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You don't wait for the oil light to come on in your car to get an oil change. Why maintain your wells any differently? BY JIM BAILEY AND ANDREAS WICKLEIN

CONSIDER A CAR-CARE APPROACH TO IMPROVE WELL PERFORMANCE

LONG-TERM WELL MAINTENANCE IS probably the most neglected component of well field operations. When a well isn't producing enough water to meet supply demands, the owner assumes the pump is the problem and calls a pump contractor or driller. If the pump isn't the problem, the next step is a quick rehabilitation and returning the well on-line.

This approach to managing well performance is like operating a car without ever changing the oil—until the warning light comes on—which shortens the car's life span and increases maintenance costs. Fortunately, well owners in the United States, Canada, and Europe are opting for a more holistic approach to well operation and maintenance by managing the entire lifecycles of their wells to optimize long-term performance.

Key factors that influence well performance include design, construction, operation, biological and mechanical plugging, and maintenance. The extra attention and money expended to address these factors will result in wells with maximized production capacity and minimized repair downtimes.

In well design and construction, it's best to maximize the screen or water-producing interval of the well to the entire thickness of the aquifer and to match the screen slot size with the formation material. This may require drilling a little deeper than anticipated or collecting additional formation samples, but the payoff is a more efficient well.

A common error in new well construction is insufficient development time. New well development is essentially the same as rehabilitation of an old well. The goal is to get enough energy into the surrounding formation to remove finer-grained material and develop a zone of relatively unobstructed pore spaces, allowing water to flow as directly as possible into the well. The more laminar flow is obstructed, the more the well is stressed and the less efficiently it will operate.

PHOTOGRAPH: NATIONAL GROUND WATER ASSOCIATION

Alan Eades (left) of Eades Well Drilling and Pump in Hobbs, N.M., consults driller's assistant Neal Heard as their down-the-hole hammer drills a residential well. The well totaled 224 ft deep and yielded 60 gpm.

PLUGGING PROBLEMS

For best results, pumps should be located above the uppermost screen or screens to promote flow along the entire screen length, which reduces entrance velocities or stress. A pumping test of at least 24 hr—ideally 72 hr—is required to determine the optimal long-term pumping rate. The operational pumping rate should minimize drawdown caused by well inefficiencies and provide for long-term safe yield from the aquifer.

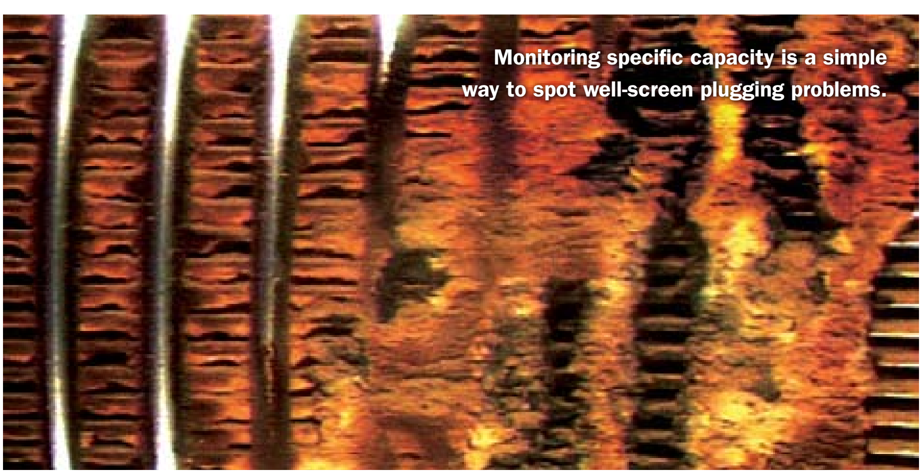
An aquifer's natural microbiology usually proliferates when a well is installed and operating. The available supply of food or dissolved minerals greatly increases around the borehole of the well and screen interval because of increased flow velocity and turbulence. This allows for more rapid growth of biological deposits or formation of mineral encrustations that can plug screen openings and the pore spaces near the screen and borehole. Operation also pulls fines in from surrounding formations, which plug the pore spaces and eventually reduce the open area for water to enter the well.

In most wells, the primary water-producing zone isn't uniformly distributed across the entire length of a screen interval. For example, in a 20-ft screen interval, a significant portion of the well's capacity might come from a 10-ft section of the screen. This zone suffers the most functional impairment from biological and mechanical plugging. Likewise, impairment of the localized zone pushes other portions of the water-bearing zone to supply water to maintain the desired capacity. Ultimately, added stress on the well reduces efficiency and increases biological and mechanical plugging problems. One of the best ways to minimize plugging is to recognize and repair problems early.

Monitoring specific capacity is a simple, reliable way to spot plugging problems. A well's specific capacity equals the discharge rate or gpm divided by the water level drawdown or feet. A well with a pumping rate of 100 gpm and 10 ft of drawdown has a specific capacity of 10 gpm/ft of drawdown. By keeping track of the specific capacity over time, a well owner can assess when conditions are beginning to affect well performance and schedule maintenance accordingly.

If plugging conditions aren't addressed early, the loss rate in specific capacity will increase faster over time, and the lost specific capacity will become more difficult to regain. A good rule of thumb is to initiate maintenance when specific capacity declines by about 10 percent.

