Quick notes for finishing the furnace kit

REFRACTORY

A form of castable refractory that I have experience with and recommend is called Kast-o-lite® and is manufactured by; A.P. Green/ Harbison-Walker. The companies are under the A.N.H Refractories family of companies. Their website is;

http://www.hwr.com

The Kast-o-lite 26LI is rated to 2600 degrees F. and is good for a backyard aluminum or bronze melting furnace. For regular brass or bronze melting you may want to use Kast-olite® 30 which is rated to 3,000 degrees F. The website lists the locations of their distribution centers in the United states where you can go to purchase the refractory.

If you use Kast-o-lite 26LI two 55 pound bags are needed . If you use the Kast-o-lite 30 two-and-a-half 55 pound bags of this are needed since it is more dense and fills less volume.

These refractories will far out perform the homemade mixtures.

VARIOUS SUPPLIES

A reliable supplier of foundry supplies for the backyard metalcasting hobbyist and small business is;

www.BudgetCastingSupply.com

CAUTION:

This item is not for use by minors or anyone under the influence of drugs or alcohol. Melting metal involves danger from extreme heat. This furnace requires high temperatures to operate which could result in injury, loss of life or property damage. Burns and unwanted fires may result especially from careless usage. Safety precautions should ALWAYS be followed. You are responsible for using this item safely and keeping the items in safe working order. Use of this item is at your own risk. Neither the manufacturer, the seller nor anyone affiliated with the manufacturer or the seller is responsible for any damage or injuries, no matter how minor or major that may result from the proper or improper use of this foundry equipment and related items. By purchasing this foundry equipment the buyer agrees to the above terms and to be solely responsible for his or her usage and the usage of anyone who uses this unit with or without the buyer's consent. If you do not agree to these terms DO NOT use this item. Propane gas can accumulate and ignite explosively. Propane fumes can cause suffocation from inhaling them. If you have any questions about properly using or storing propane or other fuel gasses contact your nearest gas distributor. Safety should ALWAYS come first!

User's manual and kit assembly instructions for the HobbyMelter personal foundry furnace

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It is the policy of the producer of this product to improve products as new technology and techniques become available. The producer of this product reserves the right to revise or otherwise change this manual at any time without the obligation of notifying any entity, group or person of such revisions. Great effort, attention and care has been taken in the preparation of this manual and the product(s) described by it. However the producer of this manual or described product(s) cannot be held responsible for any ommisions or errors that may be contained or exhibited in this manual or the described product(s). Read this ENTIRE manual before beginning. The project will be much easier that way! Do not try to take shortcuts when completing this kit! Follow the instructions carefully and use the checklists provided to ensure that all the steps are completed in the proper sequence.

Once completed this furnace is a powerful tool that has the potential to make many seemingly impossible projects easily accomplished by providing valuable castings.

KIT ASEMBLY INSTRUCTIONS BEGINS ON PAGE 21.

READ AND UNDERSTAND THIS MANUAL BEFORE USING THE FURNACE!

Do:

Follow the instructions and safety tips in this manual.

Preheat all metal to be added to the crucible to remove moisture. Use furnace AWAY from flammable of combustible materials to avoid fire.

Use furnace over dry sand and level ground.

Use at least a full 10-feet of gas line between the propane tank and the furnace.

Store the furnace in a dry location sheltered from the weather.

Let the furnace warm up with the lid open if it becomes wet.

Use the furnace in well ventilated areas only. Outdoor is recommended.

Keep onlookers safely away from the furnace.

Keep propane tank in good condition.

Keep children and pets away from hot foundry.

Keep the furnace dry to avoid the need to dry it out.

Pour molten metal over a dry sand or dirt floor.

Comply with all local, state, and federal regulations when operating this equipment.

Do NOT:

Leave the furnace unit unattended while it is in operation.

Operate the furnace without proper safety gear and clothing.

Operate the furnace if it's not in proper working order.

Modify or attempt to modify the burner for altered gas or flame output.

Use wet tools around molten metal.

Use this furnace while under the influence of drugs or alcohol, or while consuming them.

MAIN FURNACE COMPONENTS



SAFETY CLOTHING AND GEAR

Whenever using the furnace protective work gloves should be worn. Work boots with laces properly tied, full length jeans and a long sleeved shirt should be worn.

MOVING THE FURNACE

Do NOT transport or attempt to transport a hot furnace. For safety, allow the furnace unit to cool completely before transporting it.

The cart's wheels are designed to assist in transporting the furnace unit. Tilt the furnace backward raising the front support brace off the ground. The furnace unit will then be able to roll on it's wheels. Do NOT attempt to use the lid raising lever as a handle for rolling the furnace unit. This can result in bending the hinge mounting bars and severely mis-aligning the lid.

To correctly transport the furnace unit, wait until it is completely cool. While wearing protective gloves grasp the front of the side rail with one hand and the back of the hinge with the other. Use both hands to tilt the unit backward raising the front support brace off the ground. The unit can now be rolled in this position as shown in **figure 1**.

LIFTING THE FURNACE UNIT

The furnace unit is heavy and may cause injury if lifted by one person. At least two physically able people should lift the completely cool furnace unit simultaneously if lifting it is required.

