Low styrene emission and low styrene content resins

This information bulletin takes a look at the use of resins and gelcoats modified to minimize styrene emissions during application.

The LSE (Low Styrene Emission) and LSC (Low Styrene Content) resins do not suppress emissions entirely but allow work to progress in safer conditions for the health of workers on difficult tasks like open mould lamination.

Controlling emissions at workplace is fundamentally important for the safety of operators using unsaturated polyester or vinyl ester resins.

Minimizing the emission of harmful vapours, like that of monomer styrene, combined with efficient, collective and/or personal protection equipement improves workshop safety in terms of industrial hygiene.

Exposure control also involves the implementing of suitable working practices and effective preventive maintenance to maintain the performance of the industrial equipment and its operating capability in perfect working condition.

The difference between hazards and risks or "Is working with hazardous substances to be feared?"

Every reactive chemical substance (unlike most inert substances) has intrinsic properties which by definition, cannot be modified because they are linked directly to their reactive nature. Some of these properties represent hazards that is, they have an accident-generating potential.

Nevertheless, working with hazardous substances is a low risk if exposure is controlled.

The risk is the combined effect of 2 components: the hazard (present in a varying degree) and the exposure probability (also varying according to the implemented prevention and protection means).

When hazard is high, the only way of working with a low risk is to reduce exposure to a very low level:

Risk (R) = Hazard (H) x Exposure Probability (P)

=> when P moves towards 0, R also moves towards 0

Professionals who work with UPR/VER (Unsaturated Polyester Resin / Vinyl Ester resins) are exposed only to a very low risk because they use suitable prevention and protection means to control exposure to the substances they use.

The styrene consortium, in its REACH record publication, suggests a DNEL (Derived No Effect Level) of 20 ppm for long-term operator inhalation exposure (working shifts averaging 8 hours in length). Implemented by the REACH regulation, DNEL is the calculated exposure threshold below which there is no adverse effect to be expected and accordingly, the concentration to above which nobody should be exposed. It is probable that eventually, the DNEL thresholds will be used as a basis for harmonizing the European OELs (Occupational Exposure Limits).
In the EU, styrene OELs now fall between 20 and 100 ppm, depending on the member state. Adjusting the installations to meet the recommended DNEL of 20 ppm may involve investments, and take some time to implement.

The CEFIC Guides (see http://www.upresins.org/safe-handing-guides) supply relevant information about the safe handling of resins, the operating conditions, measures to control risks and the various ways of keeping exposure under control (ventilation of the workplace, good safety practices, personal protective equipment, use of innovative products like LSE and LSC referred to in this document).

Dynamic and static emission

The emission of styrene during the processing of UP/VE resins takes place in two stages: the dynamic phase and the static phase.
During the dynamic phase the resin or gelcoat is sprayed or brushed onto the mould in successive coats. In this phase the surface of the resin is constantly being refreshed which leads to the highest emission of styrene from the working surface.
As soon as the lay-up work is finished and the moulding is left to cure, the static phase of the process begins, during which the emission level will depend greatly on the quality of the resin used.

Low Styrene Emission (LSE) Resins

LSE resins are produced by adding vapour suppressant additives to the resin formulation.
These additives form a film over the resin surface once the moulding is left to stand.
LSE additives are essentially effective during the static phase of the process, as shown in the following diagram.

Low Styrene Content (LSC) Resins

Another way to reduce the emission of styrene from UP/VE resins is to lower the styrene content of the resin. Over recent years resin producers have achieved a consistent reduction in the styrene content of standard resins or gelcoats without compromising handling or performance.
LSC additives are effective in suppressing emissions during both process phases, dynamic and static.

If vapour suppressants are added to an LSC resin, an LSE/LSC resin is obtained which allows a further lowering of the styrene emission to be achieved.

The diagram on page 2 clearly shows that LSE/LSC resins may reduce the total emission by 30-50%, depending on application process used, and a combination of both technologies may further reduce emissions by 10-20%.

These boat hulls are produced by vacuum infusion with an LSC gelcoat first applied to the open mould.

Alternative monomers?

Styrene is a very efficient, effective and inexpensive cross-linking monomer. Although some reactive monomers alternative to styrene may be found a widespread replacement of styrene by a single alternative is not realistically conceivable due to technical issues. Moreover, the economic impact of such alternatives needs to be assessed on a case by case basis.
Another aspect to take into account is that styrene has a 50-year track record in FRP with well-known toxicological properties, whereas most of the current available alternatives remain to be assessed against our specific user conditions.

Gelcoats

Gelcoats do not contain vapour suppressing additives as this may lead to a reduction of the inter-laminar bond between the gelcoat and the laminate - which would increase the risk of the gelcoat peeling away from the laminate over a period of time.
Hence there are no Low Styrene Emission gelcoats on the market.

