How to Construct a 6” Core for Flooding

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Table of Contents

Chapter 1:
Parameters of the Core

When determining which method to use for preparing a core for flooding ask the following questions:

1. What material is the core plug made out of?
2. Will the core be a solid plug or fractured?
3. What pressures will be put on the core?

Use the table below to determine how the core should be prepared based on the answers to the above questions.

1. What material is the core plug made out of?	**2. Will the core be a solid plug or fractured?**	**3. What pressures will be put on the core?**	**Use the following parameters**		
			butter-coat material	Core sleeve material	Casting material
Synthetic*	Solid	Low	Rescue tape	Teflon or Nylon	Sikadur 35 HiMod epoxy
Synthetic*	Solid	Low	Duralco 4525	Teflon or Nylon	Sikadur 35 HiMod epoxy
Synthetic*	Solid	High	Duralco 4525	Teflon or Nylon	Sikadur 35 HiMod epoxy
Rock	Solid	Low	5 min epoxy	Teflon or Nylon	Sikadur 35 HiMod epoxy
Rock	Solid	Low	Duralco 4525	Metal	Cerrotru
Rock	Solid	High	Duralco 4525	Metal	Cerrotru
Rock	Fractured	Low	5 min epoxy	PVC pipe	Sikadur 35 HiMod epoxy
Rock	Fractured	Low	Duralco 4525	Metal	Cerrotru
Rock	Fractured	High	5 min epoxy	PVC pipe	Sikadur 35 HiMod epoxy
Rock	Fractured	High	Duralco 4525	Metal	Cerrotru

** The synthetic material most commonly used at the PRRC for the Reservoir Sweep Improvement Group is composed of Polyethylene made by Pore Technologies.*

For argument sake lets say low pressure cores will be cores that have an expected pressure less than 200psi, and high pressure cores are cores that will have pressures above 200psi put on them.

Some things to note before getting started:

1. Instructions are for dry cores. Water can dissolve uncured epoxy (marine epoxy is the exception as it is designed to be applied to/in wet conditions), so if the core is wet Rescue Tape or Marine Epoxy will have to be used for the butter-coat. Wet cores have to be cast in a specific way which is not covered in this manual.

2. These are general instructions, and one should always remember that depending on the end use of the core things may have to be tweaked.

3. These instructions are for cores that will have any and only the following items injected in to them:
    a. Brine
    b. Water
    c. Polymer
    d. Gel
    e. Soltrol or any other light oil

The following chapters explain in detail the steps in making a 6” core for flooding.

Chapter 2:
Pre-Butter-Coating

Make sure the rock or synthetic core is cut to a length slightly larger than the sleeve (about ¼ "- ½ " longer than the sleeve), and dry.

*If using a rock as the core material make sure it has been cleaned and dried. To clean the rock run tap water over it until the water runs clear and then rinse it with distilled water. **DO NOT use soap or a sponge on the rock:** sponges have cleaning agents built in to them and they can have left over soap from a previous use in it, either way no one wants surfactant in the rock. Place the rock in an oven to dry over night; it will take 24 hours for a rock to dry completely in an oven set to 41^{o}C.

On the left is a metal sleeve and on the right is a Berea Sandstone core that is ¼" longer than the sleeve.

Chapter 3:
The Butter-Coat

The first thing that is done to the core is a butter-coat is applied. There are three different types of butter-coats, to determine what type of butter-coat should be used refer to the table on page 4.

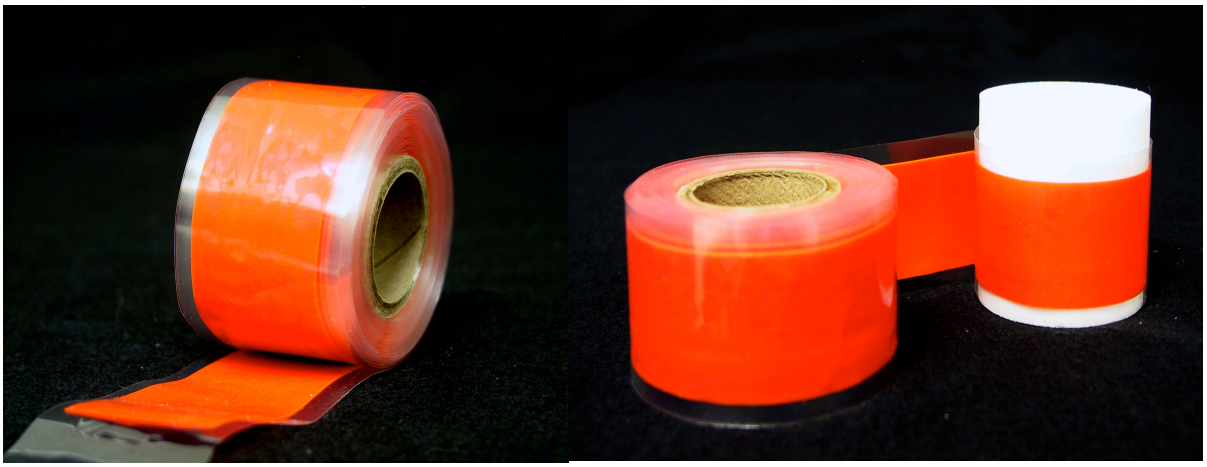
This step is crucial to get right. If there are any pinholes anywhere in the butter-coat then the casting material can leak into the core which will result in the core being completely saturated with casting material.

If a pinhole is noticed or suspected anywhere on the butter-coat it is worth time to take an extra few minutes to apply more butter-coat material to that area.

Before getting started please note the following:

- ALWAYS WEAR GLOVES WHEN USING EPOXY!
- When using epoxy (5 minute or the Duralco 4525) for the butter-coat put wax paper down on the surface being used; epoxy does not stick to wax paper but will stick to the counter.
- When using the Duralco 4525 epoxy please note that there is a 24 hour curing period between coats so if a low pressure will be applied to the core it will be more time efficient to use the Rescue Tape (cure time 1 minute) or 5 min epoxy (cure time is approximately 15 minutes until dry and 1 hour until it reaches full strength).
- When casting with Cerrotru the only butter-coat material that can be used is the Duralco 4525. The 5 minute epoxy can not withstand the high heat of the Cerrotru.
- The curing process of epoxy is based on a chemical reaction so environmental conditions can effect how long it takes for the epoxy to cure. A cold room can slow down the reaction. A humid room can keep the epoxy from completely curing as the humidity can break the chemical bonds much the same way water does with uncured epoxy. For best results a dry, warm room should be used for the epoxy butter-coating step.

Rescue Tape:



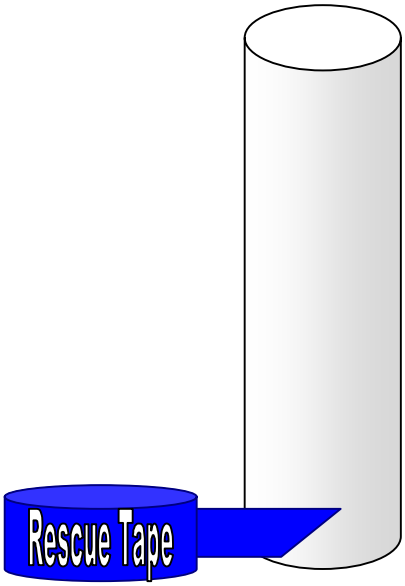
Rescue Tape is a self-fusing silicone “tape”. There is no sticky residue on the tape since it only fuses to its self. Rescue Tape is great on cores that need to be made up fast. Not enough tests have been done to determine how it reacts with the Cerrotru, the concern is if the tape melts there could be holes and the Cerrotru can penetrate in to the core. At the time that this manual is being written Rescue Tape is only being used on cores that will be cast in Sikadur 35 HiMod epoxy, and run at “low” pressures.

It takes one roll of 1” wide by 12’ long Rescue tape to wrap a 6” core. Rescue Tape is available in many colors. From experience it has been determined that white or clear Rescue Tape should not be used as it is difficult to see if the core is fully covered. Dark or bright colors are recommended for this application.

To apply the Rescue Tape to the core wrap the tape around the outside of the core by stretching and overlapping the tape on its self by 50% so that ½ the width is covered by the next wrap. Stretch the tape at least twice the length for the best fusion. The tighter the tape the quicker and stronger it fuses. Wrap the tape around the circumference of the core wrapping from the bottom to the top of the core and then back down to the bottom. For the ends wrap the tape all the way around the length of the core covering both ends. Check and make sure no part of the core is visible. There should be at least three layers covering the core once the wrapping process is done.

It is important to wrap the tape in the direction as instructed in this manual as this particular order reduces the chance of fluid flowing between the core and the Rescue Tape sleeve during the flooding process.

The following illustrations show the steps that the Rescue Tape should be applied.



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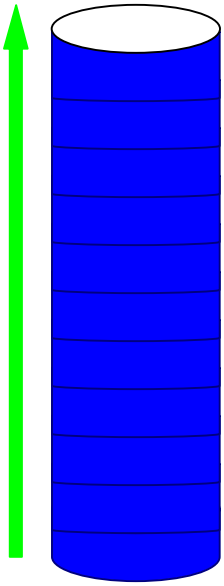

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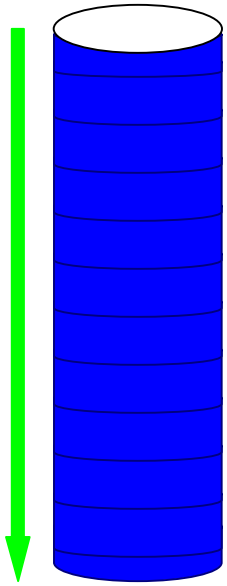

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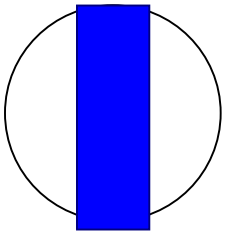

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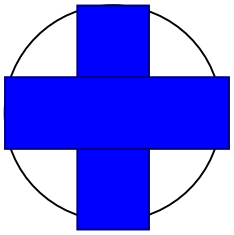

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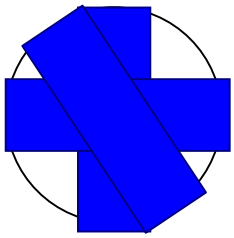

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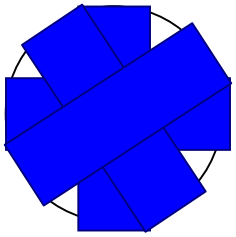

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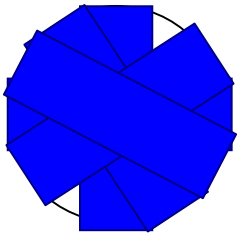

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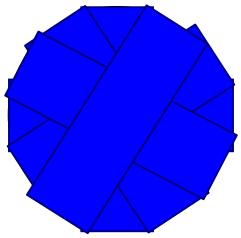

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Finished

5 minute Epoxy:

Place wax paper down on the surface that is being used. Mix one part A to one part B of the 5 minute epoxy. The epoxy is mixed when it turns a milky color. Coat the entire core in epoxy and let cure; note do not apply thick layers as multiple layers will need to be done. Repeat 3 times, but no more than 3 times. Inspect that there are no pin-holes, or bare spots.

