SEALED-VENTED-ABSOLUTE:

HOW TO KNOW WHICH TRANSDUCER TO SPECIFY

APPLICATION NOTE

CHALLENGE**:** A job to design a liquid level measurement system has just come in. The client requires a submersible hydrostatic pressure transducer in the system, but these transducers can be built in three different pressure formats-PSIg (vented gage); PSIs (sealed gage); or PSIa (absolute). Which format is best for this job? The most important factor in deciding which transducer to use is to make sure the difference between the three pressure formats is understood.

BAROMETRIC COMPENSATION

When designing a system for accurate determination of water level via the hydrostatic technique, the user must remember that the pressure sensed by the level transmitter is the total of the hydrostatic pressure generated by the liquid column plus the ambient barometric pressure acting on the surface of the liquid. **See Figure A**.

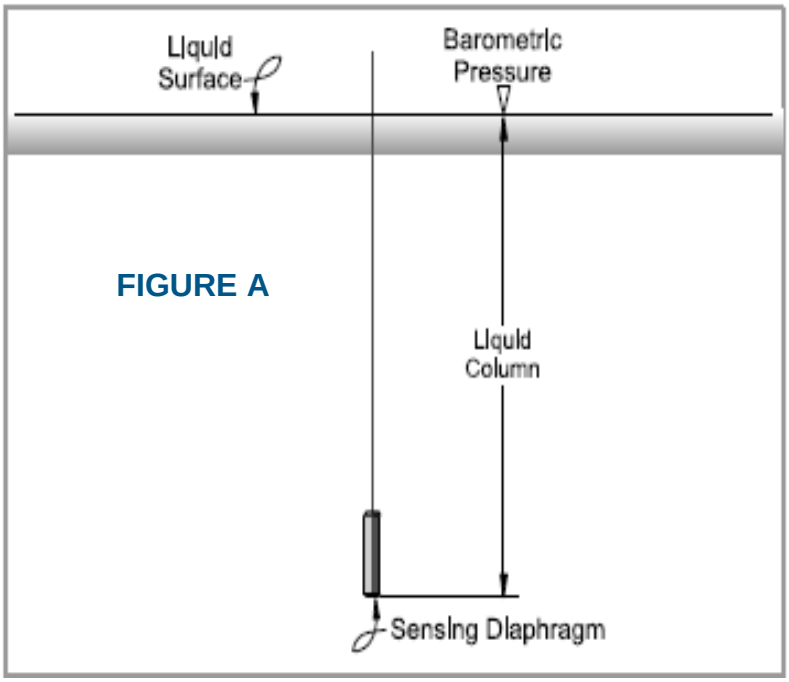


FIGURE A

Thus, in an uncompensated design, such as an absolute or sealed gage configuration, a change in local barometric pressure will cause a change in transmitter output. For example, when calculated as a percentage of the full scale of 10 feet of water column, a change in barometric pressure of 0.1 inches of mercury will cause an error of greater than 1%. If this error is not acceptable, then a separate measurement of barometric pressure must be made and this value subtracted from the pressure indication given by the level transmitter.

Because of the expense and complexity involved with the aforementioned scheme, standard KPSI level transmitters are configured to effect automatic compensation for barometric pressure changes. The simplest way to accomplish this is to vent the reference side of the sensor to local barometric pressure. Thus the same barometric pressure acts on opposite sides of the sensing diaphragm and the effect of changes are negated

THE DIFFERENCES BETWEEN PRESSURE TRANSDUCERS

By far, the most common format used in making a hydrostatic level measurement is vented gage. A vented gage pressure transducer is constructed so that the reference side of the actual pressure sensor in the transducer is open to the atmosphere. This is accomplished via a vent tube integral to the transducer cable. When the cable enters the body of the transducer, the tube is connected to a nipple that enters the reference side of the internal pressure sensor. In this configuration, the sensor reference and the atmospheric pressure acting on the surface of the liquid being measured is the exact same pressure (Figure B).

