DIRECT ASSISTANCE PROGRAM

CASE STUDY

NYSP2I Assists Monofrax with Molding Sand Recovery

Monofrax is a specialized high-temperature furnace refractories manufacturer located in Falconer, New York. Monofrax is a client of Insyte Consulting (Insyte) which is the Manufacturing Extension Partner (MEP) for the Western New York region. The company produces custom high temperature furnaces as specified by the customer and employs about 200 people at their facility in Falconer.

CHALLENGE

Monofrax has not evaluated recycling of their sand since the 1980's at which time they determined that it was not economically feasible to recycle the sand. The main problem was that there are two (2) different binders used in the sand for the refractory process: Sodium Silicate (binder most commonly used) and Catalyzed Furan.

The two binders have compatibility issues when mixed together. The Furan catalyst must be increased to counteract the residuals from the sodium silicate binder. Insyte and Monofrax wanted to investigate the latest information on technologies that may be both technically and economically feasible for sand recovery and reuse in their casting operations.

SOLUTION

Monofrax collaborated with Insyte and the New York State Pollution Prevention Institute (NYSP2I) at the Rochester Institute of Technology (RIT) for assistance in determining a cost-effective option in order to reduce annealing sand purchases and sand disposal cost, along with investigating whether Furan binder use could be reduced or eliminated.

NYSP2I assessed several technology options for recovering their molding sand for reuse. Two different potential approaches were identified; find a reduced cost outlet for the used sand (disposal cost reduction), or find a way to reuse a larger portion of the used sand besides use as annealing sand in their operation.

Monofrax had an outside lab analyze their used sand with mixed binders. This lab determined that the sand was nonhazardous, suggesting that the sand could be used for any application where new sand is typically used such as gardens, beaches, landfill cover, etc.

NYSP2I performed visual and Scanning Electron Microscopic (SEM) analysis of used sand samples with sodium silicate binder. This work was done to determine where sodium silicate was located on the sand grains, whether there was full coverage or limited coverage. Using visual analysis, NYSP2I compared the integrity of the virgin sand grains and after use in molding. The SEM was also used to determine the binder morphology for the silicate bound sand.
Initial information from Monofrax indicated that mixed binder sand (Furan and silicate) would have reuse issues due to slower curing that is caused by binder interference. Therefore, it was assumed that sand reuse would require manual separation of used Furan binder sand from silicate binder sand.

NYSP2I supported Monofrax with running 3 point bend tests on varying ratios of new sand and recovered sand. The minimum bend strength specified was

CHALLENGE

- Monofrax needed to determine a solution in their sand recycling and disposal processes. The main problem was that there are two (2) different binders used in the sand refractory process: Sodium Silicate (binder most commonly used) and Catalyzed Furan

SOLUTION

- Monofrax collaborated with NYSP2I for assistance in determining a cost-effective solution in reducing annealing sand purchases and sand disposal cost, along with investigating whether Furan binder use could be reduced or eliminated

RESULTS

- The 3 point bend testing is promising for sand reuse with mixed sand and silicate binder, sand reuse has high potential
- Mold material bend testing with 50% mixed binder sand, 50% virgin sand, and silicate binder provided strengths almost as high as 100% virgin sand
- A 50% sand reuse represents the potential savings of $335,000
- A delumper, new Rotex, transporter tubes, and silo costs combined would be approximately $337,000. Payback at 50% sand reuse would be 1 year

Monofrax

225 pounds. First, it was assumed that the used Furan sand-used silicate sand mix would perform more poorly than a new silicate sand-used silicate sand mix. Instead, the 75% virgin sand - 25% used silicate sand performed very poorly. Data also shows that the mixed binder sand performed almost as well as the virgin sand. The testing also suggests that the opposite set of tests should be performed where mixed used sand is re-molded with Furan binder, a confirmation of the finding is the 1970's and 1980's testing where residual soda from the silicate binder slowed the catalysis of the Furan. The conclusion from the earlier study was to increase the Furan catalyst to increase the curing speed.

RESULTS

Since the 3 point bend testing looked very promising for sand reuse with mixed sand and silicate binder, sand reuse has high potential. More 3 point bend tests are needed for reuse with Furan binder and possibly reuse with lower quantities of mixed sand to determine if this would improve the average strength and variation in strength. The strength variation for all the tests was quite wide which suggests the need for a Design of Experiments (DOE) to determine what process variables are the big contributors to variation. Additional testing is needed to verify that multiple sand cycles do not have progressive strength degradation; the used sand virgin sand ratio may have to be adjusted accordingly to avoid using sand with less strength. The final step would be hot strength testing using the optimum mixture conditions for both Furan and silicate binders.

NYSP2I and Monofrax determined that mold material bend testing with 50% mixed binder sand, 50% virgin sand, and silicate binder provided strengths almost as high as 100% virgin sand. Further testing would be needed to determine the impact on Furan strength using 50:50 sand mix and would include a Design of Experiments (DOE) to reduce the variation in strength results. A 50% sand reuse represents the potential savings of $335,000. Repeated sand reuse is expected to gradually reduce the mold strength so there may need to be a system in place to take into account the diminishing strength such as placing limits on re-blend ratios over time.

Equipment needed for sand reuse include a delumper, and either finer screens for the existing Rotex screening equipment or a new Rotex dedicated to screening for molding sand reuse. In-house storage and sand transportation are also required due to the expected reclaim quantities. It could not be determined whether a sand blending system would be needed to control the used-virgin sand mix.

A new Rotex would cost approximately $40,000; therefore, the payback at 50% sand reuse would be about 1.7 months using just sand purchase costs (50% of $630,000). Sand transporter and sand silo costs were estimated to be $223,000 based on a 2010 quote (Nol-Tec Systems). A delumper, new Rotex, transporter tubes, and silo costs combined would be approximately $337,000. Payback at 50% sand reuse would be 1 year.

TESTIMONIAL

"NYSP2I team provided a wealth of knowledge, experience and resources. They utilized lean concepts to resolve challenges in a highly competitive world."

- Bryan Cummings, Process Engineer Manager
Monofrax

NYSP2I PARTNERS

R·I·T Rensselaer University at Buffalo The State University of New York Clarkson University

New York Manufacturing Extension Partnership

Funding provided by the Environmental Protection Fund as administered by the New York State Department of Environmental Conservation.

For more information please contact us:

111 Lomb Memorial Drive, Bldg. 78
Rochester, NY 14623

Tel: 585-475-2512
Web: nysp2i.rit.edu
E-mail: nysp2i@rit.edu

R·I·T Golisano Institute for Sustainability
ROCHESTER INSTITUTE OF TECHNOLOGY