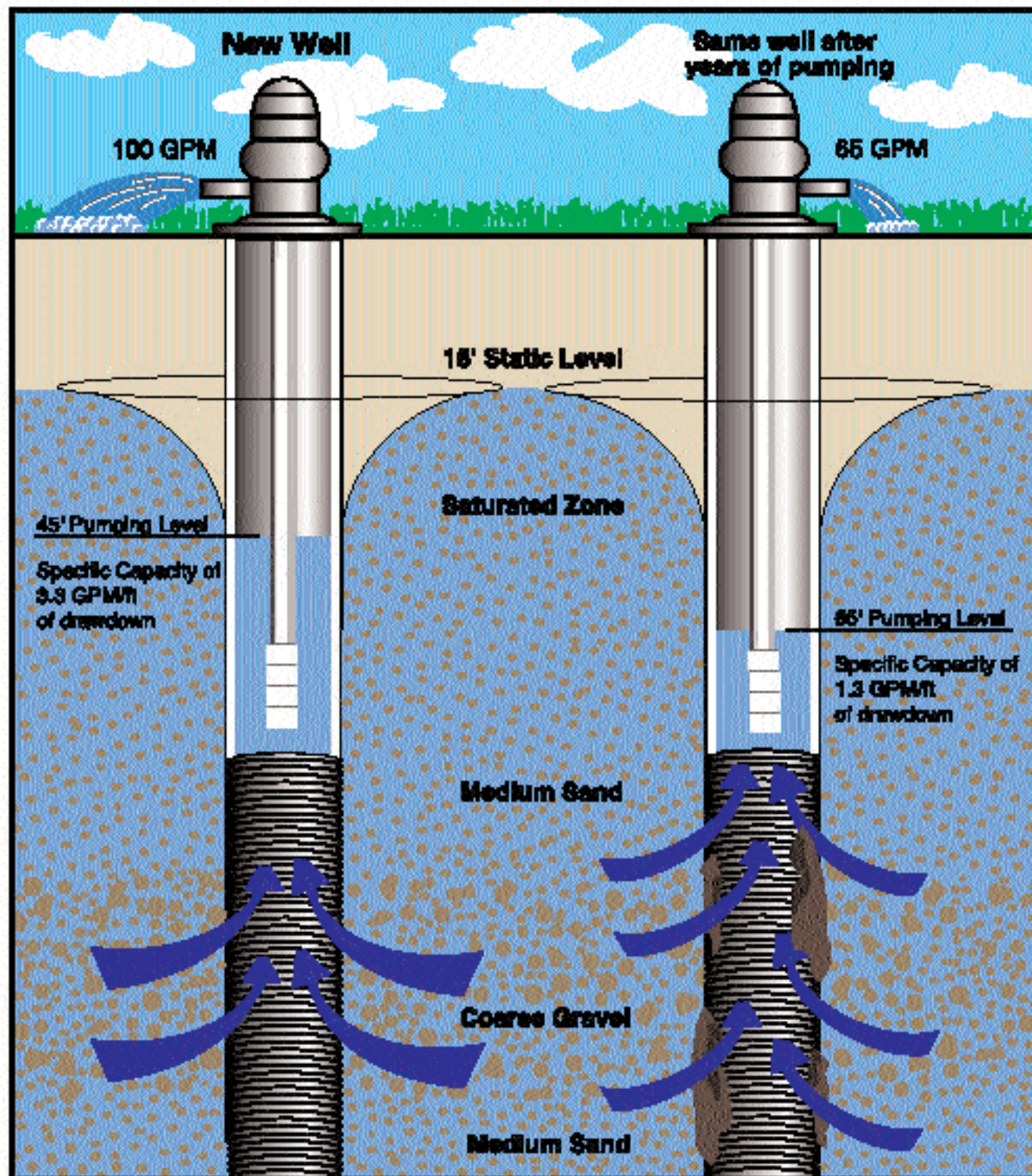


Cleaning Wells and Pipelines



Typical flow conditions
In a new well.

Flow conditions altered due to a build
up of mineral scale and/or biological debris.

General Information

Traditionally, well maintenance is performed in an emergency mode without taking time to understand the true problem. Monitoring of well and pump performance as well as the scheduling of routine maintenance is not often done. During well rehabilitation, 50's vintage chemicals are often poured into a well, surged, and simply pumped to waste 12 hours later. There is little understanding of how well the chemicals did or did not work other than comparing the pumping rates before and after the project. Little attention is given to the dangers of chemicals to on-site personnel, the effects of corrosive liquids on well casings or screens and the potential of contaminating aquifers with non-biodegradable, hazardous chemicals.

Design Water Technologies is changing the direction of well rehabilitation. We promote 1) understanding a problem before solving it, 2) manufacturing safe chemicals that provide consistent and long lasting results, 3) monitoring these chemicals during the cleaning process, and 4) disposal of products properly once the project is complete. First, some basics.

Problem Evaluation and Keeping Good Records

It is critical to keep good records of well and pump performance. Yield alone is not a good indicator of well performance. Changes in yield could be due to pump problems or system change conditions. The only true method of monitoring well performance is to calculate Specific Capacity (SC) at a certain time of pumping. Record the Static Water Level (SWL), and then the Pumping Water Level (PWL) at a consistent pumping time, (ex. say 30 minutes for domestic wells and an hour for larger diameter wells,) along with the Gallons Per Minute (GPM). Subtract SWL from PWL to obtain Draw Down (DD). Divide the GPM by DD to obtain Specific Capacity or GPM per foot of DD. This is the number to use for comparative purposes to determine declines in well yield, not the pumping rate only. For example: 32' PWL-15' SWL=17' of DD @ 30 minutes pumping 20 GPM. $20 \text{ GPM} \div 17' \text{ DD} = 1.17 \text{ GPM/ft of DD @ 30 minutes}$.

Always record the Specific Capacity at approximately the same pumping rate and time for a more accurate comparison. If the pump yield and AMP readings are lower than previous data and the SP is higher, the pump needs repair. Conversely, if the pumping rate and the SP have declined, the well needs rehabilitation.

Compare all information at least once a year on municipal or industrial wells. Record Specific Capacity on all new wells and set a target at 60% of the original SP for planned rehabilitation. Check all domestic wells whenever any maintenance is performed.

If the Specific Capacity declines more than 30-40%, the problem should soon be addressed. It is more difficult to remedy a plugging problem caused by mineral scale if the specific capacity has declined more than 40%. It is easier to successfully rehabilitate wells with plugging problems due to slime bacteria, even if the SP is zero because the plugging is closer to the bore hole and easier to remove.

A decline in the Specific Capacity can be blockage due to 1) mineral scale 2) slime bacteria 3) fine sand or silt infiltration into a screen area or bore hole 4) physical blockage in the bore hole or well screen 5) physical changes in the aquifer itself, ie., reduction in static level and even seismic activity. Chemicals are not always the solution. Determine if any sand is being pumped which can often be found in pressure tanks, water lines, or holding tanks. Check the well depth, as there may be several feet of sand or debris in a screen or open bore hole which can reduce yields. Determine if there is any build-up of hard scale or slime on pumps or piping systems. Check available water quality information. You cannot make an accurate determination of the problem without good well records.

We will address mineral scale and slime bacterial problems only in this brochure, as they are the most common. Understand your problem before designing a solution.

Mineral Scale Problems

Ground water often has high concentrations of dissolved minerals. Natural carbon dioxide (CO₂) in water produces carbonic acid, which keeps minerals in solution. During pumping, a portion of the CO₂ is lost through increased velocity and depressurization causing a portion of the minerals in solution to precipitate as hardened, mineral scale. Temperature changes enhance mineral precipitation. Sulfate levels less than 70 ppm can precipitate when velocity is extremely low, which happens when the pump is turned off. A layering effect of the various types of minerals can occur with sulfates on the surface and carbonates beneath. Sulfate levels greater than 70 ppm can precipitate in the same manner as carbonates.

