Sunday, December 10, 2023

Biofuel Foundry Parts and Materials Database

A running list of critical parts, components, and processes for the successful operation of a waste-oil bio-fuel foundry system.

Cupolette:

- **Body:** Steel cylinder with a diameter determined by need/volume. 11 gauge is appropriate thickness of steel but can be anything structurally rigid enough to hold up to the weight and heat. You must source the cylinders which will consist of a well, two support/cooling grates, top stack, lid, lid opening mechanism, and miscellaneous elements including but not limited to a bottom plate, burner ports, spout, split wind belt (see below), and legs.
- **Split wind belt** will consist of a hot and cold side, and should have two removable chambers that will each employ a port for air flow. The cold side will receive cool ambient blower air, and the hot side will eject hot air from the grates. Snap clamps and/or bolts are effective fastening solutions. We fabricated 3” **HVAC duct intakes into the chambers** to easily attach 3” flex tubing. Our setup was a squirrel cage blower attached to a 3” duct, hooked to the cold side of the wind belt that discharged out of an adjustable 3” exhaust port into ambient air from the hot side.
- **Burner Port:** the burner port is a crucial part in the modular abilities of the entire system. Through our process, we have found that **flanged tri-clamp spools** are a great way to be able to hook up and operate the burner to multiple systems, and can be quickly attached or removed with a single hinge clamp. Both the pressure washer pump burner AND the compressed air burner can be fabricated into a tri-clamp spool, which then can be applied to whatever furnace or kiln needs the burner. Here is an **image of our burner port** under the hot side of the wind belt.
- **Bed/well:** The bed is now comprised of a bott-gasketed bottom plate, covered in a tapered layer of dry bed sand that runs roughly 1” below the tap hole up on a 15 degree angle to the back of the bed. On top of the bed sand is a circular disc of **refractory fiber board** that has been coated 2-3 times with ceramic shell slurry and fine grit, and dried/fired. The bottom refractory disc is then gasketed into the bed with bott mix and the the well is ready for the grates. **(image of bed)**
- **Legs/Lid:** This part of the build is far more open to design and aesthetic decisions by the builder. We chose heavy wall 2” steel square tubing for the legs (removable) and a steel tank end for the lid. The tank end is helpful in that the domed shape will allow for more charge material to be in the stack preheating/ melting than a flat lid.
- **Refractory:** The lining of the furnace can be any high-alumina rammable or castable lining you might use for a coke-fired furnace. The grates and refractory spheres should be a specialized high-alumina low-castable 3400F rated material such as this **Plicast HyMor-98v.**

Burners:

- **Compressed air:** This project has employed two distinct styles of oil-atomizing burners to properly disperse the fuel for consumption. The first, and simplest to build and operate is the **compressed air burner**, designed by Bob Sherell from Burners Galore. Utilizing a high PSI air source to tear the oil or atomize it in the combustion chamber, the hardware is far simpler to acquire and the build is cheaper, yet this type of burner requires a 2-stage compressor that can continually deliver volumes of high PSI air. Our shop has a 2-stage 21 CFM compressor with an 80 gallon tank that can easily handle the operation of a single burner and has successfully operated two compressed air burners simultaneously, but the system was taxed. **(video instructions on the build)**.

- **Pressure washer pump:** The second style of burner we've successfully operated in the foundry is a system that does not require high volumes of compressed air, but only 110V electrical service. The burner itself is still modular, and you may adjust output by adjusting the pressure and the nozzle size, which makes it very versatile. The device requires an extremely clean oil, so additional filtering is ideal, and has a larger footprint **(shown on furnace here)**. The burner itself is significantly more complicated, has more parts that could fail, and is quite a bit more expensive to purchase. The burner intake pressurizes the oil, pushes it through a pre-heating module, and then expresses via a specific oil nozzle to atomize. **(shown apart)**.

- **Fuel delivery:** refined oil (outlined below) is delivered to the burner **via pump** through a system of hoses, ball valves, and disconnects. Brewing supply stores are a good place to source the pump, valves, connections, and hoses for this part of the process. **The pump assists the feed** from a conical vessel **shown here**.

Oil/fuel:

- **Sourcing:** Acquiring the fuel for a bio-fuel foundry setup has been considerably easy from our point of view and experience. We have developed good relationships with regional food service outfits who have agreed to donate their waste fryer oil to our cause. While in a pinch one could purchase new or un-used vegetable oil to use in the system, but the costs could be high, in the $10 a gallon range. Waste fryer oil, no matter how dirty can easily be filtered and cleaned to work well in this system if you allow time to process.
- **Filtration:** Proper filtering, cleaning, and storage of the oil is critical to make this system function effectively. As shown above, we utilize 15 gallon conical vessels to filter and deliver the oil. We employ TWO conicals, one in the filtration process and one for the fuel delivery process. For filtration, we initially run the waste oil through a series of coarse/fine screens into a conical tank with a ball valve on the bottom **(shown here)**. This tank gets filled up with screened oil and then sits for 3-5 days to allow any separation of water to occur. Water will sink in oil, and any moisture and additional waste is decanted off from the bottom of the vessel before fine filtering again into clean jugs for storage.
- **Storage:** We typically decant waste oil from the 4.5 gallon fryer oil jugs into the filtering vessel and then wash the jugs with dish detergent. Clean oil that has had all water and particulates removed is stored again in the same jugs for later use.

Ancillary systems

- **Crucible melter:** Crucible melting of alloy has been in practice for as long as metal has been flowing, and the bio-fuel foundry system can be employed in a retrofitted crucible melter. The burner mounted in a tri-clamp spool can be mounted on a crucible furnace in lieu of a propane or natural gas system. Our colleague Stephen Coles has been using waste oil to **successfully power a crucible melter** and has collaborated on our research. This system will not only melt iron, but other alloys such as bronze and aluminum as well.
- **Burnout kiln:** Another process that has been **successfully tested** with the biofuel foundry system is the burnout kiln. Used as a way to preheat or fire refractory, fire and burn away patterns from ceramic shell mold systems, and to harden or burn out wax from investment molds and sand molds, the burnout kiln is the next logical way to utilize the bio-fuel burner.
- **Forge:** The burner system could theoretically be leveraged in a blacksmithing or forging capacity.
- **Shop heating:** For those who operate studios where heat is a necessity for a portion of the year, the bio-fuel burner can absolutely be leveraged as a heating source for a building. Obviously safety is of the utmost concern, and all local zoning laws and permitting should be followed before employing a prototype heating system in a domestic or commercial structure.