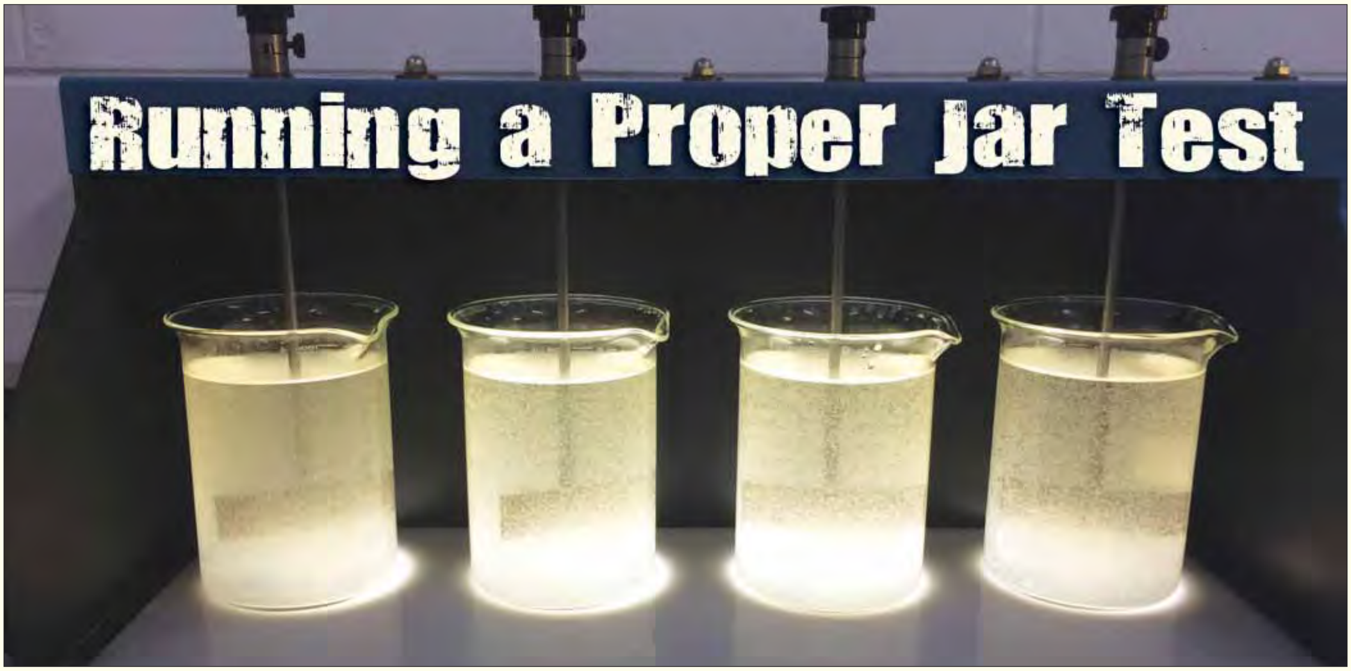
By Stewart Kasper, KRWA Tech Assistant

Running a Proper Jar Test



Jar testers are prevalent in many of the water treatment plants I visit, but I often find they are used for storage or are in storage. If after reading that, as a treatment plant operator you look over and see jars with pencils or the jars have "stuff" stored in between and front of the jars, you are not alone – not by a long shot.

The jar test is an important drinking water treatment plant design, process control, and research tool. A jar test is described as a "bench-scale" simulation of full-scale coagulation/flocculation/ sedimentation water treatment processes.

KRWA's 2100Q portable turbidimeter, being used to test the effectiveness of each jar.

Jar testing can seem daunting to learn at first, and just getting started with making a stock solution can be intimidating for some operators. It doesn't have to be that way though. When I was first shown how to run a jar test, the first thing we had to do was repair the tester – and every time it seemed. Fortunately for me, I was blessed with a very patient lead operator. At the time, it was a relatively easy process to make a stock solution.

With the growing popularity of engineered polymers, the stock solution procedures are vastly different from plant to plant and sometimes season to season at any plant.

