Which Castable Refractory Should I Use For My Furnace And How Much Will I Need?

Frequently asked questions are “Which castable refractory should I use for my furnace?” and “How much will I need?”. And like most things in life, the answer is “It depends!”

Some things to consider when selecting your refractory are:

1. Operating Temperature
2. Insulating ability
3. Strength
4. Amount of material needed
5. Total Cost of material and shipping.

1. Operating Temperature:

The operating temperature of your furnace depends on what metals you are going to melt. The most commonly melted metals are aluminum, brass / bronze, and cast iron. Cast iron has the highest melting temperature, somewhere around 2350 F. Generally a 2600 F material will work just fine for a lift out furnace melting these materials. However if you are building a cupola type furnace that can generate some extreme temperatures in the lower sections you should consider a higher temperature material for the combustion zone.

2. Insulating Ability:

The insulation ability of a castable refractory is its ability to keep the heat inside your furnace. The better the insulation the lower the operating costs, the faster the heats, and the cooler the outside surface of the furnace.

The insulating value of a refractory is typically listed as a “K” factor, or in units such as (BTU*IN/h*ft^2*°F). The thing to remember here is that the *smaller* number the better the insulation.

Typically the trade off in insulating ability is strength. The insulating properties of the refractory are created by numerous small air pockets in the cement. The air pockets limit heat transfer but also make the refractory weaker.

Generally speaking the more the insulation the better. My first furnace had walls that were too thin (2 inches) and made of refractory that didn’t have enough insulation value. If there was a wind blowing I would have to block it with a sheet of plywood or so much heat would escape from the furnace that I couldn’t melt aluminum! The outside surface was really hot.

So how thick and what insulation value should I use? This isn’t an easy question to answer because a lot depends on how much heat you can put into the furnace (electric element power, burner size), the ambient air temperature and wind speed if any, how fast you want to melt the material and the insulation value of the refractory. For a good insulating refractory such as Kast-O-Lite 26, I would say that 3-inch walls would do for aluminum but 4 inches or more would be needed for brass or iron. In general: Don’t skimp on wall thickness.

3. Strength:

The strength that you need is dependent of such factors as where the material is used and the manner in which it is used. If the refractory were used as the roof of a large burnout oven you would want a stronger mix. The same if you are using it as the floor or doorjamb for an industrial unit that sees a lot of abuse. However if you are using it in a relatively small lift out furnace that is supported by a sheet metal shell, you can get by with a lower strength (and better insulating) material.

