

Conclusion

New raw materials for coatings give formulators more options in order to develop practical, user-friendly coatings that can be applied even in the cold temperatures of the New Zealand winter. Acceptable production rates in winter can be maintained with the careful selection of appropriate products, whilst maintaining the performance requirements in the demanding atmospheric conditions of New Zealand. Extended colour and gloss retention can be achieved using proprietary formulations that have been designed to resist the higher UV exposure experienced in New Zealand.

References

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