Field Diagnosis for Mineral Scale

The specific capacity of a well declines slowly and somewhat consistently over several years, i.e., 5-15 years, depending upon water quality.

*A hard scale is noticed when pulling the pump or in a piping system. The color associated with each type of scale is as follows:

red/brown = iron **black** = manganese
green/blue = sulfates **white/light brown** = calcium

* If you have information on water quality, look for any one or combination of the following:

pH > (greater) 7 **iron** > 1.0 ppm **hardness** > 200ppm
sulfates > 20 ppm **manganese** > .02 ppm

* Bubbling or nodules may be noticed on pumps or pump column and is a sign of corrosion due to either electrochemical or bacterial activity. If total dissolved solids is greater than 600 ppm, corrosion may be due to galvanic corrosion (electrolysis). When dissimilar metals are placed in water that is highly conductive to electricity, corrosion will occur on low carbon or galvanized steel.

* In a video of a well, the scale buildup will be present in sections of screen where water velocity is the highest. Parts of the screen may be totally clean which is an indication of little or no velocity. (see Figure 1, pg. 10)

Ground water often has high concentrations of dissolved minerals. Natural carbon dioxide (CO₂) in water produces carbonic acid, which keeps minerals in solution. During pumping, a portion of the CO₂ is lost through increased velocity and depressurization causing a portion of the minerals in solution to precipitate as hardened, mineral scale. Temperature changes enhance mineral precipitation. Sulfate levels less than 70 ppm can precipitate when velocity is extremely low, which happens when the pump is turned off. A layering effect of the various types of minerals can occur with sulfates on the surface and carbonates beneath. Sulfate levels greater than 70 ppm can precipitate in the same manner as carbonates.

These deposits may precipitate in screened wells (slotted, bridge slot, louver, or continuous slot well screen) or open bore holes (fractured rock, sandstone, or limestone). The kind and amount of precipitate will depend upon the severity of water quality and the use of the well. Over pumping a well or cascading water will increase precipitation. Acids are commonly used to dissolve these scale deposits and return a well yield.

Different scale deposits react differently to acids. Calcium is the easiest scale to dissolve. When using hydrochloric (Muriatic) acids (HCl) in high calcium deposits, a violent reaction can occur. This reaction causes overfoaming or an explosion of acid spewing 20-30' out of the well. It can create a hazardous cleanup condition since inherent ingredients consist of heavy metals, i.e., lead, arsenic, zinc, etc. benzenes and other toxic organic compounds (TOCs). Muriatic is also very dangerous to store, ship, and use in the field. It is a gas by-product of other manufacturing processes, mixed as a liquid. Extreme care must be taken when working with hydrochloric, as the fumes released are instantaneously lethal. It is very corrosive and is generally not recommended to use in a well or pipeline for longer than 12-16 hours, even with inhibitors. Inhibitors only last approximately 6-8 hours. HCl will be slower reacting with high concentrations of iron, manganese, and extremely slow reacting with sulfate scale.

Sulfamic acid was developed in the 50's to more safely dissolve calcium carbonate scale. It is not effective with scales or decayed organic debris consisting of iron, manganese, or sulfate. It is generally considered much safer than hydrochloric but is classified as a corrosive product and has shipping limitations.

"Unicid" Granular was developed in 1990 to safely dissolve all scales with the consistency of hydrochloric, but more safely than sulfamic. It is not corrosive to metal parts or harmful to plastic, so the time working in a well or pipeline is only limited to dissolving scale and organic debris. This is effectively done by monitoring color and pH to determine when the job is complete. (see "Field Monitoring..." on pages 12 and 13).

Treatment for Mineral Scale

Physical cleaning of wells

A specific amount of chemistry is required to dissolve a certain amount of scale, therefore it is beneficial to physically remove as much scale as possible prior to chemical treatment. Less product would then be required and it allows chemicals to more easily penetrate into the formation. Sonic jetting, dry ice, and high energy air pressure are methods used to fracture hardened scale. These procedures are often used only on large-diameter wells because of the costs involved. Refer to manufactures recommendations and use qualified personnel to handle explosives. Another method to remove debris from the inside of the screen is to use a wire brush. This can be made easily with 1/4 to 1/2" steel cable cut slightly longer than the inside diameter of the casing, and welded horizontally through a piece of pipe with drilled holes for stability. All debris should be bailed or airlifted out of the well prior to chemical treatment.

Chemical treatment of wells with "Unicid" Granular acid

Tremie line method:

Mineral scale is generally a problem only in the screen area of unconsolidated formations or fracture zones and solution channels in rock wells. If severe scale is present in the casing, it is advisable to physically remove excess scale by a wire brush or casing scrapper. Then air lift or bail the debris out of the well prior to chemical treatment. We recommend that "Unicid" Granular be mixed with water and delivered through a tremie pipe just above the screen or open borehole in a concentrated form. All types of pipe can be used (PVC, black, or galvanized) as a tremie. Any pump can be used for mixing and pumping because "Unicid" is not corrosive to metal parts and will not damage pump seals or bearings.

Refer to the dosage chart in **Table 1** (page 4) for the recommended amount of "Unicid" Granular product for screened wells. For example: 8" pipe size, 15' long screen would require 2.6 lbs/ft of screen x 15' = 39 lbs. Mix the recommended amount of "Unicid" Granular acid into a tank using two pounds per gallon of water as a maximum mix ratio. The 39 lbs of "Unicid" Granular should be mixed into 20 gallons of water ($39 \div 2 = 19.5$). If the screen is less than 50' long, set a tremie pipe just above the top of screen and pump the acid into it. Displace the acid out of the tremie with plain water. In screens longer than 50' or multiple screens, acid should be placed with a tremie throughout the screen area in equal amounts or between a packer system to localize the acid placement. Development should be started immediately. (see Development, pg 10)

Refer to **Table 2** for dosage in consolidated rock wells and multiply by the total footage of the formation. Use a tremie line to install liquid acid just above the formation. If the formation is thicker than 50', place the acid in equal increments. Development should be started immediately.

Pour from surface method:

"Unicid" Granular can be poured from the surface, but if the static water level is shallow and the well deep, the amount of product can be costly when calculating pounds required per foot of water in the well. Since mineral scale is generally a problem in the screen area or formation only, it is better to place acid through a tremie line. If you must pour "Unicid" Granular from the surface, use the dosage shown in Table 2. The recommendations are based on pounds per foot of water in the well. For example: An 8" well with 15' of screen, static water level of 10', and a total depth of 115' would require 111 lbs. ($115' - 10' = 105'$ of water in the well x 1.1 lbs/ft of water = 111 lbs).



In screened wells, multiply pounds times length of screen. Mix as liquid, tremie to screen.	
Screen Diameter	Pounds acid/foot of screen
2"	0.50 lbs
4"	0.70 lbs
5"	1.00 lbs
6"	1.50 lbs
8"	2.60 lbs
10"	4.00 lbs
12"	6.00 lbs
14"	7.00 lbs
16"	9.50 lbs
18"	12.00 lbs
20"	15.00 lbs
24"	23.50 lbs
For other diameters of wells: Calculate total gallons of water in well screen x 8.33 x 0.12 (12%) x total feet of screen in the well.	

Table 1



In rock wells, multiply pounds by the thickness of aquifer. Mix as a liquid, tremie to aquifer.	
Well Diameter	Pounds acid/foot of formation
2"	0.25 lbs
4"	0.30 lbs
5"	0.50 lbs
6"	0.70 lbs
8"	1.10 lbs
10"	1.75 lbs
12"	2.50 lbs
14"	3.00 lbs
16"	4.00 lbs
18"	5.00 lbs
20"	6.25 lbs
24"	10.00 lbs
For other diameters of wells: Calculate gallons of water per foot of casing/bore-hole x 8.33 x 0.05 (5%) x total feet of water in well.	