ASSEMBLING THE FURNACE UNIT

Minor assembly is required for the completed unit. To install the lid lifting lever remove the clip from it's hole in the base of the lever. Slide the round end of the lever onto the mounting stub on the hinge. Align the holes in the lever and the mounting stub. Slide the clip through the holes and secure it.



Figure 1: To roll the furnace on it's wheels grasp it with one hand on the front of the side rail and the other hand on the hinge area then tilt it back.

To install the burner turn the burner mount thumbscrew counter-clockwise until the burner tube can fit in the mount. Slide the burner tube into the mount so it enters the furnace about 2 inches as shown in **figure 2**. Turn the mount screw clockwise until it contacts the burner tube and holds it securely. Hand tighten the burner mount screw only.

PROPANE COMPONENTS

The components necessary are; the propane tank, regulator, propane hose, attachment fittings and an optional attachment is a propane pressure gauge.

Most hobbyists use the propane tank size designated as

the 20-pound tank. These are commonly used for gas barbecue grills. One of these tanks can be expected to give about 6 hours worth of melting time. But that is an approximation since some variables effect the time. Such as burner type and size. Larger propane tanks can be used as well.



Figure 2: *The burner pipe is held securely in the mount by a setscrew. The screw should be hand tightened only.*

The propane regulator is essential for safely using the "self-aspirated" burner design. Self-aspirated simply means that the burner provides it's own combustion air as compared to a "forced-air" burner which requires an air blower. Another name for the self-aspirated burner's is "atmospheric" burner because atmospheric pressure pushes air into the burner as a result of the vacuum created by the gas jet.

Only high pressure regulators will work with self-aspirated burners. One such regulator is shown in **figure 3**. And the regulator needs to be adjustable. The small regulator used on most gas grills will not work because they provide propane at

a low pressure (about 5 ounces). The pressures needed for these burners range from about 5 to 25 pounds PSI.

There are several sources for these regulators. Plumbing and welding supply stores will most likely have them but at a high price. However they will probably be high quality units and possibly contain a built in pressure regulator.

Lower cost high pressure regulators may be available from restaurant supply stores or camping catalogs. Some high output gas appliances such as cooking stoves and large fryers may require them. If you have trouble locating them locally there are sources for them on the internet. Do a search for "High pressure adjustable propane regulator."



Figure 3: *Here is a propane tank and an adjustable high pressure regulator is screwed into the valve with the propane hose extending to the left.*

The propane hose should be 10 feet long for safety. The black rubber propane hoses should be available at a fairly low cost. Custom lengths can often be fabricated by the seller. Since propane dissolves some types of rubber it is not safe to use hoses designed for other gasses such as natural gas or acetylene. Only hoses specifically designed for propane should be used. The ends of the hose should have brass fittings that match common pipe sizes. 1/4" nominal pipe size threads are very convenient. Sources for hose can also be found on the internet.

A propane pressure gauge is convenient for when you want to know exactly what pressure your burner is running at. However it is not necessary. The attachment fittings used will vary depending on the way you choose to attach the burner to the propane hose. Two methods are illustrated in **figure 4**.



Figure 4: *There are multiple ways to hookup a propane system. Here are two common ones.*

Both methods begin the same. The adjustable high pressure propane regulator is screwed into the valve of the propane tank. The gas outlet of the regulator is where the pressure gauge will be installed (if you choose to use one). If not the propane hose will screw into this spot.

The way the hose attaches to the burner is where the two methods differ. In the first method the propane hose has the end fitting (usually a 3/8" attachment) cut off and replaced with a 1/4" hose barb with male threads and secured with a stainless steel hose clamp. If your hose comes with 1/4" male threads on each end then the hose barb is not necessary. These threads screw into the 1/4" x 1/8" reducer on the burner's 1/8" fuel jet pipe.

The second method uses the hose barb to screw into a ball valve which is used for a quick shut off valve. The valve screws onto a short section of pipe called a "pipe nipple." The nipple then screws into the 1/4" to 1/8" reducer coupling on the burner.

The convenient thing about having the ball valve at the burner is that you can open the propane tank's valve and keep the ball valve shut. The when you're ready to fire up the furnace you can slowly open this ball valve to release the gas while keeping the propane tank safely away from the furnace.

A third attachment method which allows for quick burner removal from the propane hose is to use the quick couplers used for compressed air (pneumatic) hoses and tools. The female connector screws into the threads on the hose barb and the male end screws into the 1/4" to 1/8" reducer on the burner as shown in **figure 5**. Always check that there are no gas leaks.

PROPANE SAFETY RULES

Check all connections for leaks with leak detector or soapy water. If a leak is detected tighten the fittings. Teflon tape designed for gas fittings should be applied to all threads. If the leak can not be corrected do not use the system. Check burner for obstructions such as dirt, rust, metal splatter etc. Clear them away if present. Examine the propane hose for cracks or other damage. Replace the hose if necessary. For safety, replace the hose every two years.

Always use caution when igniting the burner. Keep all body parts as far away as possible and wear appropriate safety

gear. Keep the propane tank as far from the furnace as possible. The propane tank should be down wind of the furnace. This will blow any leaking propane away from the flame if a leak occurred. Always keep the propane tank in an upright position.