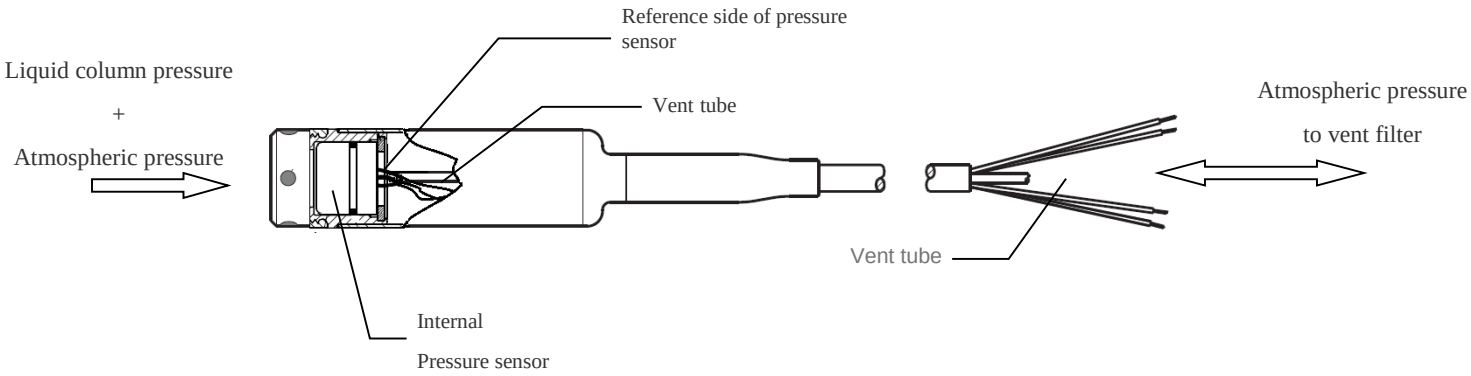


FIGURE B: VENTED GAGE PRESSURE TRANSDUCER

Unlike vented gage, sealed gage and absolute pressure transducers are identical in their physical construction. They do not have a vent into the reference cavity of the sensor. The sensor is sealed with a vacuum on the reference side. The absolute pressure transducer's zero output reading is relative to the vacuum. A sealed gage transducer has its zero output reading electronically elevated to simulate a reference to one nominal atmosphere. This is fine in many applications where the effects of daily fluctuations in the actual atmospheric pressure will not induce unacceptable errors in the level measurement being made.

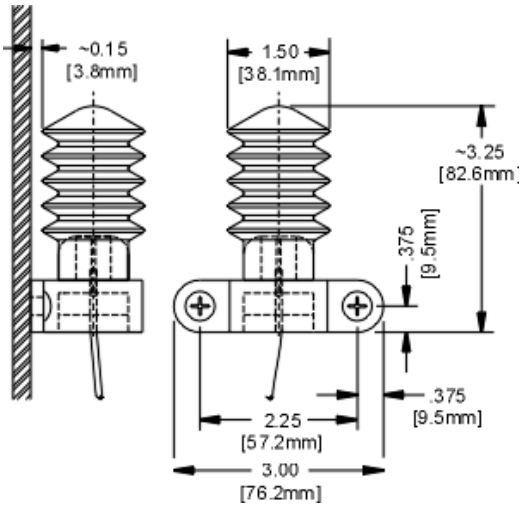
DETERMINING WHICH TRANSDUCER TO USE

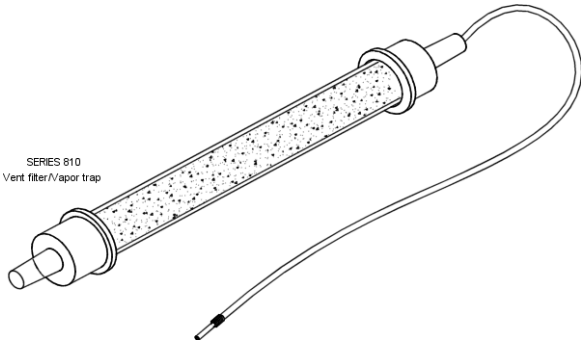
Now that the differences in construction between the different pressure formats have been identified, it is time to consider other factors to help determine which will be right for the job. An absolute pressure transducer is best suited for jobs that involve a system or tank that is under pressure and not open to the atmosphere. If it were to be used to measure a liquid level where the liquid is exposed to atmospheric pressure, a secondary barometric pressure measurement would have to be made so that it could be subtracted from the absolute measurement, leaving only the pressure exerted on the transducer by the liquid being measured.

Vented gage is the most common format used for a hydrostatic level measurement because of the open reference side of the sensor. Since atmospheric pressure is also acting on the surface of the liquid being measured, the effects of changes in atmospheric pressure on the measurement are negated. The end result is that the measurement is the most accurate possible reflection of the level of liquid above the pressure transducer. The one drawback to vented gage, however, is that the vent tube provides a possible path for moisture from the atmosphere (i.e. humidity or rain) to enter the pressure transducer. The accurate performance of a vented gage transducer depends upon keeping moisture out of the vent tube since the weight of the accumulated liquid will cause level readings that are lower than the actual liquid level. It is therefore necessary to use a moisture protection device to prevent moisture-laden air from entering the transducer.