Table 2

Chemical treatment of wells with "Unicid" Bullets

"Unicid" Bullets are pelletized with the same formulation as "Unicid" Granular. A pelleted product dropped from the surface, falls to the bottom of the well. "Unicid" Bullets are recommended only for screens shorter than 5'. They should not be used in longer screens because all the pellets end up at the bottom of the screen. The saturation point is approximately 22%, so all of the pellets may not dissolve without a great deal of development action. Liquid acid weighs 9.5 lbs. per gallon and can be difficult to move up toward the top of a screen longer than 5'. Scale is more likely to precipitate in the upper portion of the screen than a lower area (see Fig. 1, page 10). Development is critical to push acid outside the screen to dissolve scale in the formation. (see "Development," page 10.) Do not use in wells with over 250' of water as the pellets will dissolve before reaching the screen. The dosage is based upon pounds per foot of screen, see Table 3, or follow the dosage on product label. Monitor pH and adjust accordingly (see "Field Monitoring," page 12 & 13).

Bullets may also be used to loosen stuck pumps due to mineral scale buildup. For domestic pumps, pour approximately 4 to 5 pounds of Bullets on top of the stuck pump. You may have to break up the "Bullets" to get them through the pit less adapter. Let sit for several hours or overnight, and work the pump up and down to loosen the pump. In severe cases, an overshot casing scraper may be required to scrape the scale to the pump. Use an airline to blow the debris out of the well prior to installing the Bullets. **Do not use Bullets in wells with screens longer than 5'.**



Pour Bullets from surface		
Screen Dimension	Number of total pounds	Pounds per foot of screen
2" x 5'	2.5 lbs	0.50 lbs
4" x 5'	5.0 lbs	1.00 lbs
5" x 5'	7.5 lbs	1.30 lbs
6" x 5'	10.0 lbs	2.00 lbs

Slime Bacteria Problems

Common soil organisms

Most slime problems are caused by naturally occurring, common soil bacteria found in every aquifer. These are often referred to as heterotrophic bacteria. The most common of these are identified within the families of Pseudomonas, Aerobacter, Acentobacter and Flavobacter. These bacteria process nutrients within the aquifer and exist normally in numbers of tens of colonies per milliliter. Many of these families are highly mobile and can be either aerobic or anaerobic. Aerobic bacteria like areas of high oxygen in a well, ie., high velocity areas of a screen during pumping or at the static water level, cascading water, etc. Anaerobic bacteria like areas of low oxygen, ie., non-pumping wells, low permeable area of aquifers, slumps beneath screens in wells, or beneath large amounts of scale and slime or decayed debris, etc. Anaerobic bacteria often produce odors and can cause corrosion of well casings, screens, or pumps.

Slime production

Since bacteria are found naturally in all aquifers, there may be reasons for slime production in some wells or systems and not others. Our studies indicate slime production occurs:

1) if the available food source for bacteria is low or threatened. Most bacteria are carried by water velocity consistently toward the bore hole. The food source becomes depleted as the number of bacteria increase in their normal growth cycles. In lab studies, the number of bacteria will often be in the high hundreds of colonies/ml when slime problems exist. This can be compared to numbers in the tens of colonies when slime problems do not exist.

2) when velocity and pressure is excessive. Aquifers have a natural direction of flow, but when a well is installed and pumped, the direction of flow and velocity change drastically toward the bore hole. This flow has a tendency to continuously bring more bacteria to the well. The natural flow velocity within an aquifer is measured in feet per year or even inches per year, whereas the flow around a well during pumping is measured in feet per second. Tremendous changes in velocity and pressures also occur in the pump, pump drop pipe and in the system. Massive amounts of slime may be found in these areas with little slime production in the well. Poor development techniques in new wells, which results in low well efficiency, increases the tendency for both precipitation of minerals and the production of slime. Poor well efficiency increases the velocity of water moving toward the bore hole.

The slime produced is a natural protection against harmful chemicals like chlorine and acids. Studies show shock chlorination kills only some of the bacteria and will smear the outer surface of the slime mass. Bacteria may be damaged and will not repopulate as quickly for a period of time. In an incubator at 70° F, the time required for bacteria to repopulate is a matter of weeks. At normal ground water temperatures, the time required to repopulate becomes months. Bacteria can survive acid solutions with a pH of 2 for long periods which is impossible to maintain in the entire thickness of the bore hole and aquifer. Any attempt to kill these bacteria with biocides, chlorine, hydrochloric and hydroxyacetic acids is, at best temporary.

Bacteria have a 22 minute life expectancy at 70° F and slightly longer in lower ground water temperatures. Once the bacteria die, any slime produced will slowly harden over a long period of time. This becomes a ferric oxide and plugs wells just as mineral scale would. As water flows over this ferric oxide, CO₂ converts ferric to ferrous and concentrations of iron in water may fluctuate or elevate substantially. Levels of manganese and sulfates may also fluctuate.

Iron Bacteria

It was thought that iron bacteria was the main culprit of slime problems in wells, but they have only been identified in less than 10% of our water studies in the past 10 years. It was thought that iron bacteria was introduced into wells through dirty tools of well drillers and pump installers and is a possibility. Site cleanliness and disinfection are important, but iron bacteria can also occur naturally in aquifers.

Iron bacteria produces a stalk or tube like, sheath. This becomes a framework that slime bacteria attach to or fill in, which increases the severity of plugging. Iron bacteria like areas of high nutrients, ie., steel casing, pumps, and decayed debris from other bacteria. They secrete a very corrosive enzyme to process nutrients and corrosion is often found on metal surfaces. Physical indications may include musty or fishy odors and even an oily film on water. When identified, it is an indication of massive amounts of scale or biological debris. The most common families of iron bacteria are Galleonella, Crenothrix, and Leptothrix.

Sulfate Reducing Bacteria (SRBs) (rotten egg odor)

SRBs are anaerobic in nature, which means they survive in an environment where oxygen is not present. These areas include sumps below the screen or non-producing areas of a screen or aquifer. They are often found in wells that are not pumped frequently causing oxygen to be depleted. The sudden presence of a rotten egg odor in an older well may indicate a massive amount of slime growth and/or mineral scale deposits. These bacteria may be found under growth and scale because it provides a low-oxygen environment. The total biological mass may include layers of aerobic slime formers on the surface and anaerobic bacteria at the base. All could be intermixed with precipitates of minerals and dead and decayed bacterial debris.

SRBs reduce sulfates in water and require fairly substantial levels of sulfate or gypsum to survive. They process sulfate by releasing an organic acid that is very corrosive, creating a ferrous sulfate or ferrous oxide. Hydrogen Sulfide (H₂S) is a gas which smells like rotten eggs and is released during this process. This odor may not be present until a well or system is treated with chlorine or acids. Once the outside protective shell of the scale or slime is removed, the odor appears as the bacteria are exposed to the environment. A massive odor of H₂S can be present during the wire brushing of a well before a chemical treatment for slime bacteria. (see page 8)

These can be naturally occurring bacteria present in new wells within areas of clay or shale lenses. Completion of wells in clean sand with short sections of screen or casing driven to clean sandstone can minimize or eliminate these odors.

If the problem exists in a new well, the odor can be eliminated by aeration. Use either a bladder pressure tank with an air injection, a galvanized tank, or an open water storage tank to allow the gas to escape.

If the standard bladder tank is used, the bladder does not allow the gas to escape and the odor appears at the point of use.

Field Diagnosis for Slime Bacteria

***Well yield** (Specific Capacity) may decline suddenly and drastically.

*Wet, **slimy debris** may be present on pump column or in the piping system. Slime may be any color, even clear. When dry, this slime may turn into a very fine, fluffy powder, or hardened scale.

*A **musty, fishy odor** or an **oily film** on water may indicate bacterial activity.

*A hydrogen sulfide **odor (rotten eggs odor)** that suddenly appears, may indicate debris in a well.

