Where the Sand Goes: Or When Will the Other Shoe Fall?

By Jay H. Lehr

Have you ever wondered why so many wells that sand-up don't fill up with sand? I'm speaking, of course, about those damn nuisance wells that require an in-well pump protection sand separator to extend the life of the submersible or turbine pump.

For more than a decade now, since in-well sand separators have been in common use, people have been worried; if the well pumped a couple of coffee cans full of sand every day before the separator was installed, why didn't that sand eventually fill up the well once it was no longer being sucked through the pump? Why didn't the separator and pump eventually suffocate itself by means of its own power to draw sand through a formation until it virtually buried itself in grit? ("A little bit of sand" can actually be quite a lot. For example, a concentration of 25 ppm of sand in a flow rate of 100 gpm will produce 1,000 pounds of sand every 500 hours of operation.) Experience long ago taught me to tell them with a twinkle in my eye, "not to worry, it may never fill up." Now, after two and one-half years of research, I am convinced that nine times out of 10, I'm right.

How nerve-wracking it must be for these well owners and drillers to wait for the other shoe to fall, never knowing when the well will fill but certain that it will. Yet it never seems to happen.

"Let me try to put all you restless drillers at peace with your wells and sand separators."

I have looked at situations across the country afflicted with this dilemma, and the story is commonly the same. No amount of development appears to end the constant stream of sand appearing in the water.

With little confidence, desire or money to drill a new well, owners and drillers decide to live with the problem and install a sand separator in the well at the suction of their turbine or submersible pump. They hope they can get a few good years of service out of this ornery hole in the ground. And even if they know the pump will now last longer, and produce sand-free water, they know intuitively that they have merely replaced one problem with another. The well is sure to fill up with sand!

Yet, plumbing the well depth initially and then a significant time (six months to a year) later finds only a few feet of sand in the well bottom, lessening its effective depth a little. Another six months or a year later, driller and owner alike are surprised to find the depth about the same. The conscientious home owner or driller may on occasion of periodic maintenance, pull the pump, clean out the sand and re-install the pump. More often than not, but not always, the well will again fill up with sand to the pre-maintenance level but not further and, again, driller and home owner wait for the seemingly inevitable to happen—but it doesn't. When a well does not refill, it is generally because at long last, over time, the well did develop a clean envelope of coarse sand around it.

Let me now try to put all you restless drillers and well owners at peace with your wells and sand separators, calming your anxiety so that you may direct your nervous energy elsewhere.

You see, it takes the energy inherent in flowing water to carry sand into a well. When a well is first drilled, its screened or open area is capable of letting in a maximum amount of water. That water can

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carry in a maximum amount of sand as shown in Figure 1. The flow path for each particle of water is the shortest relative distance in the saturated zone of influence around the well. Thus, the water suffers the least energy loss in moving through the aquifer, enabling it to use excess energy to carry sand through this devilish formation whose sorting characteristics won't allow the development of a clean, coarse sand envelope we love to grow around our wells.

But all is not lost. If we give nature a chance, she will most often work in our behalf if only we "go with the flow" and do not choose to fight her (like when we build dams, straighten rivers, build homes hanging over soft hillsides, block recharge areas and so on and so on). In sanding wells, as shown in Figure 2, when the separator purges enough sand into the well to fill it with the right amount of sand, the flow patterns in the zone of influence around the well are no longer efficient and orderly but, instead are tortuous and elongated. As with all inefficient things, energy is lost—but in this case, for a change, that energy loss works in our favor. It is just that loss of energy that makes it difficult for the water entering the well to carry any more sand with it. Thus, the very fact that the pump protection separator has caused a controlled sand buildup in the well establishes an impediment to continued sanding of the well. If this were not the case, the result would always be ultimate self-destruction (with or without a sand separator).

In the situation in Figure 2, the sand separator will continue to recycle the sand in the well in a virtual never-ending cycle. The separator is still necessary. Without it the pump impeller, bowls, shaft, or bearing wear would cause decreased pump efficiency, as well as increased energy consumption. Be-

