

EVOLUTION OF FOUNDRY SHELL SAND FOR TODAY'S FOUNDRY



International LLC

Member of H&A Group

MITCH PATTERSON Product Manager
Resin Coated Sand & Refractory Coating
HA INTERNATIONAL

ARTICLE TAKEAWAYS:

- Comparison of Conventional, first generation low emission, & second generation low emission sand grades
- Handling high humidity conditions

The Shell Sand process or “Croning” process was invented by Dr. Johannes Croning in Hamburg, Germany in 1944. This process is the oldest core and mold making technology that utilizes synthetic resins. Although many additional sand core and molding making technologies have since been introduced, the Shell Sand process is still a very effective core and molding process today.

What is Shell Sand?

Shell sand is a dry, pre-coated sand mix that is cured by heat. Sand is coated with a phenolic novolac resin along with a hexamethylene tetramine (hexa) cross-linker and other additives specific to the core or mold making process. The coated sand is a dry, flowable mix that is blown or gravity fed into a hot die. The heat initiates the cross-linker and cures the sand. The die temperature and investment time can be used to control how much sand is cured. Because heat is the catalyst, only an outside thickness is cured. If an open area is present, uncured sand can be emptied from the shape resulting in a sand core “shell.”

Advantages of Shell Sand

- Highest flowability of all chemically bonded systems
- Highest hot strength organic binder system
- Light weight cores and molds, especially for large shell cores
- Low sand to metal ratio
- Cured Cores/Molds are storage stable
- Good dimensional stability
- Resin coated sand is storage stable

Based on the list of advantages and disadvantages, it is easy to see that shell sand is ideal for some applications. One of the key disadvantages is also the area in which Shell Sand has evolved: Emissions

Shell Sand Emissions

The primary source of emissions in shell sand core and mold making is the hexa component. Conventional formulas (HAI branding of Custom Coat) utilize a novolac resin with 12-20% hexa (based on resin) to cure the resin and create a strong core. This type of formula creates emissions of both ammonia and formaldehyde at core making. Although advanced have been made in reducing free phenol in the resins, the hexa remains as the key contributor to emissions.

The first generation of low emissions sand, commercially known as CC E-Series, was developed. The novolac resin portion can be partially substituted by a heat curing phenolic resin. The hexa content can then be reduced as low as 5% based on resin. This is then combined with other emission reducing components. The results? A reduction of 70-80% in ammonia emissions, 80%-90% in formaldehyde emissions, and a large odor reduction!

LATEST RESIN COATED SAND TECHNOLOGY

Large strides have been made in emissions reduction of Shell Sand. However, low emission grades have brought challenges to those using the technology in hot and humid conditions. The first generation of low emission sands are susceptible to sand lumping or clumping in these extreme conditions. Properties are maintained once lumps are broken back into free flowing sand, but these lumps have the potential to clog sand transport systems and create down time. Issues such as these called for a more robust, second generation of low emission shell sand, now branded as EcoFlo. The second generation utilizes hexa lowering technology along with other additives to improve flowability under hot and humid conditions.

PERFORMANCE COMPARISON

Conventional, first generation low emission, and second generation low emission sand grades were compared using identical sand, resin type, and resin content. Melt Point and Hot Tensile Strength properties were compiled to compare core making properties, Table 1. Melt Point is a gauge of reactivity and how quickly the resin coated sand mix will cure. Custom Coat and E-Series grades are very similar while EcoFlo grades exhibit a higher Melt Point. Foundry tests have shown that cure speeds can be maintained with a simple resin modification in the EcoFlo mix. Hot Tensile Strength is a measures of handling strength. A reduction in strength is noted with the low emission grades. In practice, a slight resin addition is applied to maintain the handling strengths. The emission reduction is significant enough that

a lower core making emission profile is still maintained despite increases in resin level. Note EcoFlo exhibits strengths higher than E-Series, yet still a reduction in strength vs Custom Coat grades. In a production environment, similar productivity levels can be achieved with each of these resin coated sand technologies.

