

# Measuring Level with an Onyx Isolator Ring

Onyx isolator rings are extremely effective for measuring pressure on slurries and other hard-to-handle fluids, but their utility extends beyond simple pressure measurement.

An isolator ring is a simple, inexpensive way to measure level on slurry applications like sewerage, sludge, and gypsum. With careful engineering an isolator ring can measure level with accuracy better than  $\pm 1.0$  inch H<sub>2</sub>O.

The simplest way to connect an isolator ring to an open tank is to attach it to a stub pipe near the tank bottom as shown at the right.

There is only one adjustment to the level reading that arises if the density of liquid in the tank is significantly different than the density of water, in which case:

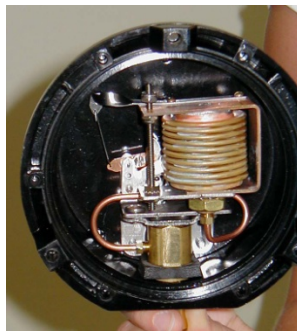
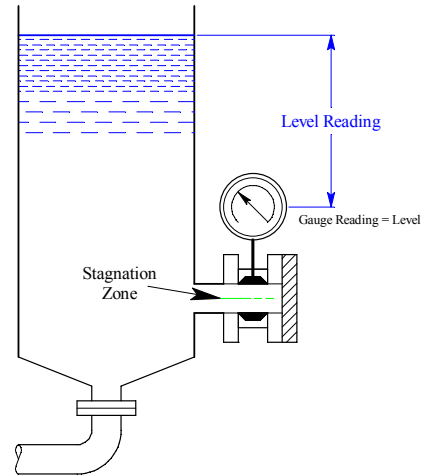
$$Level = \frac{PressureReading}{Specific\ gravity}$$

Since level measurement is generally a low pressure application, it is important to consider displacement volume and its effect on accuracy.

Pressure instruments consume a small but finite amount of fluid to operate. For example, in a mechanical gauge a few drops of liquid must be forced in and out of the sensing element to drive the pointer from zero to full scale. This change in volume is the “Required Displacement Volume” of the gauge.

If the instrument is attached to a diaphragm seal or isolator ring, the required displacement volume has to come from the isolator. But a diaphragm or isolator sleeve can only move so far until it hits the backstop. The volume that the isolator can push out before the sleeve hits the backstop is called the “Available Displacement Volume”.

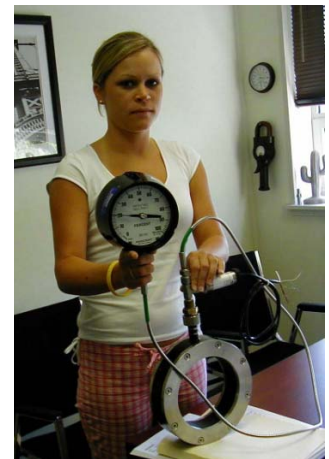
The Available Displacement Volume of the isolator ring must be greater than the Required Displacement Volume of the instrument attached to it. If not, the instrument will correctly display level through the bottom portion of its range and then it will abruptly cease when the sleeve hits the backstop.



Front and back view of the same gauge.

The bellows element requires a relatively large amount of liquid to drive the pointer to full scale.

Diaphragm seals are unable to operate this kind of instrument, but a properly sized isolator ring does the job handily.



These concepts can be used to develop practical guidelines to insure that you have sufficient displacement volume for level control systems to function properly.

Digital electronic devices require far less displacement volume than mechanical instruments. For accurate level measurement, use a **solid state transmitter** in lieu of a mechanical gauge.

Solid state instruments require less than 1/100<sup>th</sup> the displacement volume than their mechanical counterparts. If you are planning to combine an electronic transmitter with a mechanical gauge, *don't do it!* Keep the transmitter and toss out the gauge. Adding a gauge to the mix only degrades the transmitter signal to the point where the error is magnified 100 times larger than just using a transmitter by itself. The isolator ring and transmitter combination shown at the right is the ideal arrangement for accurate level measurement.



For level switching functions, use a **solid state switch** as shown on the left in lieu of a mechanical switch.

You can easily see that the large diaphragm capsule on the mechanical switch at the right has a huge required displacement volume compared to the solid state switch shown on the left.

The smaller displacement volume of the solid state switch increases the accuracy of the measuring system.



The difference is that you can order a mechanical switch without knowing the operating voltage, since mechanical contacts work on virtually any voltage, on either AC or DC circuits. To order a solid state switch, you have to know in advance if the control circuit is 120VAC or 24 VDC, or some other voltage. Sometimes it can be difficult to ascertain what the system voltage is.

