Just as water is known as a universal solvent, chlorine is known as an almost universal water treatment chemical.

The primary objective of water supply chlorination is disinfection. Because of chlorine's oxidizing powers, it has been found to serve other useful purposes in water treatment. These applications include:

- taste and odor control,
- prevention of algae growths,
- maintaining clean filter media,
- removal of iron and manganese,
- destruction of hydrogen sulfide,
- color removal by bleaching of certain organic colors,
- maintenance of distribution system water quality by controlling slime growths,
- restoration and preservation of pipeline capacity,
- restoration of well capacity.

None of the so-called alternatives to chlorine can compete with its versatility.

Historical Background

Chlorine was first introduced to water treatment as a disinfectant in the early 1900's. Since that time, it has become by far the predominant method used for this purpose. This popularity is deserved because of chlorine's potency and range of effectiveness as a germicide. It is easy to apply, measure and control; it is relatively free from toxic or physiological effects; it persists well; and it is relatively inexpensive. Other agents may equal or even excel aqueous chlorine in any one of these characteristics, but there is none that combines them in such an advantageous way. Ozone, bromine iodine, chlorine dioxide, silver ions, ultraviolet and ultrasonics have been investigated. Some of these have found important uses in special situations, but none of them so far has been a serious competitor of chlorine (for water treatment).

As a result, of all the municipal water supplies that are being chemically disinfected, at least 99% use chlorine.

From:

"The Handbook of Chlorination and Alternative Disinfectants," 3rd Edition - 1992, by G.C. White, Consulting Engineer. (A definitive textbook with major research contributions by the American Water Works Association)

Dry Pellet Chlorination

A dry pellet chlorinator is designed to operate only when the well pump runs, thereby treating the water strictly on a demand basis. Depending on the nature of the problem, the **chlorine demand** (the amount of chlorine necessary to oxidize and/or destroy certain constituents present in a water sample) is calculated, and a **chlorine residual** (application-dependent but usually about 0.5 ppm) is added to the chlorine demand calculation to arrive at a **chlorine dosage** (the amount of chlorine necessary to handle specific water problems and provide a predetermined residual).

Following are some questions asked by our customers regarding dry pellet chlorination. We hope that publishing the answers in this easy-to-use booklet form will eliminate some misconceptions and clarify the significant benefits of dry pellet chlorination in well water treatment.

Question 1:

"How do you respond to concerns that dry pellet chlorination may lead to significant fluctuations in chlorine residual levels?"

Answer:

The fluctuation in chlorine residual is usually very slight and is controllable by:

1. Proper chlorinator adjustment
2. Use of a chlorine residual test kit

Fluctuations may occur as a result of several variables such as a) temperature, b) variations in water usage rates, c) chlorine demand, d) pH, and e) the time of day the tests are taken. The less the variation in these parameters, the more consistent the chlorine residual. The New York State Department of Health (NYSDOH) conducted a study by John MacNeill, P.C., on dry pellet chlorination and chlorine residual fluctuations. Their conclusion states, "The Land-O-Matic™ pellet-type chlorinator maintains a chlorine residual and reduces coliform bacteria and standard plate count to acceptable NYSDOH standards."

Reference the project summary, Field Evaluation of the Land-O-Matic Chlorination System, a study conducted by the Water Engineering Research Laboratory of the United States Environmental Protection Agency (EPA), which concludes "The Land-O-Matic Dry Pellet Chlorinator was capable of providing an acceptable average chlorine dose in well water supplied to domestic water systems."

Question 2:

"How do you ensure that pellets do not become wedged between the pump and the well casing or liner, particularly on a well with less than a 10-inch internal diameter?"

Answer:

This problem may arise in a small diameter well (under six inches) or a well with minimal drawdown.

Two measures can be taken at the time of installation to ensure that chlorine pellets (approximately 3/8-inch diameter) do not become wedged between the pump and well casing:

1. **Pellet Catch Basket:** A pellet catch basket should be installed on wells less than six inches in diameter and wells that are not cased to the bottom. This prevents pellets from becoming wedged between the pump and casing.
2. **Recirculating Check Valve:** A recirculating check valve can be installed along with a catch basket to allow for proper pellet dissolution in wells where a minimal drawdown level results in little or no water turbulence.

