EPOXY RESINS

epigen
Performance Resins & Composite Systems

TECHNICAL BULLETIN

INTRODUCTION

This document is presented to inform potential users of some of the basic properties and application possibilities of the group of polymers universally known as epoxy resins.

1. EPOXY RESINS – DEFINITION

Epoxy resins, also known as epoxide resins, are a class of polymers, containing reactive groups which are converted to thermoset resins by reaction with compounds known as curing agents. It is the choice of curing agent which generally exerts the most influence on the final properties of the cured product. The term “epoxy resin” is used throughout this bulletin to represent the full epoxy system.

2. HISTORY

The first epoxide resins were synthesised in 1930 from work in Switzerland/U.S.A. Commercial production commenced in the late 1940’s and by the 70’s over twenty five types of resins were available, all carrying the generic term of “epoxy resin” and current production internationally exceeds hundred of thousands of tonnes.

3. THE ROLE OF THE EPOXY FORMULATOR

The physical properties of most raw epoxy resins and curing agents make them unsuitable for application by the end-user for reasons such as inadequate control of viscosity, pot-life, hiding power or pigmentation, and practical mixing ratios. The role of Peerless Industrial Systems is to convert the raw materials into useable products, having regard for the desired physical, chemical and mechanical properties necessary to meet particular applications.

4. FORMULATION VARIABLES

Apart from the essential components of resin and curing agent, virtually every epoxy resin based product requires addition of one of more of a variety of other materials to aid application or performance.

Examples of such “additives” are:-

(a) Solvents - commonly used in paint coatings to facilitate application of the product.

(b) Fillers - often used to reduce the cost of the saleable product but also to control viscosity; increasing hiding power; impart specific properties, such as heat conductance or abrasion resistance and to increase the degree of mechanical strength as in the case of fibreglass or carbon fibre reinforcement.

(c) Flexibilisers & Diluents - used mainly to reduce viscosity and to impart an additional amount of flexibility or resilience to the cured product.

(d) Accelerators - used to govern the speed of cure since certain otherwise desirable curing agents will not cure successfully below a minimum temperature.

Despite the modifying effect of these additives, the resin/curing agent combinaton holds the greatest influence over a products fundamental properties such as heat & chemical resistance, pot life, mechanical properties, and adhesive characteristics.

5. DEFINITION OF COMMON TERMS

The reaction of an epoxide resin & curing agent is accompanied by the evolution of heat and this heat provides additional energy, increasing the speed of the reaction which in turn generates more heat and so a chain reaction takes place. The speed of cure of most systems is therefore governed by the amount of energy input and this in turn is dependant upon a number of factors.

(a) Curing Agent Type - some curing agents react faster than others and some require an accelerator to cure satisfactorily at temperatures below 10?C. Others will not cure properly below 100?C.

(b) Mass - the reaction time is dependant upon mass, the larger the mass the shorter the reaction time.

(c) Ambient Temperatures - very important factor since the higher the initial energy input, the faster the reaction. It may therefore be necessary to warm or cool a particular product depending upon the ambient temperature and the desired work or cure time.

Common terms in relation to epoxy resins:-

(a) Pot Life - the time available after mixing of the product before it attains an unusable form. In practice this usually relates to a viscosity change. For example, a low viscosity grouting compound might still be liquid in the container after 30 minutes, but will not be liquid enough to pour down a bolt hole with 5mm clearance and successfully penetrate the full depth. “Pot life” should therefore be viewed as the maximum time available from time of mixing to successful application. As mentioned earlier, this is dependant upon the mass of material and the temperature of the product and that of the surrounding environment.

(b) Tack Free Time - is the point at which the product has been converted from a liquid to a solid and is often of importance when surface coatings are being applied. At the point of being “tack free”, the product will possess only a portion of it’s ultimate properties but, in the case of surface coatings, be hard enough for a further coat, if necessary, to be applied.

(c) Full Cure - the point at which the product attains ultimate mechanical properties. This is normally taken as being 7 days, although many epoxy systems attain 60-75% of their ultimate properties within 24 hours. In applications such as concrete construction and repair, engine mounting, concrete topping etc., the degree of strength developed within 24 hours is more than adequate for the application. However, in the case of protective coatings, particularly in a hostile environment and/or elevated temperatures the attainment of maximum properties can have a critical bearing upon the successful outcome of the application.

(d) Exotherm - the amount of heat generated during curing.

(e) Thixotropy - In practical terms, the "non-sag" properties of a material. A product does not have to be "thick" or "stiff" to be non-sag, in fact, often a "thick" product when applied to a vertical surface will exhibit drainage of resin prior to curing. The true "thixotropic" product should be reasonably easy to mix, be of a "gel-like" consistency and be able to be applied on a vertical surface without sagging or exhibiting resin drainage.

6. GENERAL PROPERTIES OF EPOXY RESIN BASED SYSTEMS

Properly cured epoxy resins exhibit a number of highly desirable properties, probably unequalled in any other single class of polymer and these properties are responsible for the versatility of epoxies and for the diverse applications in which they have been successfully used. These properties can be summarised as follows:-

* Outstanding chemical resistance
* Low shrinkage or curing
* Excellent adhesion to a many substrates
* High mechanical strength
* Good electrical insulating properties

A simple, standard, unfilled, epoxy/curing agent system would possess the following typical properties, after seven days curing.

*	Flexural Strength (KPa)	87,560
*	Compressive Strength (KPa)	85,500
*	Tensile Strength (KPa)	38,610
*	Elongation at Break (%)	2.0

Like all materials, epoxy resins possess some undesirable properties, the main one being poor surface resistance to weathering. Epoxy will tend to yellow, lose gloss and "chalk" on prolonged outdoor exposure and for this reason, is seldom used for decorative external coatings. It should be emphasised that this is a surface effect only and the surface chalk acts as a protective barrier, rather like the oxide coating on aluminium surfaces. Thus products such as protective coatings, grouts, adhesives, although they may discolour, should not be expected to lose integrity and functionality.

7. VERSATILITY OF EPOXIES

Epoxies are amongst the most versatile of the plastics and this can be illustrated by the following examples:-

(a) Viscosity - This can be adjusted to lie anywhere between a very low viscosity (similar to a light gear oil) and a stiff, trowellable mortar.

(b) Cure time – From a couple of hours to 48 hours. Epoxies are also available which cure within 5 minutes, however, these are of limited value in industrial applications.

(c) Temperature Resistant – Satisfactory performance can be expected in the range 80?C - 250?C, depending upon the system employed. However, systems able to withstand continuos exposure to temperatures in excess of 80?C, generally require some degree of heat curing.

(d) Chemical Resistance – Most epoxies are resistant to a wide range of chemicals and products can be developed which are resistant to specific chemical environments.

8. THE RELEVANCE OF EPOXY RESINS TO INDUSTRY

The main application areas become apparent, these are:-

1. Concrete protection and repair.
2. Steel protection and repair.
3. Plant reclamation and repair.

Peerless Industrial Systems has attempted to learn more about the problems within the industry in order to present a range of products that will perform satisfactorily. In pursuing this course, it is apparent that in certain areas, new product development is necessary and this will always require liaison with the industry to be of maximum benefit.

EPIGEN **PRODUCTS**

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