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Understanding Fluid Sampler Draw Limits

By Dean Carroll

Design, construction and operation are stages in the life of an industrial plant. These stages can be difficult to coordinate. Plant designers must balance needs and regulations; construction workers must meet deadlines and budget; and operators must make the results work—all of which can leave operators with applications that have difficult solutions. The draw limit of a fluid sampler is one such issue.

To explore this issue, the limitations on the draw should be divided into two separate factors: vertical draw and horizontal draw. The vertical draw is the height difference between the top level of the fluid source and the highest point the fluid must reach in the sample line (this is a slight simplification). Note that if the fluid source changes in height, then the lowest height should be used, as that will be the greatest vertical draw.

The horizontal draw is the distance between the sampler and the end of the intake hose, measured as if they were at the same level. The two measurements that affect these factors are vacuum (in Hg), which measures how completely the air has been removed, and volume transfer (in cubic feet per minute), which describes how fast the air is removed. Vacuum determines how high a sample can be drawn, and volume transfer determines the transport velocity.

The sampling process

Fluid samplers typically use a vacuum draw to obtain a sample. The sampler removes air from the intake tube, causing fluid to enter and replace the air. This happens because the air we normally breathe is pressing on the water, applying a pressure of 14.7 psi. When the air is removed from the intake tube, it gives the water outside an effective pressure of 14.7 psi, and water flows from the higher pressure to the lower pressure inside the tube.

The limited pressure of the water determines how high water can be drawn. The limit that water can be pulled is the same as the limit that water can be pushed with a pressure of 14.7 psi. Changes in altitude will change this limit. In a perfect world, water could be pulled vertically 33.8 ft, but a variety of factors reduce this number to around 29 ft. Stalling is another effect one can see during high lifts. The gases in aerated fluid can begin to come out of the water more rapidly at around 25 ft. This can cause the water to stall until enough gas is removed; then the water will start to rise again.

Vertical and horizontal draws make the difference in industrial plant design

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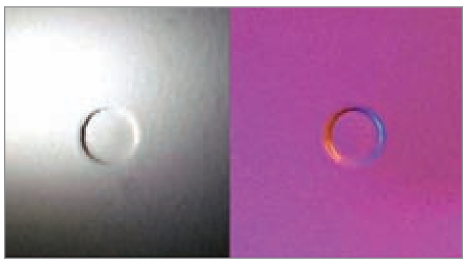

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The horizontal distance that a sampler can draw fluid depends on the speed with which it can move the fluid. A longer horizontal draw increases friction and reduces speed. The speed (transport velocity) also affects how representative a sample will be. In any long horizontal draw, large increases in vertical height should come as close to the sampler as possible. This will yield the best transport velocity over the distance.

A sampler should be situated as closely to the sample source as possible, both vertically and horizontally. Samplers can draw up to 28 ft vertically, but water moves slowly at that height. When this is not possible, one should consider the advantages and disadvantages of each type of sampler and the options available.

Finding the right sampler

A peristaltic sampler can generate good vacuum (27 to 29 Hg) when the tube is new but typically has a low volume transfer. This means it can draw close to the 28 ft vertically when the tube is new; however, as the tube degrades, the vacuum strength typically decreases, and eventually it will not be able to draw to that height. A high vertical draw uses more tube to obtain a sample, which can significantly increase the cost of tubing. Long horizontal draws also use more tube to obtain a sample. Transport velocities vary between manufacturers.

The U.S. Environmental Protection Agency (EPA) states: “It would appear that the slower-acting peristaltic and piston pump-type samplers are either not capturing settleable [sic] materials or that after introduction to the intake line, particle settling velocities are higher than liquid intake velocities.”[1]

A standard vacuum compressor sampler generates 24 Hg in vacuum unless an alternate compressor setup is used (28 to 29 Hg). The compressors can maintain these levels of vacuum over 10 years. The volume transfer is significantly higher as well, which translates to a higher transport velocity. In a high-lift application, more care must be taken to ensure that seals are set properly. Long horizontal draws present no difficulty since the transport velocity is toward the top of the EPA’s suggested transport of 2 to 10 ft/second, and a higher air volume purge helps to clear the intake line. One advantage is placing the sampler outside of class 1, division 1 or division 2 locations as an effective way to avoid paying for an explosion-proof sampler.

Another method to consider is an assisting pump. A pump that is near the source can push water much farther and higher. Some of the difficulties with this method are control and power of the assisting pump, collection of rag and debris on the pump and the pump passing solids. Manning Environmental has introduced several setups for high-lift applications (25 to 75 ft).

These are several ways to address a high-lift issue, though a final solution will depend on application. Understanding the factors and limitations is an important first step. If you are feeling unsure, contact an experienced manufacturer for assistance. WWD

References:

[1] Daniel J. Harris and William J. Keffer, U.S. Environmental Protection Agency, et al, *Wastewater Sampling Methodologies and Flow Measurement Techniques*, 78.

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