Drinking Water
Corrosion Control
PCE Stripping
Soluble VOC Removal
Contaminated Aquifer

Point-of-Use Drinking Water System for Remediation (PCE), Corrosion Control and Radon Removal

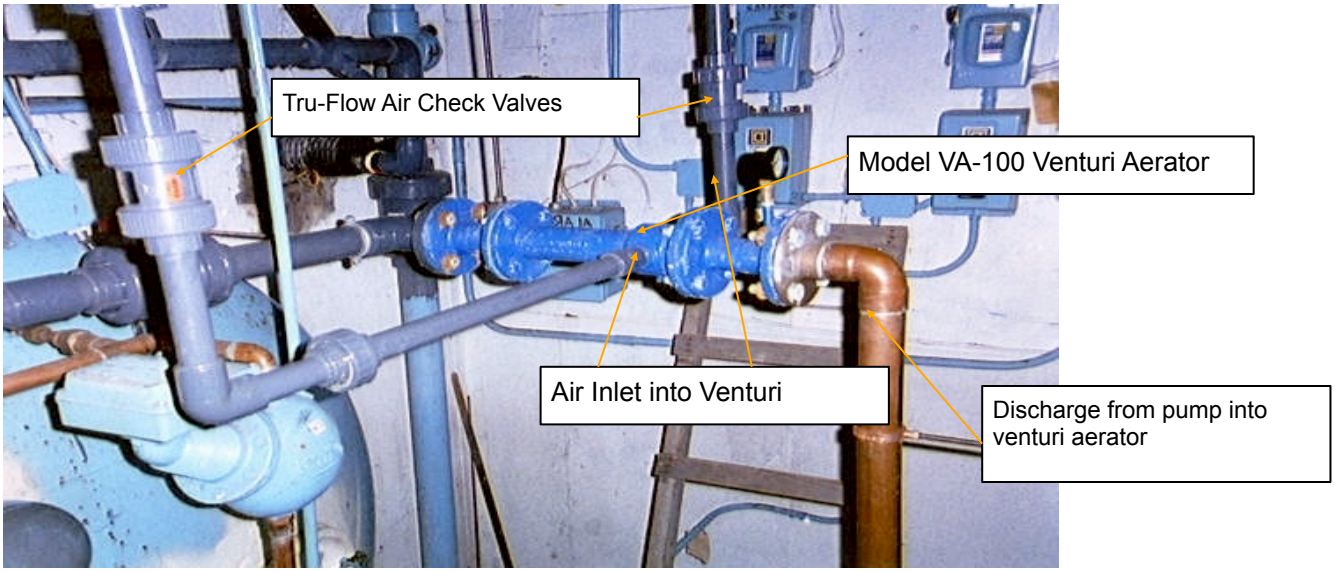
The water supply for the Pelham High School (NH) is derived from a portion of the Merrimack Aquifer in southern New Hampshire. The Merrimack aquifer is a very abundant source of water that is characterized by its natural low pH condition (5.8), and varying levels of soluble radon gas (~3,000 pCi). There is an area of the aquifer in Pelham, NH that is contaminated with Tetrachloroethylene (PCE), a dry cleaning solvent that polluted the wells that the Pelham High School uses for its water supply. PCE is water is a health risk because acute and chronic exposure to PCE studies have documented that it is a known carcinogen.(1)

When the PCE was discovered in the drinking water supply in the mid-1980's at the Pelham High School, all the uses for water extracted from the aquifer had to cease immediately because of health related concerns. This included drinking water fountains in the hallways, water used in the school cafeteria for food preparation and sanitation, showers in the locker rooms and even the water sprayed on the various athletic playing fields behind the main high school building. Expensive bottled water was brought in for drinking and cooking. The use of this water for showers after athletic events and practices was curtailed, as well as using the water for groundskeeping.

The school board was looking for an effective solution that could remove the PCE and provide a safe drinking water supply for the students and staff. Venturi Aeration, Inc. learned about the problem and developed a solution that could be easily retrofitted into the existing tanks and water treatment system that would not only solve the PCE issue but address issues with pH and radon simultaneously.(*)

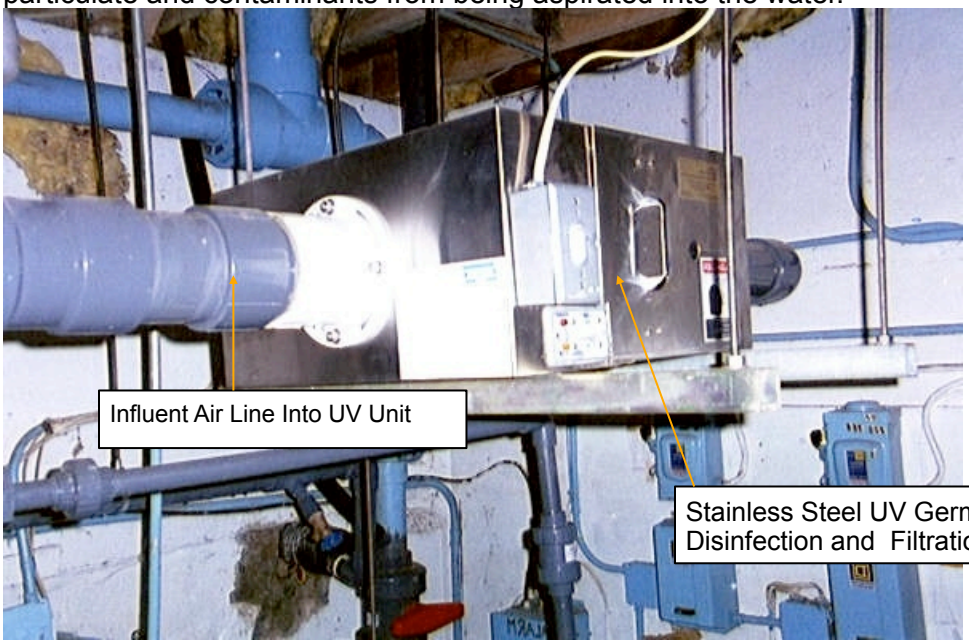
Venturi Aeration, Inc. developed a computer model of the type of results that could be achieved using venturi aerators to strip the PCE, radon and carbon dioxide. Field-testing showed that the model was predictable and accurate and that field results validated the computer model.