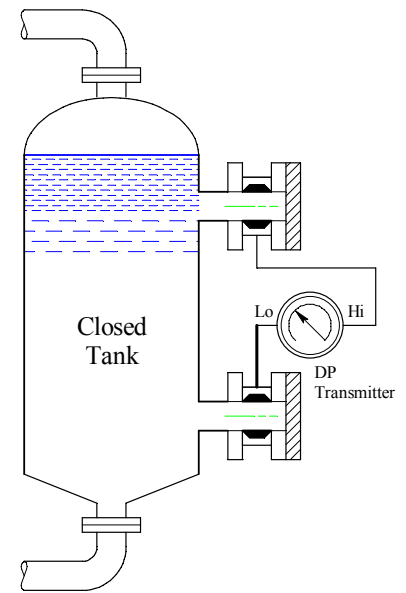
Another important concept: **A larger isolator ring has more available displacement volume** than a smaller one. The larger the isolator ring, the more accurate the level reading.

Recommended isolator ring size:

1. With an **electronic** solid state transmitter or switch, 3" is the minimum size isolator ring.
  - a. This applies to any sleeve material except Viton. If you must use a Viton sleeve because of chemical compatibility, increase the minimum size of the isolator ring to 4".
2. With a **mechanical** gauge, 6" is the minimum size isolator ring.
  - a. This applies to any sleeve material except Viton. If you must use a Viton sleeve because of chemical compatibility, increase the minimum size of the isolator ring to 10".

Measuring level in a pressurized tank requires (2) isolator rings, a  $\Delta$ -P transmitter, and some capillary tubing arranged as shown here.

The transmitter is rigidly mounted to the bottom isolator ring which is connected to the “Low” port of the transmitter. A capillary tube enables the upper isolator ring to communicate with the transmitter via the “High” port on the transmitter.

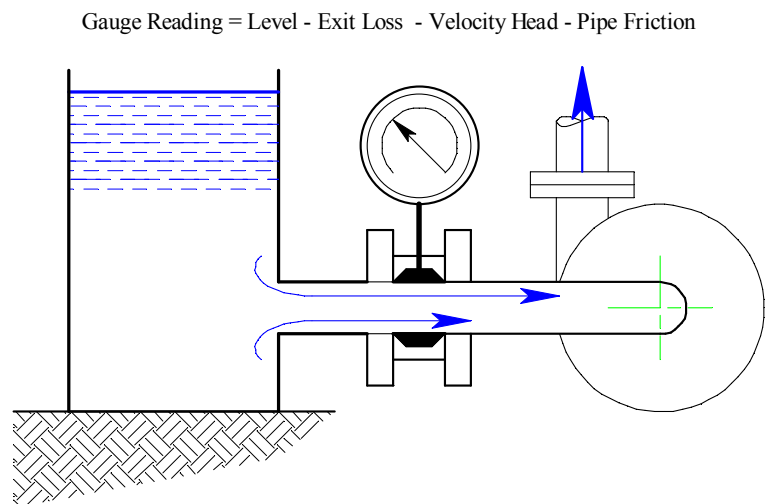


### Pump Run Dry Systems:

An isolator ring can protect pumps from damage caused by run-dry conditions. This is similar to a level measuring application because of the low pressures involved.

If the isolator ring is a considerable distance from the source tank, when the pump is running the isolator ring shows level with some minor distortions: The reading at the isolator ring equals tank level minus minor flow factors such as exit losses, velocity head, and pipe friction.

This slight downward shift in the pressure reading is perfectly acceptable because in a pump protection application you really don't care what's happening in the tank; what you really want to know is NPSH (Net positive Suction Head) at the pump inlet, which is exactly what the isolator ring shows.



When the pump stops (and there is no flow) these factors decay to zero and the isolator ring does, in fact, show true tank level regardless of distance.

Of course, there are two ways to protect a pump from run-dry conditions:

1. Pressure switch on the **suction** side as shown above, or,
2. Pressure switch on the **discharge** side. The idea here is that you monitor the difference between static and dynamic pressure on the pump discharge to infer flow versus no-flow conditions. To make this work, it is necessary to understand the difference between static pressure, friction pressure, and total pressure.

**Static pressure** is caused by elevation differences in the discharge pipe. It is the direct result of the weight of the liquid in the piping system. This pressure is present even when the pump is idle.

Static pressure is *not* influenced by pipe size, number of fittings, or viscosity. Static pressure is determined solely by fluid density and the difference in height between the pressure switch and the outlet of the pipe.

In the example shown here, the outlet of the discharge pipe is 10 feet higher than the gauge, so static head is 10 feet (which equals 4.3 psi).