On the left is a piece of uncoated Berea Sandstone on the right is a piece of Berea Sandstone coated in 5 minute epoxy. The yellow color is normal as the epoxy is yellowish when cured and is a brighter yellow when there are multiple layers.

Duralco 4525 Epoxy

Duralco 4525 epoxy is considered a high temperature resistant epoxy meaning it can withstand very high heat up to 500^{o}F which is ideal for a metal casting. The down side to using the Duralco 4525 epoxy is it takes 24 hours for each application to completely cure. Since at least 3 layers of butter-coat need to be applied, it will take at least 3 days for this step.

Place wax paper on the surface being used. Mix 100 parts of resin, by weight, to 8 parts hardener, by weight, and stir thoroughly. The epoxy is completely mixed when it feels more watery while being stirred (it will be very hard to stir the black resin before the hardener is added). Using an “acid brush” (which is a sturdy, cheap, disposable paint brush which will be thrown out after each use) coat the entire core in epoxy and let cure; note do not do thick layers as multiple layers will need to be done. Repeat at least 3 times. Inspect that there are no pin-holes, or bare spots.

Once all of the Duralco 4525 layers have completely cured sand off any puddles that have formed at the base of the core with a stationary belt sander, and then bead-blast the entire core so that the surface is rough; if the Duralco 4525 surface is not roughed up the casting material will not stick to the butter-coat properly. Check the core again for pinholes. If you can see any part of the core underneath then you need to apply another coat of the Duralco 4525 and once cured, bead blast it again.

On the left is a piece of uncoated Berea Sandstone on the right is a piece of Berea Sandstone coated in Duralco 4525 epoxy and has been bead-blasted and the bottom edge has been sanded on a stationary belt sander.

A Fractured Core:

When making a 6” fractured core there are many approaches that can be used. The easiest by far is to do the butter-coat in the same style that would be done for the long fractured cores: see *How to Construct a Core for Flooding* manual by Kate Wavrik, 2003. Depending on what sleeve will be used to cast the core in, modifications to the instructions may have to be made.

If the 6” fractured core is expected to experience normal or low pressures make it just like a long core (see the *How to Construct a Core for Flooding* manual for instructions) and cast the core in PVC pipe.

If abnormally high pressures are expected on the 6 inch fractured core then casting the core in a metal or nylon sleeve would be ideal. Follow the instructions for applying the nylon mesh to the outside of the fracture as demonstrated in the *How to Construct a Core for Flooding*, however extend the mesh around the inlet and outlet of the core so that when the butter-coat step is done the entire core is encased in epoxy.

If phenomenally high pressures are expected do the mesh step using the Duralco 4525 epoxy. It will take a lot of time to get the fracture covered in the mesh but once done the core can be cast in Cerrotru. Draw a line on the core where the fracture is (a white-out pen will work for this) as the fracture location needs to be known so that it can be lined up parallel to the pressure taps.

If pressures are expected to be higher than what a core in PVC pipe can withstand (approximately 300psi) but not high enough that it would need to be cast in Cerrotru then 5 minute epoxy can be used for the butter-coat (and mesh) and the core can be cast in a nylon or Teflon sleeve using Sikadur 35 HiMod epoxy.

Chapter 4:
The Core Sleeve

All the core sleeves used for the 6” cores are reusable. Each sleeve can be reused hundreds of times before it is retired so long as the appropriate casting material is used in the sleeve. The sleeves are made from Teflon, nylon or metal.

The sleeves have the following dimensions regardless of the material they are made of:

- Total Length approximately* 6”
- OD approximately 2.5”
- ID approximately 2”
- 1st pressure tap located approximately* 1” from the end
- 2nd pressure tap located approximately* 1” from the opposite end (4” from 1st pressure tap)

**The cores are faced off after they are cast which shaves a smidgen off the total length of the core. Over time the cores will be shorter than 6” and the pressure taps will not be quite 1” from either end. Due to this known issue the length of each core used needs to be measured each time as well as measuring the pressure tap distances.*

Depending on the use of the core there are some sleeves that have an extra pressure taps drilled 90° from the 2nd pressure tap; these sleeves are designed for fractured cores and the extra taps are the matrix taps.

Picking the appropriate sleeve

When choosing which sleeve to use think of which casting material will be used and what the core is made of. Please reference the table on page 4.

For a nylon or Teflon sleeve only the Sikadur 35 HiMod epoxy can be used for casting.

For a metal sleeve only the Cerrotru can be used for casting.

The **synthetic cores** will melt with high heat so they can not be cast with the Cerrotru so they have to be cast with Sikadur 35 HiMod epoxy which means they **will *always* be cast in a nylon or Teflon sleeve or a Schedule 40 PVC pipe.**

Rock can be cast in a nylon sleeve, however it is customarily cast in a metal sleeve even if the expected applied pressures might be considered low. Since rock can withstand high pressures to begin with, by casting it in metal the result will be the strongest core possible.

On the left is a nylon sleeve on the right is a metal sleeve.

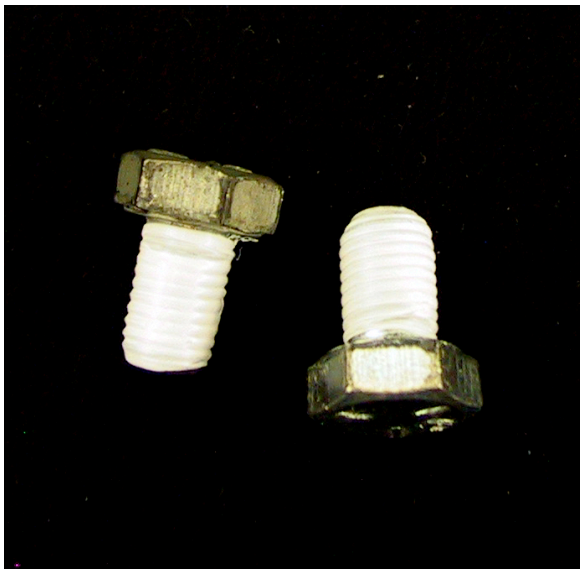
Prepping the sleeve:

The metal sleeves will rust naturally over time. The rust is easily removed with the bead-blaster. It is also important that all Cerrotru from the previous casting is removed from the inside of the metal sleeve. The Cerrotru can be removed by bead-blasting the inside of the sleeve. Once bead-blasted clean the sleeve, inside and out, with compressed air (do not wash as water will just cause the sleeve to rust) to make sure all of the "dust" and bead-blasting residue is removed from the surface.

Any markings made with a Sharpie on the nylon or Teflon sleeves can be cleaned off with acetone or Isopropyl Alcohol.

In order for the casting material to stay inside the sleeve the pressure taps need to be plugged up. This is easily done with some bolts that have the threads covered in Teflon tape (standard white plumbing Teflon tape will work fine).

Make sure all of the threads are covered with the Teflon tape before tightening them into the sleeve.



If there is a threaded hole in the sleeve there should be a Teflon covered bolt in it.

Chapter 5:
Casting the Core

The setup used for casting the core is the same regardless of what casting material is used. There are two pieces that are used specifically for Cerrotru and two pieces that are used just for the Sikadur 35 HiMod epoxy. All of the parts to make the device used in the casting process can be purchased and machined in a moderately equipped machine shop.

The above picture shows how the set up looks right before casting.

The pieces of a casting holder

Quantity 4 of 10.5” long (minimal) threaded bolts.

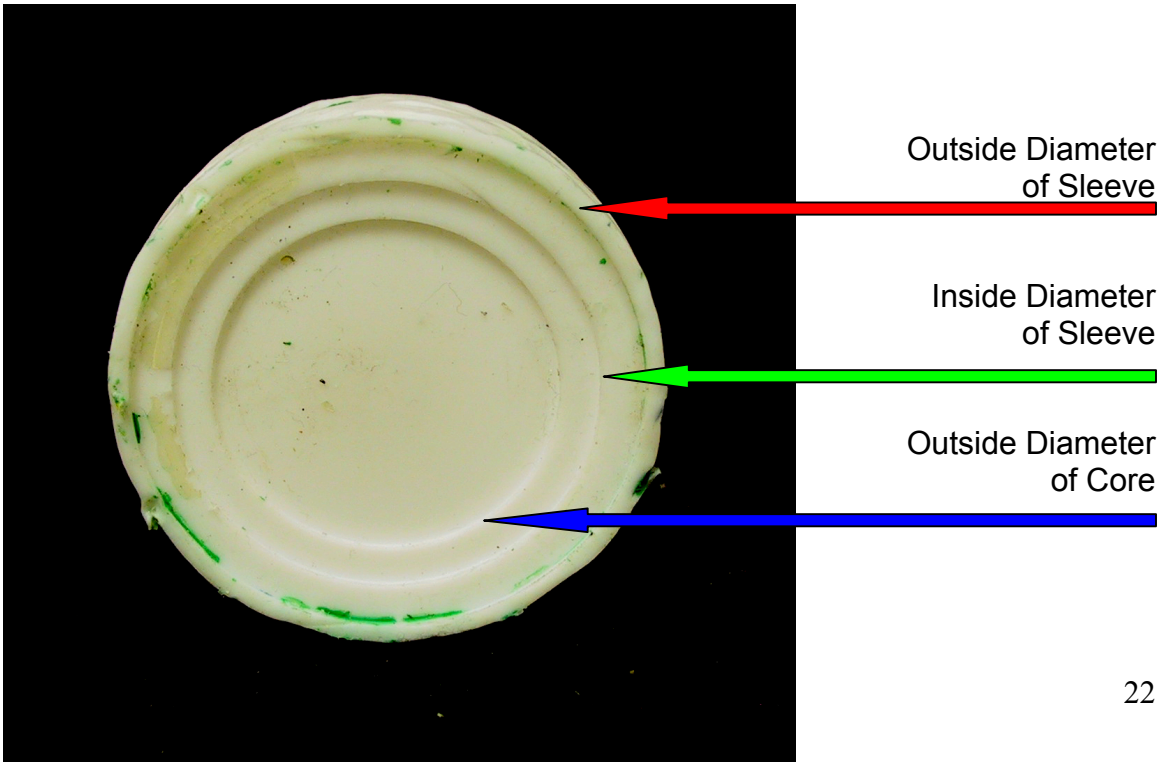
On the left is a view looking down on the base holder, and on the right is a side view of the base holder.

The base holder is comprised of a metal disk and a piece of Teflon. The large hole in the center of the Teflon is the diameter of the base that goes on the bottom of the sleeve. There are 4 bolts holding the two pieces together. Over

time the Teflon will begin to curl from the heat exposure, the 4 bolts are what keeps the Teflon from completely deforming. There are 4 equally spaced holes (90^{o}) that are slightly larger than the OD of the threaded bolts.

On the left is the side view and the right is the front view of the sleeves casting base.

The base unit is made out of a piece of Teflon. Notice there is a center circle and 3 outer rings on it. On the left side of the picture it can be seen that each ring is set at a different depth. Each ring is 1-1.5mm shorter than the previous ring with the center circle being the lowest point. The center circle is slightly larger than the OD of the core. The 1st ring around the circle is the equivalent to the ID of the sleeve. The 2nd ring around the circle is the equivalent of the OD of the sleeve. The last ring is a lip to keep any casting material from leaking out of the bottom of the sleeve; the lip will fit snuggly around the outside of the sleeve.



