

What is sample circulation?

For our purposes, sample circulation is the movement of water past a sensor in a way that continuously provides fresh sample to the active measurement surface of a water quality sensor. “Sample” does not refer to a discrete sample, as in a “grabbed” or pumped sample, but rather to the small, undivided portion of a water body that determines the sensor readings. “Water body” is the volume of water to which water quality data will be attributed. A single datum may represent the condition of a small aquarium, a cross-section of sewer flow, or an entire lake.

Sample circulation can be natural, as provided by gravity (tidal or river flow, for instance), or forced, as provided by mechanical pumps or stirring and agitation devices. The flow rate of most natural waters is not sufficient to provide all the benefits of sample circulation.

How is sample circulation useful in water quality monitoring applications?

Sample circulation improves the performance of water quality sensor in several ways:

1. Provision of threshold flow for various water quality sensors. Specifically, most types of dissolved oxygen (DO) sensors consume oxygen from the water sample being measured, and their readings tend to fall if sample circulation does not continually replenish the supply of oxygenated sample to the sensor (see Standard Methods, 1995, 4500-OG). Errors exceeding 30% of reading can result in absence of adequate sample circulation. Many ammonium sensors also have a perceptible sensitivity to flow, and so benefit from predictable sample circulation.
2. Prevention of water stagnation at the surfaces of water quality sensors. If the sample is motionless, the sensors may measure the same tiny volume or film of water over and over. Sample circulation must be sufficient to

strip away the “hydro-dynamic boundary layer” water films clinging to the sensors’ active measurement surfaces, so that the sensors are always measuring a “fresh” sample. The fresh sample is more likely to be representative of the water body.

3. Enhanced response time. If the measurement regime changes, sample circulation ensures that “new” sample quickly and completely replaces the “old” sample at the active measurement surfaces. This is important, for instance, when detecting moving contaminant plumes, or when the sensor is moved up or down within a water column. If a temperature change accompanies the change in measurement regimes or occurs independently, sample circulation speeds temperature equilibration of the sensors and ensures proper application of the sensors’ temperature compensations. Faster, more accurate data are the result.
4. Sample circulation of sufficient vigour has been shown in field experiments to reduce the harmful effects of sensor fouling. Sample circulation cannot only sweep away inert debris, such as leaf litter and sediment, but can also discourage biologically-active contaminants (bacteria, algae, fungi, larvae) from attaching to active measurement surfaces (for instance, the DO sensor membrane or turbidity sensor windows). Sample circulation can also help dislodge air bubbles (particularly detrimental to conductivity and turbidity sensors) that adhere during initial submergence, or that collect from biological activities (sediment gas) or gas coming out of solution. Longer field deployments are possible when sample circulation is used.
5. Flexibility of deployment location. If an instrument must be deployed in a poorly mixed area of a water body, sample circulation will provide the flow necessary for proper sensor performance. And in situations where the multiprobes are deployed in perforated steel or PVC pipes, sample circulation prevents



sample stagnation within the confines of the protective pipe.

6. Sample circulation can remove the measurable traces of the sensors themselves. For instance, a properly functioning reference electrode continually “leaks” potassium chloride into the water sample. Sample circulation sweeps the contaminant away, ensuring, for instance, that the conductivity sensor measures only sample representative of the water body as a whole.

How is sample circulation implemented in Hydrolab instruments?

Hydrolab has produced a number of different circulation devices over the years, and has recently developed the FreshFlow™ miniature sample circulator. Available on the DataSonde and MiniSonde4a multiprobes, the FreshFlow is a small electric motor coupled magnetically to a small impeller. At just 0.6 inches in diameter and 3.2 inches long, the FreshFlow is integrated directly into the multiprobe immediately adjacent the sensors. The circulation generated by the FreshFlow is directed at the sensors’ active measurement surfaces, providing a continuous stream of fresh sample to be measured.

Like the DataSonde and MiniSonde 4a sensors, the FreshFlow can be removed or replaced in seconds. For delicate situations, for instance when measurements are to be made near the sediment layer without disturbing the sediment, or for microgradient research, the FreshFlow can be turned off from a PC, Surveyor 4a, or other controlling or display device.

The FreshFlow requires no extra cables or housings, and consumes very little power. With the FreshFlow operating, the DataSonde 4a can be deployed for up to 120 days or more, and the MiniSonde up to 14 days or more, with their standard internal battery packs. For remote, on-line installations, a solar-charged battery can easily supply the multiprobe and FreshFlow power requirements.

Should I consider a Hydrolab FreshFlow miniature sample circulator?

The Hydrolab FreshFlow miniature sample circulator:

- ◆ is more reliable than natural circulation,
- ◆ provides flow for fast, reliable, repeatable DO and ammonium measurements,
- ◆ ensures measurement of a sample representative of the larger water body,
- ◆ speeds sensor response to changes in the sensed parameter or in temperature,
- ◆ reduces both inert and biological sensor fouling to allow longer field deployments,
- ◆ reduces the influence of protective structures near the sensors,
- ◆ reduces the influence of the presence of sensors on the water quality data,
- ◆ offers smaller size and lower power consumption than other circulation means, and
- ◆ costs less than other sample circulation means.

In addition to these benefits, the Hydrolab FreshFlow miniature sample circulator provides the same reliability that Hydrolab instruments are known for, and can carry up to five years of full factory warranty.

For more information on this or any Hydrolab application please contact Campbell Scientific (Canada) Corp. at (780) 454-2505.