***Bubbling** or **corrosion** may be noticed on pumps or the pump column and is a sign of either electrochemical or anaerobic bacterial activity. If TDS is less than 600 ppm, corrosion may be due to bacterial activity, either iron bacteria or sulfate reducing bacteria. If TDS is greater than 600 ppm, corrosion may be due to galvanic corrosion. (see "Field Diagnosis for Mineral Scale.")

***Fluctuating or increasing iron or manganese concentrations** in water. This may indicate an increase in oxides created by decaying bacteria. Compare past water chemistry to present information.

***Video's** of wells may show slimy or stringy growths on the inside of casing or screen.

Treatment of Slime Bacteria for Wells

Physical cleaning

Always wire brush the well casing, screen or open bore hole below the static water level to physically remove slimy debris. Use poly brushes on PVC casing and steel brushes on steel casing. Be aware, strong odors may be present if SRB's are exposed. Bail or airlift debris from the bottom of the well prior to chemical treatment. The chemicals will now be more effective on debris outside the screen or into the bore hole. Sonic jetting does not work effectively on soft slime because the impact is only absorbed by the bio mass. Extremely high pressure jetting and pumping can also be effective at removing this bio mass. Other physical treatments (CO₂ or high energy air pressure) are good for first step cleaning, prior to our chemistry.

Chemical treatment of wells for slime bacteria

Three separate plugging problems may exist—slime, normal mineral scale and oxides created by dead and decaying bacteria. Decayed organic debris is a nutrient for future bacterial growth. Products or treatment methods touted for killing slime bacteria do not deal with the oxides and mineral scale effectively and consistently. Acids alone may dissolve mineral scale and oxides but do not kill bacteria. Sulfamic is not effective at dissolving iron oxides so nutrient remains for future growth. Chlorine kills some bacteria but only damages the upper layer of the bio mass and has little effect on mineral scale and oxides. Bacteria will repopulate and the problems will return within months. Any products that attempt to kill bacteria produce only short-term results.

The combination of “Unicid” Granular and “Unicid” Catalyst deals with all problems consistently and for longer periods of time with a single application. The dispersion chemistry of the Granular dissolves oxides created by decaying bacteria and any mineral scale. The Catalyst penetrates the bio mass, detaches live bacteria, suspends them in solution through a series of polymers (independent of pH). This allows all debris to be pumped from the well. All physical plugging is now removed, allowing the flow characteristics of a well to return with normal bacterial counts. Once treatment is complete, airlift all debris from the bottom of the well, contain all chemicals in a surface tank, and neutralize prior to disposal. Our chemistry can simply be deposited to any ground surface but any low pH (below 5), chemistry may kill grass and plants. Again, all “Unicid” products are safe for disposal once pH is neutralized and are totally biodegradable and usable by plants and animals. (see “Disposal of Chemicals,” page 14)

Cleaning the pump:

When treating a well infested with slime bacteria, it's important to chemically clean the pump and any submersible cable before reinstallation. It doesn't help to clean the well and reinstall a pump that is contaminated. Disassemble the pump and put it in a 4% solution of the “Unicid” Granular (.3 lbs per gallon) and Catalyst (.04 gallons per gallon). The chemicals will not damage pump parts. For small submersible pumps, the entire pump and submersible cable can be soaked in a surface tank. Every 2 hours, energize the pump by connecting the cable to the starter box. Repeat 2 to 3 times until discharge is clean. We recommend new drop pipe be installed on domestic wells, as it's difficult to clean and cheap to replace. (see “Chemical Treating Water Lines and Systems,” page 9 for dosages)

Product placement in the well if the SWL is less than 100' or the column of water is less than 200':

Use a pour from surface method in applying the “Unicid” Granular and Catalyst. Refer to the dosage charts on product labels or **Tables 2.1 and 4**. The amount of Granular is calculated in pounds per foot of water in the well. Multiply the total feet of water in the well (total depth minus the static water level) times the pounds per foot recommended for the Granular to get the number of pounds recommended for the initial treatment. The amount of Catalyst is calculated based on gallons per foot of water in the well. Multiply the total feet of water times the gallons per foot recommended for the Catalyst to determine the total gallons of Catalyst required. For example: a well has 4" casing, 20' static level, and a 65' total depth. $65 - 20 = 45'$ of water in a well. Granular: $0.3 \text{ lb/ft of water} \times 45' = 13$ pounds. Catalyst: $0.04 \text{ gal/ft of water} \times 45' = 1.8$ gallons.

Pour all the Granular into the well from the surface first, followed by all the Catalyst. Wash down the inside of the casing with plain water to remove the chemicals above the static water level. Start the development process immediately, monitor pH, and adjust accordingly. (see “Development”, page 10 and “Field Monitoring,” pages 12 and 13.)

Product placement if the SWL is deeper than 100' or column of water is greater than 200':

Place as a liquid in equal amounts throughout the column of water. This can be done in equal sections through a tremie line or between packers into specific areas of the casing and screen. Use dosage recommendations to determine the correct amount of Granular and Catalyst. See **Tables 2.1 & 4**. Create a liquid by mixing the required amount of Granular at a maximum mix ratio of 2 lbs per gallon of water. For example, 200 lbs. ÷ 2 equal a minimum 100 gallons of water. Circulate with any pump to mix. Pour the Catalyst into this acidic blend, mix, and pump into the well in equal increments. Start development immediately, monitor pH, and adjust accordingly. (see “Field Monitoring,” pages 12 & 13).



Granular

Use with Catalyst for Slime Bacteria	
Well Diameter	Pounds of Granular acid/ft of water in well
2"	0.25 lbs
4"	0.30 lbs
5"	0.50 lbs
6"	0.70 lbs
8"	1.10 lbs
10"	1.75 lbs
12"	2.50 lbs
14"	3.00 lbs
16"	4.00 lbs
18"	5.00 lbs
20"	6.25 lbs
24"	10.00 lbs

Table 2.1



Catalyst

Use with the "Unicid" Granular Acid	
Well Diameter	Gallons per foot of water in the well
2"	0.02 gal
4"	0.04 gal
5"	0.05 gal
6"	0.08 gal
8"	0.13 gal
10"	0.20 gal
12"	0.30 gal
14"	0.36 gal
16"	0.48 gal
18"	0.60 gal
20"	0.80 gal
24"	1.18 gal

Table 4

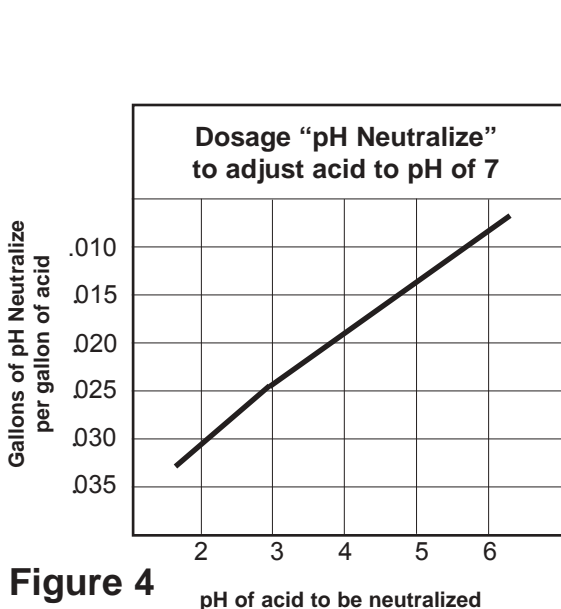
Disposal of Chemicals

Disposal issues should include chemicals that are non-hazardous, totally biodegradable and upon disposal, adjustment of pH. Check MSDS sheets on all products used. A pH of 6 to 9 is considered safe for disposal by most environmentalists. Lime and soda ash are often used to neutralize acids but require huge amounts of product and are difficult to determine dosages. They do not mix well with acid and are dangerous to work with as a powder in windy conditions. These products offer no control of pH with an instantaneous pH of 10 to 12, which, as an alkaline, is more difficult and dangerous to dispose of than acids.

