New Quench System with Agitator and Baffles

After performing our heat-treat variables tests, we considered several areas for re-tests. The first area considered was the order of quenching—relative time in the furnace. The next area was the time variability of the quench. This had to do with manual agitation during the quench. By hand, this can be a fairly inconsistent approach as well as adding to the quench time.

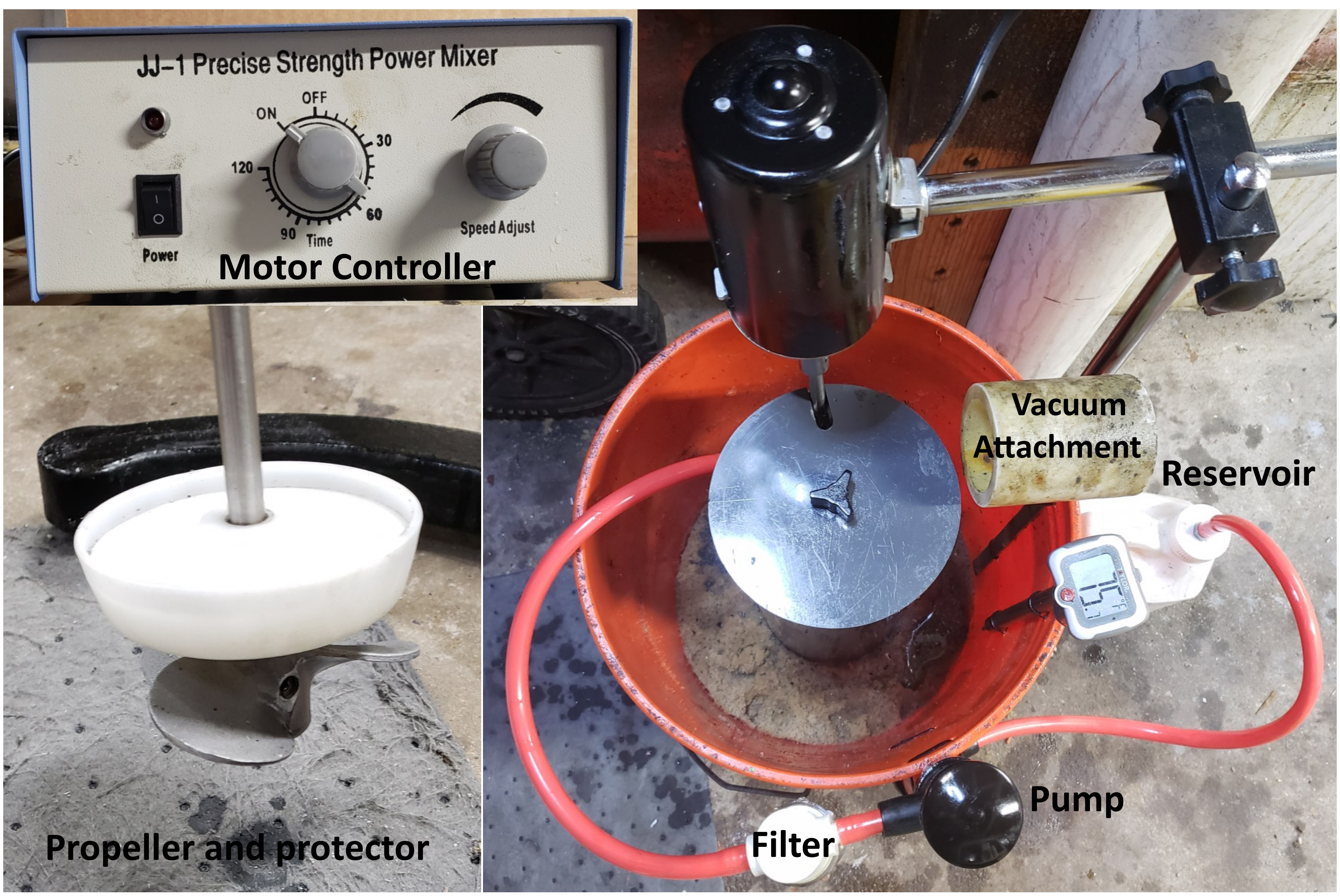
In order to address these issues, I decided to develop a more hands-free quench agitation system. Initially, we attached a paint mixer to a cordless drill. It worked great except for the awkward bit of juggling required to remove the knife from the furnace, plunge into quenchant while simultaneously starting the drill. I***** learned several things from this approach :

1. A mixer definitely dropped the knife temperature faster than manually moving it by hand.
2. Three hands, possibly four, would have been better for consistency of operation.
3. It created a hell of a vortex, sloshing hot oil (messy and a fire hazard) out of the quench tower.

So, I began researching self-standing quenchant systems. Since I already had a quench tower, I designed and built an overhead, motorized agitator. The agitator system below is based on a laboratory overhead agitator system (Amazon). I modified it by replacing the small impeller and shaft with a 3” propeller on a 5/16 shaft machined to 0.250” at the attachment point. It worked well, but it also created a huge vortex. I researched more and found that a vortex is not a good idea for a quenchant system. Who knew?