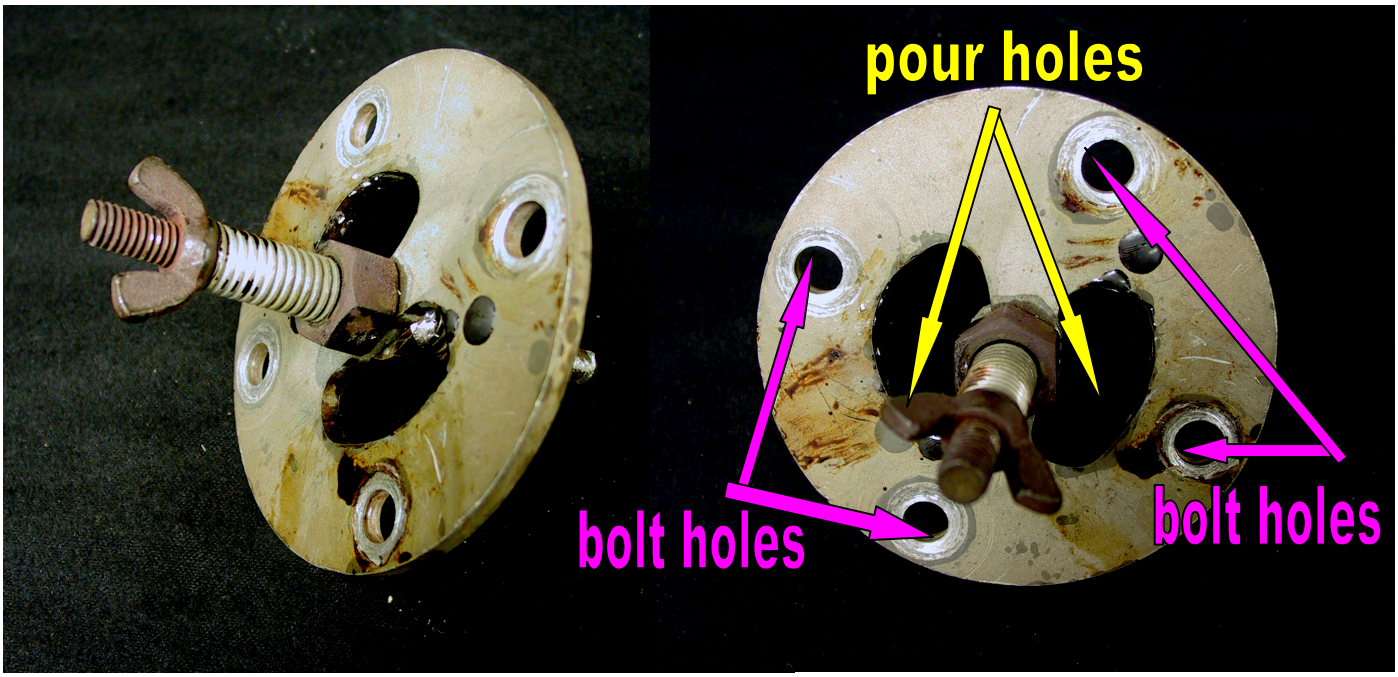
The sleeve is made of metal, Teflon, or nylon, with Teflon covered bolts in the sleeve.

The spacer ring is easily fabricated in a machine shop. The ID of the ring is the same as the ID of the sleeve. The top and the bottom of the ring fit snuggly around the tube and the OD of the sleeve respectively. The sides are a bit beaten up due to years of hammering the spacer ring off the finished casting. Because the spacer ring will get casting material all over it, it is best to have two spacer rings available made of appropriate material for each type of casting material. The spacer ring is made of a soft metal for Cerrotru castings and it is made of Teflon for Sikadur 35 HiMod epoxy castings.

Simple tube.
Object in photo is upside down

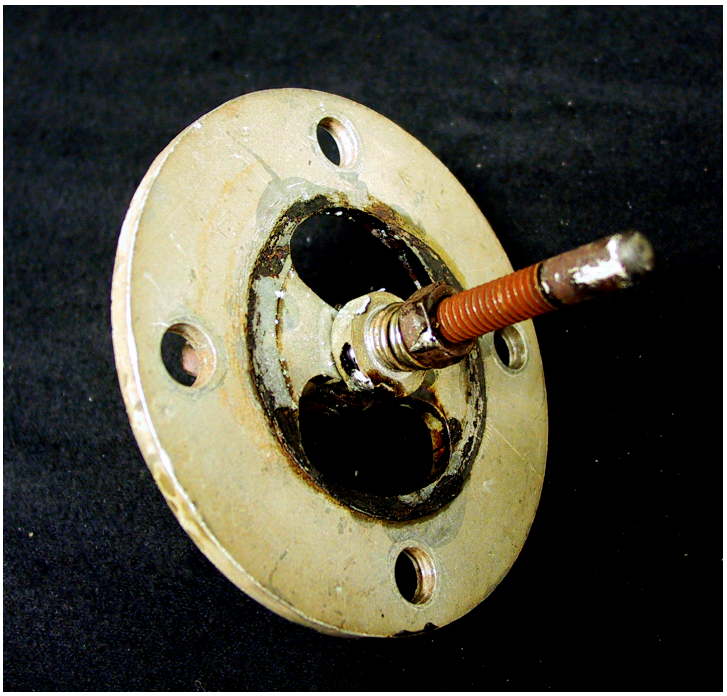
Between the spacer ring and the stabilizer is a simple tube just in case the casting material is poured past the spacer ring. This piece is constructed from some left over metal pipe, and the spacer ring fits snuggly around the outside of the tube. Much like the spacer ring it is recommended to have two of these pieces, one for each type of casting material. Unlike the spacer ring the two pieces can be made of the same material.

Just like the spacer ring the tube has been beaten up from hammering the piece off after the casting process.

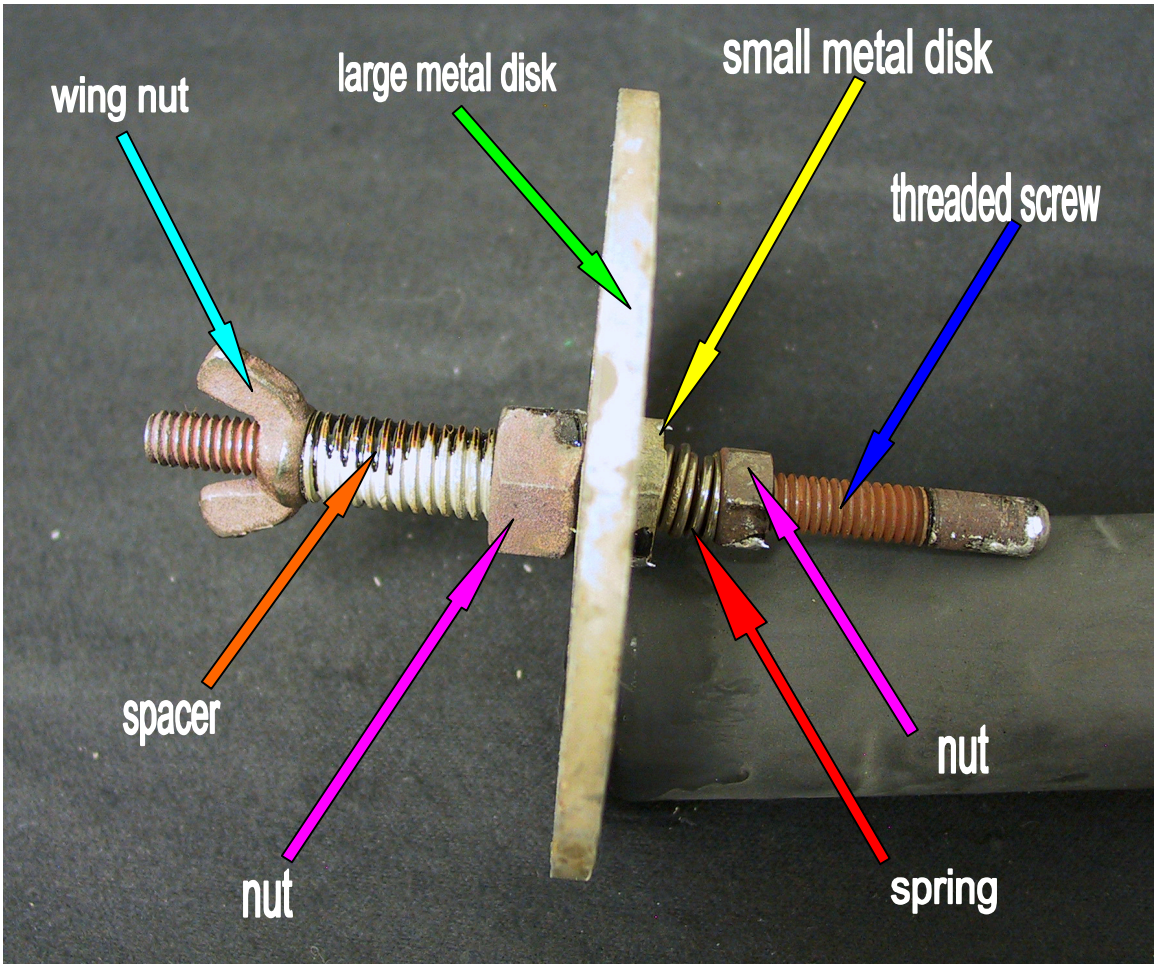


Top view of the stabilizer.

The stabilizer is easily fabricated with the use of a large metal disk, a small metal disk, a threaded screw, a spring, a spacer, 2 nuts, and a wing nut.



Bottom view of the stabilizer.



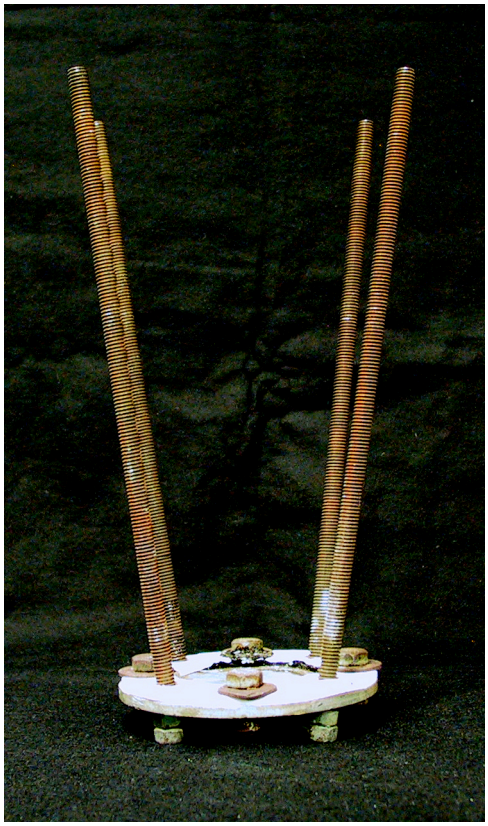
Side view of the stabilizer.

There are 4 holes that are slightly larger than the OD of the threaded bolts, equal spaced 90^{o} apart just like on the base holder. 2 pour holes have been cut in the metal disk. The center consists of a screw-spring contraption that will keep the core centered with enough force pushing down on the core that it will not float once the casting material has been poured in. It is adjustable to fit any core height.