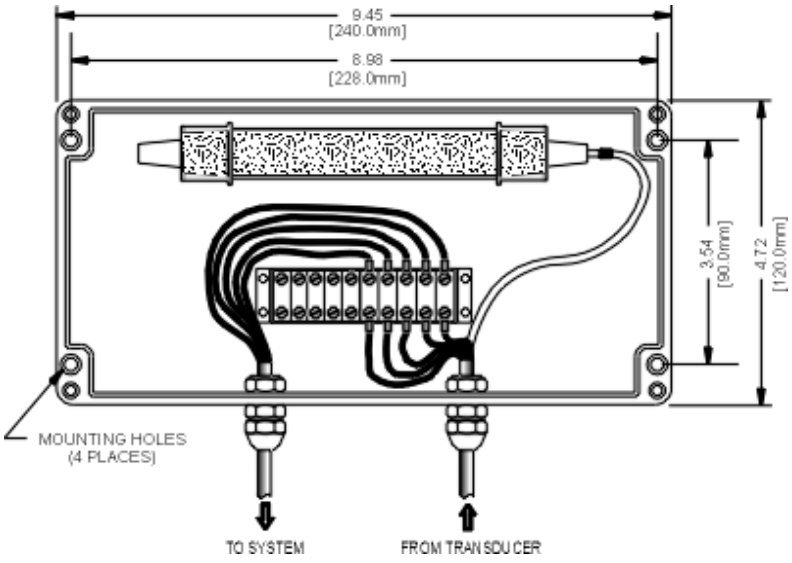
EXTENDING THE LIFE OF THE TRANSDUCER

The most common method for preventing moisture incursion is the attachment of a desiccant-filled cartridge to the vent tube at the cable's electrical termination end. This will allow air to pass through the desiccant, which absorbs the moisture in the air, as the barometric pressure changes. Some manufacturers use an indicating desiccant that changes colors as it becomes saturated so that cartridge replacement is apparent upon inspection.





Another method to prevent moisture from entering the transducer is to attach an aneroid bellows to the vent tube. The bellows, a closed system that prevents moist air from entering the vent tube, expands and contracts with changes in the barometric pressure, thereby equalizing the pressure in the vent tube with the current barometric pressure. Either the bellows or the desiccant cartridge can be mounted in a junction box or panel near the electrical termination of the transducer cable.



The longevity of the sensor also depends upon keeping moisture out of the vent tube. Gold bonding wires internal to the sensor are only a few mils in diameter; direct exposure to water will cause their rapid corrosion and result in failure of the pressure transducer.

A couple of in-the-field remedies can be attempted if moisture does get into the vent tube and pressure transducer. The transducer cable can be coiled and the cable and transducer placed in a pan. The pan should be placed in an oven at 50°C for two hours to dry the transducer and its components. It is important that the temperature does not exceed 50°C or damage to the transducer and cable may occur. Alternatively, the cable and transducer can be suspended in a vertical position (transducer end up) overnight to allow the water to drain out. There may be cases where it is impractical to use either the desiccant cartridge or the aneroid bellows. The job may be in a remote location where it is not possible to periodically check the desiccant and see if it needs replacement or there may not be a suitable location to mount the aneroid bellows. Also, the level to be measured may be so deep that the effects of daily atmospheric pressure changes will have a negligible effect on the measurement. In instances such as these, a sealed gage pressure transducer is the best option.

ADDITIONAL CONSIDERATIONS

Since a sealed gage transducer is electronically set to simulate the effects of one nominal atmosphere, it is important to take into account the elevation where the transducer will ultimately be installed. Normally, sealed gage transducers are calibrated with the zero output compensated for one nominal atmosphere at sea level. However, if the installation is to be made in a remote mountainous area or in a town that is well above sea level, it is imperative that the manufacturer of the transducer is aware of the elevation at the installation site. If the transducer were constructed without taking these factors into consideration, there would be considerable error induced in the level measurement. Using the elevation information supplied by the customer, the manufacturer calculates the nominal atmospheric pressure at the installation location and sets the zero output for that pressure.

Conclusion

In summary, the most accurate pressure format to specify for any open-atmosphere system is vented gage. Whether used in a lake, river, reservoir, well, or sewage lift station, a vented gage transducer will negate the fluctuations in atmospheric pressure and ensure the most precise indication possible of the actual level of the liquid being measured. If it is not practical from a maintenance point of view to use a vented gage, then sealed gage is the next best option. Absolute transducers are best suited for closed systems that are under pressure or vacuum and not subject to the effects of atmospheric pressure.

Now that the three pressure formats have been defined, it should be clear which is appropriate for the liquid level measurement system that is being designed. Selecting the proper format for the application will ensure that the client receives a transducer from the manufacturer that will provide years of uninterrupted, stable operation and the accurate level measurement required.

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