

3M Advanced Materials Division

3M™ Fused Silica Castables

Casting and Curing Guidelines

Note: The purpose of this guide is to provide basic information to product users for use in evaluating, processing, and troubleshooting their use of certain Seller products. The information provided is general or summary in nature and is offered to assist the user. The information is not intended to replace the user's careful consideration of the unique circumstances and conditions involved in its use and processing of Seller products. The user is responsible for determining whether this information is suitable and appropriate for the user's particular use and intended application. The user is solely responsible for evaluating third party intellectual property rights and for ensuring that user's use and intended application of Seller product does not violate any third party intellectual property rights.

Form/Mold Design

The pattern or mold surface to be replicated must be impervious to water. Most standard pattern materials such as sealed wood or plastic are acceptable. Aluminum or glass chemically react with 3M™ Fused Silica Castables and should be avoided or completely sealed, if employed.

The mold box should be designed so the most critical surface is horizontal. This allows air bubbles to rise away from the critical surface of the tool. Radii should replace sharp corners to eliminate stress areas. Ample draft and accessibility should be designed into the mold to allow ease of material

placement and tool removal. The sides of the mold box must also be impervious and easily removed from the mold. The height of the sides should allow for approximately 0.25" extra thickness of stock if the back of the tool is to be ground flat. **Any grinding or other machining steps must not be performed until the tool has been post cured to operating temperature.**

Calculate the internal volume of the mold. There should be sufficient mixing and placing equipment to allow placement of all the 3M fused silica castable required to fill the mold within 40 minutes after the initial addition of the dry castable to the water.

Mixing Equipment

3M fused silica castables are packaged 50 lbs. per plastic-lined paper bag. It is necessary to mix the castable using a high energy, shearing action. If the typical paddle type mortar mixer is employed, 1.5 horsepower (minimum) is required per bag of castable. Available horsepower determines the batch size rather than the mixer's volume.

The mixer must be free of contaminants such as un-set portland cement or iron oxide. Mixers should be thoroughly cleaned prior to use.

Mold and Pattern Preparation

If the completed ceramic tool weighs more than 1000 lbs. or if the maximum thickness is greater than 8", control of the exothermic reaction may require special attention to prevent internal overheating during the set.

Clean and then prepare the horizontal mold surface and other mold parts using 2 or 3 coats of high quality paste wax. Allow each coat to dry and polish to a high sheen. Two coats of commercially available spray-on furniture polish may be applied as per instructions on the can. Assemble the mold and install any inserts required to form holes or other internal details. These inserts should be coated with a non water-soluble petroleum jelly. All corners must be eliminated using generous radii or chamfers.

Vibration Equipment

It is essential that the placement of the 3M fused silica castables be accomplished using vibratory casting techniques. The most effective system is a commercial quality vibrating table capable of 3,600 (minimum) vibrations per minute and amplitude capability sufficient to accomplish fluid movement of the castable at the weights anticipated.

Mixing

Important. The dry castable must not exceed 75°F (24°C) at the time of use. Experience has indicated that the cooler the dry material at mixing time, especially in large volume castings, the more successful the casting. Typically, the material is cooled to 45°F – 55°F prior to casting large volume tools. Set or “working” times vary from approximately 40 minutes at 75°F to more than 70 minutes at 50°F.

Material Requirements

Calculate the estimated total volume of castable required to fill the mold as:

- 3M™ Fused Silica Castable 120: 120 lbs. per cubic foot
- 3M™ Fused Silica Castable 220: 130 lbs. per cubic foot
- 3M™ Fused Silica Castable ICL: 120 lbs. per cubic foot
- 3M™ Fused Silica Castable AR: 120 lbs. per cubic foot
- 3M™ Fused Silica Castable AR Fine/AR Fine No Lithium: 120 lbs. per cubic foot

Water Requirements

As with all refractory concretes, the exact proportion of water/dry mix may vary slightly batch to batch. The recommended amounts of water are calculated as a percent (by weight) water to dry castable and are as follows:

- 3M fused silica castable 120: 11 – 12%
- 3M fused silica castable 220: 8 – 9%
- 3M fused silica castable ICL: 11 – 12%
- 3M fused silica castable AR: 9 – 10%
- 3M fused silica castable AR Fine/AR Fine No Lithium: 13 – 14%

Only cool, de-ionized or distilled water may be used. The initial mix will demonstrate whether a water adjustment is required. Initially, the mix will appear very dry; **DO NOT ADD WATER.** Once thoroughly mixed, the wet mix should be a relatively loose “ball in hand” consistency and should not flow without the aid of vibration. If the mix is too wet, adjust or discard – **do not use as is.**

Mixing

Dust masks should be employed even in addition to dust collection systems. See the product Safety Data Sheet (SDS) for additional information.

