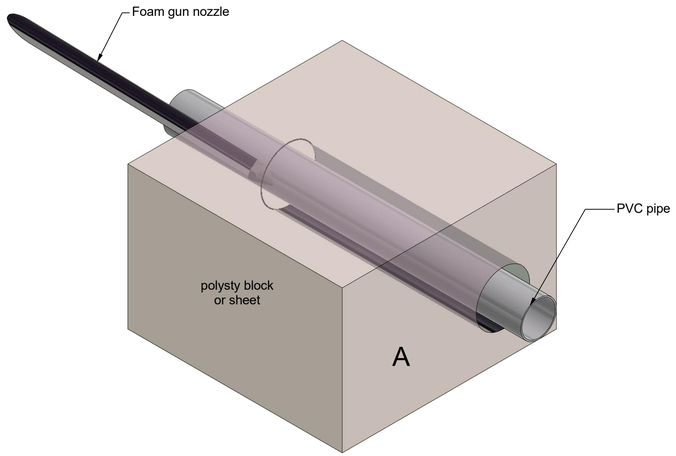
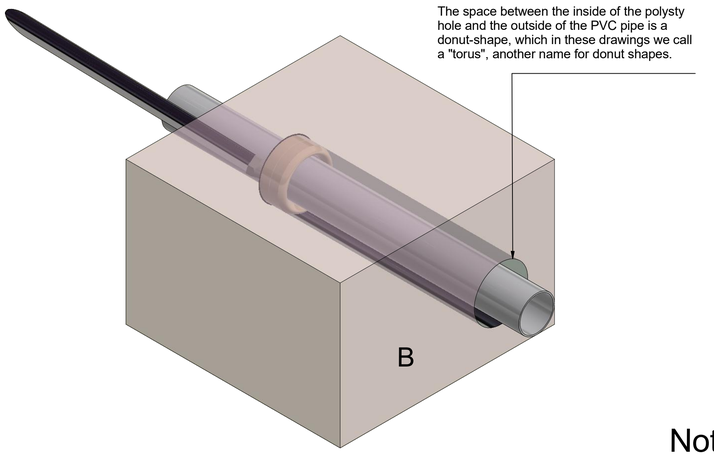
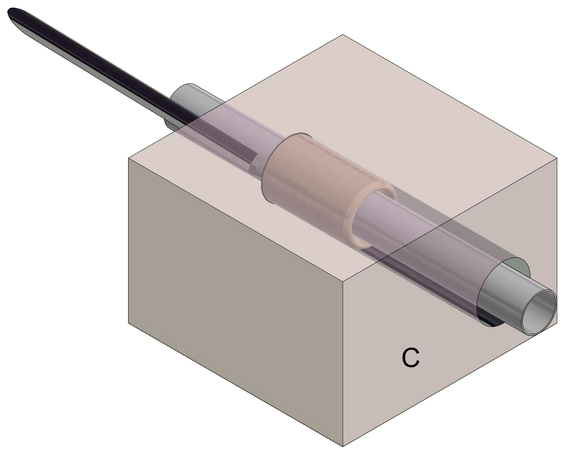
Bungholes:
Hermetic pipes through polysty walls