4 wing nuts are used to hold everything together.

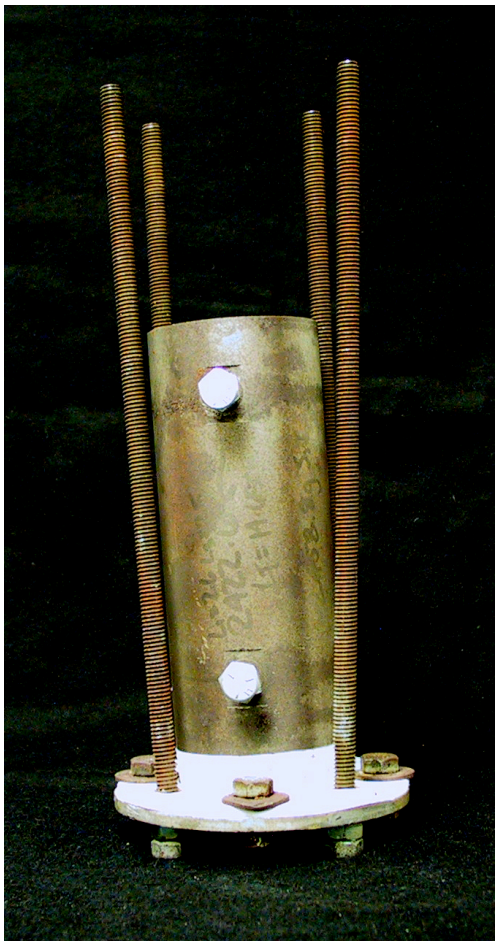
Assembling the core in the casting holder

Put the threaded bolts in the bottom of the base holder. ***Make sure the nuts on the threaded bolts are on the bottom of the base holder.***



Place the base on the base holder.

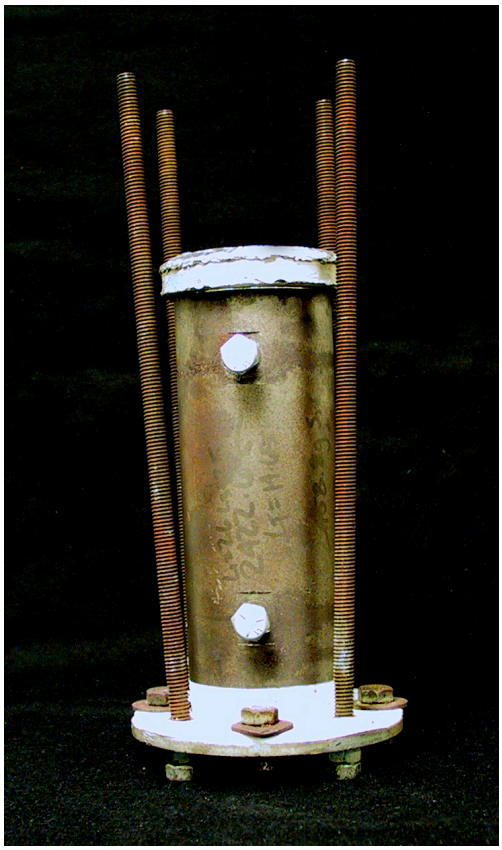
Place the butter-coated core in the center of the base.



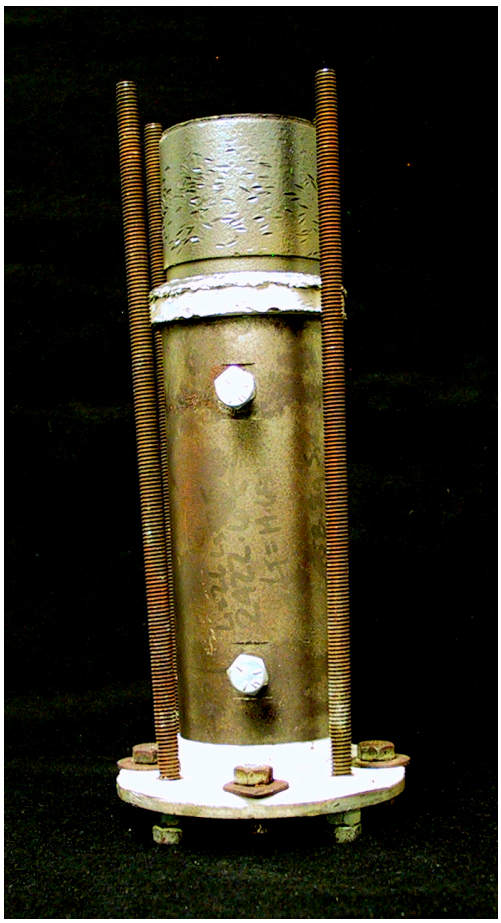
Place the sleeve, with the Teflon coated bolts, around the core. The bolts may have to be loosened if they are pushing on the core. The core needs to be centered within sleeve. The bolts can be touching the core, but not pushing on it. For best results the tip of the bolts should be approximately ½ mm from the core.

When casting a fractured core it is important to make sure the fracture is lined up with the pressure taps going down the center of the sleeve, and that the matrix taps are 90^{o} from the fracture. This is why it is important to mark the core where the fracture

is after the butter-coat process.



Place the spacer ring on the sleeve. Make sure the spacer ring fits snuggly around the sleeve, and is flush against the sleeve, if it is not the casting material will leak and it will result in part of the annular, the space between the core and sleeve, to not be filled.

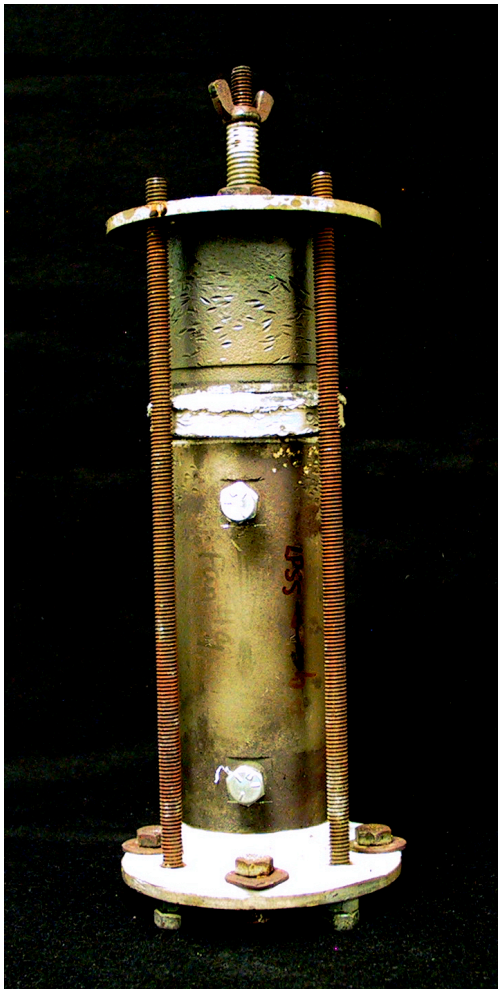


Place the tube on top of the spacer ring. Make sure the spacer ring fits snuggly around the tube, and that the tube is sitting flat against the spacer ring.

Placing the stabilizer on the tube is the most complex part of assembling the core casting holder.

The spring needs to be compressed completely which is done by tightening the nut below the spring. Once the spring is compressed, place the stabilizer on top of the tube with the threaded bolts going through the appropriate bolt-holes. The bottom of the screw on the stabilizer should almost touch the core (within 3mm) and the stabilizer should be flush against the tube. If the stabilizer is not flush against the tube then the length of the screw will need to be adjusted by decompressing the spring and adjusting the nuts as to shorten or lengthen the distance of the metal disk to the end of the screw. Once adjusted compress the spring again.

Keep doing this as needed until the Bottom of the screw almost touches the core (within 3mm) and the stabilizer is flush with the tube.



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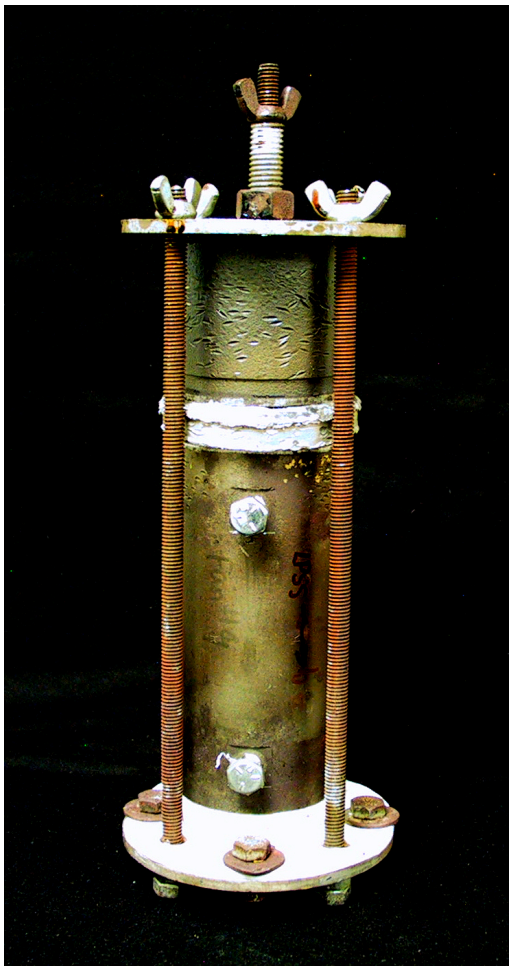
Once the stabilizer plate is in place add the 4 wing nuts to the threaded bolts. When putting on the wing nuts add them one at a time and only hand tighten them until they make contact with the stabilizer plate. Once all 4 wing nuts are on, tighten each one down, moving in a butterfly pattern (see page 44 for example), a little at a time until all of the wing nuts are completely tightened.



Using an object such as a glass stir rod, make sure the core is centered inside the sleeve. If the core is not centered it can be adjusted using stir rod to push and hold the core in the center; this is why it is important to have a little bit of clearance between the bottom of the screw on the stabilizer plate and the core.

Once the core is centered, loosen the wing nut on the screw of the stabilizer plate. This will cause the spring to decompress and the screw will push firmly against the core.

If everything has been done properly the core holder will not leak during the casting process, and the core will not move.

If the core sleeve is made of nylon or Teflon there is one final step in the assembly process.

Place children's modeling clay (or any other type of clay that never sets regardless what conditions are present) around the seam where the sleeve and the base meet. Make sure the entire seam is covered. Push the clay into the seam to insure there are no pinholes. The addition of clay will prevent the casting epoxy (Sikadur 35 HiMod) from leaking out of the sleeve.

The reason this step is unnecessary if the core sleeve is metal and Cerrotru is the casting material is the Cerrotru sets faster than the Sikadur 35 HiMod epoxy.

So if there were any pinhole spots they would most likely be plugged quickly, by the cooling Cerrotru.

Pouring in the casting material

Cerrotru (for METAL sleeves ONLY)

For safety reasons while casting with Cerrotru the following must be worn: oven gloves, long sleeve shirt or lab coat, long pants, sturdy shoes (i.e.: leather boots or running sneakers that have leather like material on them) that completely cover the foot, safety glass, and, if desired, a face shield.