However, it is possible to reduce the styrene level in a gelcoat by changing the unsaturated polyester resin base of the gelcoat. Less monomer is then required to achieve the desired liquid properties and acceptable handling characteristics.
These Low Styrene Content gelcoats can also give other benefits such as increased yield and improved yellowing resistance.

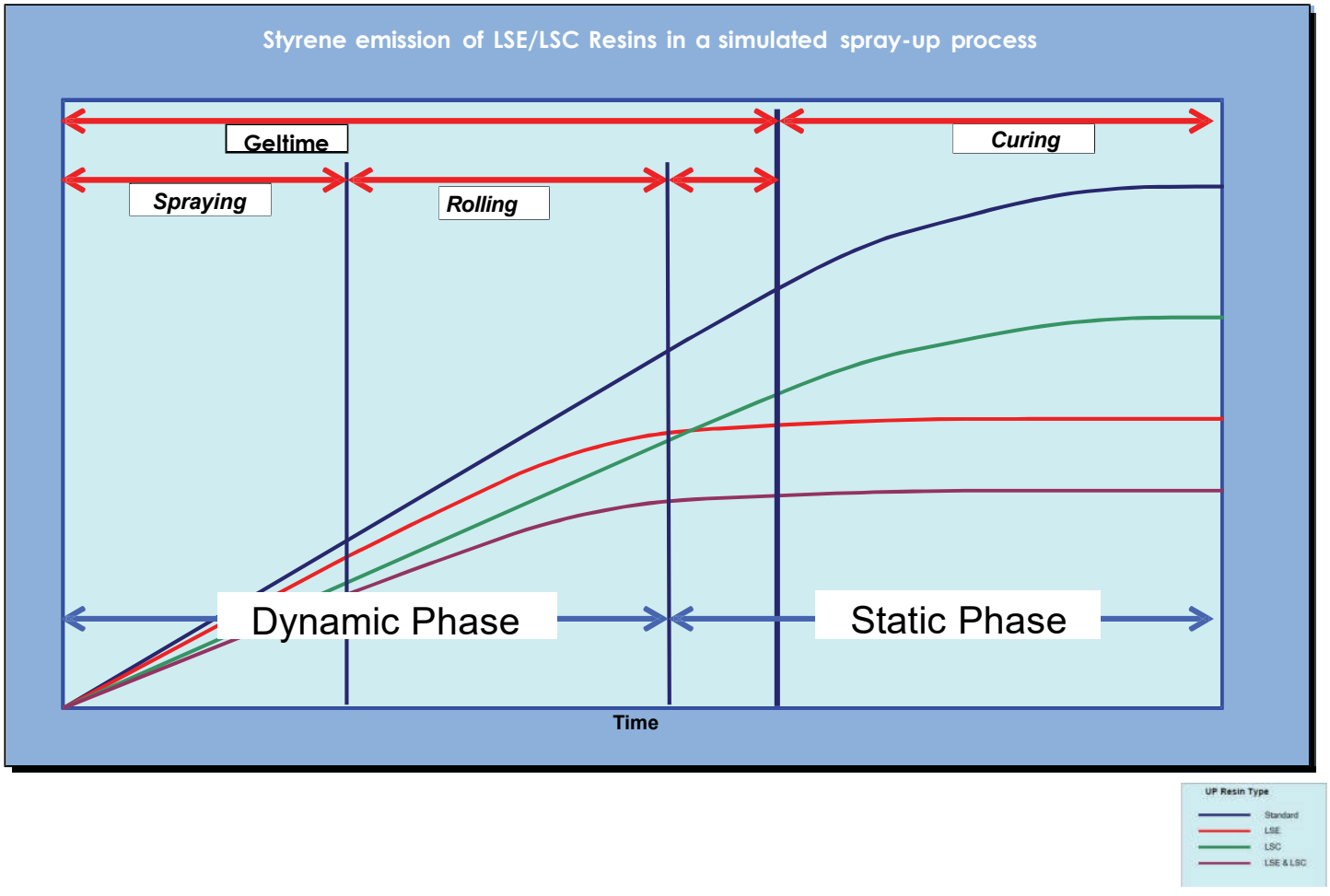
Spray gelcoats contain higher monomer levels and are thus lower in viscosity than their brush equivalents.

The spray process itself and the higher monomer content leads to higher emissions from spray gelcoats compared to brush gelcoats. Optimisation of spray equipment can also help to reduce these levels.

Topcoats

Topcoats are basically gelcoat formulations to which film forming additives have been added. The topcoat is applied as the last layer on a ready and cured laminate to give a resin-rich and tack-free inner surface finish.

Vapour suppressant is added to the topcoat resulting in much lower emissions compared with gelcoat application. Using LSE and LSC resins and gelcoats can therefore play an important part in the overall emission reduction strategies of FRP moulders, especially those working with large open moulds.



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