Technical Note
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By: Mike Nelson

ORIFICE LINE INSTALLATION

H-350, H-350XL / H-355

Orifice Line Position

The position of the orifice line is critical for maintaining accurate data. If water current or flow is pushing against the end of the orifice line, it will cause a pressure to be placed on the line that is not related to the water depth. This added pressure will cause errors in the data. The same is true if the water flow is creating a vacuum on the orifice line. If this pressure is constant, it is easy to remove its affects on the data, but as the water level changes, this pressure normally also changes, causing errors in the data that cannot be removed. The line should be installed in an area where the flow of water will not be changing much, based on other changes such as stage. Here are a few 'Do's and Don'ts' on the mounting line.

Do
- Mount the outlet in still water
- Mount the outlet so the last inch or so is almost horizontal (slightly downward side exit)
- Try to prevent swells in long runs of orifice line
- Use a muffler in more turbulent waters

Don't:
- Do not mount the outlet facing up stream, down stream, or upwards
- Do not allow any portion of the line to be lower than the exit point
- Do not allow goose necks in the orifice line
- Do not use thin walled tubing, only use USGS approved orifice line
- Do not mount outlet in the wake of an obstruction, bridge peer, rock, etc.

Loose Orifice Line

When an orifice line is installed, it is normally fixed to some permanent and secure structure, like a bridge pier or cement slab. In this case, the end of the orifice line is very stable. In time, as debris and other large objects may hit or brush against the line, it may loosen or even break away from its mounting, causing it to shift or even vibrate due to water flow. Any movement in the output of the orifice line will be directly related to the noise in the data.

We have seen times when a log has hit the conduit, breaking the mounting bolt and allowing the end of the conduit to flap in the water. When debris catches onto the conduit, then the movement gets worse. We have also seen a cement block settle and shift, causing data errors. When possible, always check the mounting of the orifice line to see that it is secure.

Tidal Affects, or Waves

Some rivers or other bodies of water are affected by ocean tides. The tide itself, on a 12-hour cycle, will have little affect on the system, but these same sites often have larger waves lasting longer than a few seconds that will cause major noise problems on a gage. In order to reduce the affect of the wave, it is best to measure the state for a time period equal to at least 3 wave cycles. For example, if it seems to be 5 seconds between waves, then the averaging time

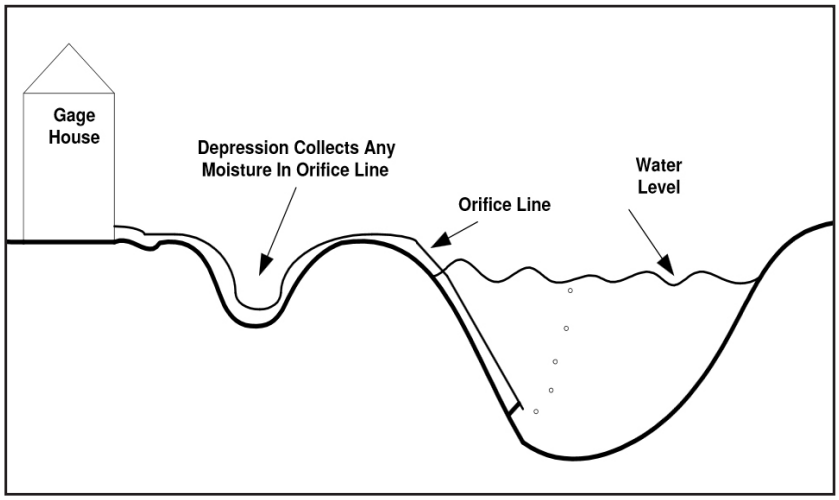
should be at least 15 seconds. Inland rivers and lakes also may be affected by boaters. Waves caused by boats are normally only a second or two apart, but averaging for a few seconds in these conditions also can greatly improve data accuracy.

Silting

A completely silted line will continually build up pressure until a max PSI is reached.This type of problem is easily identifiable. However, a slightly silted line may act much different. If the silt plugs the line for a short time, the pressure will build up slowly, causing an error and then have enough pressure from the build-up to push past the silt and look normal again for a short time. This may go on for long periods of time. In this case, rising the line slightly may get it out temporarily. Increasing the bubble rate may be the best solution, as this will help keep slight silting sites from becoming problems.

Low Point In The Orifice Line

As the orifice line runs from the bubbler to the end of the line, it is best to always position it so it has a downward slope. This will cause any condensation in the line to travel to the end and escape. If the line has a low depression, then any condensation may build up at that location. If the condensation increases to a point where it fills a section of the line, it will affect the air flow and cause irregular pressure in the line. Purging the line regularly will help, but may not remove all the water in the line. This same condition can occur when there is extra orifice line in the gage house, and it is coiled up and placed under a bench. Also, it is very important to keep the air dry, if using a system with desiccant, replace it as needed.



Kinking

A kink in the orifice line may have the same affects as slight silting does. The pressure builds from the normal air flow, causing an artificially high reading. At some time, the pressure pushes past the king and returns to normal. In this case, bubbles can still be seen at the end of the orifice line at all times and purges seem to work fine also. Use an orifice line that is thicker and stiffer so it will prevent kinking.