Never use a flame to check for gas leaks, keep children and pets safely away from the hot furnace or operating burner. Do not use the furnace without a regulator or with an improper regulator. Keep the propane tank's valve closed when not in use. And comply with all local, state, and federal regulations when operating this equipment.



Figure 5: *Quick couplers can be used on the propane line to make attachment and removal of the burner quick and easy.*

TONGS AND CRUCIBLES

There are three main types of crucibles used in a backyard foundry. The most common is a welded steel pot. This is basically just a section of pipe with a disk welded to the bottom. The disk should be 1/4" thick. The pipe can be 3 or 4" diameter for a small furnace.

Weld two 1/2" thick 3/4" long sections of steel rod to opposite sides at the top and a ring at the lower rear. The crucible can now be lifted straight up and out of the furnace with a special set of easily made lifting hooks that grab the stubs and ring as shown in **figure 6**.



Figure 6: This steel crucible with lugs is very convenient to use in a backyard foundry, and is easy to make with simple welds.

Small cast iron pots can also work well as a crucible. Even a welded steel pipe without the stubs or ring will work but for these crucibles a special set of lifting and pouring tongs are needed as shown in **figure 7**.

Iron and steel crucibles work well for normal backyard metalcasting. However certain aluminum alloys can be contaminated and weakened by iron picked up from the crucible. This isn't noticed in decorative or basic hobby metalcasting. However if you want alloys as pure as possible then a ceramic crucible is best. Ceramic crucibles can be made of either a clay-graphite mixture or silicone-carbide. Special tongs are needed for these ceramic crucibles and they must fit properly to avoid damaging them. Before using clay-graphite crucibles they must first be tempered to slowly dry them out. It's easily done by heating the crucible to about 250 degrees F. and maintaining that temperature for about an hour.



Figure 7: *These tongs are easy to make and work very well for plain crucibles.*

That can be done in the furnace with the burner at a low setting. Next the crucible is brought to a red heat and allowed to cool. It is now ready for use. This procedure should be repeated after long periods of not using the crucible.

Ceramic crucibles can vary by manufacturer but in general the crucible size is designated by the pounds of molten aluminum it can hold. So a #6 crucible will hold 6 pounds of molten aluminum.

Steel crucibles conduct heat faster and therefore pass it on to the metal to be melted quicker but they also oxidize and can deteriorate quickly if not protected. A product called "crucible or ladle wash" is available. They are materials that are brushed onto the steel crucible before each use. The material protects the steel from oxidation and can also prevent the molten metal from absorbing steel or iron if this is a concern. Sources for this material and ceramic crucibles are abundant online.

SETTING UP THE FURNACE

The furnace should only be used in well ventilated areas (outdoors is recommended) and at least 10 feet away from any flammable materials. Use the furnace on level ground on top of a bed of dry sand or loose dirt.

Do not use the furnace or pour metal over a bare concrete floor. Molten metal spilling onto concrete will cause moisture in the concrete to boil into steam and spray chips of concrete and hot metal.

Ensure that there is enough clearance around the furnace to walk around easily without obstacles. All molds, metal stock, tools and propane hose should be neatly organized for easy and safe access.

A supply of water should always be available to put out any unwanted fires from wood, paper or similar material. A fire extinguisher should always be available to put out any unwanted fires in materials not suitable for water extinguishing. Be sure to wear appropriate safety clothing and gear. This includes gloves, long sleeved shirt, jeans and work boots. Safety glasses or a face shield should also be worn. All clothing must be made of a natural fiber such as cotton. Synthetic fibers should be avoided since they melt when hot and could cause severe burns.

DIRECTIONS FOR USING THE FURNACE

Be sure that the furnace unit is in good working order. The lid raising lever should be installed properly and the burner secured hand tight in it's mount. Place the crucible on the plinth block centered in the furnace (figure 8). Loosely load the metal to be melted into the crucible. It must be loaded loosely because the metal expands as it heats up and melts. Tightly loaded metal can expand and damage the crucible.



Figure 8: *Here is the plinth block centered on the furnace floor. The carved bottom of the block covers the drain hole. The crucible sits on the plinth.*

With the lid raised prepare to light the furnace. An easy way to do this is to crumple a piece of newspaper and drop it into the furnace in front of the burner. With the lid still up off the furnace slowly open the gas valve allowing gas the enter the burner. The flames should ignite the gas. Turn gas valve as needed for proper burner functioning.

CAUTION: Igniting the burner with a crumpled wad of newspaper may result in burning pieces of paper floating out the furnace.

Once the burner is running properly lower the lid into position. If the burner did not ignite before the paper burned out allow the furnace to air out the gas fumes then repeat the procedure. If the flame extinguishes CLOSE THE GAS VALVE IMMEDIATELY. Let the furnace air out and then relight it.

If the burner will not stay lit the gas pressure at the regulator may be too high. Turn it down and retry the burner. On cold or windy days it may be difficult to ignite the burner reliably. In this situation you can soak a piece of charcoal in charcoal lighter fluid and ignite it in front of the burner. This burning charcoal should keep the flame burning until the furnace is warmed up. Let the burner run at a lower flame setting for 2 minutes to heat the furnace before turning it up to full operating flame.

