Benefiting from a Lead/Lag Configuration

Simple technique provides safety and economic advantages for POU/POE systems

- By Frank DeSilva

There are many applications today that offer potential new business for water treatment dealers because of increasingly stringent drinking water requirements. These applications include the removal of arsenic, nitrate, perchlorate, fluoride, radium, uranium and other emerging contaminants. The removal of these contaminants may be required by local, state or federal regulations. They represent a defined health threat to the consumer, so the utmost consideration must be given to the design, proposal and supply of appropriate equipment.

Ion exchange resins have been designed for the selective removal of many of the aforementioned contaminants. The selective ion exchangers are often expensive, but they are usually designed for once-through, long-life applications. It would, therefore, be prudent to maximize the available capacity to realize the total worth of the resin. Using a lead/lag ion exchange configuration for point-of-entry (POE) or point-of-use (POU) can introduce safety and economic benefits to a water treatment system.

Definition

A lead/lag configuration uses at least two vessels on line, in series, at all times. The primary bed, sometimes referred to as the worker bed, is doing most of the work. This initial column is removing the contaminant of concern, usually to acceptable levels just by itself. The second column, sometimes referred to as the polisher vessel, is acting as a safeguard against premature leakage or exhaustion of the primary vessel.

Operation

The primary bed of a lead/lag system is removing essentially all of the contaminant of concern, at least during the initial part of the run. The configuration should incorporate a means of monitoring, with sample ports, or flow totalization (see Lead/Lag Illustration) to establish when the lead unit should be taken off line.

The primary unit can be taken off line at the first hint of breakthrough leakage, or at a preset level of breakthrough leakage (i.e., 50% of inlet concentration), or at total exhaustion (inlet contaminant level equals effluent level). Once taken off line, the unit is rebedded with new media or regenerated.

At this point, the system is started back on line with what was the polisher vessel now in the lead position. The previous primary bed, which was just rebedded or regenerated, is put into the polisher position. The polisher, or guard bed, has the freshest, most highly regenerated media in it. The design of such a system must incorporate the proper plumbing and connections to allow the “round-robin” switching of the primary and polisher vessels.

The POU devices in Figure 1 are a pair of simple, two-bowl systems. Usually, both cartridges are replaced at the same time after a predetermined time.

The three-bowl system shown in Figure 2 has a prefilter of activated carbon followed by two cartridges of selective media. This POU system has a countdown valve that automatically shuts off upon reaching a preset gallonage. At that point, all three cartridges are replaced and the countdown valve is reset. This system offers the benefits of the lead/lag philosophy, plus the safety of the automatic shutoff. The gallonage shutoff value is predetermined by the water analysis and application, and should contain a significant safety design factor.

Added Safety

The obvious advantage that a lead/lag system has over a single-vessel system is the added safety blanket. The final polishing vessel can maintain effluent water quality in the event of premature leakage or exhaustion of the primary bed. This added layer of safety should be comforting to the homeowner or consumer of the treated water, especially when the contaminant of concern is something as onerous as arsenic or nitrate.

Capacity Advantages

The ion exchange process (see Figure 3) requires a certain volume of resin, called the transfer zone, for exchange to occur. This ion exchange zone, or mass transfer zone, represents a small percentage of the bed that is not totally utilized in single-column operation. Note that at the end of the service cycle, the ion exchange transfer zone occupies the bottom of the bed.

Running the vessel past the point of initial breakthrough leakage is not recommended in single vessels because of the high levels of effluent leakage that would be encountered. In some lead/lag configurations, how-ever, the lead vessel can be run until complete exhaustion because the polisher vessel will be performing the remaining work.

The most significant capacity advantage would be realized when the primary vessel is allowed to completely exhaust; however, there are other factors to consider. If the resin is to be regenerated, then this total exhaustion would not be advisable because of the amount of regenerant chemical required to bring the resin back to service. Total exhaustion makes the most sense when the resin is destined for single use.

Effluent Quality

The highest level of removal is achievable with a lead/lag configuration because you are essentially doubling the bed depth compared to a single unit. There is less chance of contaminant ions leaking through the system, especially when operating in a non-regenerable mode. Similar results can be expected in a regenerable mode when a counter-current regeneration method is used.

It is good practice to have some built-in insurance when treating drinking water for the removal of emerging contaminants. The lead/lag technique is simple and effective and can actually be more economical by utilizing the full potential capacity of the ion exchange media.

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