Stripping PCE: The venturi aerator has a unique design, in that it operates under a low pressure gradient, i.e. 20 psi, and it will strip substances with weak Henry's constants(2) that are partially soluble in water. PCE, radon and carbon dioxide all have weak Henry's' constants. Further, even at low pressure, the ability of the venturi aerator to strip these substances are a function of the pressure differential of the liquid exiting the nozzle and the rapid expansion of the liquid in a "mixing and oxidizing" zone within the venturi unit with minimum back pressure (6 psi). This pressure differential, 14 psi, allows the partially soluble substances to be released with predictability based on their Henry's number. Stripping efficiency for PCE, radon and carbon dioxide is ~80% per circulation through the Venturi Aeration system.(3) This means that ~80% of the substance will be effectively released for removal in the gaseous phase. To achieve reductions to non-detect levels, the liquids can be recirculated to the desired reduction levels by modeling the number of passes required through the venturi aerator.



In the case at Pelham High School, PCE is stripped using the venturi aerator system to N/D (non-detect) levels making the water acceptable for drinking, cooking, showering and landscaping. Further, stripping carbon dioxide non-chemically adjusts pH from acidic to neutral levels. The addition of chemical alkalinity *is not required* for corrosion control. A side benefit of the venturi aeration process is the stripping of soluble radon gas to levels below 300 pCi.

A simple venturi aerator system achieved the desired New Hampshire Department of Health (DOH) Water Quality Standards for Safe Drinking Water Quality in this point-of-use (POU) system. Multiple venturi aerators were used to achieve the desired circulations. An innovative Air Disinfection and Filtration System was developed to prevent any airborne particulate and contaminants from being aspirated into the water.



The air being aspirated into the venturi aerator is treated in an UV Air Disinfection and Filtration Unit. This system kills airborne bacteria that could be aspirated into the drinking water being treated. The device also has a particulate filter to trap solids. This particulate filter is exposed to the UV bulbs and its surface is therefore continuously disinfected. It has simple status lights and a mircoswitch to deactivate the UV component when the chamber is opened for inspection or bulb replacement. UV Bulbs are replaced annually regardless of service life left in the bulb as a precaution[3], and filters are changed monthly.

At Pelham High School the system has operated effectively since it was first installed in 1990 and has been subject to routine inspection and continuous sampling by the New Hampshire BOH. It has proven itself to be a reliable technology that is simple to operate, requires little maintenance, and the service life has exceeded the original ten years it was designed for. PCE continues to be a contaminant in the aquifer and the daily treatment of water in this POU system is still required.

Non-chemical Corrosion Control

Stripping carbon dioxide will raise the pH non-chemically. There is interdependence between three factors: pH, alkalinity and carbon dioxide. Traditional engineering will almost always add to the alkalinity to raise an acidic pH. In New England the groundwater is naturally acidic with low alkalinity. However, another method of adjusting pH produces the same log value increase in pH. Review the following formula:

pH = 6.35 + log (alkalinity/carbon dioxide)

By stripping CO2 the log value of pH increases. Pelham H.S. has a raw pH of 5.9 and two passes through the venturi aerator yields a pH of 7.5 and is an excellent method to control corrosion and eliminate the leaching of copper and lead frequently associate with the flux or pipe solder.

NOTES:

1. NIOSH Doc. 76-185 (1976); DHEW Pub. No. 77-813 “Bioassay for Tetrachlorothylene (PCE) for Carcinogenicity.”
2. Henry’s constant (number) a value assigned to a substance partially soluble in a liquid that can be removed from the liquid based on a change in the partial pressure the keeps the substance is solution.
3. Variables that effect stripping efficiency – Stripping efficiency with the venturi aerator system can be affected by temperature and inorganic substances dissolved in the water (TDS). The warmer the temperature the easier it is to strip substances with weak Henry’s numbers. Carbon dioxide can combine with inorganic substances to form a carbonate.
4. Life of UV Bulbs – The wave length intensity of UV bulbs degrades with continued use, therefore a bulb can diminish in effectiveness over time. As such, UV Bulbs should be changed annually to ensure the efficiency even if the bulb is still lit.

BIBLIOGRAPHY

*O’Brien, Joseph E., Ph.D., P.E., “Reducing Corrosivity and Radon by the Venturi-Aeration Process,” ***Journal of the New England Water Works Association***, June 1995, Vol. CIX, No. 2, pp. 105-114.