If the burner produces a pulsating, "woopf... woopf... woopf..." type of sound there may be too much back pressure in the furnace. Try sliding the burner backward away from the chamber. If that does not solve the problem the gas pressure may be incorrect. The burner sound should be like a smooth sound of "rushing wind" or like a large torch.

Once the furnace is warmed up turn the burner up to full operating flame and allow the metal in the crucible to begin melting. At this point any other metal to be added to the crucible must be preheated by setting it on the furnace lid near the vent hole. Do not obscure the vent hole as this can cause excessive back pressure in the furnace and blow out the burner's flame.

The flame should not be pointed at the crucible. It should

enter the furnace on the side at a tangent and spin around the crucible as shown in **figure 9**.



Figure 9: *The flame should enter the furnace and swirl around the crucible, not directly contact it.*

Narrow pieces of metal can be added to the crucible by sliding it in through the vent hole in the lid. This method prevents excessive loss of heat. Larger pieces must be placed in the furnace by raising the lid and using charging tongs to lay it in the crucible. You may want to turn the flame down on the burner while adding new metal.

Thin pieces of metal (less than 1/8" thick) should only be added to already molten metal in the crucible. If such thin metal were added initially it would oxidize more resulting in more slag/dross and decreased useable metal.

DO NOT drop metal into the crucible. It can cause splashing of molten metal, tipping of the crucible or damage to it. Also set it in the crucible gently with tongs.

Once the last of the metal has melted in the crucible all-

ow it to sit in the heat an additional 3 minutes for aluminum and 4 to 5 minutes for brass/bronze. This process "super heats" the metal above it's melting temperature making it less likely to cool and solidify before the mold fills.

After the super heat, it is skimmed with the skimming tool to remove slag/dross from the surface. If melting is complete close the gas line to shut off the burner, remove the crucible and pour the metal, (figure 10).



Figure 10: *Pouring the metal with a simple set of pouring hooks designed to grasp two lugs.*

Ingot molds should always be available to accept the extra metal left over from pouring a mold. Ingots are simply blocks of clean metal. They can be stored easier than the plain scrap and can be put into a crucible as melting stock. Steel cupcake pans are popular for making small ingots. With some coated pans the ingots stick until the pan gets a layer or rust on it. Ingot molds can also be welded together from sections of angle iron. The size of the ingots should be what will easily fit in the crucible. It is recommended that the burner be removed from the hot furnace after shutting it down to prevent it from absorbing excess heat and being damaged.

When the propane tank comes close to empty a layer of frost will form on the bottom of the tank and the gas pressure will decrease. Propane gas is stored in liquid form and once the valve is opened it rapidly vaporizes into the useful vaporous form. To help solve this "freeze-up" problem the tank can be placed in a tub of warm water. NEVER try to heat a gas tank with flames, exhaust from the furnace or by setting the tank on or near the furnace.

DRYING OUT THE FURNACE

The furnace should always be kept dry. The drying procedure should be performed before the first use of the furnace, after a long period of disuse or if the furnace becomes very wet.

To dry the furnace safely attach the propane components to the burner. Install the burner in the burner mount and raise the furnace lid. Ignite the burner and let it heat the furnace chamber for at least ten minutes with the lid up. Lower the lid and allow the furnace to cool. This procedure prevents a buildup of steam pressure within the refractory which can blow out pieces of the refractory. Hairline cracks in the refractory are normal.

CLOSING WORDS

With your new furnace you have the potential to create a multitude of castings from otherwise useless scrap. Whether your goal is to cast artistic pieces, machine or model parts, pieces to an invention, "knick-knacks" or even items to sell, you have the equipment to do the job. Additional study and practice and maybe even added tools and materials will increase your potential and you may soon realize that you can do much more than once imagined. Have fun with your foundry and happy metalcasting!

KIT ASSEMBLY INSTRUCTION MANUAL

CAUTION!

SHEET METAL HAS SHARP EDGES, WEAR GLOVES!

FURNACE BUILDING KIT INSTRUCTIONS

INSPECTING THE PACKAGE CONTENTS

After receiving the package inspect all the contents. Most of the kit is assembled so it's more of just a matter of organizing everything to work on it. It is recommended that the kit be completed in the following steps;

- 1. Assemble brackets and fittings, tighten bolts.
- 2. Paint the furnace shell and cart.
- 3. Fill lid and furnace shell with refractory.
- 4.Cure the refractory lining.

ASSEMBLING THE HARDWARE

Lid assembly

These steps are simple. On opposite sides of the lid form there are "T" shaped brackets installed. Using two 7/16" or 11 millimeter wrenches tighten the bolts completely.

Next install the internal support ring through the holes centered in the lid form. About an 1/8" of the ring's mounting arms should extend out the sides of the lid form through the holes in the brackets. **Figure 1**. The lid can be set aside for now.

Main body assembly

There is no assembly needed for the main body.

The furnace cart

Until the cart is painted it should not be fully assembled. The wheels should not be on the cart during painting unless you want them painted also.

The lid raising lever should not be installed at this time either since it will be easier to set the cart upside down while painting it's bottom without the lever installed.



Figure 1: The bolts in the lid brackets can be checked and if necessary, tightened with a 7/16" or 11 millimeter wrench.

