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Determining Your Binder Work Time

A common nobake binder work time testing procedure may not be as accurate as you think...

Introduction

If you work in the nobake molding department of your metalcasting facility, it is likely you are using the B scale mold hardness gauge method to determine the work time of your binder. The test, which was originally designed to measure green sand hardness and now is used for nobake molds, is one of several common tests used across the metalcasting industry to measure work time offered by the AFS Mold and Core Test Handbook. However, few of the tests are scientific ways of measuring work time.

In nobake molding, sand is mixed with the binders and then packed into a pattern. This step must be finished quickly before the binders start to react, resulting in stiff sand, poor mold strength and, eventually, flawed castings. Determining how long the molder has to pack the pattern before the sand mix loses its optimal molding properties is necessary to keep molds or cores from breaking or producing defective castings.

Work Time Defects

The consequences of exceeding the work time of your binders are costly. Compacting the sand too long after curing begins could result in:

- Reduced strength.
- Mold breakage during handling.
- Mold cracking or core failure at casting.
- Poor mold and core density.
- Penetration defects and poor surface finish in the casting

Unfortunately, many mold and casting problems also can be attributed to other issues in the casting process, so exceeding the worktime may not be recognized as the root cause. Telltale signs that your facility is compacting its molds too late after curing include weak molds and the penetration defect, as well as stiff sand during compaction. A good molder will notice when the sand is starting to stiffen up, indicating it is curing too fast and the catalyst should be reduced.

Measuring Work Time

In the sand lab at ASK Chemicals, Dublin, Ohio, researchers developed an interval testing method to determine work time. After the sand was mixed with the binder, laboratory core specimens were produced at 3-minute intervals until the cores were too weak to hold. Each specimen was tested for tensile strength and compared (Fig. 1).

The experiment was performed with the three most common nobake binders used in the North American metalcasting industry—1% furan nobake, 1% phenolic urethane nobake and 1.25% ester-cured phenolic. These systems were run with catalyst or coreactants to provide the same 20-minute strip time for each binder chemistry. Tensile strengths of the specimens at each interval were recorded and the percentage of tensile loss calculated. It was determined that a binder had exceeded its work time when it experienced more than 25% tensile loss. In the case of the experiment, furan nobake achieved 25% tensile loss in 3 minutes, resulting in a 3-minute work time. Phenolic urethane and ester-cured nobake had longer work times of approximately 9 minutes (Fig. 2).

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The results were compared with the results of a B scale hardness gauge test run to determine the work time. The commonly used readings of 45 or 60 for the B scale hardness gauge were used to determine work time.

The interval and gauge tests gave conflicting results. For instance, the gauge test indicated the amount of time before the tensile strength of the furan nobake binder would be too low was 14 minutes. However, the interval test indicated the sand mix produced with the same chemistry had just 3-6 minutes before tensile strength would be too low for proper core or moldmaking.

Disparity of work times between the two tests occurred for the other binders, as well. According to the experiment results, metalcasting facilities depending on nonscientific methods to determine work time, including the B scale hardness gauge, in particular, run the danger of attempting to produce molds and cores past their window for optimal tensile strength.

Figure 3 shows a comparison of the percentage tensile loss in the interval test versus the B scale mold hardness gauge measurement for the furan nobake. This graph suggests that a much lower B scale gauge reading of 20-25 corresponds to a 25% loss in tensile strength.

On the Shop Floor

The advantage to the gauge test is its simplicity, and it could still be used on the shop floor, but with different indicator readings. Metalcasting facilities may perform the interval test once for each type of binder used to lay the foundation for work times and adjust the indicator amount from the B scale hardness gauge accordingly.

- Metalcasters also should remember the following to ensure the proper production of molds and cores:
- Keep work time as short as possible for better productivity.
- Size the sand mixer to the size of the mold or core.
- Slow down the cure time using slower catalysis if necessary for a longer work time.
- A B scale mold hardness of 60 is not a good work time measure. Work time is much less on the B scale gauge, depending on the binder.
- Furan nobake binders have a short work time compared to the strip time (the time it takes to fill the corebox and then cure before the core is ready to be removed).
- Phenolic urethane nobake and ester-cured phenolic binders

Sidebar:

Food for Thought: Mixing Work Times

Typically, nobake casting facilities set the work time and strip time of its molds and cores to allow enough time to fill the mold and then wait for it to cure before removing it from the pattern. With a more accurate way of determining work time, along with the sophisticated sand mixing equipment available today, it might be possible to adjust the catalyst of the sand as it fills the mold.

By using a slow catalyst in the first sand to fill the mold, then adjusting that catalyst to work more quickly so the last sand has the fastest reactivity, theoretically, the molder could have the whole mold set at once. This would reduce the time needed to wait for the mold to cure and increase the amount of molds or cores made in a shift.

While the idea has not been put to the test yet, with the computer controls available today, the possibility does not seem too far out of reach.

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