“pH Neutralize” has several advantages:

- 1) dosages are consistent so estimated amounts can be calculated (see Figure 5)
- 2) it is a liquid for easy and safe mixing
- 3) it requires only a few, reclosable containers on site, rather than many bags of powder that can break or get wet
- 4) pH is controlled as it rises and will not rise above 9
- 5) a chart provides specific dosages dependent upon the pH of acid being neutralized (see Figure 4)
- 6) can neutralize any type of acid.

Do not pour “pH Neutralize” into a well to neutralize acids. This liquid weighs 12.4 lbs per gallon and may force debris out the screen or bore hole and cause additional plugging. **When treatment is complete, pump or airlift all chemistry from the bottom of a well or system into a tank.** Measure pH of the acid, and pour the required “pH Neutralize” into the acid and mix slightly. pH will rise quickly. Dispose of chemicals, according to federal, state and local regulations, once a pH of 6 is obtained. Pump a second batch of acid from the well and repeat the process. The pH may vary substantially throughout the pumping process until pH returns to normal. All “Unicid” products are totally biodegradable and safe for disposal once neutralized. “Unicid” can be land disposed without being neutralized, but any low pH product may kill plants.



Estimates for product on site	
Casing Diameter	Gallons/foot water in well
2"	.01 gal
4"	.04 gal
5"	.06 gal
6"	.10 gal
8"	.15 gal
10"	.29 gal
12"	.31 gal
14"	.38 gal
16"	.50 gal
18"	.65 gal
20"	.80 gal
24"	1.20 gal

Table 5

These estimates would be the minimum amount of product to have on site for neutralization of acids after treatment. The calculation in **Figure 5** assumes an average pH of 4 and approximately 3 times the volume of the bore hole that would require adjustment. This number may vary depending on the calcareous content of the formation, the amount of acid used, and the time the acid is in the well. 6 to 15 volumes of the bore hole may be required.

Hydrochloric (Muriatic) liquid acids may have inherent ingredients that are not totally biodegradable and are classified as hazardous. There may be questions regarding proper disposal. Hydrochloric and sulfamic acids may vary greatly in actual percentages of acid. The amount of “pH Neutralize” required to adjust pH may vary slightly (less) from the above dosages.

Development in Wells

New Well

After 4 Years

After 8 Years

After 12 Years

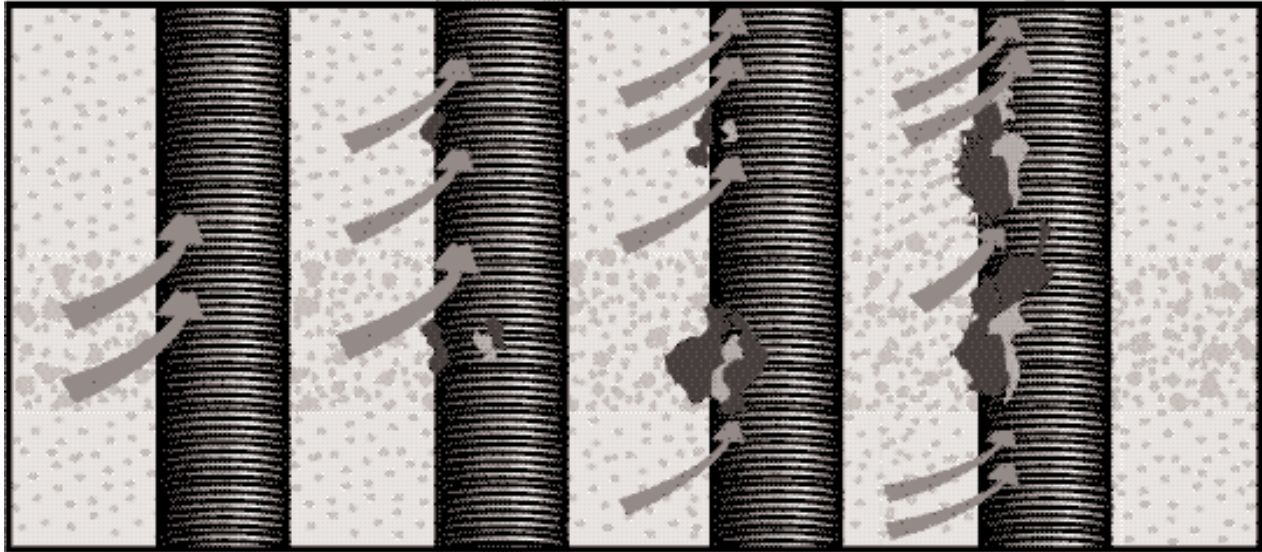


Figure 1

Mineral scale deposits

Slime bacterial growth

Figure 1 indicates how velocities in wells may change over time.

Importance of physical development

Development is extremely important and is the contractor's responsibility. Dirty clothes don't get clean in a clothes washer if the machine is not turned on. It's the agitation that allows the detergent to work successfully. Chemicals are too often dumped into wells, surged slightly or not at all, and pumped out in 12 to 24 hours with no understanding of why the process did or did not work. Chemicals need to be pushed back and forth through openings in the screen or into fracture zones of consolidated formations during the development process.

Incrustation (mineral scale) and slime produced by bacteria often occur first in areas of the screen or bore hole where the velocity is the highest. Once that area is plugged, the water is forced to flow from other areas. This creates greater head loss, increased drawdown, and potentially sand pumping (see **Figure 1**). If new wells are not developed properly, plugging due to drilling muds and silts increases velocity to the bore hole and enhances plugging due to mineral scale and/or slime bacteria. During well rehabilitation with "Unicid" and proper development, the specific capacity is often increased over the original specific capacity. If the development action consists only of airlifting water and allowing it to fall back into the well or surging the well with a vertical turbine pump, acid may follow the path of least resistance through areas of the screen that are already open. In longer screens, localized development becomes more important.

Always check the well for any fill and bail or airlift out prior to installation of chemicals. In the early stages of development, you may find that only a small amount of scale or debris will be pulled into the screen. As the development process continues, sand may be pulled into the screen as the scale is dissolved and there is greater access to the formation. Do not be alarmed, this is an indication the scale has been dissolved. Now finer sands can be pulled into the screen, and further development of the formation will be required. This will increase the yield of the well.

Development does not have to be constant over 24 to 36 hours. Do as much as physically possible and economically feasible. Municipal and industrial wells generally warrant more effort, but the development of domestic wells should not be forgotten. Surge a domestic well for 3 to 4 hours in the afternoon, check pH and adjust as necessary. Let the chemicals sit over night, surge for 30 minutes the next morning, check and adjust pH as necessary. This is better than no development at all. Sell the development process. Monitoring and adjusting pH is just as important in domestic wells as in municipal wells, because you want a successful and complete rehabilitation. "Unicid" chemicals will work consistently and the process will last much longer if the contractor performs this critical step of development.

Types of Development: There are four basic types of development: 1) Surging with the pump or “rawhiding”, 2) Airlifting or air development, 3) Surge Block, and 4) Jetting. There are advantages and disadvantages to each but the choice should be based upon effectiveness not cost. Development plays a more critical role in well rehabilitation than it does in a new well. You can pump water from a new well even if it’s only 30% efficient. Efficiency may be virtually zero in a well plugged with scale or biological debris because we too often let the well go until the pump is breaking suction. The energy required to move chemistry against this blockage will be much greater. The greater the decline of Specific Capacity (see page 1), the greater the requirement for more effective, localized development.

Surging with the pump or Rawhiding: In well rehabilitation, this is done with a vertical turbine pump by removing the non-reverse ratchet. The purpose is to pump chemistry to the surface, shut off the pump and allow the chemistry to fall back into the well, using the pump column as a conduit. Submersible pumps can’t be used because of a check valve in the pump. You can recirculate chemistry back into the well with a submersible pump, but the it may become plugged with loosened debris. This only creates recirculation of chemistry inside the casing. The greatest advantage to this method is low cost, because the pump isn’t removed. The disadvantage is that it becomes impossible to obtain specific or localized velocity against plugged areas (see Figure 1, page 10). Chemistry will take a path of least resistance and flow in and out (already) open areas of the screen or bore hole. A high Static Water Level does not allow much head pressure for back flow velocities. We only recommend this method of development as a last resort, especially in long screens or boreholes.

