BLUE RIBBON CORP.

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LEVEL MEASUREMENT UTILIZING A PRESSURE TRANSMITTER

Technical Note #1

One method of determining level in a tank, pond, weir or well is to utilize a pressure transmitter. There is a direct relationship between liquid level and "head" pressure. Depending on the installation requirements, pressure transmitters are available in submersible, screw on, flange mount, flush mount and many other installation configurations.

Pressure & Level Relationship

The pressure at the bottom of an open tank or body of liquid is related to the height of the liquid. This level pressure is called hydrostatic head pressure. Typical units of measure for hydrostatic pressure are inches of water column or feet of water column. (in WC / ft WC)

27.679 inches of water column is approximately equivalent to 1 PSI at 40º C. The volume of water will not affect the hydrostatic head pressure, it is the height that affects the pressure. Whether 27.679 inches deep in the middle of a large body of water or small bucket of water the head pressure is the same.

When measuring liquid level with a pressure transmitter, specific gravity must also be taken into account.
P=SG • H (H = P/SG) shows the relationship between the height of the liquid, specific gravity and hydrostatic pressure.

H – Height of the liquid being measured
P – Hydrostatic head pressure at the bottom of the tank
SG – Media's specific gravity. (A dimensionless number)

If the media's specific gravity is unknown it can be calculated from the density of the liquid being measured.
SG = Density of media ÷ Density of water at 40° C. Density of water is 1.00 g/cm^3. The density of gasoline equals 0.82 g/cm^3. Therefore, the SG of gasoline is 0.82 g/cm^3 ÷ 1.00 g/cm^3 = 0.82

Example:

Calculating hydrostatic head of 240 inches of gasoline in a vessel is as follows:

Height (H) = 240" of Gasoline
Specific Gravity (SG) = 0.82 P=SG • H therefore
P=0.82 x 240 inches = 196.8 in WC.

The hydrostatic pressure (P) at the bottom of this vessel is equivalent to 196.8 in of water column.

To convert this level measurement to pressure (PSI) the following conversion is used:
1 inch of water column = 0.03613 PSI (≈27.679 inches of water column = 1 PSI).
196.8 in WC x 0.03613 = 7.110 PSI
240 Inches of Gasoline = 7.110 PSI of hydrostatic pressure at the bottom of this container.

Specific gravity can have a significant effect on the level measurement. If this same vessel were filled with water to the same depth there would be a 22% increase in head pressure.

INSTALLATION TYPES

Open Tank / Pond / Weir Level Measurement

When utilizing a pressure transmitter for level measurement the installation must carefully be considered. In an open tank or body of water where the liquid being measured is open to atmospheric pressure, there are a variety of installation options.

Tank Mounted Level Sensor

Fig. 1

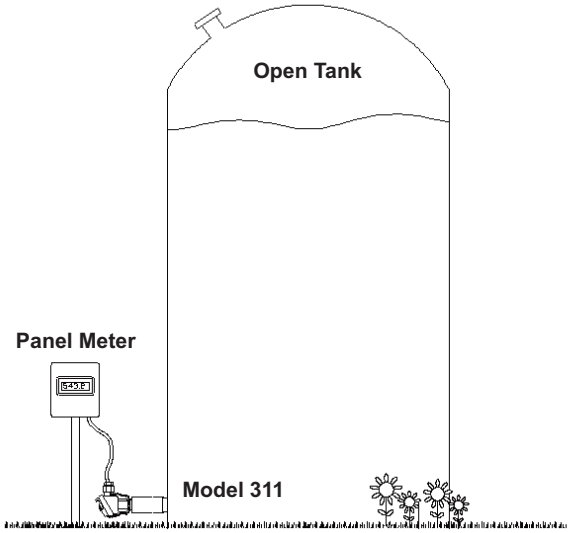

Figure 1: Shows a pipe mount style pressure transmitter. This style transmitter is typically plumbed to the base or side of a vessel & the signal sent to a panel meter or other reading device. This can be utilized where a pipe tap or other mechanical process connection can easily be accessed. A shut-off valve should be utilized for ease of removal.