Before pouring Cerrotru into the metal core sleeve, place the entire core casting set up in the oven that the Cerrotru is melting in. Ideally the core should sit in the oven overnight. It is important that the core and sleeve are the same temperature as the molten Cerrotru as this will prevent bubbles and unnecessary void zones around the core as the Cerrotru cools. It is also important that the core is completely dry. If there is any moisture in casting area when the Cerrotru makes contact with it there will be an eruption, for lack of a better description, of Cerrotru out of the casting device which will splatter all over the pourer. Cerrotru when melted is very hot, 281^{o}F, so **wear oven gloves**, keep moisture away from the core, and make sure the core is the same temperature as the molten Cerrotru.

Once the core is to temperature take a large piece of tin foil and fold it down to a 6” x 6” square (should be at least 2-3 layers thick). Fold the edges of the tin foil up so it looks like a small tin foil tray. This tray is what keeps the Cerrotru from covering the counter if there happens to be a pinhole leak anywhere. The Cerrotru will not stick to the tinfoil but it will stick to the counter.

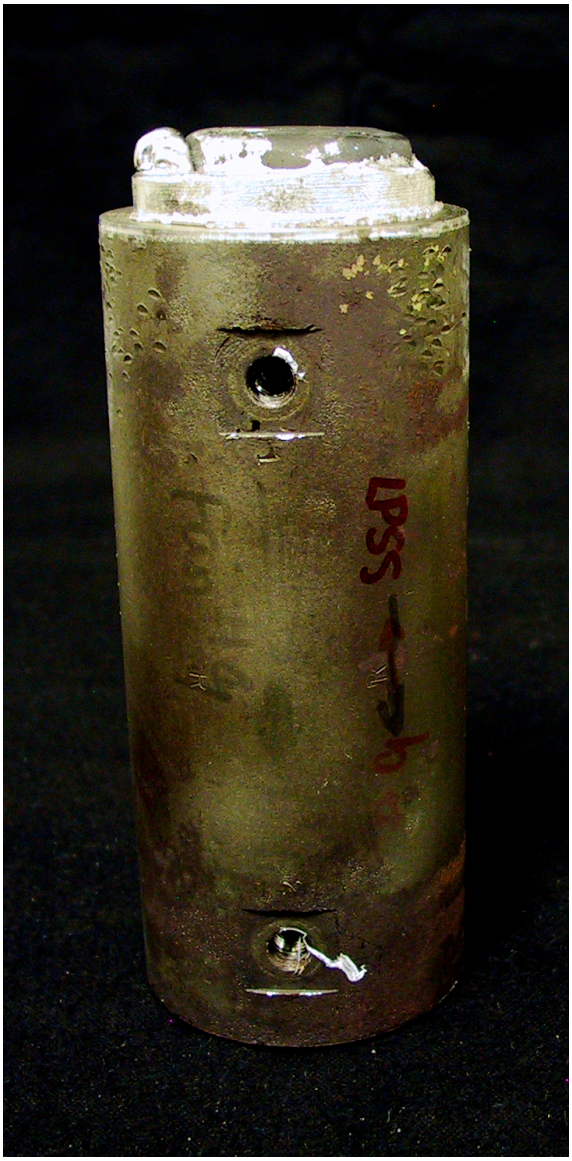
Place the casting set up on the tin foil tray and carefully pour the Cerrotru through the pour holes on the stabilizer plate just past the bottom of the spacer ring. Do not fill past the top of the spacer ring as it will be very difficult to disassemble the spacer ring from the core sleeve and tube.

NOTE: It only takes the smallest of pinholes for the Cerrotru to leak completely out of the sleeve. There is no way to plug up pinhole leaks, just let everything cool, tighten up the setup and or take apart and resemble, bring core back up to temperature and pour again.

Murphy’s Law says that once molten Cerrotru has been poured people will flock to the casting room and touch the very hot core casting set up. To combat this phenomenon take a piece of tin foil, fold it in half like a tent and on both sides

write **VERY HOT!!!!** with a bright colored Sharpie. Place the tent loosely on top of the screw of the stabilizer plate. The tinfoil tent will teeter a bit which is fine.

Let the casting set up cool completely before disassembling it. The cooling phase takes several hours. Once the core is cool to the touch let it sit 1 hour more before you start disassembling it.



Side view and top view of a sandstone Berea core cast in Cerrotru.

Sikadur 35 HiMod epoxy (for NYLON or TEFLON sleeves ONLY)

Before any casting is done, cover the work area with 2 layers of wax paper. Epoxy will not stick to the wax paper but it will stick to the counter. There should be wax paper underneath the gallon buckets of Part A and Part B of the Sikadur 35 HiMod epoxy in addition to the areas surrounding them.

Gloves **MUST** be worn when using the Sikadur 35 HiMod epoxy. Part A and Part B need to be kept separated. Cross contamination of A into B or B into A will result in the entire kit being tossed out. Use fresh clean gloves for retrieving part A, change gloves to a fresh pair when retrieving part B.

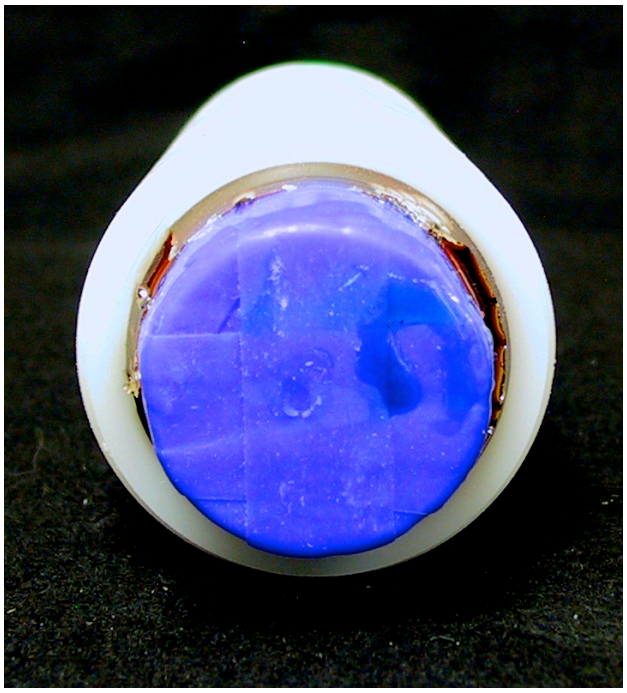
Part B of the Sikadur 35 HiMod epoxy is corrosive. Take extra precaution to **not** get any epoxy on skin or clothes. If Part B makes contact with skin, immediately wash skin off with dish soap and water.

In a small cup mix 2 parts of A and 1 part of B, **DO NOT ADD SAND**! Since the annular space is not very large volumetrically very little epoxy will be used. Mix epoxy thoroughly. Pour epoxy through the pour holes on the stabilizer plate. Stop pouring once the casting epoxy looks like it has just passed the bottom of the spacer ring. Do not fill past the top of the Teflon spacer ring as it will be very difficult to disassemble the spacer ring from the core sleeve and tube.

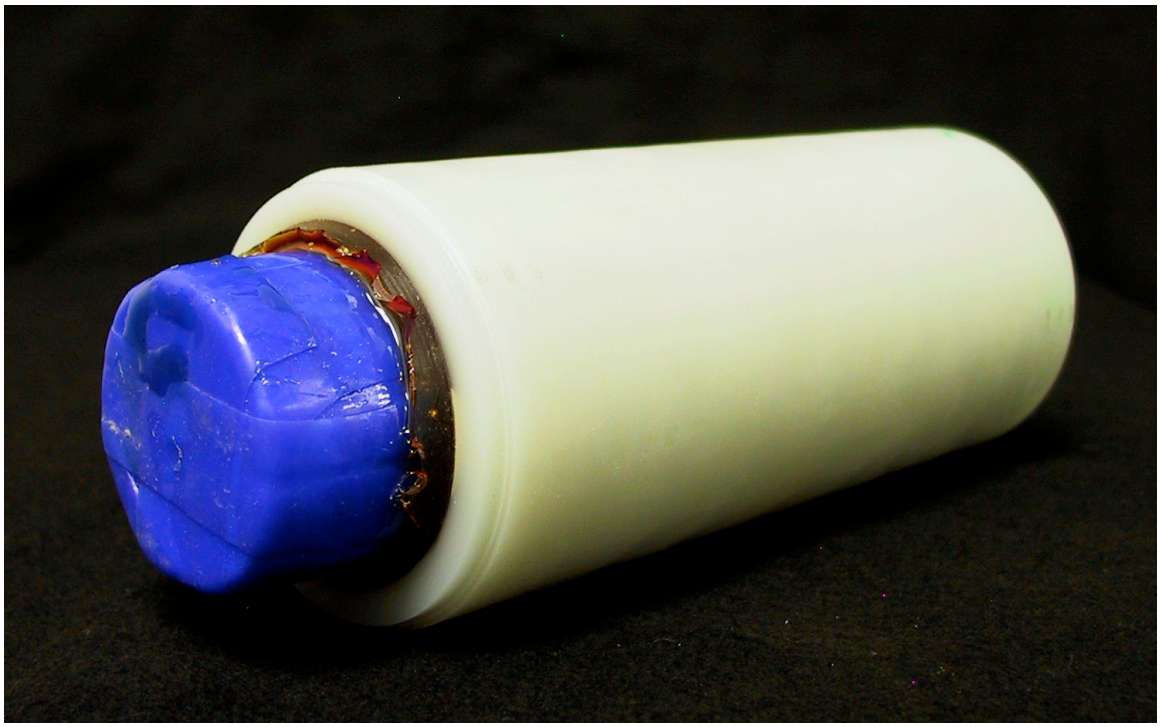
If any epoxy leaks out of the annular plug up the hole with a bit of children's modeling clay. Once the epoxy has cured the clay can be removed and more epoxy can be added to fill the annular space. Sikadur 35 HiMod epoxy layers very well.

Let epoxy cure over night. The core casting holder can usually be disassembled after about 8 hours after the epoxy has been poured, but the epoxy needs to be completely cured before facing off the core. If the epoxy is even a tiny bit soft the lathe will gum up during the facing off process.

After disassembling the core holder if it looks like either end of the core needs a little more casting epoxy it would be good to mix some up and add it to any void zones before facing off the core. Let epoxy cure completely before facing off the core.



Polyethylene core, wrapped in Rescue Tape, cast in a nylon sleeve using Sikadur 35 HiMod epoxy.