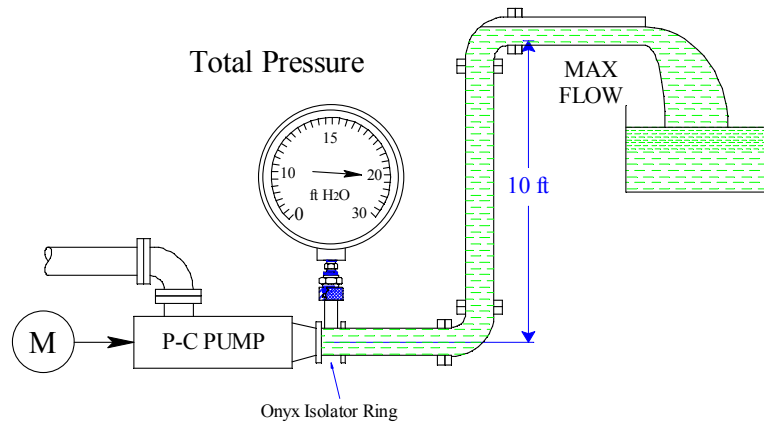
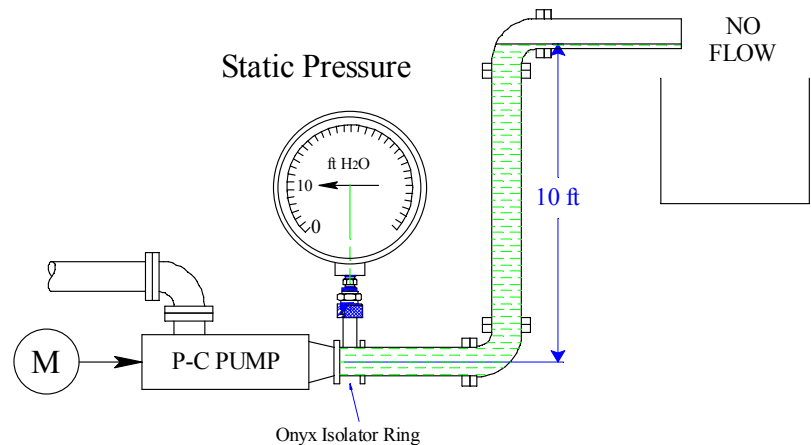
**Friction pressure** is caused by the flow of liquid through a pipe and is present only when the pump is primed and running.

It depends on flow rate, size and length of pipe, roughness of the inside of the pipe, number of fittings, and fluid viscosity.

**Total pressure = Static Pressure + Friction Pressure.**

When the pump is idle, the gauge shows static pressure. When the pump is running with flow present, the gauge shows total pressure.

In the example, total pressure is 20 psi.



For run dry protection, the low-pressure switch should be set midway between static and total pressure.

In our example the correct setting for the low-pressure switch is 15 psi. When the pump is running correctly, the low-pressure switch signals that flow is present. If the pump runs dry and flow stops, pressure falls back to the static pressure. This causes the low-pressure switch to signal that flow has stopped. If the pressure falls below the low-pressure setting (which indicates the pump is running dry) the switch stops the pump and signals a "Run Dry" fault.

### Can An Isolator Ring *Really* Work As A Flow Meter?

Yes, actually.

This requires some deft engineering and programming skills but an Isolator Ring *can* function perfectly as the poor man's flow meter.

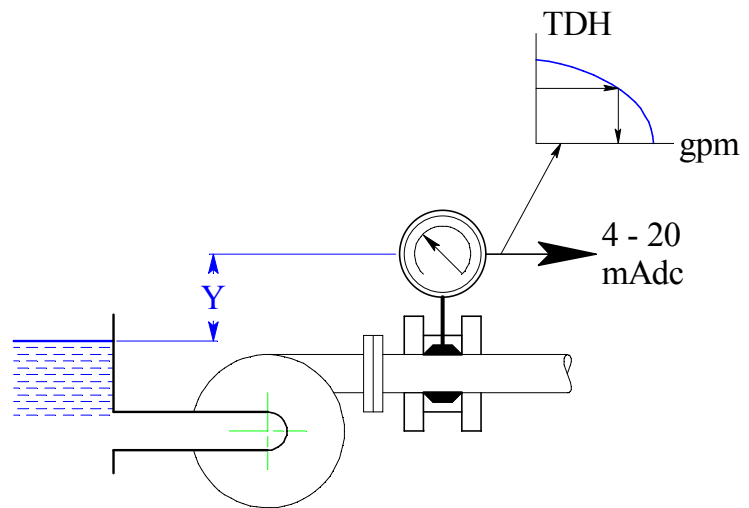
The key concept here is that every pump has a characteristic curve relating the discharge pressure (psi) to the flow rate (gpm).

This system utilizes an isolator ring with a pressure transmitter. An analogue electronic signal is sent by the transmitter to the PLC or SCADDA system.

The PLC or SCADDA is programmed with an equation or look-up table based on the pump curve.

When the transmitter is operating, the PLC or SCADDA takes the pressure reading, adds or subtracts the level of the feed tank, goes to the pump curve, and converts this signal to flow in gpm.

It's not as accurate as a real flow meter, but if you have to measure the discharge pressure anyway, you essentially get a free flow indication out of the deal.



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