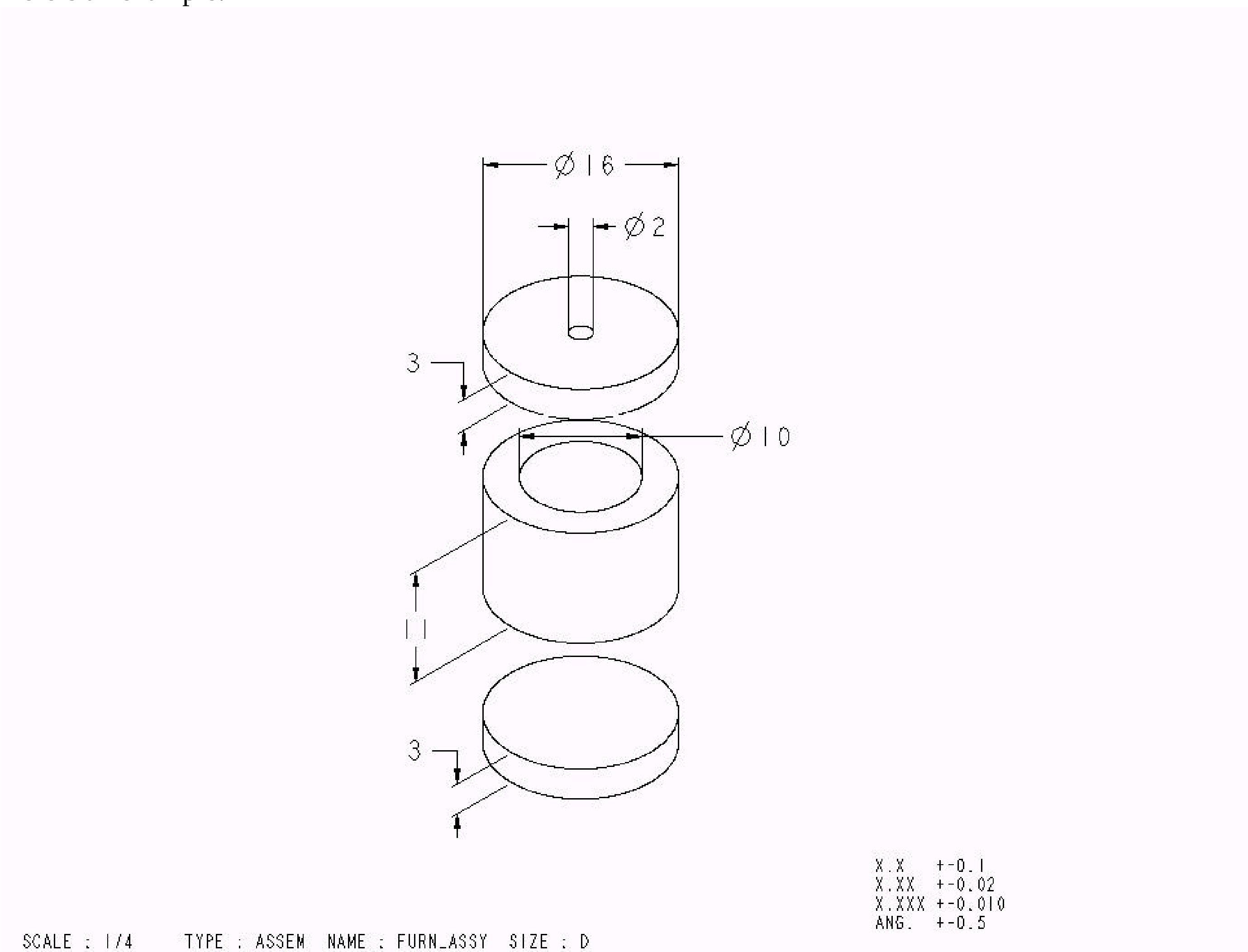
Strength is listed by several terms, but the primary one of concern for most applications is the cold crushing strength. This is expressed in units of lb/in^2. The larger this number the stronger the material. The trade off in strength is insulation ability, as in #1 above.

I have never had a serious problem with castable refractory strength in my lift out furnaces. I have had some minor cracking, but these did not cause any problems. Any small to medium cracks that appear after firing can be patched with a material like ITC-200, more castable refractory, or fireclay.

4. Amount Of Material Needed:

The amount of material needed is calculated by multiplying the volume of your furnace walls, base and lid by the density of the material.

Here's an example:



Volume of Lid:

$$V_{lid} = V_{total} - V_{hole}$$
$$= (\pi * (d/2)^2 * h) – (\pi * (d/2)^2 * h)$$
$$= (\pi * (16/2)^2 * 3) – (\pi * (2/2)^2 * 3)$$
$$= 603.1 – 9.4$$

$= 593.7$ cubic inches

Volume of Body:

$V_{body} = V_{outside} – V_{inside}$
$= (\pi * (d/2)^2 * h) – (\pi * (d/2)^2 * h)$
$= (\pi * (16/2)^2 * 11) – (\pi * (10/2)^2 * 11)$
$= 2211.7 – 863.9$
$= 1347.7$ cubic inches

Volume of Base:

$V_{base} = V_{total}$
$= \pi * (d/2)^2 * h$
$= \pi * (16/2)^2 * 3$
$= 603.1$ cubic inches

So now the total volume is the sum of the lid + body + base:

Total = 593.7 + 1347.7 + 603.1
= 2544.6 cubic inches.

So how much refractory is needed? It depends on the material density. The denser the material, the more the material required.

Kast~O~Lite 26:

This material has a density of 86 lbs per cubic foot. Since a cubic foot is 1728 cubic inches the amount of material needed is:

Weight = 2544.6 cubic inches ÷ 1728 inches per cubic foot x 86 lbs per cubic foot
=126.6 pounds

Don’t forget to add in some for mixing losses. It’s a problem to wind up without enough refractory to fill your forms! Any extra can be poured into a form to make a block for brazing on.

5. Total cost of material and shipping:

Now that you know which material and how much you need you can calculate your material costs.