Chapter 6:
Facing-Off the Core

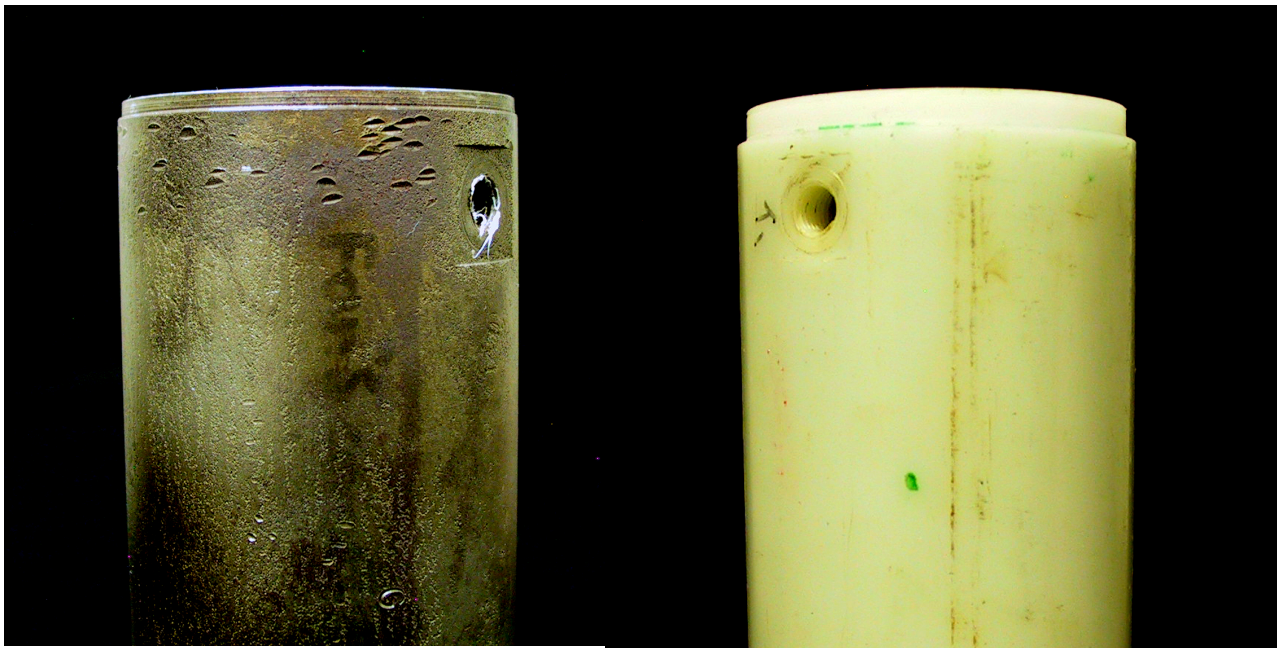
Once the core is cast and the casting material has completely set, disassemble the core casting set up. Remove the Teflon coated bolts that are in the core sleeve.

If Rescue Tape was used for the butter-coat take an Exacto knife (or any other type of sharp blade) and score the visible Rescue Tape that is above the cured Sikadur 35 HiMod epoxy. The Rescue tape should peel back exposing a bare core. Try and remove as much of the visible Rescue Tape as possible. When facing off the core the Rescue tape will not cut so much as curl, so it is best to get as much off at the beginning as possible. The remaining amount of Rescue Tape that is on the core after it is faced off will act as a back-up o-ring against the endcap.

The core can be faced-off using a standard lathe. When facing-off a core made of rock the bit will dull fast which is fine until the final pass. For the final pass make sure the bit is sharp and the cut is done at a slow and steady pace (the automatic feed works beautifully for this step). The face should be perfectly smooth so that the endcaps, and the o-rings in the endcaps, sit flush against the core.

Once the core is faced-off clean the ends with compressed air to make sure that there are no cuttings or residue left from the facing off process on the core. Any residue on the face can plug the core.

On the left is a Berea sandstone core cast in Cerrotru faced off. On right is a polyethylene core butter-coated with green Rescue Tape and cast in Sikadur 35 HiMod epoxy faced off.



Side view of the faced off cores.

faced off cores.

Chapter 7:
Assembling the Core

The most important tool that will be needed when assembling the core is a bench top vice. The vice will stabilize the core so that every piece can be tightened up to its maximum tightening capacity which is very important in insuring there are no leaks.

Before assembling the core for flooding drill out the pressure taps. Pick a drill bit that is slightly smaller than the hole of the pressure tap.

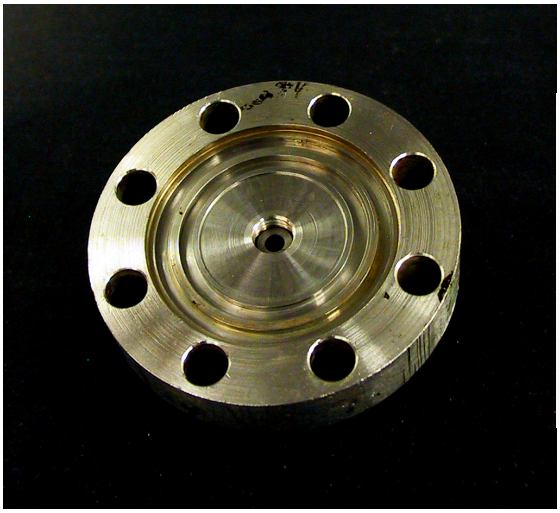
Place the core in a vice to hold it steady. Drill the pressure taps, using a corded or cordless drill, to just below (1-2mm) the butter-coated surface. Make sure the bit does not touch the threads in the sleeve while the holes are being drilled. Using compressed air, blow out the drill shavings that remain in the core. Make sure there is no sediment inside the pressure taps as even a grain of core material can plug the pressure tap lines.

Once the pressure tap holes have been completely cleaned out, insert a Swagelok o-seal straight thread male connector. Tighten down the connector as much as possible. The o-ring of the connector should be perfectly flush with the core sleeve.

Take a dry weight of the core once all of the fittings and plugs are on.

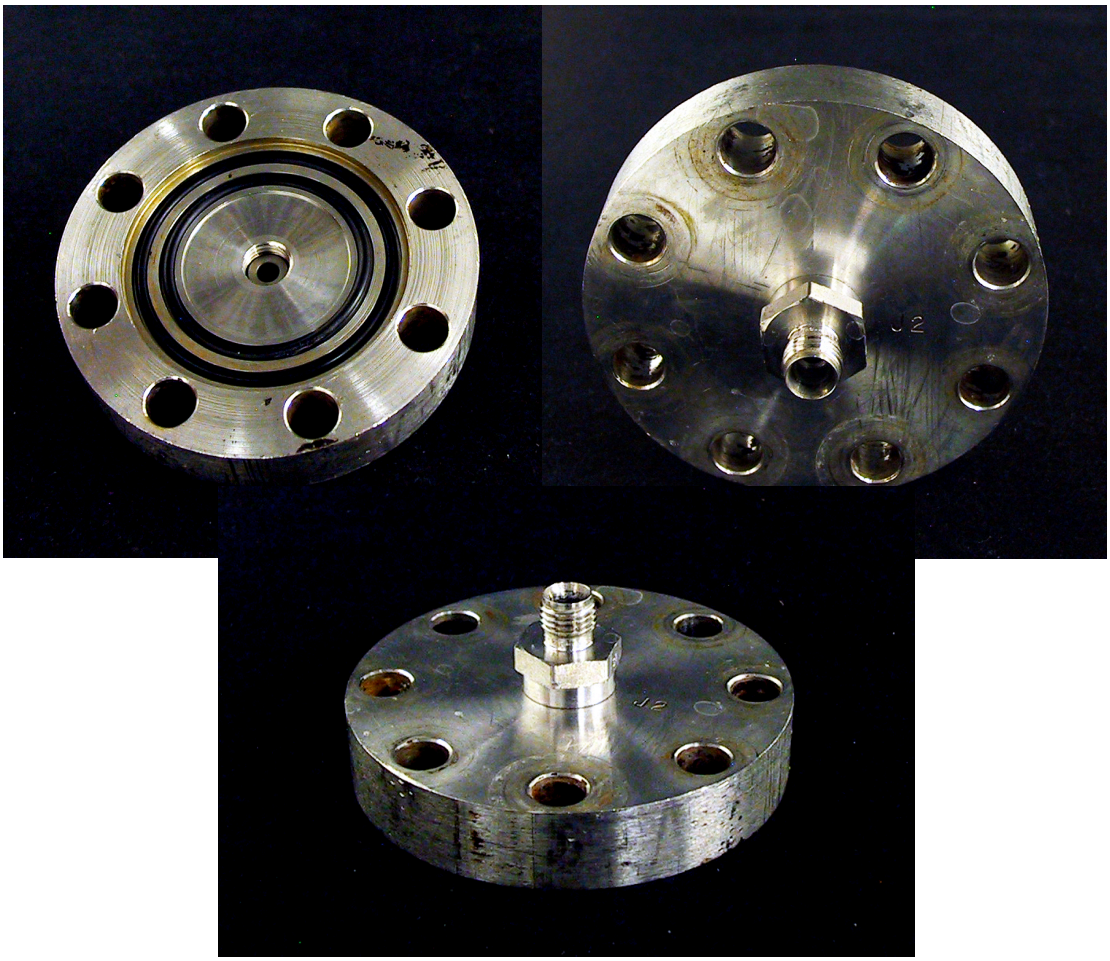
The basics of the core holder are the core, the endcaps, nuts, washers, and bolts that hold it together. The endcaps are easily made from stainless steel disks that can be purchased from a metal yard and with the use of a lathe and a mill can be fashioned to meet the needs of the experiment; these endcaps are reusable indefinitely. The nuts and bolts are easily purchased at the local hardware store.

Nuts, bolts and washers are used to hold the core together. Make sure the bolts are longer than the length of your core. Notice these bolts are not completely threaded, if they are too long stack washers on either/both end(s) until the nuts can be sufficiently tightened on the thread. The washers are the only thing between the nuts and the endcaps.



o-rings for the endcap

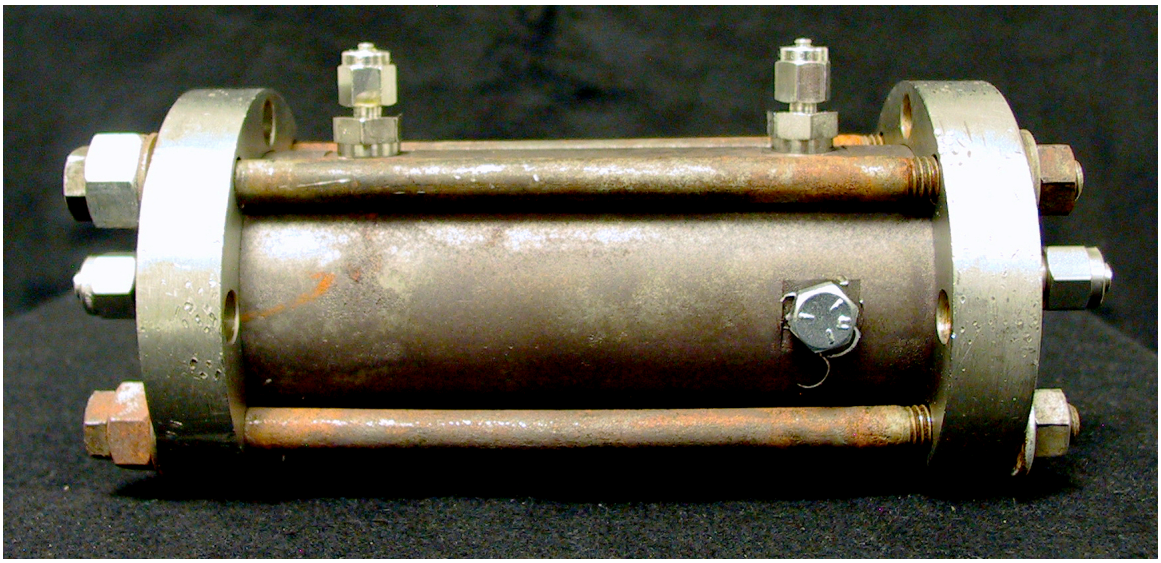
Above photo is the endcap without the o-rings; smaller o-ring is the same size as the OD of the core, the larger o-ring is the ID of the sleeve.