The burner

The burner is sent pre-assembled.

PAINTING THE FURNACE

The cart

The furnace cart can be painted any color. The official factory paint scheme is a semi-gloss black. Spray paint is quick and easy to apply. The entire cart should be painted. Most modern spray paints don't require a separate primer, but the surfaces to be painted should be cleaned of dirt, dust, oil and/or other foreign matter for a clean paint job. Setting the cart on newspapers makes the job neater. For best results apply at least two coats following the paint manufacturer's usage instructions. Don't forget to paint the bottom of the base rails!

Installing the wheels

Once the cart's paint job is completely dry the wheels should be installed. The wheels have a central hub on each side. The longest hub must face inward.

Slide one washer on the axle followed by the wheel and the second washer. Insert a cotter pin in the hole in the axle. Bend the cotter pin's legs to secure it. Repeat for the second wheel (figure 2).



Figure 2: Slide a washer and the wheel on the axle (long hub side first), install second washer and cotter pin. Bend the legs of the cotter pin outward to secure it.

Installing the lid raising lever

Remove the locking pin from the hole in the lever. Slide the round end of the lever onto the mounting stub welded to the cart's hinge. Align the holes in the lever and the stub. Slide the locking pin through the holes and secure the pin's clip.

Painting the furnace body and lid shells

Since the furnace shell can become very warm and even hot during furnace usage, regular paint may burn away. It's best to use a heat resistant paint. These paints are designed for use on barbecue grills, fireplace stoves and other hot objects. Only the outside of the shell must be painted.

Set the lid shell on a sheet of newspaper and spray the heat resistant paint on the outside. Also spray the lid brackets. The internal support ring should not be painted.

INSTALLING THE REFRACTORY

Before any refractory can be installed the inner forms must be made. The refractory is packed in around these forms. When the forms are removed they leave the necessary hollow areas (chamber, vent and drain) in the refractory lining.

The lid's vent form

The finished lid has a 3-1/2" diameter hole through the center to allow exhaust gasses to escape from. The form can be as simple as a 3-1/2" outer diameter section of sturdy mailing tube as in **figure 3**. You can even roll some flat cardboard into a tube. Nearly any 3-1/2" diameter cylindrical object could work. If a cardboard tube is used (probably the best choice) then it should be cut to 2-1/2 inches tall to match the height of the lid.

The main body chamber forms

The drain form

The main body of the furnace requires two forms. The first is for the drain hole which passes through the base, This hole drains away molten metal in case a crucible ever breaks or spills in the furnace. This form is similar to the lid's vent form but it is only 2" outside diameter and should be 2-1/2" tall, **figure 3** again.



Figure3: *The lid vent and drain forms are simple shapes and can be cut from appropriately sized mailing tubes.*

The chamber form

The inner chamber of the furnace is 8" in diameter and 11-1/2" deep. Therefore the chamber form must also be 8" in diameter and be 11-1/2" tall. I've discovered that the easiest way to make the form is to start with a pre-made concrete form tube. These are sold in hardware and home improvement stores. They are

simply large cardboard tubes which are buried in the ground (on a construction site) and concrete is poured into them. When the concrete is cured the result is a solid cylinder of concrete inside the tube in the ground. This concrete cylinder is used as footings for decks, sheds, porches and other small structures.

These tubes come in a variety of diameters. For this furnace an 8" diameter form is needed. I've noticed that sometimes even forms of the same designated dimension can actually differ in size by as much as 1/4" inch. So obtain a tube as close to exactly 8" outer diameter as possible and make sure it's also as stiff and sturdy as possible.

The tube must be reinforced on the inside when packing the refractory in the furnace, otherwise the tube will collapse inward or otherwise distort. To reinforce it, two plywood disks must be cut which exactly fit the inside of the tube.

Measure the inside of the tube to find the inner diameter, if the tube is distorted and not perfectly round then you should take several measurements from different positions and use the average.

Then using a compass draw two appropriately sized circles on 3/4" thick plywood. Cut the disks out with a jig saw or other available method. The disks should fit the inside of the tube without being too tight nor too loose. Once the disks fit you can set one aside as complete but the second disk should have two ovals cut out of it to form a handle (figure 4).

Secure the wooden disks into the ends of the tube with small nails. The form is now ready for use.

Centering guides and tamping stick

The form needs to remain centered in the furnace while tamping in the refractory. The best way to do this is to cut four strips of wood which will center the form as in **figure 5**.

Since each cardboard form may differ it is necessary to make these measurements custom. Measure the outside diam-



A = Exact inner diameter of your concrete tube form

Figure 4: *The form for making the central chamber is made from two plywood disks and a cardboard concrete form tube.*



Figure 5: Four centering guides cut from wood keep the central form centered as refractory is tamped into place.

eter of the central form and note the measurement. Since the inside of the furnace body shell is 13", subtract the forms outer diameter from 13". Divide the result by two. This is how wide each centering guide should be.

For example, if the outside of your form is exactly 8" diameter then subtract 8" from 13" (the inside diameter of the sheet metal body shell) the equation is;

13 - 8 = 5 then divide 5 by 2

5/2 = 2.5

Therefore the centering guides should be 2.5 inches wide and a good length for them is 14".