Airlifting or air development: This is done by installing a rigid airline into the casing and forcing air into the well to lift chemistry upward without overflowing at the surface. A quick cutoff of air allows chemistry to fall in the well for the two way development action. This method does provide turbulence with a two directional flow. This process is somewhat limited in longer lengths of screen (>20’) or open bore hole (>50’) as specific, localized velocity against plugged areas may not be obtained. Chemistry again, will follow a path of least resistance and have a tendency to flow outward, into areas of a formation that are already open. This method can be done between two packers to force localized development in specific areas and is much more effective.

In larger diameter wells, an eductor pipe can be used. This is a second pipe placed first into the well with the airline inside. Keep the airline within the eductor pipe to achieve a pumping and surging effect. The smaller annulus between the airline and educator pipe minimizes the air requirement. It’s a great way to “vacuum” debris from the bottom of a well after wire brushing or upon completion of well rehabilitation to totally remove debris and chemistry. (Call for pipe sizing).

Surging/surge block: This can be done with a tight-fitting, flexible surge block and a rig with a sand reel or free-fall line to create a block velocity (up and down) of approximately 3-5’ per second. The downward motion of this block acts like a plunger, forcing chemistry outward into the formation. The upward motion pulls debris into the screen or bore hole. A small cable tool rig works best for this as it allows a 3’ stroke and an automatic action with a walking beam. This is highly effective in low open area screens (slotted, bridge slot, or louvered) and high open area screens or open bore holes. Some pump truck manufacturers make a walking beam insert that can be installed and removed from the bed of a pump truck. It’s very versatile, mobile, and easy to set up and tear down. Most hydraulic rigs don’t provide the vertical speed required for good development action and the operator is required to constantly operate controls.

Jetting: This method is not very effective in low open area (3-5%) slotted pipe because 95-97% of the energy is directed against blank pipe. In bridge slot screens, the slot design diverts the flow sideways. It can be effective in louver screens if the flow is directed at an angle, directly toward the bore hole. Jetting may be the most effective in high open area, continuous slot screens. It provides a very specific, high energy, development action directed throughout the entire length of screen.

It is absolutely necessary to keep chemistry in the well concentrated during well rehabilitation. Jetting with plain water while chemistry is active in a well will dilute and reduce chemical effectiveness. One of the other development methods should be used first. Jetting is highly recommended, once pH is stabilized in a well and the chemical treatment is complete. (see “Monitoring of pH,” page 13) We highly recommend to simultaneously pump (airlift or a submersible pump) the well 2-3 times the amount of water injected through the jetting tool. This pumping action adjacent to the jetting tool provides a gradient toward the well to remove debris. Monitor this debris at the surface and spend more development time in areas of the screen that appear more dirty.

Jetting can be used during chemical rehabilitation but you must maintain a concentration of chemistry under high pressure and return the chemistry to the surface for: 1) monitoring of pH and color, 2) adjustment of pH, 3) settling of debris before reinjection. This is a complex process requiring highly technical equipment and a very competent contractor.

Field Monitoring of “Unicid” During Treatments

For the first time in well rehabilitation, there is a method of monitoring chemistry during treatment. This helps to determine, 1) the type of scale encountered as some scales react differently to acids. (see color correlation below), 2) when or if to add more acid, 3) when the project is complete as pH will not rise if no carbonates are present.

Coloration of acid

Monitor pH and color of “Unicid” during any rehabilitation project. The color of “Unicid” is unique and is an indicator of the type of debris encountered. The correlation between color and pH helps indicate when and if to add more acid and when the project is complete. A sample of acid can be obtained from the bottom of the well with a “dart bailer” or a “ball-check bailer” and should be taken every 2 to 4 hours. In screens longer than 25’, a sample from various areas of the screen gives a more accurate indication of pH. You may find different reactions in different areas of the screen. Contractors can maintain records of pH and color for customers along with results of test pumping “Before and After” treatment, which is a great sales tool.

Color correlation to scale using “Unicid”

Yellow = iron **Dark Brown** = calcium/iron **Black** = manganese **Green** = sulfate

Yellow color = iron. Iron levels in water might be greater than 1.0 ppm. Iron scale can be caused by normal mineral precipitation or iron oxides created by decaying bacteria. Fluctuating or increasing levels of iron may be caused by increases in iron oxides created by decaying bacteria. “Unicid” turns yellow as it dissolves iron. You may notice some bubbling with 2 to 4 feet of foam building on the static water level while the acid is working, along with a moderate rise in pH. The amount of bubbling depends upon the amount of calcium carbonate in the scale along with the iron. Adjust pH accordingly (see “Monitoring of pH,” page 13). When pH has not risen for several hours, the project is complete.

Dark Brown color = calcium. This will be the most common reaction in wells or systems. Calcium or hardness levels in water would generally be higher than 150 ppm. This is the easiest and fastest scale to dissolve. You may see 4 to 6’ of foam and heavy bubbling on the static water level, but it will not explode out of the well, as may happen with hydrochloric acid. The bubbling is a release of carbon dioxide only and is not dangerous, but it is a good idea to work in a well ventilated area. Monitor pH every 1 to 3 hours, as it will rise quickly. Adjust pH accordingly (see “Monitoring of pH,” page 13). When pH has not risen for several hours, the project is complete. See **Figure 3**.

Black color = manganese. Manganese levels in water would generally be higher than 0.05 ppm in a water analysis. “Unicid” will be black when dissolving manganese. Many times, iron and manganese will be found in conjunction with calcium and the color of acid will be dark brown and may include black chunks. Adjust pH accordingly (see “Monitoring of pH,” page 13). When the pH has not risen for several hours, the project is complete. See **Figure 3**.

Green color = sulfate. Sulfate levels in water generally would be greater than 40 ppm. Sulfate scale is often found on the outside of several layers of scale because it precipitate in slow moving or static water. When dissolving sulfate, “Unicid” turns green. pH is not affected when acid dissolves sulfate so pH will remain low. When encountering sulfate, the amount of bubbling on the static level will be minimal and foam nonexistent. Once the “Unicid” dissolves a sulfate layer, the acid may change color based on the scale encountered. A greater degree of bubbling may occur as dependent upon the level of calcium carbonate, and pH will rise. Adjust pH accordingly (see “Monitoring of pH,” page 13) and maintain the development effort. A second layer of sulfate may exist and the color may change back to green and pH will remain low. Maintain the development effort and monitor color and pH. Adjust accordingly. See **Figure 3** for typical pH adjustments. You may find some wells with constant green color. Measure total dissolved solids in the acid and when stable (does not rise) the project is complete. When a green color remains for more than one day, contractors have found great success by leaving chemistry in the well for 4 to 5 days and agitating periodically.