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This type of transmitter can also be installed using a flanged or flush mount connection. Flush mount transmitters are typically found in sanitary applications or where the media being measured can plug a recessed process connection.

Figure 2: Shows a submersible pressure or level transmitter. This style of transmitter is lowered into the well or tank via its integral cable. Installation is easier than the pipe mount style especially where a plumbed connection is not readily available, like on a fiberglass tank, underground tank or in an open well or pond.

For both installations the transmitter should be of gauge format to eliminate any barometric effects.

Submersible transmitters typically come with an integral vent tube in the cable, which is terminated in the panel meter or junction box topside. The pipe mount version transmitter is also available with a vented cable option so as to provide ingress protection when mounted outdoors.

Fig. 2

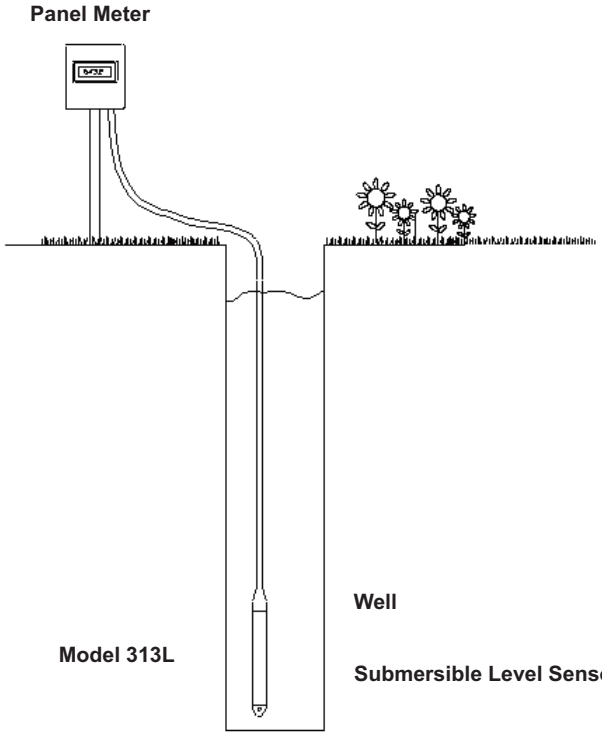

Figure 3: Shows a pipe-mounted transmitter with a zero suppression option. Zero suppression allows for level measurement of just the upper bowl and cancels out the tower pipe level / head pressure.

Fig. 3

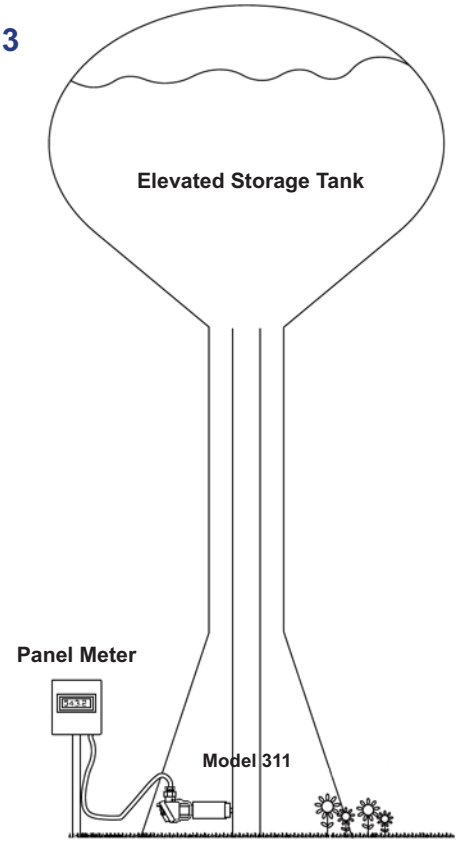

Fig 4. – Pressurized Tank level

Sometimes media is stored in a tank under a pressurized gas blanket. This gas blanket can vary from a fraction of a PSI to many PSI. This pressurized gas blanket has an additive effect on the total media head pressure. The total head pressure is now equivalent to the blanket gas pressure plus the hydrostatic head pressure.