Table 1. Modifications of Custom Coat 80-3.25

NAME	CUSTOM COAT	E-SERIES	ECOFLO
Melt Point, °F	227	230	238
Hot Tensile Strength, psi	299	223	250

EMISSIONS

The core making emissions were compared for the three different technologies. In the testing, air samples were taken from directly from above a core box during a standardized core making cycle. Figures 1 and 2 display the results for ammonia and formaldehyde emissions, respectively. Note the concentrations are dependent on the air movement, exhaust conditions, and core making cycles. Concentrations will differ from each operation; the numbers should be taken as comparative only.

As expected, the E-Series sand grade showed drastic reduction in core making emissions, over 70% in ammonia and over 90% reduction in formaldehyde. The EcoFlo sand grade mimicked the ammonia emissions with over 70% reduction. Formaldehyde emission reduction was not as significant as E-Series but still resulted in around a 70% reduction vs Custom Coat grades. *Continued on page 18*

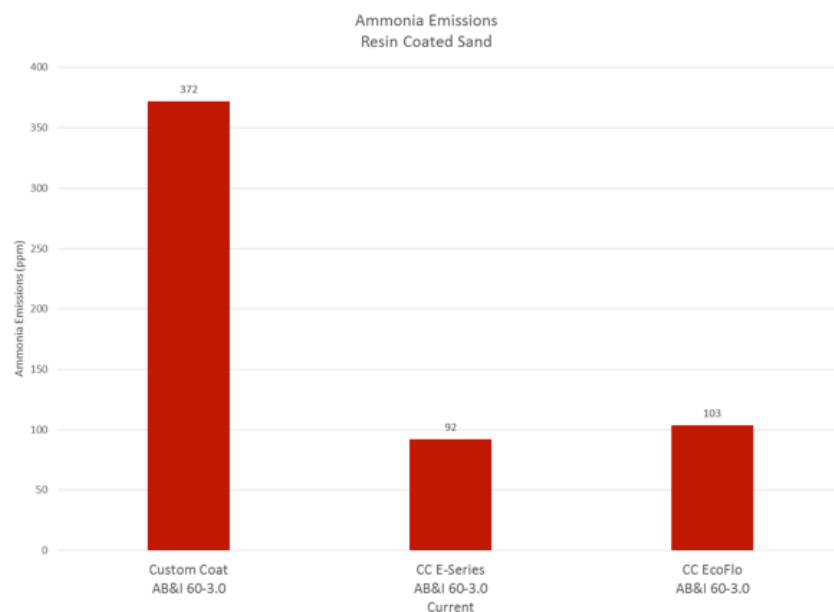


Figure 1. Ammonia emission comparison of conventional, E-Series and EcoFlo RCS technologies.

SIMPLE SOLUTIONS THAT WORK!

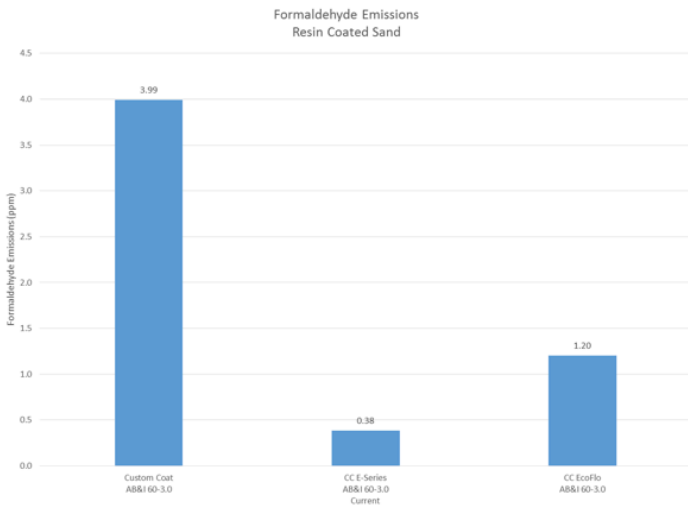


Figure 2. Formaldehyde emission comparison of conventional, E-Series and EcoFlo RCS technologies.

