Case Study

MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY • ENVIRONMENTAL ASSISTANCE DIVISION • 1-800-662-9278

Wolverine Bronze Company

Roseville, Michigan

LOW ENERGY RECYCLING OF FOUNDRY SAND

"Every time we reuse sand, our sand costs go down" is the way Paul Smith of Wolverine Bronze Company, Roseville, Michigan justifies sand reclamation. "It just makes good business sense to reuse as much sand as possible," he states.

THERMAL RECYCLING TRIED FIRST

Like other metal foundries, Wolverine Bronze has seen the costs of buying new sand and disposing of used sand rise steadily over the past several years. In 1984, in an effort to contain these costs, the company installed a sand recycling system. The system included a shaker unit to break up sand lumps and a gas-fired burner that "burned" residual casting binder from the surfaces of the sand grains.

The thermal recycling process yielded a very satisfactory sand product, fully meeting the demanding requirements of metal casting. Unfortunately, the economics of thermal recycling began to be questioned.

The basic problem was that the thermal recycling system was designed for round-the-clock operation. But, production needs for sand at Wolverine Bronze were actually quite variable. This was due to the fact that the company is a job shop that specializes in rapid delivery of low-to-high quantities of castings that vary from one to 30,000 pounds in weight. In a single month, sand requirements were found to vary from eight tons per day to 90 tons per day.

As a consequence, the thermal recycling system was often idle. Nevertheless, heat had to be continuously applied to permit quick start-up without the threat of damage to the system. The alternative would have been operating the system for periods of time followed by shutdown. But, this would have necessitated a larger investment in sand, an enlarged sand storage area and larger sand handling equipment.

MICHIGAN DEPARTMENT OF
ENVIRONMENTAL QUALITY
ENVIRONMENTAL ASSISTANCE DIVISION
PO BOX 30457
LANSING MI 48909-7957
www.deq.state.mi.us
Environmental Assistance Center
1-800-662-9278

Month 1996 • #9303A

AUTHORITY: PA 451 OF 1994 TOTAL COPIES: 1000
TOTAL COST: $189.98 COST PER COPY: $.19
MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

RECYCLED PAPER

Although exact data was not recorded, it is estimated that the thermal recycling process cost approximately $30 per ton of sand, not including equipment amortization. This yielded only slight savings to Wolverine compared with using 100 percent new sand.

Another problem with the thermal recycling system was that it did not remove inorganic impurities, such as calcium carbonate, that can interfere with good sand bonding during mold making.

LOW ENERGY RECYCLING SYSTEM INSTALLED

In 1989, the company began looking at a low energy sand recycling system. The non-thermal system has proven to be a real cost saver. At the heart of the system is an "attrition" unit, in which sand grains rub together at high speed. Residual binder and inorganic contaminants are "scrubbed" from the sand grain surfaces by the abrasion. The resulting cleaned sand is almost like virgin sand.

Cost analyses for the new system indicate the recycled sand cost to be $9.72 per ton, not including equipment amortization. Of course, the big savings are in energy costs. Also, maintenance costs ($2.40 per ton) are much lower with the new system. Much of this is due to system operation.

LOW ENERGY SYSTEM OPERATION REQUIREMENTS

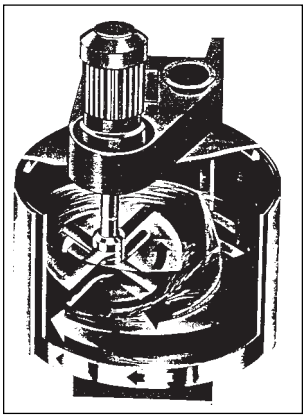
Company management's objective was to have the system run without human control or monitoring. Tanoak Enterprises, Inc., of Barrie, Ontario, Canada designed the system so that attention would be required only when a system failure occurred. The low maintenance cost per ton attests to the success of the design, which incorporated the following into the system:

- *Sand must meet all mold making requirements.*
- *System complies with federal and state environmental requirements.*
- *System is flexible and meets variable sand demand.*
- *System operates automatically and unattended.*
- *System shuts down automatically to avoid:*
  1) *unacceptable releases to the environment;*
  2) *unacceptable sand quality;*
  3) *equipment damage.*
- *System provides a record of operating parameters and indicates the cause of all automatic shutdowns.*

UNIQUE SYSTEM FEATURES

A number of unique operation features contributed to system success.

