Monitoring Sand Content: The Rossum Tester

Introduction

The bane of many well operators is sand that is produced during pumping. While it is not uncommon for a small quantity of sand to be discharged during start up, chronic sand production will usually accelerate the normal wear of impellers and other pump parts and clogs meters and valves. If left uncontrolled, sanding also increases the frequency of equipment maintenance and replacements, and causes nuisance problems for pipelines and water storage facilities. Whether the cause for sand production is design related or the result of corrosion, it is important to monitor the quantity of sand that is discharged from the well on a regular schedule.

Sand production is a key criterion of new wells and should be carefully monitored when the well is developed and pump tested. During the early stage of well development, the quantity of sand discharged often exceeds 50 milligrams per liter (mg/l). Such concentrations are expected and even desirable. Precise measurements of sand content during this phase of well completion can be made with an Imhoff cone or other suitable device. However, in the later stage of well development and during performance testing, accurate sand content measurements are needed. In fact, most operators cite a specific criterion in well construction specifications that defines the upper limit of sand production that is acceptable. Generally, this can range from 15 mg/L to less than 1 mg/L.

During a well's life, sand production may increase for various reasons. For example, corrosion of casing and/or screen may allow for passage of sand into the well. Or, a poorly selected gravel pack might be unable to filter fine sand from passing through the well screen. In either case, if routine sand monitoring were conducted, the change in sand content could signal the problem to the well owner.

For monitoring sand content during a pump test or at regular intervals during a well's life, American Water Works Association (AWWA) Standard A-100 suggests the use of the Rossum Sand Tester (RST). An RST is easy to operate, low in cost, reliable, and widely used in the water industry.

Theory and Design of the Rossum Sand Tester

The RST functions like a centrifugal sand separator and is used to measure the quantity of sand in milligrams per liter (mg/L). The recommended setup of the RST is to connect it to ¼-inch diameter pipe at the midline of the discharge line, as shown below on Figure 1. By opening the gate valve on the ¼-inch line, water from the well is directed into the centrifugal cylinder. A constant flow of water should be maintained by a control valve rated at 0.5 gallons per minute (gpm) (Rossum, 1954). Water entering the tester circulates at high speed and spins the sand up against the side of the chamber. As the sand settles out, it collects in a graduated tube that is attached to the bottom of the tester.

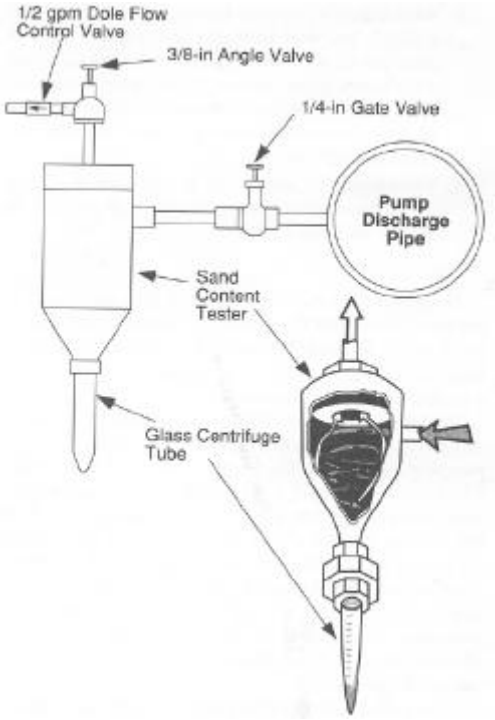

Figure 1

Sand Content Monitoring

The RST is an effective device for measuring sand content at concentrations less than 50 mg/L. This makes it very useful to monitor sand content while pumping a well at a high rate of discharge during development and production testing. The tester can be used to measure sand content in any water system; however the water sample for sand determination must be carefully obtained. A sample connected from a horizontal pipe at a low velocity is unacceptable. The sample may be obtained from a vertical pipe or a horizontal pipe with highly turbulent flow. Samples taken immediately downstream from elbows, tees, and other fittings that create turbulence are generally satisfactory if the water velocity is 5 feet per second or more. Readings taken close to the pump discharge head will have required turbulence.

The sampling procedure is as follows:

1. Install the RST as shown in Figure 1. The inlet should be located on the horizontal centerline of the discharge pipe and positioned as close to the discharge head or other turbulent flow area as possible.

2. Open the inlet valve to the tester wide open. Adjust the outlet valve to 0.5 gpm. A flow of 0.5 gpm will fill a 1 quart container in 30 seconds or 1 gallon container in 2 minutes.

3. Close the inlet valve, remove, clean, and replace the glass tube.

4. When ready to start the sand content test, open the inlet valve wide open and note the time.

5. After 5 minutes, record the accumulated sand. The sand rate is the accumulated sand divided by the time it took to accumulate. The test can be repeated or run for longer periods of time. To see the effects of surging a well, the test is often run following surging and after a period of steady discharge.

6. Check the flow rate through the tester during each run. If the flow rate is not 0.5 gpm, repeat the test.

7. Record the pump discharge rate (in gpm) during each sand test and note whether any surging was done prior to the test.

Calculations

The sand rate in milliliters per minute (ml/min) is used with the flow rate of 0.5 gpm to determine the rate of sand production per unit of water, as shown in Calculation 1. The answer will be milliliters of sand per milliliters of water (ml of sand/mil of water), as shown in Calculation 2. This answer is converted to parts per million (ppm), as shown in Calculation 3.

$$\frac{\text{Sand (ml)}}{\text{Time (min)}} = \text{Sand rate (ml/min)} \qquad (1)$$

$$\frac{\text{Sand rate (ml/min)}}{0.5 \text{ gpm} \times 231 \text{ in}^3 \times 16.387 \text{ ml/in}^3} = \text{ml of sand/ml of water} \qquad (2)$$

$$\text{Conversion to parts per million (ppm)} = \text{ml of sand/ml of water} \times 1{,}000{,}000 \qquad (3)$$

Example:

Measured sand = 0.1 ml

Time of test or accumulation = 10 minutes

$$\text{Sand rate} = \frac{0.1 \text{ ml}}{10 \text{ min}} = 0.01 \text{ ml/min}$$

$$\text{ppm} = \frac{0.01 \text{ ml/min}}{0.5 \text{ gpm} \times 231 \text{ in}^3 \times 16.387 \text{ ml/in}^3} \times 1{,}000{,}000$$

$$= 5.28 \text{ ppm}$$

Summary

The RST makes accurate sand content measurements an easy, straightforward and low cost task. The device can be used for monitoring during later stage of development when sand content is below 50 mg/l, during production testing, and in routine monitoring events conducted during the well's regular operation. The real value of the RST is that it makes it easy to track changes in sand production whenever such data are needed. Noticeable increases in sand production often indicate that further investigation of the well is needed, particularly if the sand content approaches or exceeds the operator's upper limit of tolerance.

References

American Water Works Association, 1997, Standard for Water Wells, A100-97.

California Department of Water Resources, 1981, Water Well Standards: State of California, Bulletin 74-81.

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

Rossum, John R., 1954, Control of Sand in Water Systems, reprinted from Journal American Water Works Association, Vol. 26, No. 2, February 1954.

The Engineer's Manual for Water Well Design, 1985, Roscoe Moss Company.

U.S. Environmental Protection Agency, 1975, Manual of Water Well Construction Practices, EPA-570-75-001.

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