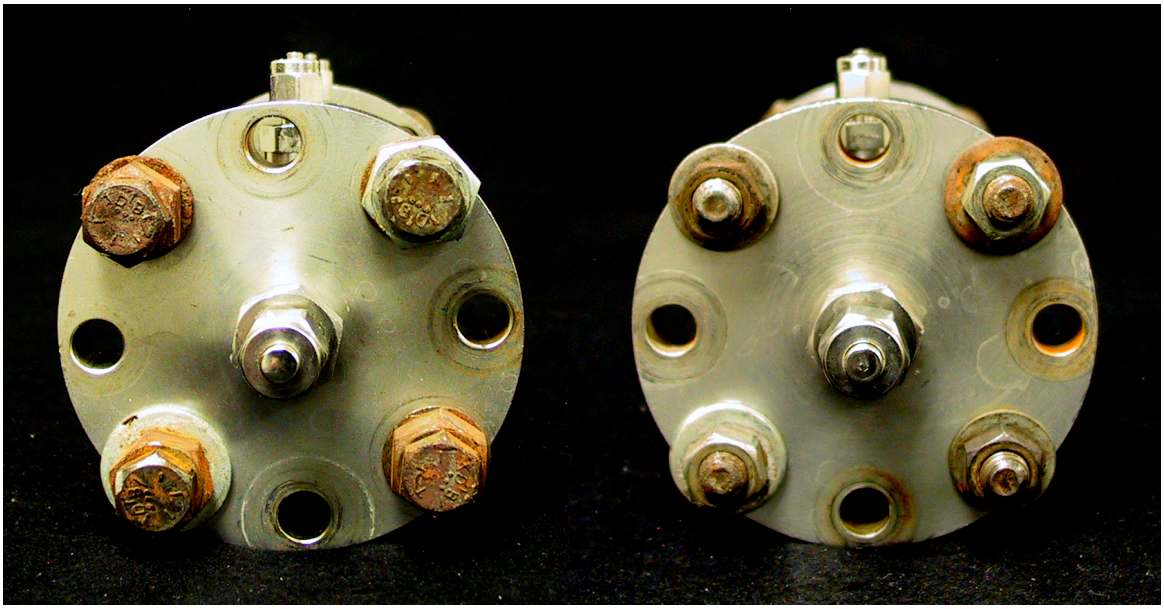


Bottom (with o-rings), top, and side view of endcap: ¼" Swagelok o-seal straight thread male connector installed in the endcap.

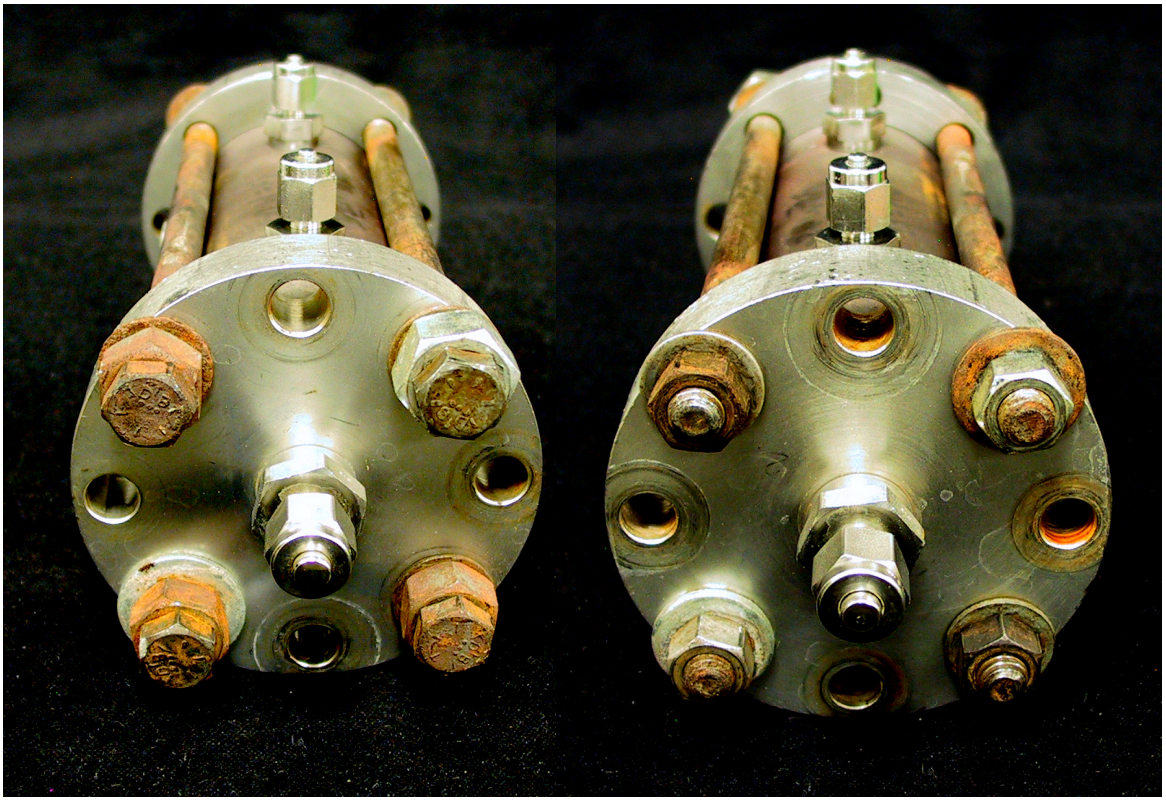
Faced-off core: picture does not contain pressure fittings, but at this stage they should be installed and the dry weight measured.

To assemble the pieces place one endcap, o-ring side up, in a vice. Place the core on the endcap. Place the other endcap on the core lining up the holes of the endcaps. Place bolts, with washers, in the lined up holes. There should be evenly spaced bolts with a minimum of four bolts total. Place a washer and nut combination (washer needs to be between the end-cap and the nut) on the bottom of the bolt and finger tight. To tighten the bolts it is very important to work in diagonals, or butterflies if using only 4 bolts, just like putting lug nuts on a car. Tighten one bolt a little, and then tighten its diagonal a little. Keep repeating until all of the bolts are completely tightened.





Inlet and outlet of assembled core.



Inlet and outlet of assembled core.

Core Assembly Quick Reference Checklist

Assembling the core is easy so long as the following is done:

1. Make sure there are washers between the nuts and the endcap.

2. Do NOT tighten any bolts until all of the bolts have been placed through both endcaps.

3. Tighten bolts finger tight first.

4. Tighten each bolt a little at a time before moving to the next bolt, working in diagonals, or a butterfly pattern if dealing with only 4 bolts, until all of the bolts are tightened completely. Do NOT tighten bolts in a circular direction around the endcap, **tighten in diagonals**.

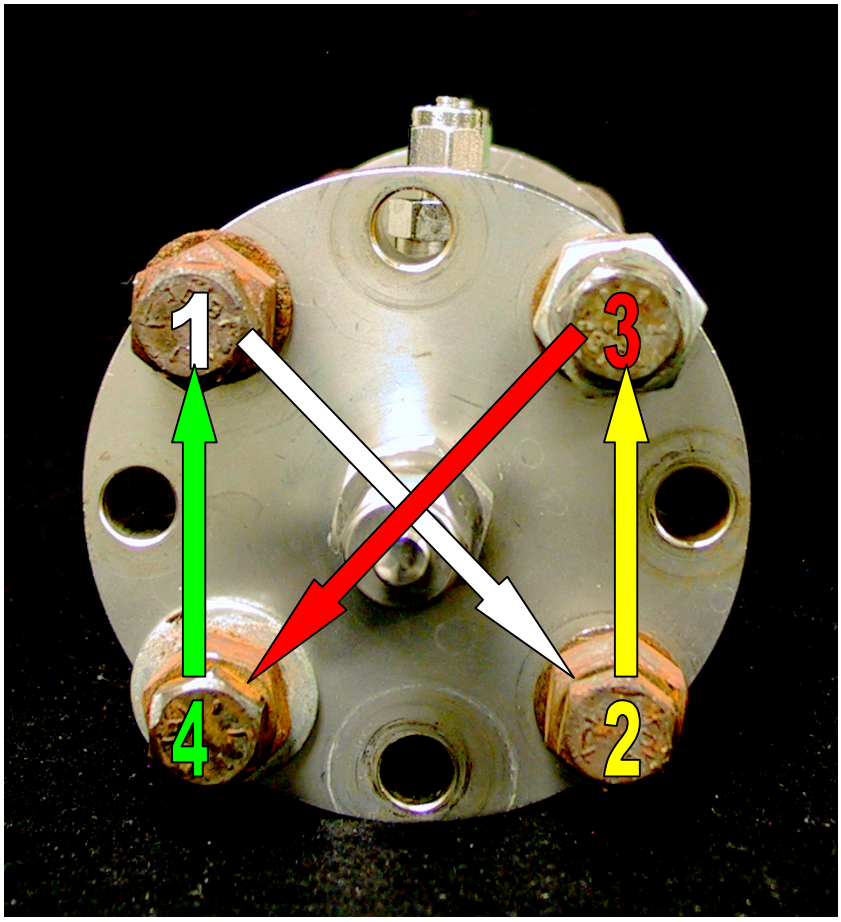
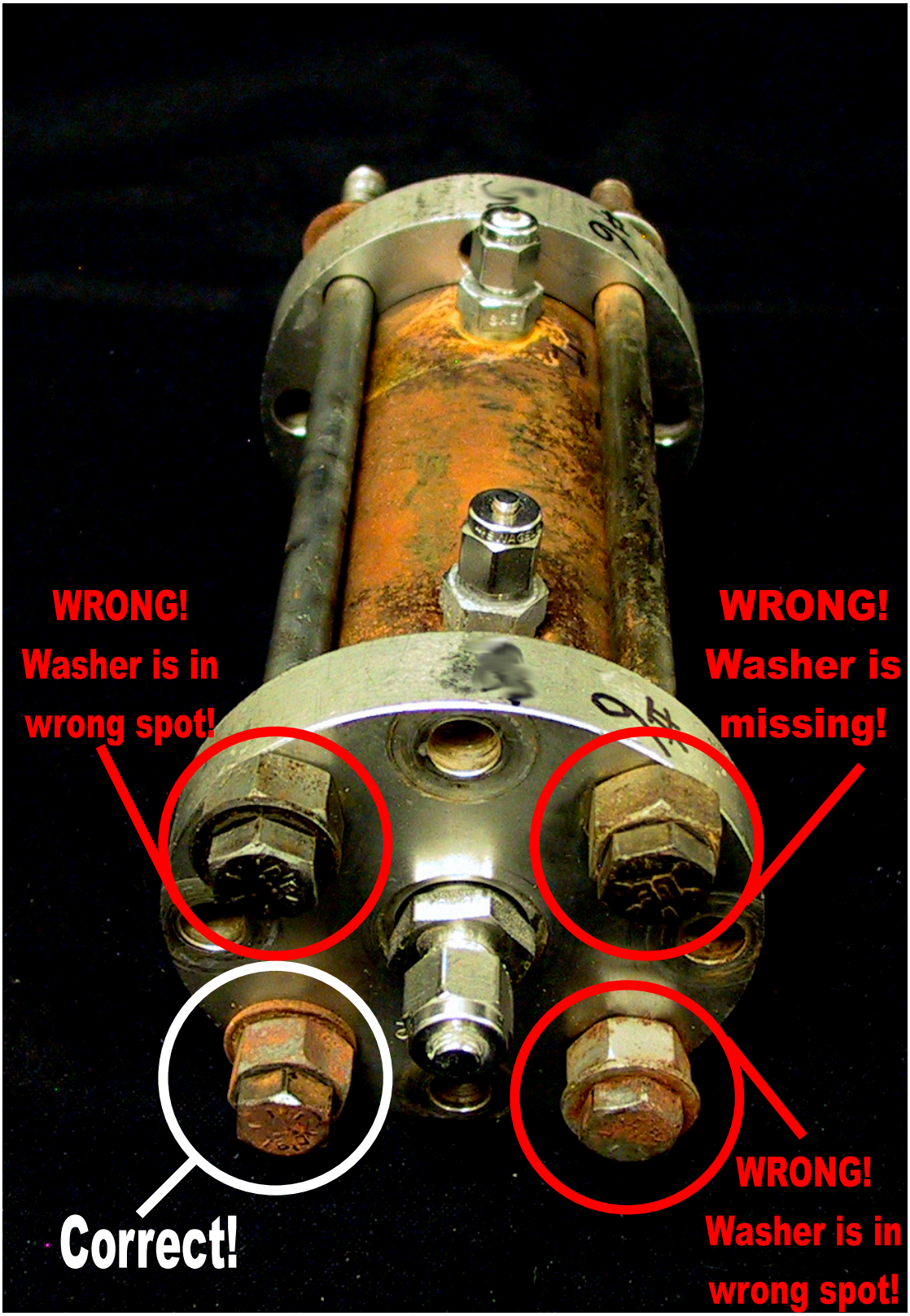


