Fluid Samplers: Vacuum vs. Peristaltic

Water & Wastes Digest examines two types of samplers and their associated myths

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As most readers of Water & Wastes Digest are aware, a fluid sampler is essentially a smart pump that takes a liquid sample from a source and deposits it into one or several containers for inspection. Fluid can either be pulled up the intake hose, or pushed from the source. Two types of samplers typically used are vacuum/compressor and peristaltic.

Both peristaltic and vacuum samplers pull fluid from the source. As each pump removes air from the intake hose, fluid from the source flows in to equalize the pressure difference. The faster the pump can remove air from the tube, the faster the liquid can be transported through the system.

Ideally, physics dictates that a liquid can be pulled a maximum of 32 ft. vertically, however, friction and other factors reduce that number slightly.

In applications where it is necessary to lift a sample near or greater than 32 ft, pumps can be placed near the source liquid to push samples through the intake tubing or a collection trough. This method has no physical limitations, save the pressure the pump is able to generate and the strength of the tubing. A pressure of roughly 15-psi is needed for every 33 ft of vertical climb. Losses for friction and altitude are also present.

Vacuum Samplers

Vacuum samplers use a vacuum/compressor to provide the vacuum and pressure that move the liquid. A chamber is used to hold and measure the liquid sample before deposit. The compressor forces air into this chamber, purging it and the intake hose of fluid, then draws liquid into the chamber until it is full.

Pressure is then applied to the chamber, expelling the excess liquid above the preset sample volume. The sample is then deposited into the sample bottle. This process reduces cross contamination by diluting any liquid remaining in the intake line.

Vacuum Advantages

There are several manufacturers of vacuum samplers. One of these, Manning Environmental Inc., claims that one of the several advantages of the vacuum system is its precise volume repeatability. The method of completely collecting the sample volume in the vacuum chamber reduces the amount of variation between samples (within 5ml) regardless of factors that typically interfere with a sample such as head height, bubbles or other adverse conditions.

Another distinct advantage of vacuum samplers is its high transport velocity. Falling well within the EPA recommended range; vacuum samplers can achieve transport velocities in excess of 5.5 feet per second, which enable them to perform a much wider range of functions. Much longer draws are possible with vacuum samplers, making it possible to keep personnel clear of hazardous sites.

Vacuum systems also have no consumable parts that need regular replacement, and because the fluid does not travel through the pump unit, large particles or solids will not damage the sampler.

The compressor in a Manning vacuum sampler will also generate up to a 45-psi purge. This is useful when dealing with high fiber, rag or other material that can clog the intake tube. This purge uses a high cubic feet per minute rate causing more liquid to be cleared from the wetted parts and reducing cross contamination.

Finally, vacuum samplers lend themselves to variations in the diameter of the through path. The increased rate of flow enables the use of a 5/8-in. through path, as well as the standard 3/8-in. Greater diameter through paths are possible, but not commonly used.

Peristaltic Samplers

In contrast to vacuum samplers, peristaltic pumps use two or more rollers to push against a flexible tube creating a pillow of fluid or air.

As the rollers move, the pillow is pushed toward one end of the tube. The pillow exits the pump and then next pillow is then pushed through.

Peristaltic Advantages

Peristaltic units are well suited for toxic applications. Using a Teflon intake hose or other approved material is usually the only modification a peristaltic sampler requires to sample toxic fluids.

Peristaltic units are less sensitive to set up than vacuum units, so proper intake hose placement and accurate calibration are generally the only critical steps to accurate sampling.

Peristaltic samplers also have fewer parts, and are more enclosed than vacuum units, making them fairly rugged and easy to operate and maintain. Due to the type and number of parts required for peristaltic samplers, they also tend to be priced less than vacuum samplers.

Common Myths

Several common misconceptions exist about the performance and functionality of vacuum samplers.

Vacuum samplers cross contaminate more than peristaltic samplers.

In truth, results are equal between the two types. The majority of wetted surface area in a sampler is in the intake hose, which is cleared better with the high-pressure/high volume purge of a vacuum.

A USGS test in Madison, Wis., tested this with a distilled water blank in both vacuum and peristaltic samplers. The conclusion was both units were equal in cross-contamination.

Higher velocity and stronger purge, as found in vacuum samplers, will disturb the source bed load more so than a slower, lighter purge, and stronger suction will grab heaver particles into the sample more than a less powerful suction.

This is untrue on both accounts. Stronger purge and suction does not change the level of disruption of the bed load or cause a higher particulate count than slow purge and sample units. Placing the intake hose directly on the bed load would cause higher levels of disruption and particulate intake from the vacuum unit, but only marginally more than a sampler with lower purge and suction strength. In both situations, intake hose placement is vital to accurate sampling.

Strong suction concentrates solids.

Strong suction does not in any way concentrate solids. The physics of moving a less dense particulate, or bio-solid, through a more dense substance such as water, requires a force to act independently on the individual particulate. A hose drawing fluid acts on the whole and material of all densities are moved together. Any vacuum or peristaltic sampler creating stronger suction will actually give an equal or better representation of the source liquid. This is supported by the EPA reports on samplers recommending higher transport velocity, or stronger suction. It is further supported by the USGS test in Madison, Wis., which tested and found that stronger suction did not concentrate solids.

Final Analysis

When choosing a sampler, correct analysis of your application is vital. Peristaltic samplers are convenient for short draw applications, toxic applications and for those who need a less expensive sampling solution, while vacuum samplers offer a higher level of performance that can be used in more demanding applications.

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For further information on samplers, contact Manning at 512/863-9337.