Question 3:

"What would be the consequence of pellets not properly breaking down in the well?"

Answer:

1. Pellets not properly breaking down in the well can occur from a) overchlorinating and/or b) minimal water circulation in the well casing.
2. "Bridging" of the pellets can occur in either situation, as would happen if an excessive number of sugar cubes were added to a glass of water and they failed to completely dissolve. An excessive number of pellets in the well will immediately result in water with an unusually high chlorine residual. This will be detected when the well owner conducts a regular chlorine residual test.
3. Proper chlorine demand calculations and proper, regular testing by the well owner will eliminate the problem of bridging.

Question 4:

"Only 65% to 75% of the chlorine pellets dissolve to form a chlorine residual, while the rest remains as a precipitate, usually on/or around the pump or falling to the bottom of the well. What is to prevent this precipitate from accumulating in the well?"

Answer:

See appendix, "Material Safety Data Sheet" (MSDS) regarding pellets' chemical composition. The active ingredient is 70% chlorine, with the remaining 30% composed of inert ingredients. Of this remaining 30%, approximately 80% consists of constituents which are quite soluble in water, (sodium chloride, calcium chlorate, and calcium chloride.) This leaves approximately 6% of the total pellet (20% of the remaining 30% inert ingredients), comprised of the remaining two compounds, calcium hydroxide and calcium carbonate. These are compounds which occur naturally in groundwater. Calcium hydroxide is partially insoluble in water. This **minute percentage** (<4%) of insoluble constituents is readily pumped out of the well with the regular water flow.

Question 5:

"How do you explain the claim that a well owner's pump became cemented to the plastic or steel casing by pellet residue?"

Answer:

Pumps becoming stuck or cemented in the well casing can be caused by a number of factors. It is common for pumps to become cemented in well casings where chlorine has never been used. Various mineral constituents naturally occurring in the groundwater (e.g., hardness, alkalinity, iron and manganese) or biofouling (incrustation by iron bacteria and sulfur bacteria) can lock pumps in place. "Deposition of only a minute fraction of the mineral in the water will cause serious clogging." (<u>Groundwater and Wells</u>, p. 634). "The incrustation often forms a hard, brittle, cement-like deposit similar to the scale found in water pipes. Under different conditions, however, it may be a soft, paste-like sludge or a gelatinous material. The major forms of incrustation include:

1. Incrustation from precipitation of calcium and magnesium carbonates or their sulfates
2. Incrustation from precipitation of iron and manganese compounds, primarily their hydroxides or hydrated oxides
3. Plugging caused by slime-producing iron bacteria or other slime-forming organisms (biofouling), (<u>Ibid</u>., p. 634)

In addition to these **naturally-occurring**, scale-producing constituents, the pumping action itself can also cause mineral deposits. "During pumping, velocity-induced pressure changes can disturb the chemical equilibrium of the groundwater and result in the deposition of insoluble iron and manganese hydroxides. "(<u>Ibid</u>., p. 635). "This decease in pressure, plus the turbulence in the pump bowl area, results in the release of carbon dioxide, which decreases the solubility of water. Therefore, it is at this point that the scale-forming compounds of calcium, magnesium, iron and silica are deposited." (Handbook of Chlorination, 1986, p. 374). It is apparent, as indicated above, that many natural factors can cause pumps to become cemented in the well casing.

Question 6:

"Why is it better to treat water in the well and aquifer, compared to above-ground treatment?"

Answer:

In-well chlorination has two advantages over surface treatment at the pressure tank. First, the well itself is used as a contact chamber for oxidation of iron, manganese, hydrogen sulfide and iron bacteria. Second, and more importantly, in-well chlorination provides for complete treatment of the water supply system **at the source**.