Photo of how to tighten a 4 bolt set up (butterfly style). 1 – 2 – 3 – 4 – 1 – 2 – 3 – etc.

A 5 bolt set up would be more of a star pattern. If numbering bolts 1 through 5 clock wise. Tighten 1 – 3 – 5 – 2 – 4 – 1 – 3 – 5 – 2 – etc.

5. Your assembled core should **NOT** look like this:



Chapter 8:
Terms and Explanations

acid brush:
Metal handled small paint brush with horse hair bristles. Available in a variety of sizes however the most common size is a 6" handle with a ½" chiseled edge horsehair bristle. This is an economical, throwaway type brush ideal for applying the Duralco 4525 epoxy as the brush can be thrown away after each use.

butter-coat:
Butter-coat describes a barrier layer between the casting epoxy and the core. The butter-coat is a material that when applied or cured does not absorb into the core. 5 minute epoxy and Duralco 4525 epoxy are ideal butter-coat epoxies as they barely penetrate the surface of the core, yet they adhere to the core and prevent the casting material from penetrating into the core (the casting materials flow like water and can saturate a core through a pin-size hole). Rescue Tape is a silicone tape that has a high tensile strength and can withstand high heat. It makes for an ideal butter-coat as it will completely cover the core but will not penetrate the surface of the core. Rescue tape is self securing so there is no sticky residue; it just adheres and bonds with its self.

Cerrotru:
A low melt point metal, melts at 281^{o}F, used in casting cores in metal sleeves. Cerrotru is an ideal casting material for high pressure cores.

core:
Any material you are running permeability and porosity tests on: this is the material you will be pushing brine, oil, polymer, or gel thru. The core will have a permeability and porosity, it may or may not be fractured. Typically cores will be made of rock, however, man-made synthetic cores can be made from a variety of materials including, but not limited to, polyethylene.

core sleeve:
The core sleeve is made from a reusable material. A single core sleeve can be reused for multiple cores year after year. For polyethylene cores or any core where the casting material is Sikadur 35 HiMod epoxy a sleeve made from Teflon or nylon will be used. For cores that are going to have high pressures applied to it and cast with Cerrotru a metal sleeve is used. The sleeves are pre-tapped. The taps on the original sleeve are set 1" in from the inlet and outlet. The more the core sleeve is used the smaller that distance gets as a little bit of each end is lost during the facing off process. Once an experiment is done the core in the metal sleeve can be melted out and the core in the nylon or Teflon sleeve can be pushed out and the sleeve can be reused. D*o not pour epoxy in the metal sleeves, or Cerrotru in the nylon or Teflon sleeves, as it will prevent the sleeves from being reused.*

Duralco 4525 epoxy:
A high temperature stability, low moisture absorption, high bond strength, low shrinkage, chemical resistant epoxy. Duralco 4525 epoxy has a 24 hour cure

time. During the curing process the epoxy does not produce a lot of heat which makes it ideal for coating polyethylene cores. Duralco 4525 epoxy can withstand 500°F – 600°F heat which is why it is used as the butter-coat for cores that will be cast in Cerrotru. After the butter-coat process any core that is coated in the Duralco 4525 epoxy needs to be sanded or bead blasted (roughen the surface so it is not glossy) so that the casting epoxy can stick to it.

5-minute epoxy:
Rapid-curing, general purpose epoxy that starts to set with in 5 minutes of mixing. It dries in 15 minutes with full strength achieved in 1 hour. Used as a butter-coat for cores that will be cast in Sikadur 35 HiMod epoxy. Not recommend for cores cast with Cerrotru as the 5 minute epoxy does not stand up well to the heat of molten Cerrotru.

ID:
The ID is the inside diameter of a tube or casing.

nylon:
Nylon is a commonly used polymer that has significant structural strength and rigidity. In the lab nylon is purchased in the form of tubing, fittings, and in rods which are machine to specifications required for experiments. Core sleeves can be fashioned from a nylon rod.

OD:
The OD is the outside diameter of a tube or casing.

PVC pipe – Schedule 40:
Polyvinyl chloride (PVC) pipe is used frequently as water pipe. In the lab it is used as a holder to cast a core in. The Schedule 40 is a thick walled and sturdy pipe. The heat produced by the chemical reaction of the casting epoxy does not effect the Schedule 40 PVC pipe. Use only Sikadur 35 HiMod epoxy in the PVC pipe.

Rescue Tape:
Rescue Tape is a self-fusing silicone repair “tape”. There is no sticky residue as the tape fuses to its self, and only to its self. Rescue Tape has a 950 psi tensile strength, can withstand 500°F of heat, remains flexible at low temperatures, and can insulate 8000 Volts per layer. Rescue Tape, when applied properly, creates a permanent air-tight and water-tight seal in seconds. Rescue Tape is also resistant to fuels, oils, acids, solvents, brine, and UV rays.

Sikadur 35 HiMod LV/LVLPL epoxy:
High-modulus, low-viscosity, high strength, epoxy adhesive. Used as a casting material for cores in the lab. With a short core, 6” or less, the epoxy is mixed straight in a 2 parts A to 1 part B mixture. For long cores the epoxy is mixed in a 2 parts A to 1 part B plus sand. Sikadur 35 HiMod epoxy produces a lot of heat

while it cures so sand must be added to control the temperature. If the temperature of the curing epoxy gets too high the epoxy can bubble causing air pockets or it can over-heat and damage the core. Since the annular is so small on short cores very little epoxy is used which means there is less risk for the epoxy overheating while curing therefore sand is not needed. The sand has an added benefit that it also increases the volume of epoxy made, so 1 kit of epoxy can last 2 – 3 times longer with sand added.

Teflon:
PTFE (polytetrfluoroethylene) is a thermoplastic polymer. It is white at room temperature. With a melt point at 327^{o}C it is ideal to be used as a casting base for all cores. In short, nothing sticks to Teflon, not even a gecko, which makes it an ideal reusable material for core casting. For lab use Teflon rods are purchased and then machined down to specifications of use.

’ (foot):
A unit of length originally derived from the length of the human foot. It is divided into 12 inches and equal to 30.48 centimeters. Denoted with an apostrophe ‘ with a plural of feet which is also denoted with an apostrophe ‘. Symbols: ft, ‘, feet, foot.

” (inch):
A unit of length, $^{1}/_{12}$ foot, equivalent to 2.54 centimeters. Denoted with an open quotation mark “ with a plural of inches which is also denoted with an open quotation mark “. Symbols: in, “, inches, inch.

Chapter 9 :
Where to Purchase Items

The following list is for distributors in the Socorro and Albuquerque Areas. Please contact distributors for current price listings.

Acid Brushes –

Gambles – True Value
101 Manzanares
Socorro, NM 87801
(505) 835-1230

Harbor Freight in Albuquerque
11035 Menaul Blvd
Albuquerque, NM 87112
(505) 323-2052
www.harborfreightusa.com/usa/common/start.do

Amazon.com
www.amazon.com

Cerrotru –

Previously purchased from Cerro Metal Products which has since gone out of business.
HiTech Alloys
18501 Adler Lane
Suquamish, WA 98392
(306) 394-1334
www.hitechalloys.com/hitechalloys.htm

Devcon 5 minute epoxy –

Catalog # 00261099
MSC Industrial Supply Co
1-800-645-7270
www1.mscdirect.com

Duralco 4525 epoxy –

Contronics
131 47th Street
Brooklyn, NY 11232
(718) 788-5593
www.cotronics.com

Metal Scraps (ie: pipe) –

Bralco
6718 Jefferson NE
Albuquerque, NM 87109
(505) 345-0959
www.rsac.com/site/company.asp?intCompanyID=6

Nuts, bolts, washers –

Ace Hardware
701N California Ave
Socorro, NM 87801
(575) 835-1872

Gambles – True Value
101 Manzanares
Socorro, NM 87801
(505) 835-1230

Home Depot
www.homedepot.com

Lowes
www.lowes.com

Nylon/Teflon/other plastic like materials -

Piedmont Plastics Inc
3455 Princeton NE
Albuquerque, NM 87107
(505) 884-2651
www.piedmontplastics.com

Polyethylene Core –

Pore Technology
95 Eames St.
Framingham, MA 01702-8728
(508) 879-1220
www.poretech.com

PPE (Personal Protective Equipment; i.e.: gloves, safety glasses, etc) –

Fisher Scientific
www.fishersci.com

VWR
www.vwrsp.com/

Ace Hardware
701N California Ave
Socorro, NM 87801
(575) 835-1872

Gambles – True Value
101 Manzanares
Socorro, NM 87801
(505) 835-1230

Lowes
www.lowes.com

Home Depot
www.homedepot.com

Rescue Tape –

Harbor Products Inc., Rescue Tape
Carson City, NV
(702) 953-0968
www.rescuetape.com
Can also be purchased through Amazon.com

Sikadur 35 HiMod epoxy –

Smalley & Co
8920-A Adams St NE
Albuquerque, NM 87113
(505) 797-7222
www.smalleyandcompany.com

Stainless Steel Metal Disks –

Bralco
6718 Jefferson NE
Albuquerque, NM 87109
(505) 345-0959
www.rsac.com/site/company.asp?intCompanyID=6

Swagelok fittings –

Albuquerque Valve and Fitting
2732 Vassar Place Notheast
Albuquerque, NM 87107
(505) 842-0213
www.swagelok.com

Tin Foil / Wax Paper –

Smith's Food and Drug
Wal Mart