The tamping stick can be as simple as another piece of plywood cut to the size of the centering guides. All you need is a piece of material that you can use to tamp the refractory in the gap between the sheet metal shell and the central form.

Plinth block form

A plinth block is just a circular "brick" of refractory that is set in the bottom of the furnace and the crucible is set on top of it. The blocks are 3-1/2 to 4" diameter and 1-1/2" tall. A short section of 3-1/2 or 4" diameter plastic tubing, pipe or cardboard tube will work well for forming them.

Preparing the furnace shell

One last step is necessary before the refractory can be mixed and installed in the shell. The tuyere (tweere) hole cut into the lower section of the furnace must be completely covered with tape. Duct tape is the best for the job since it sticks securely and is waterproof. The tape stops the refractory from squeezing out of this hole. Once the refractory has started to harden the tape is removed and a passage is dug into the refractory through this hole until the passage reaches the central form. This passage will eventually be where the burner enters the furnace chamber to heat the interior.

THE REFRACTORY

The refractory is the heat resistant material that lines the inside of the shell. It's job is to contain the heat so that the metal can absorb it. There are two options for refractory.

Purchased refractory

The first option is to buy it pre-made. These factory made refractories are high quality and are usually sold in powdered form in sacs like cement. This is the recommended way to go. A specific amount of water is added and the mix is scooped up and tamped into the furnace shell similarly to how concrete is put into forms to create a sidewalk or similar structure.

These refractories are commonly referred to as castable refractory and are available in 50, 55, or 100 pound bags. Usually two 55 pound bags are needed to fill the furnace body and lid. A few pounds will be left over and should be used to make plinth blocks. But one 100 pound bag will also work. There are several manufacturers of these products. You can purchase them online or contact a distributor directly. The "sources" section of this manual will provide contact details.

Some refractory is rated for 3,000 degrees F and is more dense. For these you'll need three 55 pound bags.

Homemade refractory

There are several formulas for making your own refractory. It's usually agreed that homemade refractories don't last as long as the purchased type. One easy formula is; Portland cement (1.5 parts) Silica Sand (2 parts) Perlite (1.5 parts) Fireclay (2 parts)

A small bucket (2 gallon size) is the best thing to measure the components with. So since the sand calls for "2 parts" you'd use two buckets worth of sand. Portland cement would be 1.5 buckets worth. All using the same 2 gallon size bucket.

In case you're unfamiliar with some of the components here is some information.

Portland cement is plain cement powder and specifically says Portland cement on the package. It is mixed with sand and gravel to make concrete. It is also the main component in brick mortar. Portland cement should NOT be confused with "masonry cement" which usually has other components mixed in with it. You want plain Portland cement. It's available at home improvement stores and masonry supply dealers. It is usually sold inexpensively in 96 pound sacs. One sac is more than sufficient.

Silica sand is the same type of sand found at the average beach. It is also the type of sand used to make concrete or brick mortar. It is sometimes called "builder's sand." The best place to get clean silica sand is a home improvement store or masonry supply dealer. It is usually sold inexpensively in 50 pound sacs. Two sacs will be enough.

Perlite is a white, light-weight, odorless, sterilized, heat-expanded volcanic mineral. It's used in potting soil to loosen and aerate the soil. It works well in the refractory because it does not conduct heat well. Therefore more of the heat stays in the furnace where the metal can absorb it. It also makes the refractory lighter weight. The best place to buy perlite is a garden supply store. It is usually sold in bags containing 8 dry quarts. Four bags will do

the job.

Fireclay is a type of clay sold in dry powdered form. It is available from ceramics or some masonry supply dealers in 50 pound bags. One bag will do the job. For some reason some people in various areas of the country have trouble finding fireclay. Do not let anyone convince you that a product called "furnace cement" is fireclay. Fireclay is called Fireclay.

MIXING THE REFRACTORY

The best tools to mix the refractory with is a small hoe and shovel. The hoe will do the majority of the work of mashing the mix back and forth until it is evenly blended. A plastic concrete mixing tub is an ideal container to mix the materials in. A large tub about 4-feet long will hold the materials fairly easily, the smaller tubs may be harder to work with.

It's recommended that you wear rubber gloves when working with refractory. Since it is a form of concrete it can easy dry out your skin if left on it.

Since both the purchased castable refractory and the homemade refractory harden like concrete all your tools, the furnace shell and lid, and all forms must be ready and in position before you begin mixing the refractory. And also for this reason it is best not to begin mixing the refractory when you are tired, otherwise you may want to take a break when you should instead just finish the job. Also since you need to return after an hour or two to cut the tuyere passage, you don't want to risk falling asleep or forgetting to do so and ending up with rock hard refractory and no tuyere passage!

Mixing purchased, castable refractory

The factory made purchased refractory should be mixed according to the manufacturer's instructions. It will most likely be a looser mix than the homemade refractory which should be rather stiff. And like concrete it can harden rather rapidly (within 2 hours). So once it is mixed it needs to be installed without delay.

Mixing the homemade refractory

All your tools, the furnace shell and lid with forms must be ready and in position before you begin mixing the refractory.

The homemade refractory should be mixed in a specific order. Start by completely mixing the Portland cement, sand and perlite. These should be mixed while dry. It is likely that the sand will have some moisture in it and that is ok.

