Binder Matches Phenolic Urethane Performance, Reduces HAPs, VOCs

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New binder offers latent reactivity characteristics comparable to conventional phenolic urethanes, but with significantly reduced odor and hazardous emissions.

A uniquely formulated resin system has been designed to react with specific polyisocyanate co-reactants and amine catalysts. This distinct chemistry provides similar binder performance characteristics as standard phenolic urethane systems without the negative qualities of phenol, formaldehyde, and aromatic solvents. The result is a core and mold binder system that offers comparable latent reactivity characteristics to that of conventional phenolic urethanes, but with significantly reduced odor and hazardous emissions. Emission testing has shown a reduction in total HAPs of over 50% and VOC reductions of almost 60%. While the system is a three-part urethane, it may be used as a suitable replacement for any chemical binder system.

Lovox® resins can be used in any conventional no-bake operation. The two-part system reacts with a third part, a liquid amine catalyst. It can be used in reclaimed sand as well as new sand. Recommended binder levels are 0.8% to 1.5% based on sand weight. The Part 2 resin is an isocyanate formulated to optimize the performance characteristics of the Part 1. The ratio of Part 1 to Part 2 resins is typically 40:60. With the elimination of the phenol, formaldehyde, and aromatic hydrocarbons, resin reactivity is slightly lower than that of a standard phenolic urethane system, but the latent reaction properties typically yield a work time/strip time ratio of around 0.60-0.65:1. Catalyst levels will run from 3 to 12% based on Part 1 weight.

While the low VOC, HAP, and odor properties are significant benefits, the most attractive features of the Lovox binder system are its casting performance. This novel approach to urethane resin chemistry provides superior thermal stability, as compared to other sand binder systems. Reduction in, or elimination of, veining defects without the use of powdered sand additives or core coatings has been demonstrated in numerous ferrous casting applications. In addition, the binder has been shown effective at eliminating certain types of gas defects. Shakeout properties, particularly in aluminum casting applications, are next to difficult. Reductions in shakeout time of over 80% have been demonstrated in some of the most difficult castings.

Performance features — Lovox binders exhibit a variety of benefits in a broad range of casting applications. Excellent casting performance has been seen in virtually all grades of ferrous and nonferrous castings. In iron and steel, the combination of superior thermal stability and high hot strength results in casting finishes that are defect-free and require little time in the cleaning room. Eliminating sand additives such as iron oxide and anti-veining compounds are routine. In some applications, elimination of core coatings has been successful.

In numerous applications, the combination of hot strength and excellent collapsibility yields superb casting finishes while providing unmatched shakeout properties. Thermal reclamation efficiency was measured to be 33% better than a phenolic urethane bonded sand.

Thermal stability — Lovox resins have exceptional thermal stability properties that result in exceptional veining resistance. The photos here show a cored passageway in a gray iron manifold casting. The cored area is 5/8 in. in diameter and it is surrounded by 0.75 in. to 2.5 in. of iron. In general terms, this is a severe application for core expansion properties. Casting A was produced with a phenolic urethane bonded core. The binder level was 1.0% and sand mix included a 5% addition of a commercial anti-veining additive. The core was uncoated. As shown in the photos, despite the addition of the anti-veining compound, a signifcant amount of veining occurred.

Casting B is the same manifold produced with a Lovox bonded core. The binder level was 1.0%, and no anti-veining additive was included in the sand mix. The core was uncoated.

Shakeout properties — The unique chemistry of the Lovox system enhances the thermal decomposition of the binder after the pouring operation. This more thorough burn-out of the resin during
the casting cooling process results in exceptionally effective mold and core shake-out. Figures 1 and 2 illustrate this quality.

Figure 1 shows vertically parted stack molds produced with phenolic urethane at 1.0% total binder in reclaimed sand. Castings are poured with alloyed iron at approximately 2,700°F. This photo was taken one hour after pouring and, as seen, there is little breakdown of the molding sand evident.

Figure 2 shows the same set of stack molds. Except for the outside right mold, these were produced with Lovox at 1.0% total binder in new sand. This photo also was taken one hour after pouring. The difference in collapsibility properties between the two systems is substantial. These shakeout properties are typical and have been demonstrated in a number of core and molding applications. The result from this product feature is less casting time in shake-out processes, reduced disposal of non-reclaimed molds and core butts, potential reduction in reclamation energy costs, and a reduction in the level of core binder introduced into green sand systems.

VOCs and HAPs — As its name suggests, Lovox is a low-VOC chemical binder system. The elimination of phenol, formaldehyde, and aromatic hydrocarbon solvents provides a binder system with virtually no odor at the mixing station. This leads to a much more pleasant working environment in the mold and core room. In addition, VOCs and HAPs at pour-off have been measured at less than half of those emitted from phenolic urethanes. Charts 1 and 2 illustrate the comparative emission profiles of Lovox with phenolic urethane bonded sand. In these tests, samples of each sand were heated to 1,800°F and the emissions were captured and analyzed for various species of gases. Results are expressed as MPTE, which is “maximum potential to emit.” This metric indicates that amount of a particular emission product that would be generated when a given quantity of binder were completely burned off the sand.

Chart 1 illustrates measured quantities of total and major emission compounds detected in phenolic urethane and Lovox-bonded sand. As seen, reduction in total potential emissions is over 70%. The elimination of phenol in the resin has an obvious effect, and benzene emissions are less than half.

Chart 2 shows the comparative quantities of additional species of VOCs/HAPs of interest for foundry operations. These compounds were charted separately due to the significant difference in scale from Chart 1. (DEB is diethylbenzene. TMB is trimethylbenzene.)