Efficiency Loss and Its Relationship to Plugging of Well Screens by Fine Sediment and Encrustation

Introduction

Most well owners, well designers, well drilling contractors and, certainly, Roscoe Moss Company share a common goal of constructing highly efficient wells that promote cost-effective, long-term service. This goal is most regularly achieved when the well is constructed with highly efficient well screens that are properly developed. However, after being put into operation some wells experience a noticeable decline in efficiency within a relatively short time. Experience has shown that often such changes occur when well screens become plugged by fine sediment or encrustations. This memorandum discusses these conditions and various methods that can be used to ameliorate their effects.

Well Efficiency

Well efficiency is defined as the ratio of actual specific capacity to the theoretical specific capacity. (Specific capacity is ratio of the production rate to the drawdown required for produce that yield.) A well that is highly efficient exhibits less drawdown and requires less energy to deliver the water to ground level, resulting in less cost to the owner. (The reader is referred to Technical Memorandum 005-1 which explains well efficiency and power costs.) However, when well screens become plugged with sediment or encrusted, the total open area of the screen is effectively reduced so that ground water is no longer available to freely enter the well. Pumping under these conditions, a well will usually exhibit greater drawdown (i.e., due to the increased head loss) and lower specific capacity.

Plugging Phenomenon

During the development phase of well construction, remnant drilling fluid and cuttings adhering to the well bore and filter pack are agitated and loosened so that they can be drawn into the well. Similarly, as development proceeds fine sediment (down to silt size) from the aquifer is also captured and pulled into the well with the net effect of enhancing the formation's permeability near the borehole wall. As a result, ground water flow from the aquifer is more easily accomplished.

When properly and fully developed, a newly constructed well will exhibit its developed capacity during its initial production testing. This then becomes the benchmark against which subsequent calculations of the well's specific capacity are compared. As noted above, when wells are put into service, it is not uncommon for some of them to experience well screen plugging. Anecdotal reports suggest that such plugging occurs more frequently in wells that are pumped continuously for protracted periods at a constant rate (i.e., with no change in pumping rate or periodic shut-downs). This type of operational scenario is thought to promote the slow migration of fine sediment from the aquifer. When this happens, sometimes the fines collect within the filter pack and around the well screen. The operator may then detect a noticeable decline in specific capacity of the well.

Encrustation

Precipitation occurs in a well when conditions exist such as biological activity, corrosion, dissolved oxygen, and, with less frequency, mixing of ground water (e.g., different aquifers). When the conditions for such reactions exist they produce chemical precipitates which adhere to the interior and exterior linings of the casing and well screen. Many possible species of incrustations can result; however, for purposes of this memorandum, they are considered to similarly impact the efficiency of water wells when they retard or interfere with the free flow of ground water through the well screen. In like manner to well plugging by sediment, encrustation often markedly affects the specific capacity of a well as the buildup begins to close off the open area of the well screen. The resultant head loss caused by the reduction in open area is evidenced by a decline in the specific capacity of the well.

Rehabilitative Action

It is certainly possible to restore production and efficiency to wells affected by sediment plugging or encrustation. However, to be perfectly honest, as in most things technical, there are no guarantees that rehabilitation will be completely successful. Experience has shown that well rehabilitation is capricious and sometimes very difficult, particularly when attempting to remove silt from the filter pack and well screen. Even vigorous rehabilitation methods are sometimes ineffective. Therefore, some well operators have taken to periodically backwash wells so as to agitate the fines thereby freeing them so that they can be pumped out. When a well is operated in this way, silt is removed before it builds up and unalterably reduces the wells production and efficiency. Weekly backwashing is one way to maintain effective well operation. It should be noted that to get the most from backwashing, it is best if the foot valve or column pipe check valve is removed.

Encrustation is typically removed by various chemical and/or mechanical methods. Generally, the best approach is to determine the type of encrustation by sampling and analyzing the material. Then, an appropriate remedial approach can be selected.

SUMMARY

The losses of efficiency and production due to plugging by sediment or by encrustation are problems that plague many water wells. While there is no perfect solution to combat plugging by sediment, it is possible to effectively remove silt buildup by periodically backwashing the well. Another possible approach is to reduce the pumping rate so that less silt material is drawn from the formation. Encrustation is, in some respects, more problematic because it can occur due to several conditions. Dealing with the effects of encrustation is most effectively handled by determining the species of the buildup and then selecting appropriate chemical and/or mechanical rehabilitation methods.

References

Roscoe Moss Company, 1990, *Handbook of Ground Water Development*, John Wiley and Sons, New York, NY.

National Water Well Association, 1980, *Manual of Water Well Maintenance and Rehabilitation Technology*

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