Be sure that these three components are completely blended and there are no spots of unmixed material.

Add a small amount of water. Very little water is needed, the amount varies depending on the moisture content of the sand. But you only want the mixture to be damp. It should be fairly stiff and clumpy.

Add the fireclay to the damp mixture. Mix it thoroughly until the mixture is completely uniform. Add just enough water to keep the mixture moist but still somewhat stiff. You DO NOT want a wet, soggy mixture. However it you get it a little too wet and the mix ends up very "gooey" and extremely sticky then it'll still work but it'll be more of a challenge to tamp into place.

The less water that you need to use the better. Because as the refractory dries, and especially when it is heat cured it will form small cracks. All refractory forms some cracks, hairline cracks are normal and are no problem but a mixture that is too wet is more likely to shrink and crack severely since there is so much more water that needs to evaporate out.

Once the refractory is completely mixed it should be tamped into the furnace shell without delay since it begins to harden with the cement in it.

INSTALLING THE REFRACTORY

Installing refractory in the main body section

Begin by setting the drain form in the hole in the base plate. Make sure it is in place securely. Dump a few scoops of refractory into the bottom of the shell onto the base plate and tamp it down smooth and level all around the drain form. Make sure the form stay's straight and centered. It is not necessary to tamp the refractory down as hard as you can, just get it in place securely and with no voids or air pockets.

Keep adding refractory to the base until a solid layer 2" deep is formed. This should equal the top of the drain form, **figure 6**.

Set the central form on top of the refractory in the base and center it. The top of the central form should be level with the top of the furnace shell. Slide the centering guides in place around the form to keep it centered. The four guides should be 90 degrees from each other, refer back to **figure 5**.

Dump a scoop of refractory in between each guide and tamp the refractory in place forming a wall going up the side of the shell. Don't try to work too fast. Tamp in only one or two inches worth of refractory at a time. Working systematically without rushing will produce a solid lining without voids and that is what you want.

Whenever you tamp in a new layer of refractory raise the centering guides and be sure to temp refractory in the gaps left by the guides. Once the refractory is halfway to the top of the shell you probably won't need them anymore since the refractory already tamped into place should do the job of keeping the form centered. But stay mindful to ensure that it doesn't sway off center. In addition make sure that the chamber form is not "floating" upward and being pushed up out of the furnace. You need the top of the central chamber form to stay level with the top of the shell.



Figure 6: The base is tamped in and must bee smoothened off before adding the central form seen on the left. Notice the void left by the drain form.

When the refractory lining is completely installed in the shell, the resulting furnace body will be very heavy (70+ pounds). So it is a good idea to slide the furnace shell into the cart when the refractory is only half complete. The reason it's done now rather than in the very beginning is because the furnace needed to be on a flat surface initially to keep the drain form from being pushed down out the hole in the base.

The seam in the furnace shell is to the back of the furnace. Raise the body up and slide it into position in the furnace cart. It will be necessary to first insert the furnace with the seam facing one corner so that the base fasteners will slide through the gaps in the corners of the side rail. Then once in the cart the furnace is twisted into the proper angle. With the shell in place in the cart you can continue tamping in the refractory without worrying about lifting a heavy furnace into place. Once the refractory has been tamped in all the way to the top, use your ramming stick or other suitable tool to scrape or "strike off" the top nice and flat. The main body is complete for now. Cover it with a sheet of plastic so it can begin it's chemical curing without drying too fast.

In an hour or two you must check the refractory for stiffness. Because once the refractory is stiff enough to support itself without slumping you need to remove the duct tape from over the tuyere hole and carve out the burner passage.

Installing refractory in the lid section

The lid will be completed much quicker than the main body, but the same focus and effort needs to be put into the lid to ensure it is made with solid refractory and without voids.

Starts by ensuring that the internal support ring is centered in the lid shell. The shell should be round without kinks and on a flat surface. The support ring should be horizontal and an equal length of the ring's mounting arms extend out of the brackets on each side of the lid form.

Set the lid's vent form in the center of the lid within the support ring (figure 7). Dump some refractory into the lid form and begin tamping it all around inside the form. Be sure that the refractory makes solid contact with the surface that the lid is setting on. This will ensure a solid bottom surface of the lid.

Dump in another scoop of refractory and tamp it in. The support ring must be completely surrounded by refractory. As with the main body, the goal is to form a solid mass of refractory in the form without voids or air pockets.

Once the lid form is filled strike off the top surface flat. Cover the lid with a sheet of plastic so it can begin it's chemical curing without drying too fast.

The plinth blocks

The remaining refractory should be used to form plinth blocks. Several blocks should be made since they are in close contact with the flame and therefore take a lot of abuse. Making the blocks is simple. Just tamp some refractory firmly into the plinth block form and then push the block out onto a flat surface.

When the blocks are firm enough to hold together a cross pattern should be carved into them as shown in **figure 8**. This pattern will allow spilled metal to flow to the drain hole. There for in use, the end of the block with this pattern is the block's bottom.



Figure 7: *Here is a comparison view of a completed lid on the left and on the right is a lid shell showing support ring and vent form.*

Carving the burner passage

After about an hour the refractory should be firm enough to support itself and not slump. You can determine this by tapping on the refractory at the top of the main body. If it feels firm and when you tap on it your finger does not push into it then it is ready.