Determine the number of mixes required to fill the mold as calculated by available horsepower (see **Mixing Equipment** section). Pre-open all bags for each mix, assuring that no threads or paper are left loose to contaminate the mix. Add the predetermined quantity of water to the mixer. Engage the mixer, then follow the instructions below (apparent load on mixer should dictate rate of addition):

- Again, the initial mix after adding all castables to the water will appear very dry. **DO NOT ADD MORE WATER.** Once thoroughly mixed, the wet mix should be a relatively loose “ball in hand” consistency and should not flow without the aid of vibration. If the mix is too wet, adjust or discard – **do not use as is.**
- For ALL castables: Add water to mixer and engage mixer. Add half of the dry material within 2 minutes. Add the rest of the castable slowly. All material should be in the mixer within 4 – 5 minutes of the initial bag.
- 3M fused silica castable 120: Mix for a total of 10 minutes or until a slightly wet ball-in-hand consistency is attained.
- 3M fused silica castable 220: Mix for a total of 13 – 15 minutes or until a slightly wet ball-in-hand consistency is attained.
- 3M fused silica castable ICL: Mix for a total of 8 – 10 minutes or until a slightly wet ball-in-hand consistency is attained.
- 3M fused silica castable AR/AR Fine/AR Fine No Lithium: Mix for a total of 10 – 12 minutes or until a slightly wet ball-in-hand consistency is attained.

Placement

Important. If more than one mix is required to fill the mold, retain all the mixes until they can be placed concurrently with no interruption between mixes. Ensure that the mold is firmly mounted and leveled on the vibrating table. Begin adding the castable at the lowest point in the mold. Immediately engage the vibrating table. Continue adding castable only at the lowest point of the mold until the entire horizontal surface is covered. Additional access openings can then be used to finish adding the balance of material; be careful not to create voids (bubbles) within the casting.

- 3M fused silica castable 120: After mixing is complete, an additional 25 – 30 minutes are available for placement before the initial set occurs. Continue vibration until 1 minute after final mix placement. Cover the filled mold with plastic.
- 3M fused silica castable 220: Placement of all the castable should be accomplished within 10 – 15 minutes. Continue vibration for no more than 1 minute after final mix placement. Cover the filled mold with plastic. Over-vibration will produce an unacceptable result.
- 3M fused silica castable ICL: After mixing is complete, an additional 25 – 30 minutes are available for placement before the initial set occurs. Continue vibration until 1 minute after final mix placement. Cover the filled mold with plastic.
- 3M fused silica castable AR/AR Fine/AR Fine No Lithium: After mixing is complete, an additional 25 – 30 minutes are available for placement before the initial set occurs. Continue vibration until 1 minute after final mix placement. Cover the filled mold with plastic.

Removal from Mold

Hydrated castable requires 12 to 14 hours to complete the exothermic reaction. The casting must remain stable and covered for at least that time period. Prior to and during the exothermic reaction, the casting will be relatively weak. If pins or other details might interfere with the core or pattern expansion, they must be removed immediately after noticeable exothermically generated heat is detected, approximately 12 hours after placement. All pattern materials have a much higher thermal expansion than the castable. This may require timely removal of cores or other details. Subsequent cooling of the tool can be accomplished using water sprays. Avoid cooling with fans, which may remove water still required for hydration.

The tool may be removed from the mold at any time the exposed surface temperature of the tool is known to be decreasing. Subsequent to removal from the mold, clean the critical or working surface of the tool using clean water and light scrubbing using an appropriate scouring pad. Re-cover the tool with plastic.

Drying

Remove the plastic cover from the tool 24 hours after mix placement. Orient the tool such that as much surface as possible is exposed. Dry in ambient conditions for a minimum of 48 hours. Place in a drying/curing furnace capable of attaining temperatures equal to the eventual use temperature of the tool. Dry at 180°F to 200°F for 48 hours, longer if the maximum thickness exceeds 6 inches. At this temperature, large mass castings will require 72 hours exposure or even more, depending on mass.

Curing

After drying, raise the temperature of the tool to its eventual operating temperature, at a rate not to exceed 50°F per hour, and allow the tool to soak at operating temperature or 1200°F, whichever is greater, for 12 hours (minimum).

Patching

In the event a patch is required, the best time to accomplish this is immediately upon removal from the mold. Please note that 3M™ Fused Silica Castable 120 or 220 Patching Compound can be purchased separately in 1-gallon containers.

First, thoroughly clean the area to be patched with a clean brush and clean water.

Mix sufficient dry patching compound with approximately 20% (by weight) de-ionized or distilled water. Mix until smooth. Working time is approximately 20 minutes. Wet the area to be patched using clean water. Apply patch compound immediately.

Work the patching compound into the area and leave sufficient material to compensate for subsequent shrinkage of the patch. Cover with plastic film for 4 – 6 hours. Sand the patched area to the geometry desired. Process the tool as required in the **Drying** and **Curing** steps above.

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3M Technical Ceramics, Inc.
780 Park North Blvd., Suite 122
Clarkston, GA 30021
Phone 404-292-4242
Web www.3M.com/advancedmaterials

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