Monitoring pH

As acid dissolves carbonate scale, the acid becomes neutralized and pH rises. pH is logarithmic, meaning, a pH of 1 has ten times the acid dissolving power of a pH of 2. A pH of 2 has ten times the power of 3, etc. Therefore, the speed and ability for acid to dissolve scale would decrease as pH rises. Once pH rises above 3.5, the power of acid is diminished and the time required to dissolve becomes much longer. (see **Figure 2**)

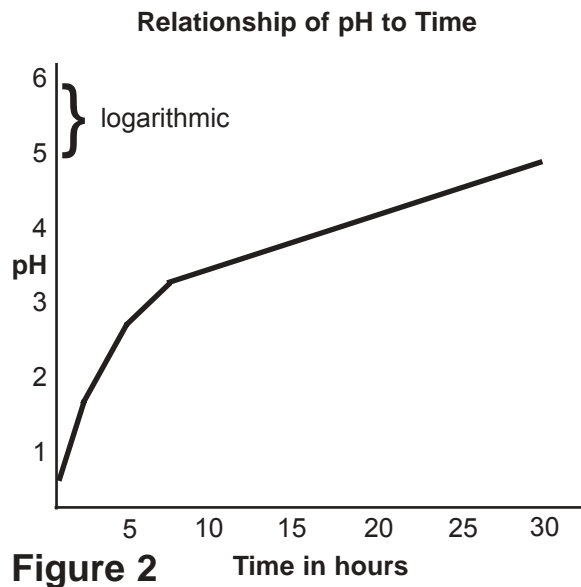


Figure 2

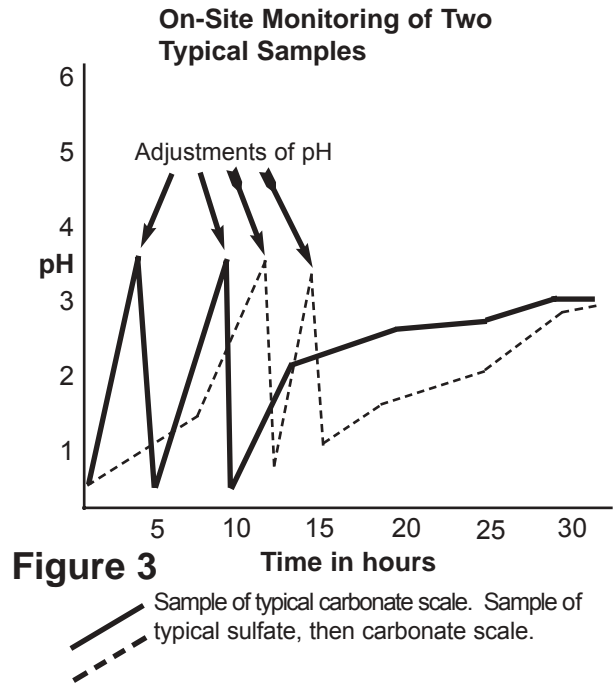


Figure 3

— Sample of typical carbonate scale. Sample of typical sulfate, then carbonate scale.
- - -

Dosage recommendations for “Unicid” represent averages based on history. It is impossible to know how much scale or bacterial debris is present in a well or system, so it is impossible to know how much acid will be required to complete the job successfully. A pound of “Unicid” Granular and a pound of hydrochloric (Muriatic) acid both dissolve an equal amount of scale. The coloration of “Unicid” is unique to any acid and along with the monitoring of pH helps determine 1) if and when to add more acid, and 2) when the job is complete, and all the scale or debris is dissolved.

As long as debris is present, pH will continue to rise. When pH rises above 3, add 30% of the initial dosage of just the “Unicid” Granular acid to adjust pH below 2.0. For example, if the initial dosage in either a mineral scale or slime bacterial application required 40 lbs of Granular, 12 lbs would be required to adjust pH (40 lbs x 0.3). Add the dosage using the same method as the initial dose, ie., “Pour from surface” method or “Tremie line” method. If more debris is available, acid has something to dissolve and pH will rise. Adjust pH by adding another 30% of the initial dose. Continue to monitor and adjust pH accordingly. Once all debris is removed, pH will rise much more slowly, as the acid has nothing to dissolve. We recommend you have enough Granular on site to do 3 pH adjustments.

The project is complete when; 1) the pH has not risen for 3 to 4 hours or has risen much more slowly. 2) the color of the acid is yellow, dark brown, or black. Each well will be different. (see Figure 3 and “Before” and “After” video photo’s on back cover)

The exception to this rule is when the acid becomes diluted from water entering into the screen from the formation. In this case, pH will rise very quickly (greater than 4.5) or may be difficult to maintain low after adjustment. This is an indication the treatment is also complete. The dilution rate may depend upon the permeability of the formation.

There may be new wells or systems that plug from massive slime formation only. There may be very little scale and oxides from decaying bacteria that have had time to harden. The acid will not have any debris (carbonates) to dissolve and therefore pH will not rise. Since the “Unicid” Catalyst works independent of the “Unicid” Granular and pH, live bacteria and slime will still be removed but pH may not rise as much as expected.

Cleaning Pipelines

Dimensions and Capacity/Lineal Foot of Pipe					
Nominal Size Pipe	Inside Diameter *	Gallons/Lineal Foot of Pipe	Nominal Size Pipe	Inside Diameter *	Gallons/Lineal Foot of Pipe
1"	1.0"	0.041 gal/ft	5"	5.0"	1.04 gal/ft
1 1/4"	1.38"	0.08	6"	6.0"	1.5
1 1/2"	1.61"	0.11	8"	8.0"	2.6
2"	2.0"	0.17	10"	10.0"	4.2
2 1/2"	2.44"	0.25	12"	12.0"	5.9
3"	3.0"	0.37	14"	13.25"	7.17
3 1/2"	3.5"	0.50	16"	15.25"	9.5
4"	4.0"	0.64			

* For other diameters or for questions on specific sites, call our Technical Services Line, 888.437.6426 (888.4.DSN.H2O) or 952.474.4651.

Table 6

Plugging problems can occur in water lines and environmental recovery or treatment systems. Symptoms may include, 1. reduced flow, 2. reduced pressure, 3. discoloration, 4. an increase in chemical injection (phosphate or chlorine) requirements may indicate a demand due to biological growths. See "Physical Diagnosis" for chemistry direction.

For pipelines less than 1500', we recommend using a mix tank near the well and recirculation of chemistry into the system and recirculated through a surface line. The tank is used for mixing chemistry and during recirculation acts as a settling pit for debris. In a submersible pump application, there is often a pitless adapter with a discharge 6-7' below surface. The pump has to be pulled and the spool adapted to allow a pipe to the surface to be connected to a recirculation pump in the tank. For longer pipelines, call our technical service line for design help.

Total chemistry required is based upon total gallons of water in, 1. the original pipeline, 2. single or multiple surface piping from different points of the system used for recirculation, 3. the mix tank. Multiply volumes in Table 6 times total footage of the pipeline (1) plus whatever diameter and footage of recirculation piping (2) used back to the mix tank. Multiply total gallons (1 + 2) times .30 (30%) for the amount of water in the tank (3) to use for recirculation. Add all three amounts of water for total gallons required. In mineral scale applications multiply total gallons times .3 lbs of "Unicid" Granular. In slime or iron bacteria applications, multiply total gallons times .04 gallons of "Unicid" Catalyst and add to the mixture of Granular.

Fill the mix tank with the required amount of water for the entire pipeline. Start circulation in the tank with any standard contractor pump. Slowly pour the Granular into the intake and circulate in the tank to mix. In slime applications, mix the Granular first then pour the required Catalyst into the intake of the pump and circulate to mix. Multiple tanks can be mixed to obtain required volume for a piping system but maintain dosages per gallon in the mix tank before pumping into the pipeline. Run surface piping from the end of the system back to the mix tank. Connect piping into the system to the pump in the mix tank. Start the pump and run the discharge from the surface line to waste until pH declines drastically, then recirculate into the tank. Early in the process, you can measure a discharge amount in a bucket or barrel with time. As debris dissolves in the pipeline, the volume will increase in the same time frame. You can also inspect the piping. When done, circulate plain water through the entire system. Discharge until pH is absolutely normal. Reconnect all piping.

Cleaning Water Storage Tanks

There may be applications to clean slime forming bacteria from a water storage tank. This can be done easily and safely with a combination of the “Unicid” Granular and Catalyst products. The application is dependent upon the tank size and accessibility to the interior of the tank. Most storage tanks are too large to fill with chemistry because the cost may be prohibitive. Cleaning small tanks can be accomplished by following procedures outlined on page 9, “Chemical treating water lines...”

