The Los Angeles Silhouette Club

The "Simple" Act of Fluxing

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Questions that often get asked by bullet casters just getting started are, "What's the best flux to use?", "How much flux should I use?", and "How often should I flux the pot?"

The source of this confusion is easy to find; just about everything that can burn, smoke or raise a stink has been reported at one point or another as a flux for bullet metal, usually with varied claims of success.

Some of the more commonly recommended materials are paraffin, beeswax, bullet lube, oiled sawdust, and rosin, as well as a variety of commercially available formulations. Heck, I've even seen used motor oil recommended to flux bullet metal (this just can't be a good way to make points with one's Better Half, or even the neighbors!). About the only thing I haven't seen recommended is tire rubber, but it wouldn't surprise me if somebody has tried it!

Let's look at what a flux is expected to do, and how some of the different fluxes work. When we melt a pot of bullet metal, we have a high temperature pool of liquid metal in contact with the air. The oxygen in the air slowly oxidizes the metal at the interface; the hotter the metal, the faster this oxidation takes place. Since this is a heated liquid pool, convection leads to rapid turnover at the surface of the liquid, and the more easily oxidized components of the melt are preferentially oxidized as this mixing takes place. The resulting oxides are almost always insoluble in the molten alloy, so they tend to separate and form a separate phase. In the case of bullet casting alloys, tin is more readily oxidized than is lead, so the tin oxide forms a "skin" across the surface of the melt.

Some of the other metals that may be present as minor impurities are even easier to oxidize, and "follow" the tin up into the "skin" (lead is pretty dense stuff and most all of these oxides are of lower density, so they float).

What we want a flux to do is to remove those impurities that affect the surface tension of the alloy and cause problems during casting (most notable here are things like calcium, aluminum, zinc and copper). In addition, we want to remove any wettable particulate matter that might go on to form inclusions in our bullets. Since tin is so valuable to the bullet caster, it would be helpful if we could slow down, or even reverse its oxidation. These are the things that we ask a flux to do.

Some folks seem to think that if they sprinkle some "magic powder" on the top of their lead pot and it pops and fizzles, smokes and stinks, then presumably all of these things are being accomplished. T'aint necessarily so. While it may be fun to put on a wizard's cap and play modern alchemist for a little while, that doesn't automatically force the chemistry to conform to the wizard's wishes.

Now that we know what we want a flux to do, let's look at how some of the different fluxes work.

Waxes, greases, oils and other hydrocarbon fluxes all serve as a sacrificial reductant and reduce the tin oxide back to the metallic state, returning it to the molten alloy, where it can still do the caster some good (reduction is the reverse of oxidation). In addition, if used in sufficient quantity to form a pool across the entire surface of the alloy (usually about 1/4" deep), then the molten wax forms a barrier to prevent oxygen from re-oxidizing the tin during the course of the casting session.

Paraffin and beeswax are both equally effective in doing this (but paraffin is much cheaper, I prefer to save the beeswax for bullet lube, where its flow properties provide major advantages over paraffin). Using paraffin as a bullet flux has the advantage of being cheap and widely available in most grocery stores, but it doesn't necessarily remove detrimental impurities, like calcium, aluminum, copper and zinc.

Some of the commercial bullet fluxes are formulations that have the advantage of generating virtually no smoke or odor (in contrast to the waxes just discussed). These formulations are commonly based on borax, or other boric acid derivatives. The way these commercial fluxes work is to combine with the oxidized components of the alloy (including any oxidized tin) and form an insoluble molten borate glass, which collects on top of the melt as a dark molten crust. This process is smoke-free and cleans the alloy very effectively, but the dark molten crust must be removed to prevent inclusions in the bullets. Unfortunately, any oxidized tin is also removed in this process. Relatively little of these borate-based fluxes is needed to effectively clean up bullet metal (only about half a teaspoon is needed for a 10 lb pot), but too much can cause problems by generating excessive amounts of this molasses-like glass that sticks to the ladle and lead-pot, and can cause inclusions if not removed.

Sawdust is another material that has been used as a flux for bullet metal, and it has the advantages of both the previous classes of bullet fluxes (it has often been employed in conjunction with oil, but all that does is make fluxing smokier and smellier). Sawdust is also a sacrificial reductant that reduces tin, thereby returning it to the melt (again, reduction is the opposite of oxidation). It also has many building blocks (lignin's, tannins, gallates, etc.) that bind to oxidized metals. Lead, tin and antimony are fairly easy to reduce back to the metallic state, others are not so easy.

Of particular interest to the bullet caster are calcium, aluminum and zinc -- all of which are difficult to reduce and all of which cause casting problems if present in any significant amount (they muck up the surface tension of the alloy and prevent the alloy from filling out the mould properly). As the sawdust chars, it can be thought of as a kind of activated carbon. Both the lignin's of the original sawdust and the oxygenated sites of the activated carbon are very effective at binding metal ions like calcium, aluminum and zinc. Thus, the advantage of sawdust is that it does both jobs, returning the tin to the melt and removing the problematic impurities. Sawdust has the added benefit of being free.

I generally use walnut sawdust, left over from my grip-making activities. Different types of wood are known to give rise to grades of activated carbon with different activities, but whether or not this would make any difference to the bullet caster I don't know (doubtful, any sawdust should work just as well, and some, like cedar, redwood and pine smell awful purty!). A heaping tablespoon is just about right for a 10 lb pot, stirred in thoroughly to begin with and then left in place. Halfway through the pot, the lead-pot is stirred again, this time the activated carbon (dross) is removed. By leaving the charred sawdust on the melt for the first half or so of the casting session, a barrier is formed to slow down the oxidation of the tin, and by removing the charred dross before reaching the bottom, the sequestered impurities are removed before they can sneak through the bottom-pour spout and possibly cause inclusions.

- Glen E. Fryxell

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