1. **Bungholes?**: Pipes have to pass through the polysty if you want to make a poly-panel digester. Slurry comes in. Effluent goes out. Biogas is collected. Biogas is recirculated. Slurry is withdrawn for testing or to inoculate new slurry. All these functions and more require pipes to pass *through* the polysty, holes must be made in the polysty thorough which the pipes go, and that hole-through-(with-pipe) must be ***hermetic***: no gas must pass, no water should weep.
2. **Become an expert**: If you study this drawing, think about what is said below, and try some of your own experiments, then you should be able to develop the knowledge and skill needed to make bungholes of any size called for in these plans. or indeed to make bungholes for any of your designs.
3. **Polysty hole size**: Any ('to-be' bung) hole in the polysty must be larger than the OD of the pipe it will surround, by no less than 1/4" to 3/8". Thus for example a 3/4" class 200 PVC pipe-- one kind of pipe commonly used in this design— has an OD of 1-1/16", and so any hole in the polysty intended to surround and support that pipe should be close to 1-5/16" in diameter. We put the pipe through and then fix it in place— and make it hermetic— by spraying expanding foam all around the pipe, then letting it harden. (Try it: it's kind of magical and better than 75% *coolio*.)
4. **Polysty hole technique**: When making these holes, don't tear things up; make *smooth* holes. Whenever drilling polysty, drill slowly. A good hole will leave polysty dust, not polysty chunks. As well, be sure to drill *perpendicular* to the surface of the polysty. Use a Forstner bit, and we strongly recommend using a drill press, as possible. If you do not use a drill press (or for larger holes, since large Forstner bits are fairly expensive), you may want to use a hole saw, but in any case, without a drill press, you should use a simple jig. Drill a hole of the proper size in some plywood or similar, and carefully drill down through that into the polysty. If properly used, the plywood jig will keep the bit centered as it chews down into the polysty.
5. **Constraints**: Besides the foam, the pipe, and the hole in the polysty, we will need some means of constraining the expanding foam on either flat side of the polysty (usually 'inside' and 'outside'). We want the foam to completely fill the 'doughnut' (torus) between the pipe and the polysty, and there should be foam between them everywhere. (That is, the foam should surround the pipe with a more or less constant gap between inside of the polysty hole and the outside of the pipe. Does that make sense?) To encourage the foam to fill the space in that way, and yet not to leak out beyond the polysty, we will need something that fits snugly around the pipe, on both sides of the polysty, so that as the foam expands into the polysty-and-pipe torus, it is forced into every crevice, and the pressure of the expanding foam makes it adhere more strongly to the pipe and polysty. (As well, when the foam is constrained and expands under that modest pressure, the cured foam becomes a bit denser, and therefore a bit stronger.) One thing we can use to constrain the foam (as you will see further on in this drawing package) is a 'shield' cut from thin (1/16" or thinner) plastic. Broadly speaking, it does not matter very much what kind of material you use— you might even have success if you use a carefully cut piece of stiff cardboard— but something has to hold/constrain the foam in on both sides; and in turn, that something should be able to resist being pushed out of the way by the expanding foam: it has to be stiff. Besides something to press against the foam, we need something to hold it in place. To hold the shields or constraints in place around a ¾" class 200 pipe, we most commonly use a ring cut from pipe of the same type/OD as the pipe in the bunghole, ~1" length and sliced lengthwise so it can be expanded. These 'ring-clips' can be put on the pipe and then pushed toward the polysty, and if the shield is stiff and fits properly snugly around the pipe, these rings will be sufficient to hold the shields/constraints in place while the foam is solidifying.
6. **Injection hole**: Sometimes the constraint or shield that holds in the foam is made with a hole in it that allows injection of foam into that gap between, the torus. And sometimes the polysty itself has a smaller hole in it near to and connecting with the inside of the bunghole, through which the straw or the nozzle of the foam can or gun can be put while you inject the foam into the bunghole torus/doughnut. But if the design does not call for either kind of injection hole, you can pull one of the shield/constraints out of the way, inject the foam and then quickly replace the shield/constraint.
7. **Visualize and/or practice**: Once all the parts, tools and materials have been gathered or made, put things loosely together: pipe through hole, shields/constraints on pipe, ring-clips or other jigging put in place, and so on. Are you sure you have everything you need? If you are using a jig or clip or something else to hold the constraints together, do you have all those thingies too? If the pipe needs to be inserted according to a certain measurement, have you marked that position? Will your set-up allow the pipe to maintain that measured position when you inject the foam? *Especially the first several times*, with everything put loosely together in front of you, *it is important to practice and/or clearly visualize what you will do when the foam is injected*.
8. **Foam it!**: If you've made a large enough hole in the polysty as suggested, the pipe should be fairly loose in that surrounding hole. If you are injecting directly into the torus, it is best to first inject the foam *underneath* the pipe (i.e. as determined by gravity; the side toward which everything wants to fall). As you inject the foam, move the pipe up and down and turn it slightly clockwise and counterclockwise to assist the foam to flow entirely around the pipe, all along its length within the hole in the polysty.
9. **Shields up, Scotty**: As soon as the (torus) hole is full, put down the gun/can and fix the shields or constraints in place (if they have moved or might move), and to make sure the pipe stays centered in the hole. (It will depend on the kind of bunghole you are making as to exactly how this might be done. For example, you might be using a jig, or be holding the constraints in place with ring-clips.) Again, check any critical measures.
10. **Wait**: It may take 4 to 24 hours for the foam to harden completely, depending on how warm the weather is, how much water vapor is present, and so on. (For most urethane foams, water vapor helps it cure.) It is good to plan the work with this timeline in mind so that you are able to make progress without having to wait on the new bunghole to solidify.