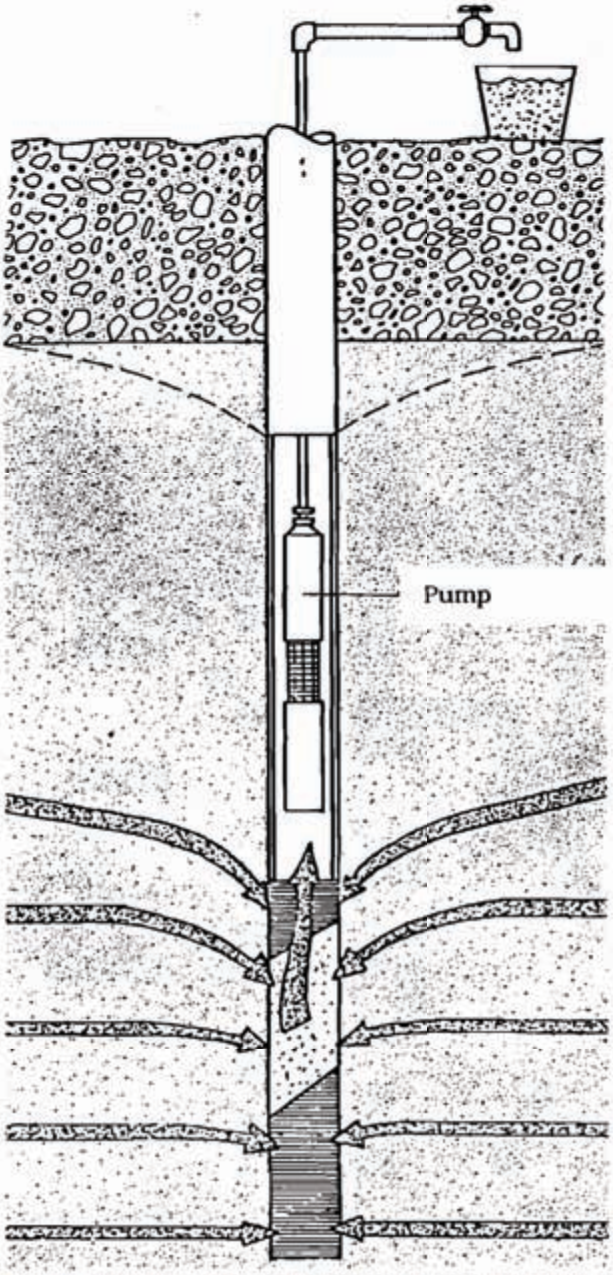

Figure 1. When a well is first drilled it can carry in a maximum amount of sand.

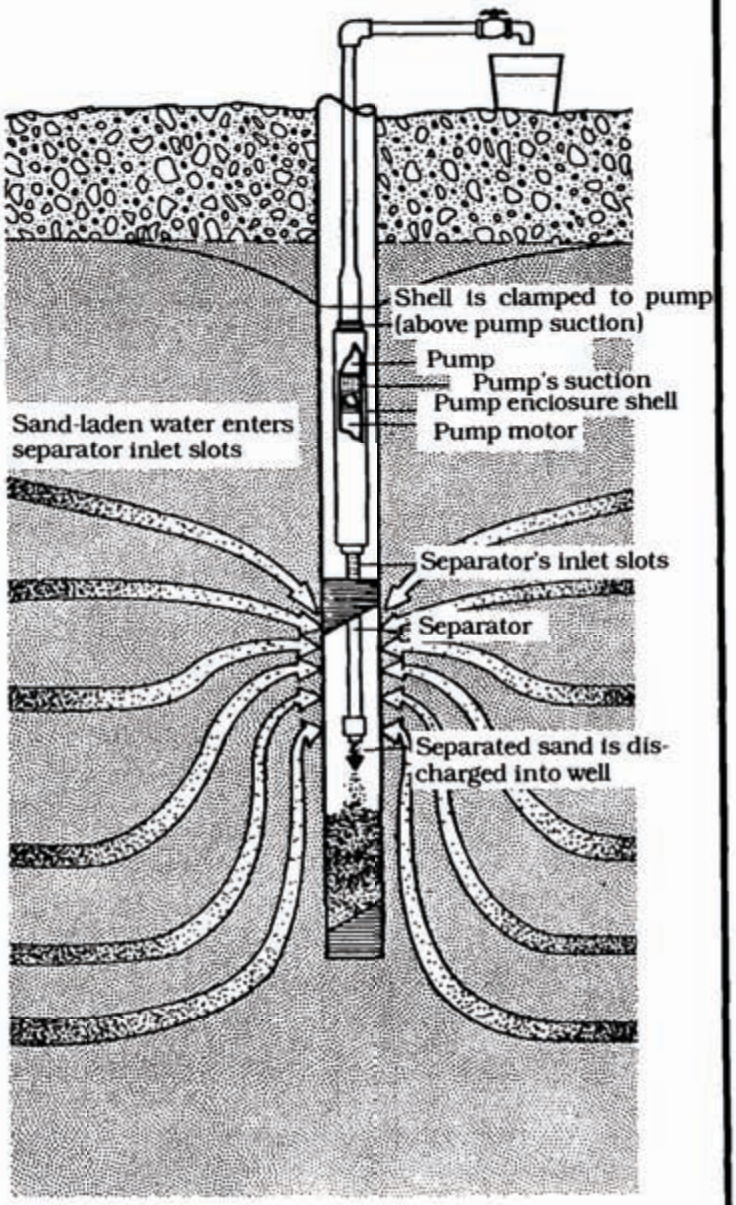

Figure 2. When the separator purges enough sand into the well, the flow patterns change, making it difficult for water entering the well to carry sand.