Remove the tape from the tuyere hole. Using a spoon, dull knife or similar tool carve out the refractory directly visible in the tuyere hole. Carve the refractory away forming a passage the same width and height as the tuyere hole all the way to the central form.

The tricky part is to carve the passage at a tangent to the chamber form. When done correctly the passage will have the same oblong shape that the tuyere hole has as shown in **figure 9**.

Once this is done allow the refractory in the main body and the lid to cure and harden for at minimum 3 days. If you have the patience to wait a week then that's even better.



Figure 8: *The plinth blocks are easy shapes to form using a section of pipe or tube as a mold and carving the channels.*



Figure 9: *The tape must be removed from the tuyere hole and the burner passage carved in the refractory before it's too hard.*

FIRING THE LINING

Whether you used a purchased refractory or a homemade one it is necessary to SLOWLY heat the refractory to remove the moisture from it. If you do this step too quickly the moisture in the refractory could build up intense steam pressures internally which can blow out chunks of the refractory.

Therefore a slow "simmering" type fire is needed. The easiest way to accomplish this is to light a fire of wood and paper in the bottom of the furnace. The fire will probably create a noticeable amount of smoke so if you're in a sensitive area you may want to instead use barbecue grill type charcoal.

Punch a hole in the chamber form by pushing a sharp object through the tuyere hole passage. This will help air to pass through. If you can manage to remove the top plywood disk from the form without damaging the refractory then you'll have an even easier time at firing the lining. Otherwise it'll just burn out, or you'll be able to remove it with a wire hook after a few minutes of the fire burning away the cardboard form tube.

Keep adding cardboard, dried twigs and other thin pieces of wood to the fire for about ten minutes once there is a nice blaze going. At this point the lid should NOT be on the furnace, the goal is to give the main body a chance to get an initial drying.

Let the fire burn out completely and let the furnace cool completely. Once cool clean out any ashes and coals. Inspect the lining of the furnace. The central form should be burned away except possibly for part of the bottom plywood disk. It should be possible for you to remove the remaining section of this disk by installing a screw and lifting it out.

If there are any flaws in the lining a small batch of refractory can be mixed and packed into them before the firing is completed. Before beginning the next firing step the lid should be installed on the furnace. To install the lid set it on the furnace body with it's seem also facing back. Align the holes in the brackets on the lid lifting arms with the holes in the lid brackets. Install the bracketry hardware in the way shown in **figure 10**.

If the lid lifting lever is not already installed, do so now. Press down on the lever until it contacts the ground to hold the lid up. If the furnace was scratched while installing it in the cart it can be touched up with the spray paint.

After patching the flaws, if any, and installing the lid, begin the slow firing process again with a wood, cardboard and paper fire. Get a nice blazing fire going.

Drop some charcoal into the furnace until the furnace is about half full. Once all the coals have ignited lower the lid into position on the furnace. Let the furnace sit this way for an hour so the heat can begin slowly drying the lid.

For the final firing of the furnace you will need a small air blower. A handheld hair dryer will work and if used, it should be set on a setting where only air will blow out without heat. This will preserve the life of the hair dryer.



Figure 10: *The lid is attached to the lifting arm with a pin, two washers and a cotter pin. Notice the spacer between the lid bracket and arm bracket.*

Set the blower about a foot away from the furnace but aim the air stream straight into the tuyere hole. The flames should really pick up and start blowing out of the lid.

At this point you can either keep adding sticks to the fire or you can use more charcoal. As the sticks burn down to coals add more.

During this time a lot of steam will be coming out of the refractory. You may even see water dripping out the bottom of the furnace. This is all normal and it is what you want. Keep this fire going for about one or two hours or until steam stops coming from the furnace and lid. Shut off the blower and let the furnace cool completely. At this point the firing of the lining can be considered done and the furnace can be used to melt metal with it's propane system. Follow the instructions in the furnace user's manual for setting up the propane system. Inspect the lining again after the furnace has completely cooled. Most likely some hairline cracks will have formed. This is normal and is nothing to be concerned about. Cracks form is every type of refractory. It's a consequence of the refractory requiring water for mixing and the water evaporating out. This helps to explain why adding too much water is not good for the refractory.

THE KIT IS COMPLETE

After the refractory is completely cured the kit is complete. The propane burner can be installed and the propane line and other components can be connected. Refer to the furnace user's manual for instructions in this stage.

Additional Assistance

If you have any questions about the furnace kit, usage, or metalcasting in general visit; **www.BackyardMetalcasting.com**

On the website there is an abundance of metalcasting information and examples as well as a message forum where metalcasters of all experience levels can post questions comments of photos of their backyard foundry!

Closing words

With you new foundry furnace you have the potential to create a multitude of castings from otherwise useless scrap metal. Whether your goal is to cast artistic pieces, machinery components, model parts, pieces to an invention, decorative "knickknacks" or even items to sell, you have the equipment to do the job. Additional study in the topic as well as practice and maybe even added tools and materials will increase your potential and you may soon realize that you can do much more than once imagined. Have fun with your foundry and happy metalcasting!