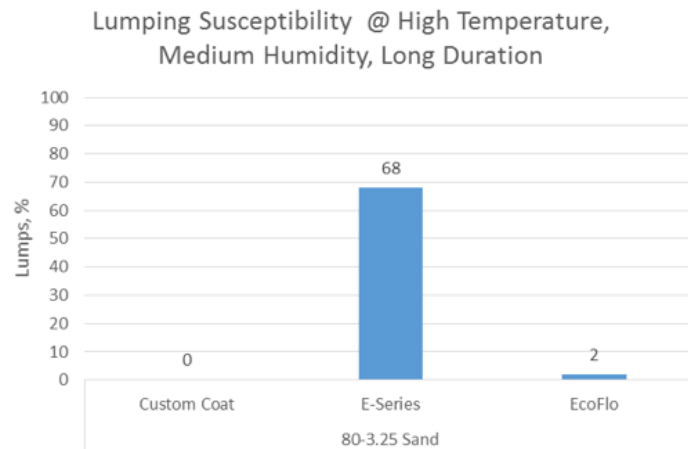


Figure 3. Lump comparison for each of the RCS technologies at high temperature, medium humidity, and long duration.

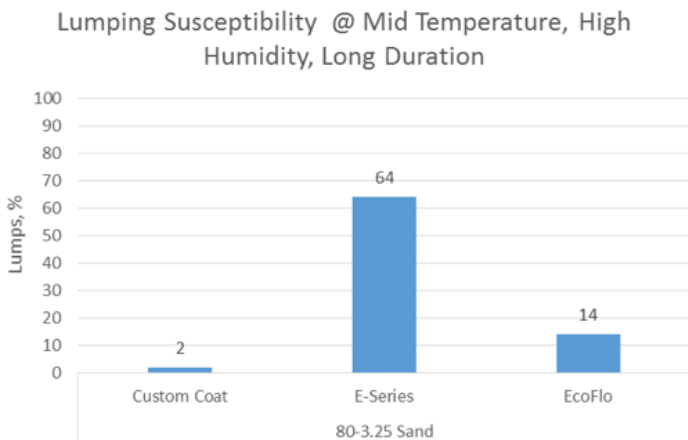


Figure 4. Lump comparison for each of the RCS technologies at mid temperature, high humidity, and long duration.

HEAT & HUMIDITY RESISTANCE

The largest hurdle of low emissions sands is heat and humidity resistance. To measure this, samples of sand were subjected to multiple heat and humidity environments. The samples were evaluated for percent of sand that had agglomerated in these environments. The testing (Figures 3-4) confirms that low emissions sand grades have a susceptibility for lumping while conventional grades remained mostly lump-free. For high temperature and medium humidity environments, E-Series sands experienced 68% lumping while the second generation of low emission sand, EcoFlo, exhibited only 2% of lumps. Switching to high humidity, medium temperature provoked lumping even in the conventional Custom Coat sample. The same environment provoked 64% lumping in E-Series sand and only 14% in EcoFlo sand. Mission accomplished, a low emission sand is now available with humidity resistance that more closely resembles a conventional grade.

SUMMARY

Since the inception of Shell Sand, new technologies have emerged that each have their own advantages. Conventional grades provide a robust core making material with the highest strength and well documented levels Shell Sand emission and familiar odors. The first generation of low emission sand offers high reductions in core making emissions and serves as the most effective technology for formaldehyde emission reduction. These grades are easily implemented to reduce emissions and maintain productivity with the exception of high heat and humidity environment. The second generation and latest low emission technology offers similar emission reduction while maintaining effectiveness in high heat and humidity environments. By balancing the need for each of these properties, resin coated sand offerings can be reviewed to determine which technology best fits your foundry's specific application and environmental requirements.

Contact:
MITCH PATTERSON
 mitch.patterson@ha-international.com

CC EcoFlo RESIN COATED SAND



IMPROVE YOUR SHELL CORE MAKING ENVIRONMENT **IN HOT & HUMID CLIMATES!**

REDUCED EMISSIONS

70% reduction in ammonia & formaldehyde emissions vs. conventional formulas

INCREASED HUMIDITY RESISTANCE

Humidity resistance is substantial vs. other environmental grades

REDUCED LUMPING

Reduced lumping means better flowability in hot & humid climates



APRIL 27-30, 2019

ATLANTA, GEORGIA

CASTEXPO
& METALCASTING CONGRESS
connecting SUPPLIERS | METALCASTERS | CASTING BUYERS

VISIT HA INTERNATIONAL IN BOOTH #1219

EcoFlo[®]

800.323.6863

HA International LLC

Member of 汉高 Group

HA-international.com