



MEASURING LIQUID LEVEL IN A VESSEL WITH GASEOUS HEAD PRESSURE

Introduction

Pressure measurement is commonly used to determine liquid level for a variety of applications. A column of liquid exerts a downward force due to gravity. Pressure measurement at the base of the column may be used to measure this force, translate it into head pressure, which can then be translated into liquid level depending on the media specific gravity. Pressure measurement to determine liquid level is particularly useful for applications with foaming or bubbling liquid, where other level measurement technologies have difficulties.

Process liquids contained in vessels are often kept under pressure with nitrogen gas. The nitrogen gas maintains purity and can be used to transport liquid without needing a pump.

In order to measure the liquid level, the gaseous pressure in the head of the vessel must be measured with a second transducer. The head pressure is subtracted from the overall pressure to obtain the hydrostatic pressure due only to the column of liquid.

$$\text{Liquid Level (inches)} = \frac{27.7"/\text{PSI} \times (P1[\text{PSIG}] - P2[\text{PSIG}])}{\text{Liquid specific gravity}}$$

Step 1. Compute pressure difference, ΔP , between the gaseous head pressure ($P2$) and overall pressure ($P1$). If there is no gaseous head pressure $P2=0$.

$$\Delta P = P1 - P2$$

Step 2. Multiply by conversion factor.

$$\frac{27.7"}{\text{PSI}} \times \Delta P (\text{PSI})$$

or

$$\frac{10.07 \text{ cm}}{\text{kPa}} \times \Delta P (\text{kPa})$$



Figure 1: NT® Pressure Transducers

Step 3. Divide by specific gravity of liquid, s.g.

The second transducer is not needed if the vessel is vented and maintained at atmospheric pressure.

$$\frac{27.7" \times \Delta P}{\text{s.g.}} = \text{Liquid Level (inches)}$$

or

$$\frac{10.07 \text{ cm} \times \Delta P}{\text{s.g.}} = \text{Liquid Level (centimeters)}$$

Example 1. No Head Pressure

30% hydrogen peroxide is in a 70" tall vessel at room temperature. The head of the vessel is at atmospheric pressure. The specific gravity of room temperature 30% hydrogen peroxide is 1.11. An NT® Flow-through Pressure Transducer, model 4210, that measures from 0 to 3 PSIG (0 to 21 kPa) is installed on the outlet at the base of the vessel.

Using the formula above, each PSI of pressure represents 25.0" of liquid height. A full vessel with liquid level at a height of 70" will measure 2.8 PSIG (19 kPa). An empty vessel will measure 0.0 PSIG. A monitoring device measuring the pressure transducer output can be scaled to display the liquid level in inches, such as the NT® Dual Channel Display.

Example 2. Head Pressure Present

98% sulfuric acid is in a 42" tall vessel at room temperature, specific gravity 1.83. Two NT® Flow-through Pressure Transducers that measure 0 to 6 PSIG (0 to 41 kPa) are mounted one each on the outlet at the base of the vessel and on the inlet at the top of the vessel. The vessel is under a 3 PSIG (21 kPa) gaseous nitrogen blanket, as measured by the second transducer.

Using the formula, each PSI of pressure represents 15.1" of liquid height. A full vessel with liquid level at 42" will measure 5.8 PSIG (40 kPa) from the lower transducer. An empty vessel will measure 3.0 PSIG (21 kPa). An NT® D80 Dual Channel Display can be used to simultaneously measure both pressure transducers, display the vessel liquid height in inches, and alarm at high or low liquid levels.

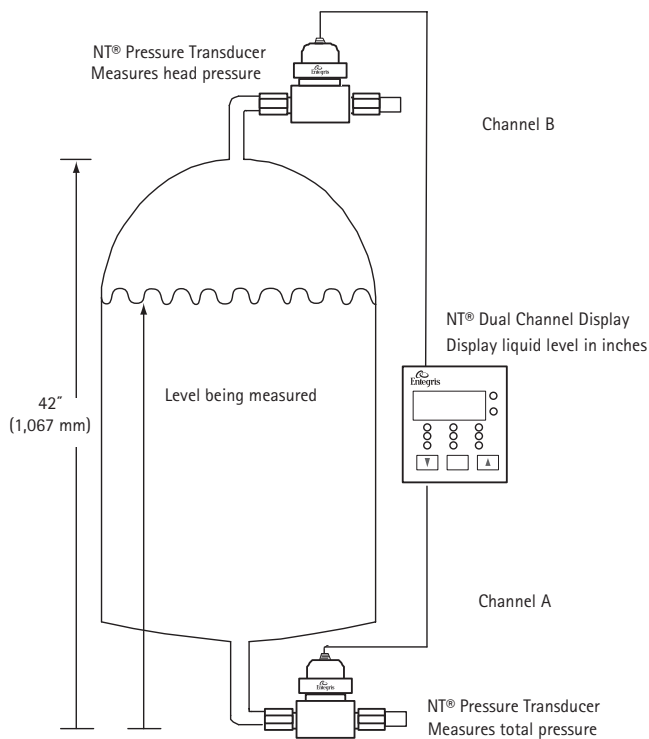


Figure 2: Measuring liquid level in a vessel with gaseous head pressure using two pressure transducers and a dual channel display.

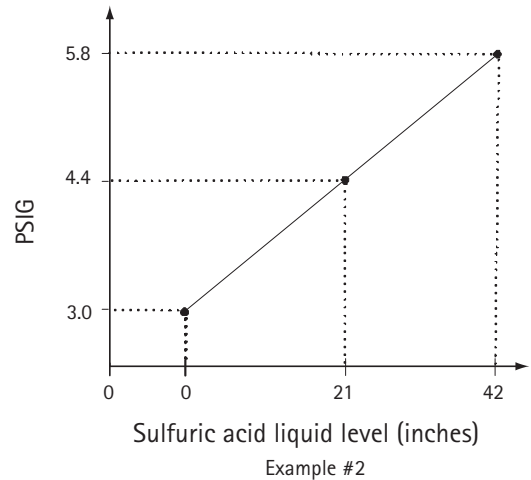


Figure 3: Sulfuric acid liquid level vs. pressure measurement for Example 2.

Entegris designs and manufactures measurement instruments for the high purity and corrosive chemical environments of the semiconductor industry. Our products measure flow, pressure, and level for the various acids, caustics, solvents and slurries used in the industry.

For More Information

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To review our complete line of sensing and control product solutions visit Entegris' Web site at www.entegrisfluidhandling.com or contact Entegris Customer Service.

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