Bubble Line Test

On the H-350XL sensor/data logger, there is an option for testing the bubble line. This test is performed by continuously taking readings on the pressure line and displaying the difference between the highest and lowest reading. If the line has no noise, then the high and low reading will be the same and the difference will be zero. Running this test with the orifice line disconnected from the system, will indicate how much noise is caused by the data logger and sensor. This should show very little noise. For example, a 15 PSI H-350XL after normal measurement averaging and filtering has a resolution of about 0.00075 (published resolution is around 0.0007). Running the bubble line test for about 30 seconds to a minute with the orifice line disconnected in this case should give a value less than 0.005. This is better than the USGS desired resolution of 0.01 feet.

Now with the orifice line connected and all the water out of the line (purged), run the bubble line test again. After 30 seconds to a minute of running the test, notice the difference between this value and the value of when the line was disconnected. This difference is the noise caused by the orifice line. The hope is to have this less than the USGS desired resolution of 0.01 feet or some other desired limit.

In many cases the orifice line noise is greater than the desired 0.01 feet. If all efforts have been made to the orifice line installation for reducing noise, then other actions may be needed (see averaging and bubble rate).

Averaging

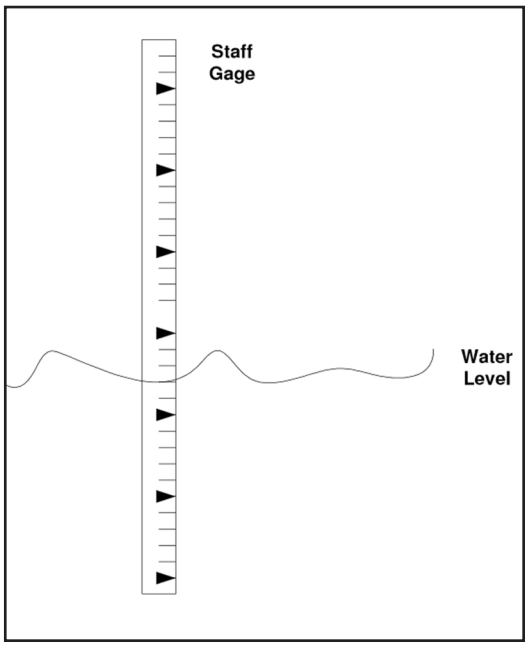
Averaging is the easiest way to remove noise from the system. On the H-350XL, the default averaging time is 1 second and on the older H-350, the default is 0.5 seconds. In both cases this is the fastest the unit can measure the stage value. The averaging option can be set to average for a few minutes if needed.

In most cases when a system shows data that is 'painting', the averaging time can be changed from the default value to a value between 4 and 8 seconds, and the painting is greatly reduced if not removed.

Bubble Rate

The effect of the bubble continually building and then releasing from the orifice line, actually creates a fair amount of noise on the line. For applications that do not need to have a higher bubble rate, it is recommended to set the bubble rate to 30 bubbles per minute. This seems to help with the 'painting' promblems.

Setting the Stage Offset



The H-350 and the H-350XL can automatically calculate the stage offset when the user enters in the current stage. When this option is used, the unit will take a measurement based on just the depth of the orifice line, and then calculate the difference between the measured value and user-entered value to end up with an offset. The measured value takes into account any added pressure on the line due to other forces such as flow. Now it is imiportant for the user to make sure the value they enter is as accurate as possible. In some cases, the water will have a ripple and may make it hard to accurately determine the level. When reading a staff gage with water that is fluctuating, be consistent on how the gage is read. For example, always use the value at the bottom of the ripple, the top of the ripple or an estimated average, but always use the same method. Using the bottom of the ripple or the average, is most likely closer to the actual water level.

Purging

Purging the line helps keep it clean and free of moisture. It helps to keep sediment build up away from the outlet. Purging can be used to find leaks and to locate the outlet. It also can cause problems in the measurements if not handled correctly. The purge will create a lot of noise in the orifice line, so it should be timed with the measurement to prevent this from happening. Based on how a purge is implemented, it can take some time for the line pressure to stabilize again, allowing precise measurements to be made. The time for the line to stabilize is determined by the line length, the pressure applied, the diameter of the line, and mainly how the purge process controls the line. For these reasons, all purges should be done long before the measurement is made. Auto purges should be done just after a scheduled measurement, allowing the maximum amount of time from the purge to the next measurement.

When using the H-355, the line will be stable within just a few seconds of a normal purge. All automatic purges are synchronized with the measurements to allow for the most amount of time from the purge to the next measurement. A single measurement can be made by the H-350 or H-350XL during a purge (manual) without any noticeable affects. The most common problem is to use too short a purge duration setting, which may cause the unit to have a higher bubble rate than normal for a few minutes after the purge. A higher bubble rate can cause the stage reading to increase by 0.01 feet. At the end of the purge, the tank pressure should be balanced to the line pressure. At the end of the purge, the compressor should turn back on for just a few seconds, indicating the tank pressure needed to be increased to start bubbling again at the proper rate.