Attrition Unit - The sand attrition unit causes two sand streams flowing in opposite directions to repeatedly collide. One flow is caused by a rotating, drum-shaped outer container having an axis of rotation approximately 30° from vertical. The other flow is driven by impeller blades inside the container that are offset from



Attrition:
The act or process of wearing away or grinding down by friction.

the axis of the outer container and turn in the opposite direction. One sand stream flows at high speed (approximately 70 feet/second) while the second stream flows at low speed (approximately seven feet/second). Both streams form "pseudo-fluid beds," which result in intensive collision of sand grains with each other.

A low pressure air stream is used to convey fines, which surfaces from the attrition unit to a dust collection system. These fines can cause low mold strength and are replaced with new sand. Normally, about eight percent of each recycled batch is collected as fines and disposed.

The attrition unit is actually designed for combined sand abrasion and thermal "burning" of binder from the sand grain surfaces. The combined action is known to yield higher strength recycled sand. The thermal units can be added to the Wolverine Bronze system if needed, such as when a more abrasion resistant binder is used. With the current 1.3 percent alkyd oil, no-bake binder, the attrition process alone provides a sand product that is fully satisfactory for both mold and core production.

Controls - Motion, temperature, electrical power, pressure and limit sensors are used to monitor system operation. Values of key measurements are automatically recorded for each batch in a computer data base and printed for periodic review. If the system shuts down due to pending or actual malfunction, the computer prints the "out-of-spec" condition and the corrective action to be taken. An alarm alerts the foundry that a problem exists.

Throughput - The Wolverine Bronze system produces 4 tons of recycled sand per hour in 700 pound batches. Typically, the system operates 13 hours per day, usually at night and on weekends when power rates are lowest.

Cooling - Due to intensive friction in the attrition unit, sand temperature can rise 30° to 50°F above the initial sand temperature. A cooling unit is used to hold sand temperature to 85±5°F when leaving the attrition unit. Close temperature control is important because hot sand can cause the binder to set prematurely while cold sand will retard binder setting and potentially cause moisture condensation.

The cooling system has a cooling tower on the foundry roof. The water drains from the cooling tower into a sump within the foundry building when the cooler is not operating. In this way, anti-freeze is not needed in the cooling water.

Dust Collection - Fines from the attrition unit are conveyed to a two-stage (cyclone plus bag house) dust collection system. Additionally, material larger than 20 mesh US sieve is removed with a screen downstream from the cooler and fed to the dust collection system. The exhaust air flow from the bag house is closely controlled to maintain a consistent pressure drop (between 4" and 5" of water) so that a layer of dust coats the inside surfaces of the bags. This helps trap very fine particles and avoids blowing fines into the air.

Sand Handling- A pneumatic system is used to convey sand from the recycling system to storage silos. A unique feature is that sand flow is held to less than 10 feet per minute to avoid sand friction and further generation of fines.

ENVIRONMENTAL COMPLIANCE

Wolverine Bronze has been operating the low energy recycling system for several years. There have been no air emission problems, which can be severe with thermal recycling systems.

Wolverine Bronze has demonstrated that recycling can save money.

CONCLUSION

Wolverine Bronze has demonstrated that sand recycling can save money. It has also demonstrated that low energy sand recycling works and can be a much lower cost process than thermal sand recycling. As stated by Paul Smith, "We got what we hoped for and are very happy with it."

The Michigan Department of Environmental Quality (MDEQ) will not discriminate against any individual or group on the basis of race, sex, religion, age, national origin, color, marital status, disability, or political beliefs. Questions or concerns should be directed to the MDEQ Office of Personnel Services, PO Box 30473, Lansing, MI 48909.