If a standard pressure sensor is attached to the base of the tank as shown in Fig 4 it would provide a signal equivalent to the media's head pressure and the pressure of the gas blanket combined.

For example, if the gas blanket was 1 PSI and the media had 10 ft of head pressure, a bottom or side mounted gauge transmitter would read 5.335 PSI or 12.31 FT WC
since 1PSI = 2.306 FT WC +10FT WC = 5.335 PSI.

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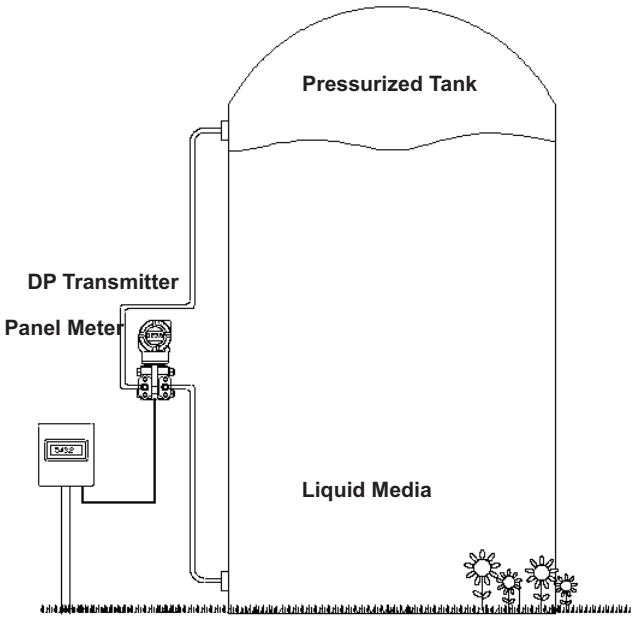
Utilizing this style of pressure transmitter will work if the blanket pressure can be measured and subtracted from the readings of the transmitter. This can be difficult to accomplish and total accuracy is affected.

The most common method of getting an accurate level measurement in this application is to utilize a Differential Pressure Transmitter (DP). Fig 4 shows a DP transmitter installed with the High side plumbed to the base of the tank and the Low side is plumbed to the air blanket on top. Typically stainless steel, oil-filled capillary tubing is attached to remote diaphragm seals and coupled to each side of the DP transmitter, as shown in Fig 4. This provides a flanged or clamped style fitting for tank mounting purposes.

The High side then senses the media head pressure combined with the air blanket pressure. The low side senses just the air blanket pressure.

The low side air blanket reading then offsets the high side combined reading and provides an accurate level measurement.

Fig. 4



For example, assume this tank is 10 feet tall and has 9 feet of water level inside and 1 PSI of an air blanket.

Knowing that water has a specific gravity of 1.00, the hydrostatic head pressure and gas pressure reading at the base of the tank or on the high side of the DP would total: 9 FT WC + 1 PSI = (2.307 FT WC) = 11.307 FT WC TTL.

The low side of the DP is measuring the gas blanket pressure of 1 PSI which is then subtracted from the High side reading. 11.307 FT WC – 1 PSI = 9 FT WC level.

9 FT WC is the corrected media level in this tank example. Changes in the gas pressure blanket or level are all
corrected via the DP measurement.

There can be a number of variables to consider with this type of installation.
- What is the media and ambient temperature?
- Are the capillaries exposed to the same temperature?
- Mounting location of the DP transmitter
- Will the system be exposed to vacuum?

Whatever your level or pressure application requirements, Blue Ribbon Corp. has a technical staff willing to assist you with your needs.