



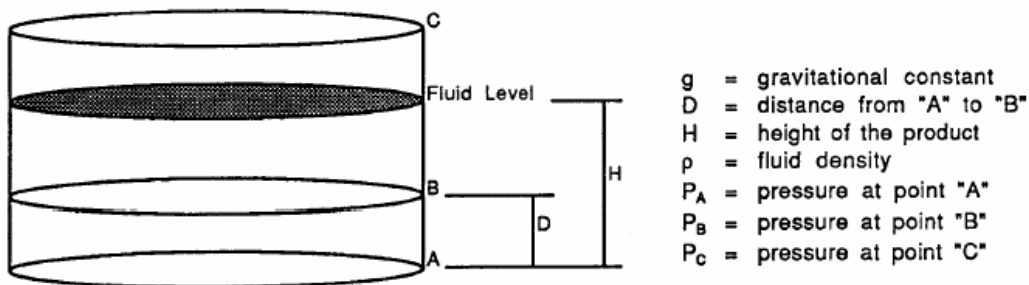
## PETRO TAG™ 400 - TECHNICAL NOTE THEORY OF OPERATION

PETRO TAG utilizes a novel form of Hydrostatic Tank Gauging (HTG) technology to measure the contents of liquid storage tanks accurately and consistently. Standard HTG systems use transducers mounted at strategic locations on the tank to measure in-tank pressures. The mass, density, height and volume of fluid in the tank can be derived from the measured pressures. Unfortunately, each of the transducers has its own characteristics and ages in a unique way.

This means that systems must be finely tuned and calibrated at installation and periodically after.

PETRO TAG systems use only a single pressure transducer for up to 16 tanks. In-tank pressures are "transmitted" to the transducer via pneumatic hoses. This effectively eliminates the need for precision tuning and ongoing calibration. The system is calibrated only once, at installation time. The single pressure transducer also offers increased accuracy for the measurement of height and temperature corrected volume.

PETRO TAG's unique measuring technology has been patented in the United States and Canada. Other patents are pending. The analysis below outlines the theory of PETRO TAG operations and shows how the system can achieve the accuracy specified.



$\Delta P = \rho g \Delta H$  (1) The standard equation (1) above states the relationship between pressure and the height of a column above it.

Consider the simple upright cylindrical tank shown in the figure above. Equation (2) gives the pressure at the bottom of the tank is given by the sum of atmospheric pressure and the created by the fluid above point "A".

Equation (2) can be rewritten as

$$P_A = \rho g H + P_c \quad (2)$$

Similarly the pressure at point "B" which is part-way up the tank is given by equation (3).

$$P_B = \rho g (H - D) + P_C \quad (3)$$

Subtracting equation (3) from equation (2) gives

$$P_A - P_B = \rho g D \quad (4)$$

$$P_a - P_c = \rho g H \quad (5)$$

Dividing (4) by (5) yields

$$\frac{P_A - P_B}{P_A - P_C} = \frac{\rho g D}{\rho g H} \quad (6)$$

Solving for H gives

$$H = \frac{(P_a - P_c) D}{(P_a - P_b)} \quad (7)$$

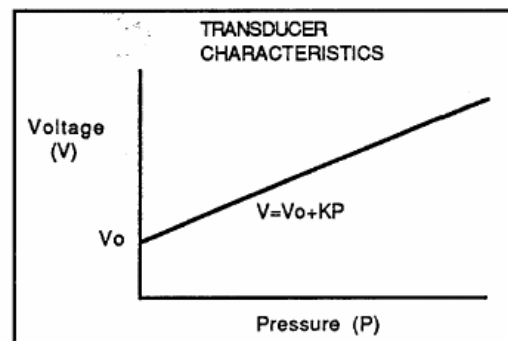
Hydrostatic Tank Gauging (HTG) systems use pressure transducers to sense and convert pressure to a voltage reading. Sample transducer characteristics are shown in the figure and represented by equation (8)

$$\text{This equation could be simplified greatly} \\ P = (v - v_0) / K \quad (8)$$

Typically HTG systems use three transducers, one each at points "A", "B", and "C".

Substituting equation (8) for each of the pressures in equation (7) yields the complex equation (9)

$$H = \frac{\frac{(V_a - V_{a0})}{K_a} - \frac{(V_c - V_{c0})}{K_c}}{\frac{(V_a - V_{a0})}{K_a} - \frac{(V_b - V_{b0})}{K_b}} * D \quad (9)$$



if  $K_A = K_B + K_C$  and if  $V_{0A} = V_{0B} = V_{0C}$ . PETRO TAG achieves that simplification by using the same pressure transducer for all three measurements. This not only simplifies the equation to (10) below, it also has the effect of canceling out calibration errors. After the initial installation, Petro tag never needs to be calibrated again.

$$H = \frac{(V_A - V_C) D}{(V_A - V_B)} \quad (10)$$

Since PETRO TAG can cancel out transducer offset and slope these common error sources are eliminated. The result is a system which offers high accuracy performance with only one transducer and no ongoing calibration requirements.

The standard production accuracy of PETRO TAG is 0.1% of full scale or 1 centimeter in a 10 meter tank.

The "extra precision" PETRO TAG (XP400) systems offer 0.02% accuracy or 2 millimeters in a 10 meter tank.

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