MINNESOTA
TECHNICAL
ASSISTANCE
PROGRAM

Evaluation of Alternatives to TCA Used in a Foundry Process

INTERN SUMMARY

Intern Project Date: Summer 1992
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Process Background

M.E. International (MEI), an iron and steel foundry, manufactures high-quality wear parts for the mining industry. The foundry has three major production stages: melting of metal, producing molds and cores, and casting and finishing.

Part of the production process involves dipping sand cores into a "wash" slurry which contains 1,1,1-trichloroethane (TCA). After the wash is applied to the cores, the TCA evaporates and leaves a protective coating on the cores. This coating prevents molten metal from penetrating the cores during pouring, and leaves a smooth surface finish on the casting. Using TCA as a carrier produces the following favorable results: the coating dries quickly and provides a consistent coating thickness of 15-25 thousandths of an inch; the coating has adequate tensile strength and does not chip easily; and the core characteristics are not affected by the coating process.

Incentives for Change

In 1991, MEI used over 95,000 pounds of TCA for the core wash. Prior to the internship, MEI made the commitment to reduce TCA emissions by 95 percent by the year 1995. The motivation for reducing emissions and finding a substitute for the TCA-based core wash was due to new regulations imposed on the use and production of ozone-depleting chemicals, including TCA. The 1990 federal Clean Air Act Amendments (CAAA) banned TCA production after the year 2000. This date was later moved up to 1995 by President Bush. The CAAA also mandated excise taxes on TCA, which will result in a 40 percent increase in the cost of the TCA core wash by January 1993 with further increases expected in the future. Currently, MEI spends over $200,000 for the TCA-based core wash slurry and TCA solvent (used for thinning the slurry).

Intern Activities

The intern project focused on evaluating water- and isopropyl alcohol (IPA)-based substitutes for MEI's TCA-based core wash. Based on consultation with core-wash vendors, eight alternative core washes (four alcohol- and four water-based) were selected for testing. Results from the TCA-based core wash were used as the standard against which the alternative core washes were measured. The following tests were conducted on core samples for each of the alternative washes:

- Coated surfaces were observed for cracks and smoothness.

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- Tensile strength tests were conducted on core samples to determine if water-based washes would weaken the water-soluble sodium silicate core binder.
- Coating thicknesses were measured to determine the thickness required to avoid cracks, and to measure uniformity of coating (to ensure that castings have consistent dimensions).

Based on the test results, two water-based core washes with the best performance were selected to use in the casting production process. Sodium silicate cores were dipped in the water-based washes, dried in a natural convection oven at 300°F for about 20 minutes, and inserted into casting molds before molten metal was poured into the molds. The finished castings were inspected to find out if metal penetrated the sand cores and to examine the surface finish quality of the metal.

Results

IPA-based Washes

IPA-based washes required less time to air-dry than water-based washes, but required more time (three times as much) to air-dry than TCA-based washes. IPA-based washes also needed constant mixing to keep the solvent and the slurry from separating. Other concerns about IPA-based washes include: (1) IPA is a regulated volatile organic compound (VOC) and may need to be included on an industrial air permit, and (2) IPA is flammable and regulations may require instituting protective measures to prevent fires and explosions.

Water-based Washes

The two water-based washes tested by the intern prevented metal from penetrating the cores, and produced excellent casting surface finishes. Water-based washes should work well on small water-soluble sodium silicate cores in a production casting if the core is quickly oven-dried after the wash is applied. It was found that the quick-drying method maintained the required tensile strength of the cores. However, the coating on the large sodium silicate cores chipped easily after being dipped and dried, requiring careful handling of the cores.

Advantages of water-based washes:

Water-based washes are:

- Nontoxic
- Nonflammable
- Nonhazardous
- Inexpensive

Disadvantages of water-based washes:

- There is a greater risk of bacterial growth than that of IPA- or TCA-based washes. A biocide would be required in the wash.
- Air-drying time is about 12 times slower than that of TCA-based washes. This will require that the cores be oven-dried.
- Slower air-drying could cause the coating to run while it is still wet, which may lead to variable coating density.

Although concerns exist about core handling requirements and inconsistent coating density, production tests indicate that a water-based core wash used with a drying oven can help MEI completely eliminate TCA. This would result in an estimated net cost savings of nearly $120,000 per year with a pay-back period of under two years.