We used strictly aluminum sulfate. The procedures were printed, laminated, and stuck to the front of the cabinet. As always, things progress and improve. With the growing popularity of engineered polymers, the stock solution procedures are vastly different from plant to plant and sometimes season to season at any plant. With the changing of coagulants and the ever-changing quality of the raw water we were pulling out of the Marais Des Cygnes River, you can imagine, spinning jars became a regular thing. I credit Tom Lasser with Hawkins Chemical for all the help he provided to me. Tom was instrumental in helping me to understand how to compare varying chemicals side by side in jars and how to create the setup for these different chemical formulas.

Making stock solution

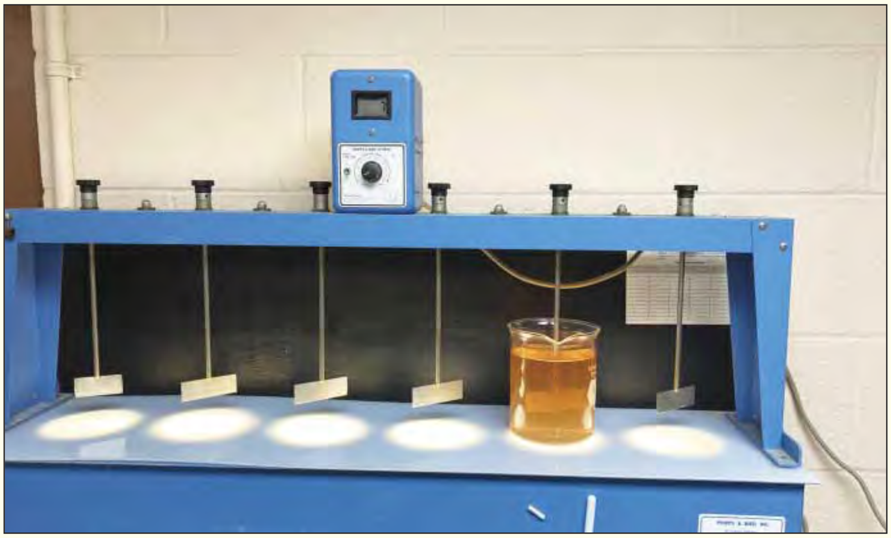
I want to cover the making of a stock solution and explain how different solutions are used. I have always preferred the KISS method or Keep It Simple Silly. For that reason, I am only going to cover making two solutions. For a one percent (1%) and a two percent (2%) solution, and what is used for simplicity will depend mostly on the jars. If using one-liter jars, the operator will want to use the 1% solution, and if using 2-liter jars, the 2%. I mention this now so if any reader wants to follow along, there is no need to guess which solution to make.

No fancy lab needed, as KRWA Tech Stewart Kasper demonstrates KRWA's new 4-bank jar tester in a parking lot.

When making a solution out of dry material, it's a matter of weighing out either one gram for 1% or 2 grams for 2%. One mL of water weighs 1.0 grams; this is the basis for specific gravity, and all liquids are compared to water. If a substance has a specific gravity greater than 1.0, then it will sink in water, and if less than 1.0, it will float.

In a 100-mL graduated cylinder (you can use a beaker if you do not have a graduated cylinder), fill it with 99 mL of distilled water. (If you do not have distilled water, you can use tap water, but I avoid tap water to keep the solution as clean as possible). If you are using a beaker, just fill up to the 100 mL; use a syringe and remove 1 mL of water. Then add your 1 gram of dry solution. Or, remove 2 mL of distilled water, and add 2 grams of dry solution for a 2% solution.

The process for creating a stock solution with a liquid chemical is very much the same if you are just adding 1 or 2 grams into distilled water to make the solution. The only extra thing needed is the specific gravity of the chemical. Let's use Aquahawk 457 for this example since it's a widely used coagulant throughout Kansas. The easiest way to find the specific gravity is look on the SDS sheet, under the 9th section "Physical and Chemical Properties" heading. It says the specific gravity of 457 is 1.285, or in other words, 1 mL of 457 weighs 1.285 grams. To determine how much 1 gram of Aquahawk 457 weighs, use this formula: 1/1.285 = 0.778 or 0.78. We know that 0.78 mL of Aquahawk 457 weighs 1 gram. If using 2% solutions, the operator will need 1.56 mL of Aquahawk 457. Suppose for some reason the SDS does not have the specific gravity? In that case, either call the chemical manufacturer or if preferred, use a gram scale and measure out 1 mL of the chemical. Whatever it weighs is your specific gravity.