Ideally, well maintenance shouldn't wait until there's a loss in specific capacity. Like regular oil changes in a car, regular well maintenance extends well life and results in lower long-term operational costs. When a well pump is pulled, a video inspection can help determine if biological plugging is occurring and if rehabilitation is necessary. A periodic pumping test will help determine if the well has lost efficiency, which—if there's no biological plugging—could indicate mechanical plugging from the migration of fines.



Monitoring specific capacity is a simple way to spot well-screen plugging problems.

TIME TO REHABILITATE

Most well owners must eventually address well performance and rehabilitation. To maintain long-term performance and well life, rehabilitation should be planned at regular intervals. Primary rehabilitation options fall into three categories

- Chemical—acids, bases, dispersants, antibacterial agents
- Mechanical—surging, brushing, jetting, freezing
- Impulse generation—detonation cord, impulse generators

Before selecting a particular method, the contractor should assess the well's condition and prepare a rehabilitation plan. Remember, a successful rehabilitation project typically isn't related to one particular rehabilitation method. Rather, it's a process that includes using approaches from the categories outlined above.

The contractor should monitor the rehabilitation work throughout the process to evaluate progress and document when further efforts aren't necessary. Concluding the rehabilitation work too soon will result in a less efficient well and one that will likely need additional rehabilitation much sooner.

A NEW REHABILITATION ALTERNATIVE

Impulse generation has shown significant results when used in old well rehabilitation and new well development. The principle effect of this process lies in the managed sudden release of a compressed gas that produces an elastic impulse and a secondary expansion of the gas bubbles, which cause the formation material and well screen to vibrate, loosening mechanically plugged sediment and biological deposits. The impulse generator is inserted and positioned in the well screen or water-producing

When a well pump is pulled, a video inspection can help determine if biological plugging is occurring and if rehabilitation is necessary.

An impulse generator uses compressed gas to loosen mechanically plugged sediment and biological deposits.

PHOTOGRAPHS: KLEINFELDER

zone, and, through a pressurized hose, temporal impulses of high-pressure nitrogen are released. The impulse generator is equipped with a valve system that releases the accumulated energy (200 psi to 1,200 psi) in millisecond bursts through a large cross-sectional area.

Recent independent research by the Ground Water Research Center in Dresden, Germany, compared the ability of various well rehabilitation technologies to affect the gravel pack and surrounding formation materials. The technologies evaluated included high- and low-pressure water jetting, sonic devices, and impulse-generation devices. The study focused on each method's ability to generate energy at various distances into the formation surrounding a well. The impulse generator proved the most effective technology concerning penetration depth and energy measured beyond the well screen.

Impulse generators can be used in various well types, including vertical and horizontal stainless steel screened wells, perforated or slotted steel casing wells, uncased open-hole wells, and PVC-lined wells. The technology's advantages include

- a wide range of applications.
- effectiveness.
- a powerful impulse simultaneously sustained throughout the well screen or screens that provides good coverage.
- fast, cost-efficient operation.
- no harmful side effects or by-products.

This impulse generation method has been used in Germany for several years. It's one of the primary methods the city of Berlin uses to maintain more than 850 wells.

The impulse generation method has also been used in the United States for new well development and rehabilitation. For example, the city of Coeur d'Alene, Idaho, built a 24-in.-diameter well for water supply purposes. Initial well capacity was about 2,200 gpm. In less than one year, the city noticed declining specific capacity, with the pumping rate eventually lowered to about 1,600 gpm with 90 ft of drawdown. After initial assessment, the city determined that the well hadn't been adequately developed. Subsequent redevelopment was completed in three phases, with each phase consisting of the following steps:

- 30-min pumping tests to determine specific capacity
- impulse technology with simultaneous pumping
- isolation pumping and surging through the screen interval
- sediment removal from the well bottom

Specific capacity values were used to gauge progress after each phase of the redevelopment process, and water quality was monitored with an Imhoff cone during each phase to observe turbidity and the volume of sediment being removed from outside the well screen. The rehabilitation work succeeded in returning well yield to nearly the original capacity and improving well efficiency to a pumping rate of 2,100 gpm with 30 ft of drawdown. Specific capacity improved from 18 gpm/ft to 70 gpm/ft.

In addition, the city of Salisbury, Md., has used impulse generation technology on several wells. One well constructed in 1983 had an original specific capacity of about 31 gpm per ft of drawdown and a yield of 1,000 gpm. The well's construction included a 12-in. casing and stainless steel screen to a depth of 64 ft, with a screen interval consisting of one continuous length of wire-wrapped screen from 44 ft to 64 ft. A 2006 pumping test indicated that the specific capacity had declined to 3 gpm/ft and the pumping capacity was less than 100 gpm.

Video inspection of the well showed extensive biological plugging of the screen slots throughout the screen interval. The rehabilitation plan included

- brushing of the well casing
- high-pressure water jetting
- impulse generation technology
- mechanical surging and pumping

The initial brushing and high-pressure jetting improved specific capacity from 3 gpm/ft to about 10 gpm/ft. Impulse generation technology further rehabilitated the well by loosening fines and biological deposits outside the screen and in the surrounding formation. After three rounds of impulse technology consisting of mechanical surging and pumping, specific capacity improved to 20 gpm/ft.