sides if the separator were removed from the well, the sand would go up through the pump, upsetting the equilibrium existing in the well, reducing the inefficiency outside the well, and increasing the energy available to carry more sand into the well to replace that which is pumped out. Therefore, instead of reaching equilibrium with a fixed volume of sand in the well (and no more movement through the formation outside the well), we would have a continuous movement of sand into the well and up the pump.

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So hang on to the separator, don't worry about the reduced depth of your well, and thank Mother Nature for an almost free lunch. (Remember floods, pestilence, drought damage, etc. are not a result of Mother Nature working alone; man is part of the equation that results in havoc.) Here Mother Nature and pump protection separators combine to help us solve a knotty problem. We have only to understand the strange way they work as shown in Figure 3. Actually, it is basic physics of flow through porous media—nothing really mysterious about ground water flow—and a unique form of the hydrocyclone that does the trick.

If per chance you know of a well where the other shoe did drop, here is why:

- The distance between the depth of the pump setting and the bottom of the well was not great enough to allow adequate sand buildup to reduce ground water flow energy. In turn, the water's sand-carrying capacity was never reduced enough to set up the equilibrium. If room allows, this can be remedied by raising the level at which the pump intake is set in the well. There are occasions where adequate depth does not exist.
- There may be some situations where the high permeability of the aquifer (whose sorting characteristics produce sand) is so great that no amount of sand buildup in the well will reduce the energy of the water to carry more sand into the well. In this case, the problem can be solved in one of two ways:

1. Dramatically reduce the flow rate and subsequent drawdown till the yield is the minimum necessary for use. Such highly permeable formations usually have an extremely high specific capacity, making possible a reduction in hydraulic gradient outside the well that will thwart sand movement. Here, a separator may be needed to further reduce the energy of the flowing water via sand buildup in the well, as well as to eliminate any sand or grit that might damage the pump.

2. Such high-yield wells can also be lined with a screen and sand pack that will act as a filter to physically block the entry of sand. A drop of 40 to 60 percent in specific capacity can be expected, but the high-yielding characteristics of the aquifer, which posed the problem with using the sand separator may still produce acceptable amounts of water.

It is important to point out here that a large percentage of our sand-producing wells are not entirely due to irrevocable geologic conditions but are the result of poor well design, construction and development. Our first line of defense is to be sure the job is done correctly and preclude the need for a sand separator; failing this, however, it's great to know that nature and the pump protection separator can limit our losses and keep our wells operating for a long and useful life. ■

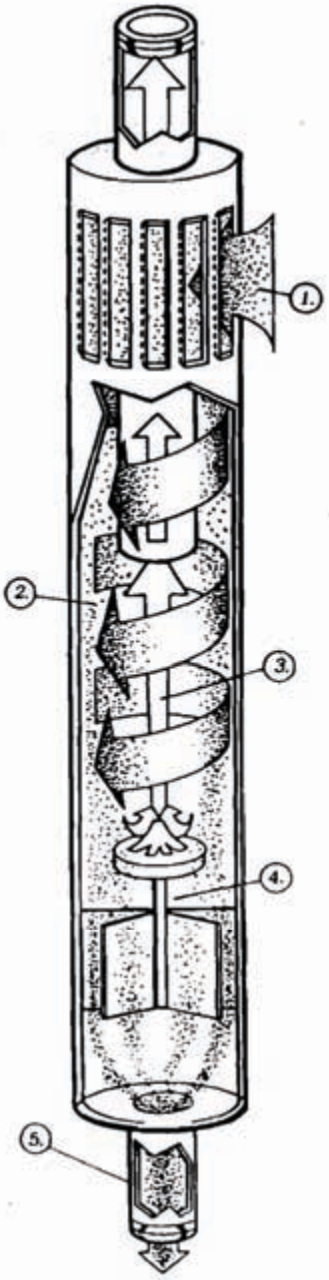

*Figure 3. **Mother Nature and the sand separator combine to help us solve the problem, as shown here.***

1. Sandy water is drawn through tangential inlet slots into separation chamber.

2. Sand is centrifugally separated from water and tossed to perimeter of chamber.

3. Sand-free water is drawn to center of separator and up through vortex outlet to pump's enclosure shell.

4. Sand particles fall downward, along perimeter, to bottom of separator.

5. Sand is purged, via tail pipe, into bottom of well.

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