Some details of the quench system are shown below.

*****I’m speaking in the first person singular for this part of the project because my associate in design and testing, The Bearded RAT, is frittering away his time diving in Bali for two weeks with his lovely wife while I slave away in the shop!



The Agitator Baffles:

After further research into quench oil agitation systems, I found that the vortex should be broken up in order to provide a bottom-up agitation, instead of a swirling motion, for more uniform quenching. So I went about fabricating a baffle system based on recommendations from George E. Totten's book, "Handbook of Quenchants and Quenching Technology". That's actually a book!

Since we already had a quench tower, I decided to come up with a retrofit. According to Totten's book, baffle designs for cylindrical quench towers are typically based on a set of four equidistant baffles that are ~1/12 of the column diameter in width with a baffle stand-off from the column wall of ~1/36 of the column diameter. Since our quench tower internal diameter is 4.875", some quick calculations provided a baffle width of 0.41" (I went with 0.50", width of the steel) and baffle distance to column wall of 0.135" (I went with 0.125", the thickness of the steel). So, I just needed three pieces of 0.50" x 0.125" x 36" soft steel from Home Depot.

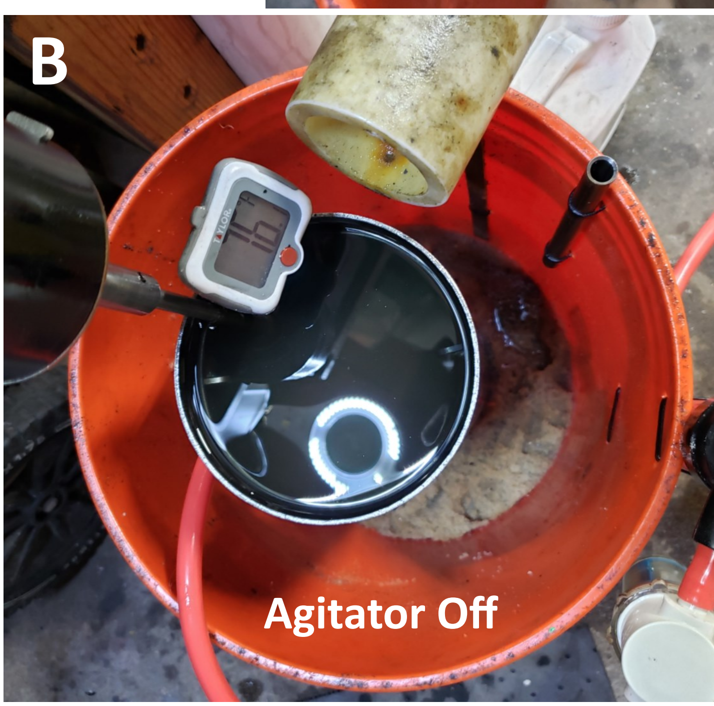
Because it was a retrofit, I made it an interference fit, so I wouldn't need to modify the quench tower. Below is the result of cutting, then heating and forming (support ends), and welding of the four baffles.

The Baffles, continued:

Once completed , the baffles were placed in the quench tower. The bottom one was designed to fit snuggly while the top took more force to place in position. Picture **A** shows the baffles partially removed from the tower.

The baffle system is ~1.0” below the top and ~3.0” above the bottom. I wanted to make sure that there was adequate clearance for the bottom propeller.

When turned on, the baffles provide a nice bottom-to-top flow (Pictures **B** and **C**)—agitation with no vortex!



The Quench Oil Pump with In-line Filter:

Another issue that has arisen over time is how to keep the oil at the proper temperature when quenching several knives. Originally, we used a bar of aluminum that we kept in the freezer. It worked well enough, but it was an inelegant solution. Additionally, we were concerned over water contamination.

Next, we decided to try transferring some hot oil out and replacing it with room temperature oil. We used a ladle to transfer the hot oil to a container and a pan of room-temperature oil to replenish. This worked quite well, but got messy and took time to transfer. When you have several knives to heat-treat, you don't want to waist time whenever possible. So, I stuck with the oil transfer process, but improved it.

I started with an old hand pump that I bought when rebuilding my old Sportster. I added an inlet filter to help remove some of the debris from the decarb coating that flaked off during the quench. The filter is attached to a hose that can be placed into the quench tower to remove some of the hot oil. The inlet is held in place by a magnet, allowing for quick attachment and removal. The outlet of the pump is attached to a hose that plugs into an empty half-gallon container acting as a reservoir for the hot oil.

After a knife is quenched, the temperature increase of the oil is compensated for by pumping hot oil into the half-gallon container and quickly filling the tower with room-temperature oil poured from another half-gallon container while the agitator continues to run. The process is much faster than other techniques we have tried in the past.

Going forward, we plan to calibrate the amount of oil to transfer (number of pumps) as we observe the temperature fall back to the proper value for the next knife quench.