In Pursuit Of The Perfect Glass Of Water

Water, classified as one of the basic elements since ancient time, is so essential, so simple, yet can be so challenging to deliver at high quality in high volumes. Pursuing the "perfect" glass of water involves two major influences: 1) regulatory requirements and 2) aesthetics or organoleptic quality (i.e., taste, odor, appearance, etc.). To start, it helps to be blessed with the good fortune of good source water quality, but beyond that it comes down to how a water utility treats and "polishes" the final product. Even for utilities not totally obsessed with garnering national taste-test honors, here are several factors to be considered when searching for the perfect glass of water, and the role that turbidity measurement can play in them.

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The Interconnectedness Of Things

No single isolated factor can ensure the perfect glass of water. The secret lies in balancing multiple interrelated factors. Disregard for any one of them can lead to a domino effect on the others, resulting in noticeably subpar results. Here are a few considerations to take into account with any water treatment plant (WTP) and distribution system:

- **Source Water.** Source water can be classified by a variety of major sets and subsets — for example, surface water vs. groundwater or rivers vs. reservoirs (including shallow reservoirs, natural reservoirs, or artificial reservoirs). The hydrology of each can be different, influenced by multiple factors from seasonal changes to reservoir aging. Whether those factors are under WTP influence or not, each source creates multiple considerations that can require different approaches to filtration and treatment.

- **Disinfection**. In addition to the variety of source water conditions, subsequent influences surrounding disinfection include: pre-oxidation, post-chlorination, and then, within chlorination, major choices ranging from free chlorination to chloramination.

- **Regulatory.** While regulatory monitoring and reporting are an automatic part of any U.S. water treatment process, the differences between the technical aspects of monitoring and crafting the perfect-tasting glass of water are as substantial as the differences between a boxed cake mix and a made-from-scratch dessert.

Layer on top of those core considerations the wild cards of ancillary water chemistry, pH, chlorine residual, turbidity, and water handling processes, and it quickly becomes evident that the idea of crafting great-tasting water requires a certain degree of pride and effort.

Preparation Is Essential

Whatever the source water, taking

turbidity readings on each source is an important factor in early pretreatment decisions, because water quality can vary so much from source to source and from season to season. Typically, the greater the turbidity at the intake, the more important the pretreatment process becomes in reducing pressure on the filters and reducing the complexity of post-filtration treatment (polishing). With those turbidity readings taken into account, efficient steps can be made to reduce total organic carbon (TOC), a major disinfection byproduct (DBP) precursor.

Once source water characteristics are understood, there are several key steps to take at the preliminary or pretreatment stage, before filtration. These include prescreening, coagulation, flocculation, and sedimentation. Because many WTPs use at least two sources of water as a risk-hedging strategy, the prospect of blending water from diverse sources — river, reservoir, or groundwater — can require adjustments to preliminary treatments over time in order to deal with seasonal changes. Situations with widely diverse source water streams might even call for parallel pretreatment streams geared to the extreme demands of each unique source.

Other factors that can come into play at different points in time are seasonal problems with pH or with manganese rising due to thermal stratification in reservoirs. It is important to avoid underestimating the role that pH plays in the need for coagulant and in subsequent effects on disinfection, another pillar of safe drinking water. It is also important to recognize how temperature affects pH readings. That is why it is important for WTP operators to measure temperature and pH together, and to build charts for seasonal fluctuations between the two, in order to understand how it changes and influences the process.

The All-Important Turbidity Reading

After the chosen pretreatment is performed to compensate for source water conditions, and after filtration occurs — whether that is conventional sand-bed filtration or membrane filtration — comes the one turbidity reading that trumps any other, the post-filtration reading outlined under U.S. EPA methods. The specifically low turbidity standards mandated by these methods are what provide confidence in protection against microscopic pathogens such as Giardia lambia and Cryptosporidium parvum. At WTPs serving 10,000 or more customers, this includes the requirement to report any instance of readings exceeding 1.0 nephelometric turbidity unit (NTU) or any readings greater than 0.3 NTU at the 95th percentile.

Even with appropriate pretreatment, WTPs might not be able to achieve such low turbidity levels with conventional (sand) filtration. Depending on water conditions, they might need to step up to membrane filtration — microfiltration, ultrafiltration, nanofiltration, or, ultimately, reverse osmosis (RO) filtration, which provides, basically, 99.99 percent molecularly clean water. Where RO membranes are used, the engineering-intensive processes WTP operators use to get the right balance of minerals back into the water play a large part in the taste of the finished glass of water.

While the turbidimeters (nephelometers) used at this stage in the process are primarily there to satisfy EPA requirements, they also play a significant role in helping WTP operators optimize whatever filtration method they use. Using turbidimeters to monitor backwash water enables users to ensure a thorough cleaning without excessive cleaning cycle time or excessive loss of treated water.

A Flavor To Savor

Beyond pretreatment steps removing any earthy taste or smell in the water stream — with or without the additional use of ozone or chlorine dioxide — managing the right balance of pH, hardness, and alkalinity can bring out the best taste in water. This can be achieved by selectively adding supplements such as potassium, calcium, and magnesium to achieve the desired chemical balance and taste. Doing this is particularly important where RO membrane filtration has removed virtually all naturally occurring minerals. Other water polishing steps can also include fluoride and phosphates added for dental protection or anti-corrosion protection in distribution piping.

The AWWA offers more than 800 documents relating to taste in water, to address a wide range of source water and process circumstances and influences.

Turbidity Beyond The Treatment Plant

Just because water leaves the WTP with a crisp, clean taste does not guarantee that it will taste the same once it reaches its customer destination. Consider monitoring water distribution systems citywide to help protect an initial investment in good water quality and taste. Taking turbidity measurements at multiple locations throughout the water distribution system, as part of multi-parameter field-test instrumentation panels, can help detect what is happening upstream in the system. Doing this helps system operators deal with impacts from water main breaks and repairs, disinfectant residual, potential nitrification events caused by sloughing off of biofilms in the piping, etc. ■