"The American Water Well Association prefers in-well treatment to protect pumps, pipe, and casing," (Planning for an Individual Water System, p. 62). "A popular method is to use an automatic chlorine pellet dispenser (Figure 39b). It feeds the pellets directly into the well casing at a predetermined rate, depending on your water use." (Ibid., p. 45). The "most common" methods used to meet the varying iron conditions in farm and home water supplies are the following: phosphate feeders, ion exchange units, and oxidizing filters, (all for dissolved iron), and chlorinator-filter units, (for dissolved iron, or bacterial iron, or both.") (Ibid., p. 62).

Question 7:

"Does in-well chlorination affect the surrounding aquifer?"

Answer:

In-well treatment poses no discernible risk to groundwater resources. "As the pump removes water, an area of low pressure develops near the well bore. Because the water level is lower in a pumped well than at any place in the water-bearing formation surrounding it, water moves from the formation into the well to replace water being withdrawn by the pump. The pressure (force) that drives the water toward the well is called the head. This is the difference between the water level inside the well and the water level at any place outside the well." (Groundwater and Wells, p. 207). Due to the inward hydraulic pressures of the aquifer, chlorinated water in the well casing will be contained within the confines of the casing.

Question 8:

"Does the dry pellet chlorinator system provide the high levels of chlorine residual necessary to shock-treat iron bacteria, similar to the traditional approach of biannual in-well chlorine shock treatments?"

Answer:

A dry pellet chlorinator provides continuous chlorination as opposed to shock chlorination. Shock chlorination (superchlorination) is a method of feeding extremely high chlorine dosage levels (>200 ppm) using an abbreviated contact time to provide an initial kill. This method is normally used periodically as a **temporary** cure for problem water and is also used as a preliminary procedure to continuous chlorination.

When the term continuous is used, it does not imply that the chlorinator is operating continuously; rather, it means that the chlorination process is ongoing, feeding small dosages of chlorine based on the demand for water.

"Of all the municipal water supplies that are being chemically disinfected, at least 99% use chlorine." (Handbook of Chlorination, p. 256). **Continuous** chlorination has been used by municipalities for over 75 years.

"Two reasons why health authorities, in general, favor chlorine disinfection over other disinfection methods...are:

a. The chlorine residual lasts for a long period of time after leaving the disinfection unit, thus providing continuing protection and
b. You can measure the amount of chlorine residual with a test kit so at any time you can determine how much protection is being provided". (Planning for an Individual Water System, p. 45). By adding the proper chlorine dosage to problem water, a slight chlorine residual (0.5-1.0 ppm), remains after the chlorine demand has been satisfied to continuously disinfect the system and prevent the problem water situation from recurring. "Continuous chlorination is the only dependable permanent solution." (Private Water Systems, p. 59).

Question 9:

"Has any research been undertaken to determine the incidence of iron bacteria and other bacteria acquiring a resistance to chlorine given the long-term, consistent exposure provided by the dry pellet chlorinator?"

Answer:

There is no existing empirical data showing any type of iron bacteria or other water-borne bacteria developing a resistance to continuous chlorination. Conversely, there are studies too numerous to mention extolling the consistent germicidal power of chlorine. Chlorine is effective in penetrating the cell wall of an organism. "It is assumed that after penetration of the cell wall is accomplished, the disinfecting compound has the ability to attack the enzyme group whose destruction results in death to the organism." (Handbook of Chlorination) p. 195).

Although iron bacteria is persistent and stubborn, it is not impervious to the bactericidal effects of chlorine.

Question 10:

"Concerns have been expressed about continual injection of chlorine pellets into wells and aquifers. What are the short and long-term effects on the well and aquifer water resource of the precipitate of iron, manganese, iron bacteria residue, sulfate-reducing bacteria residue, and calcium pellet residue, which have settled out in the aquifer, rather than being removed by pumping?"

Answer:

Since the dry pellet chlorinator is treating the well water with low doses of chlorine on demand, only water residing in the immediate vicinity of the well pump is being dosed. Oxidation of iron, manganese, iron bacteria, and hydrogen sulfide will occur in that vicinity. Chlorine is only fed into the well when the pump is running, any settling of these particles is severely hampered by the agitation generated by the well pump and the inward hydraulic pressure of the aquifer. This tends to keep the particles suspended, allowing them to be removed by pumping.

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