Notes about sprayable urethane foam:

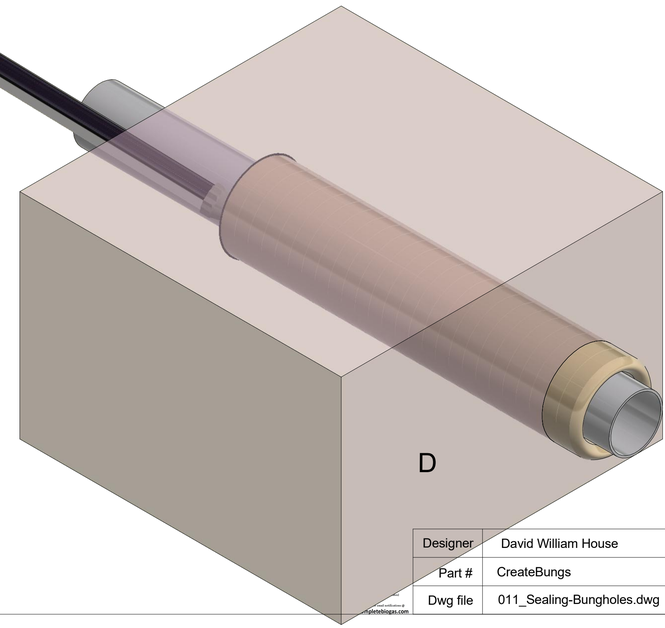
We show a 'professional' foam gun in this drawing, but if you wish, you can use an ordinary can of expanding foam, such as Great Stuff. However, using a can will probably mean that you can only use it once or twice (because the foam tends to dry in the 'straws' used as nozzles in these cans), whereas when you have a good foam gun, then you will more likely be able to use *all* the foam in the canister, because (with due care) the foam in the gun's injector tube will not harden between uses.

When building a digester, you will ultimately need to use a good amount of foam for any number of its parts. If you are supplying it by purchasing 'one-use' cans, you are likely to waste a good fraction of that foam because your use is likely to be intermittent. (You will use some to accomplish a given task, then set it aside as you work on other things.) 'Pro' foam guns cost $15-$150, and several in the $30 range get good reviews. Therefore, we recommend the purchase and use of a foam gun. (We've used a Great Stuff Pro 14, which cost us $42, and we liked it a lot.)

At this point, you may wish to review the information in the previous drawing about working with urethane foam...

Once more, carefully note that foam hardens or cures *only* when gets exposed to moisture (usually moisture drawn from the surrounding air). So when there is a large glob of foam, the outer shell of the foam will grab any available moisture and begin to cure, and further moisture will not penetrate deep into the glob. This will prevent a portion of the whole volume of foam from getting the moisture it needs to cure. As such, a large volume of foam usually remains goopy on the inside. Bad juju. **Therefore you should be prepared to spray or sprinkle water on any mass of foam as you create it *in layers***. That is, lay down a layer, sprinkle or spray; wait a moment; then lay down a layer, sprinkle or spray.

Please also note that foam does not like to be cold. Read the label for the temperature ranges that apply to the foam you will be using...



1" pipe 'ring'

Designer	David William House
Part #	CreateBungs *[ASM v2018-01(a)]*
Dwg file	011_Sealing-Bungholes.dwg *[DWG v2018-01(a)]*