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Technical Article

Oxazolidines: A useful aid to solving polyurethane formulation problems

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Introduction

Today's polyurethane formulators face a number of hurdles when trying to achieve the desired film properties and appearance for their systems. Whether the target is a high gloss finish for a VOC-compliant coating, a fast curing adhesive or a strong, flexible defect-free sealant, the issues facing PU formulators when attempting to develop new technologies include:

- Retaining and improving performance cure and physical properties of PU systems
- Meeting legislation demands such as volatile organic component (VOC) reduction
- Reducing toxicity by decreasing isocyanate concentration

One of the biggest issues is the ongoing battle to deal with the presence of moisture often attracted through hydroscopic polyols and solvents or present in pigments, fillers and plasticisers. The reaction of moisture with isocyanate can seriously compromise performance (such as film strength) and appearance properties through the generation of carbon dioxide.

Oxazolidine technology, available in the Incozol® range of products supplied by Incorez, offers an alternative low toxicity solution to formulators of both one and two-component polyurethane systems in overcoming moisture related formulation issues. All oxazolidine products are triggered by the reaction with moisture and it is their preferential reaction that helps the formulator limit the moisture-isocyanate reaction problem. Oxazolidine products can be used in aliphatic and TDI based prepolymers, and a number of grades can be used in MDI systems. However, oxazolidine products offer additional benefits other than simply inhibiting the reaction with moisture, some of which are described below in more detail.

Improvements in performance properties

Formulators of sealants, adhesives and high build elastomeric coatings are always striving to improve performance properties. Traditionally, polyurethane systems incorporate a high level of isocyanate to expedite the cure at an effective rate, often with the incorporation of toxic catalysts such as lead, mercury and more recently tin types. Oxazolidine technology however, offers a number of routes forward. For example, high solids one-component systems can incorporate oxazolidines in a number of ways. The presence of an oxazolidine not only reduces the problems associated with CO_2 generation and subsequent gassing, but enables PU manufacturers to reduce the level of isocyanate present in the formulation. This is achieved by mixing the oxazolidine, initially latent in the formulation, with the formulation components to yield in-can stability. On application, and subsequent exposure to moisture, the oxazolidine-moisture reaction yields amino alcohol functionality which can affect a through cure at much lower isocyanate concentrations, by a so-called 'moisture-triggering' route. The 'moisture-trigger' approach allows formulators to reduce prepolymer isocyanate contents from typically 10-15% to much lower toxicity levels of 2-5% total isocyanate.

Incozol 4 and Incozol EH are examples of oxazolidine products from Incorez that can help formulators achieve this aim with their selection based on property requirements. Furthermore, the oxazolidine latent curing agent imparts an increased level of crosslinking through its 4 functionality (2 secondary amine and 2 primary hydroxyl groups). This helps formulators improve cure rate and impart additional tensile strength to the coating, adhesive or sealant. Other routes are also available to formulators through the use of oxazolidines. The reaction of a hydroxyl-functional oxazolidine such as Incozol 3 enables PU formulators to partially end-cap the isocyanate groups in the prepolymer to further reduce isocyanate content. This approach also helps to impart other benefits such as early tensile strength development through latent in-situ crosslinking on exposure to moisture.

Reducing VOC in polyurethane formulations

Continuing legislative pressure is forcing polyurethane formulators to find ways of significantly reducing the amount of solvent used in product design to make them more environmentally friendly. Low viscosity oxazolidine reactive diluents such as Incozol LV, allow the design of 2K PU high solid systems, with the added benefit of eliminating gassing. Incozol LV is a 4 functional bis-oxazolidine curing agent that significantly reduces hydrogen bonding through its carbonato-link and has a low viscosity of 50cps, allowing formulators to very effectively reduce the viscosity of the product mixture. Therefore, it allows formulators to continue to use the same application tools, eliminating the need to retrain operators or dispose of the contaminated waste associated with using alternative water-based products.

Improving film appearance

The addition of an oxazolidine also has the ability to improve coating appearance. The elimination of carbon dioxide pinholes from coatings, which occur as a result of the moisture-isocyanate reaction, by the preferential reaction of a moisture scavenger such as Incozol 2, provides further significant benefits for the formulator.

Pinhole defects can yield problems such as downglossing or more significantly can compromise the film integrity leading to weaknesses such as loss of film strength or ease of attack by chemical reagent.

Main applications

Oxazolidine technology has been adopted in a wide array of polyurethane coating, sealant and adhesive applications.

The polyurethane coatings sector has adopted this technology for use in two component, high solids systems for applications in the automotive, marine, wind turbine and aerospace sectors. The use in one component polyurethane coatings is focused on the industrial maintenance sector.

Oxazolidines are widely used in one component aliphatic and aromatic polyurethane cartridge sealants. These high performance elastomeric polyurethane sealants require no mixing and typically no priming to adhere to many substrates, including concrete and masonry.

There is a growing interest in the use of oxazolidines in the production of one component reactive hot melt adhesives, where they accelerate the cure rate, improve the green strength and improve cross link density





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