Most large tanks are accessible through a manhole. We recommend to drain the tank and check the natural pH of water for a reference point, after the cleaning process. Once inside the tank, physically brush the interior walls and floor below the high water level. Simultaneously, high pressure spray the walls and floor to further remove debris. Set up a pump at the bottom of the tank and remove all debris or vacate from the tower base. Do not allow sludge to flow into the permanent pipeline.

Once most of the debris is physically removed, chemistry can be used to microscopically clean bacterial attachment from the tank interior. Any type of high pressure sprayer can be used. Calculate the amount of water in the sprayer tank and use a 3% solution of chemistry.

The dosage for the “Unicid” Granular is .25 lbs./gallon of water in the sprayer tank. Physically mix the granular into water and circulate with any standard contractors pump to mix more thoroughly. The dosage of the Catalyst is .03 gallons per gallon in the sprayer tank. Pour the “Unicid” Catalyst into this acidic blend. Physically mix or continue circulation to mix more thoroughly. Pour the chemistry into the tank and pressurize the unit. Spray the chemistry on to the side walls and the base of the tower while physically brushing the chemistry. Repeat the treatment in specific areas of large amounts of debris if not fully clean.

Flush the interior with plain water under high pressure, until the discharge water returns to a normal pH. This will require some time, but it is mandatory to follow this procedure before reconnecting water lines.

Safety Issues:

Even though there are no dangerous gasses released by the chemistry, there may be a release of carbon dioxide from dissolving scale or decaying debris from bacteria. It is absolutely necessary to use a self-contained breathing apparatus while working in this enclosed environment. Use rubber boots, rubber gloves, and protective clothing along with full eye wear protection (goggles).

Disposal:

Chemical debris being flushed from the tower should be contained to prevent inadvertent runoff and maintain control for disposal of chemistry. Check local regulations for proper disposal. “Unicid” chemistry can be land disposed with a low pH, but any acidic chemistry with a pH below 5 may kill plant life. Calcium in the soil will neutralize acids and complete degradation is 27 days. If neutralization is required, see “Disposal of Chemicals,” pg 14. Chemistry can now be disposed to sanitary sewers or land disposal without any environmental concerns. See MSDS sheets for further safety information.

Lab Services

Lab services are available to help determine problems in wells and systems. These services include:

- 1) analysis of water chemistry to determine the tendencies for mineral scale and corrosion
- 2) identification and quantification of slime-forming bacteria
- 3) identification and severity analysis of anaerobic bacteria (odor & corrosion problems)
- 4) total bacterial counts via ATP analysis.

Please contact us or your local "Unicid" distributor for prices and information.

Contractor/Sales/Promotion/Professionalism

- Education is your key to success.
- Strive to be better!
- There may be factors that are unknown, so success can not be guaranteed.
- Learn about well rehabilitation, it is not an exact science.
- Customers make better decisions if they are informed.
- Learn what your customer's needs are!

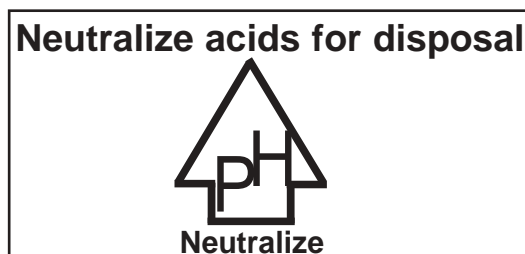
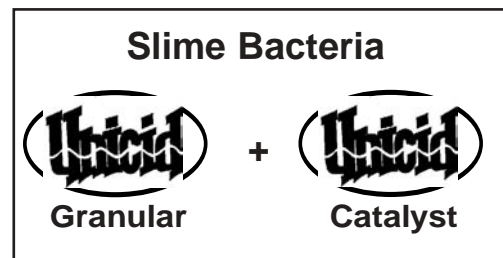
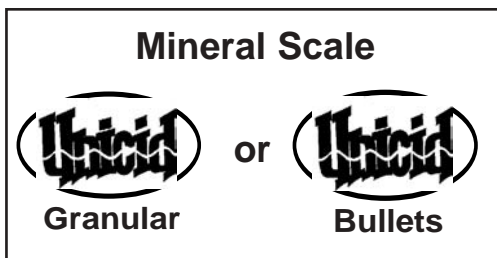
Use this manual and the drawings to explain the phenomena of mineral scale and bacterial growths. List and compare the actual well information regarding well yield and Specific Capacity. **Do a pumping test before and after rehabilitation.** Provide your customer with the results and a graph on actual pH adjustment during the rehabilitation process. Your customers deserve this information and adds to your professionalism. It is important that a job is completed in the least amount of time, on a cost effective basis, and completed successfully and safely.

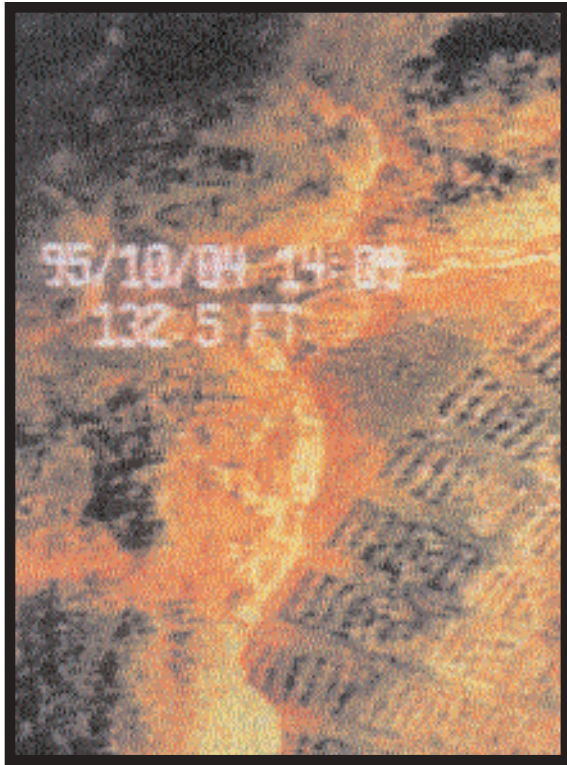
We have treated 4500 wells for mineral scale and over 6000 wells for slime bacteria with over a 99.9% success rate.

There is a huge difference in contractors, chemicals, development methods, obtained results, and longevity of treatment. Work for consistency. Study the history of the well. Understand the problem prior to designing a solution. Diagnose potential problems through symptoms. If you are puzzled, our lab services are available.

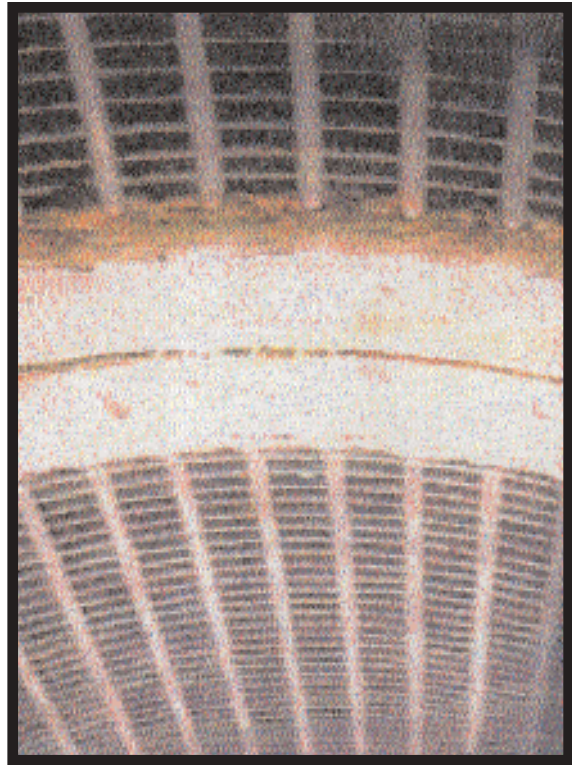
If you have questions, call Toll Free 888.4.DSN.H2O (888.437.6426), or 952.474.4657

Well rehabilitation by Design, not by accident.





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After "Unicid"

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