This photo shows a jar tester being used to check permanganate dosage for the control of manganese.

Now that we have our stock solution, preparing the jars is much easier. The one thing to make certain is that the water being put into the jars is collected before the injection of any chemical being added. It seems relatively simple, but that is a mistake I made early in my career. Another important thing to remember when collecting the water is try to collect all of the water at once if possible. You can do this by using a clean five-gallon bucket if practical. If jars need to be filled one at a time, that's perfectly fine too. The reason to collect them all at once is for consistency of the raw water.

Dosing the jars with our coagulant or other chemical is pretty easy at this point, once the solution is made and the jars are at the 1,000- or 2,000-mL line. When using the 1% for 1 liter and 2% for 2 liters for dosing, then 1 mL of stock solution will equal 10 mg/L in the jar. Since most operators do not run in whole 10-digit increments, 0-10 mL syringe will be needed to add in smaller increments. The range will depend on experience with the treatment plant. If the operator is just fine tuning the dosage rate, the operator will want to range the jars in small increments of dosage, while using one of the middle jars as the current dosage settings. For instance:

Short Increments	Large Increments
Jar 1: 32 mg/L	20 mg/L
Jar 2: 35 mg/L	35 mg/L
Jar 3: 38 mg/L	50 mg/L
Jar 4:41 mg/L	65 mg/L

If the operator is in a situation where he/she just does not know what the outcome will be, then use a larger increment of 10+ mg/L difference between each jar. This was a common occurrence for me when I worked for the city of Osawatomie and we pulled water directly from the river with no holding pond. Eventually, I learned how to fine-tune the dosage using smaller increments. For the most part though, operators will usually want to stick with smaller increments unless something has interfered with the source water because the changes will be minor.

The jar testing settings should be customized to each plant. However,

See this close up view of floc formed in a jar.

this can be complicated and requires a lot of math. Good results and useful data can be achieved using a very simple method. That is a fast spin to simulate the rapid mix, then slow it down for the flocculation and then even slower once more, then stop spinning and let the jars rest for a while to simulate the sedimentation. This simple procedure often works well. I typically like to do the following when I am unsure what to do.

Speed RPM	Time (m)
300	5 Seconds
50	5 Minutes
25	5 Minutes
0	10 Minutes

After the jars have had time to simulate the sedimentation is when it becomes apparent which jar works best. Similar to collecting the raw water, it's best to do this all at once and uniformly as possible. The 2-liter jars typically have a valve on the front where a sample can be grabbed. Again, just do the best possible to pull the same amount of water out of each jar. Then measure each sample with the turbidimeter. As an operator learns and depends on the plant, the particular range in which the plant functions best will become apparent.

Jar testing is not just strictly for coagulant dosage as explained here. Jar testing can be used for a multitude of ways to help plant operators. Testing the proper dosages of permanganate, carbon, lime or caustic are some examples of other ways a jar tester can be used to create the highest quality of water possible.

I want to emphasize that jar testing is just a tool in the operator's toolbox. It is not the end-all, best decision guide all the time. For instance, the Miami County Rural Water District No. 2 plant at Hillsdale Reservoir where I worked prior to joining KRWA has pulsating clarifiers with a sludge blanket. I have never successfully mimicked a sludge blanket in a jar test. It's important to remember when there is a sludge blanket in the plant that there is a large chain floc in that sludge blanket with the polymer in it as well. It takes practice to see the jars and understand what kind of floc in the jars translates into acceptable effluent in plant.

"Just Practice!"

To be good at anything takes practice. That is my best advice with jar tester: "Just Practice!" Even when the plant seems to be operating at its optimum, run a jar test and get an eye for what the floc looks like when running at the current dosage. Doing that will help later when things may not running smoothly to see in the jars what will help to optimize treatment.

If you have any questions about jar testing or want to have a jar test run at your plant, give me a call at 913-731-4004 or e-mail me at stewart@krwa.net. I would be happy to bring the KRWA jar tester to your plant and help out.

Stewart Kasper joined KRWA staff in August 2020 as Technical Assistant/ Trainer. He holds a Class IV operator certification for water and Class IV operator certification for wastewater in Kansas. Prior to joining KRWA, he was water plant operator at Rural Water District No. 2, Miami County.