Capillary Fill Fluid Density Compensation

Introduction

For transmitters with remote seals, changes in ambient temperature can cause a “zero shift” in the transmitter / seal system. Zero Shift is defined as an error in which the zero pressure output shifts; thus, the entire calibration curve moves in a parallel displacement, yielding an inaccurate output signal from the transmitter. The component of the remote seal system that causes this reaction to the temperature change is the Fill Fluid.

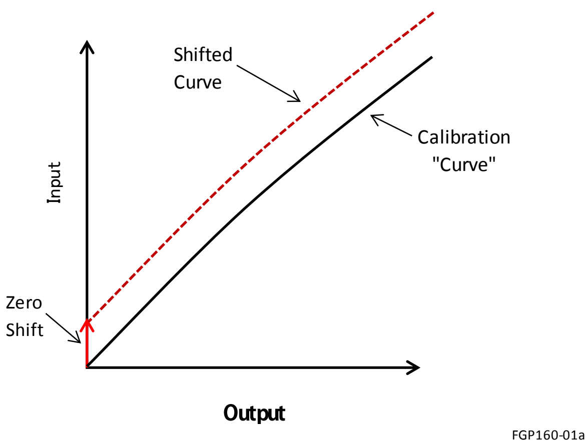


Figure 1: *Zero Shift causing parallel displacement of calibration*

The Fill Fluid, like any liquid, expands or contracts as a result of temperature changes. This volume change can cause the pressure not to be hydraulically transferred to the transmitter correctly. The volume change is due to the density of the Fill Fluid changing with temperature. Each of the Fill Fluids offered has a unique amount of density change per degree Celsius. This effect can be especially prevalent in installations that have large temperature swings between day and night and/ or season-to-season.

All Pressure Transmitter / seals system manufactured have this issue. It is not unique to any one brand.

Yokogawa Solution

Knowing the relationship between temperature and the fill fluid, Yokogawa can use the temperature sensor built into the transmitter housing to compensate the output signal for the zero shift.

The relationship can be expressed by the equation:

$$\mathbf{Output_C = Output + (K \times Temperature)}$$

Where **Temperature** is measured temperature from the sensor, **K** is the Compensation Constant (%/°C), **Output** is the transmitter output, and **Output$_C$** is the compensated output.

Once the **K** constant is programmed into the transmitter, the unit can compensate the output based on changes in temperature detected by the RTD built into the housing.

K is dependent upon characteristics of the fill fluid and certain aspects of installation. **K** is expressed as the following equation:

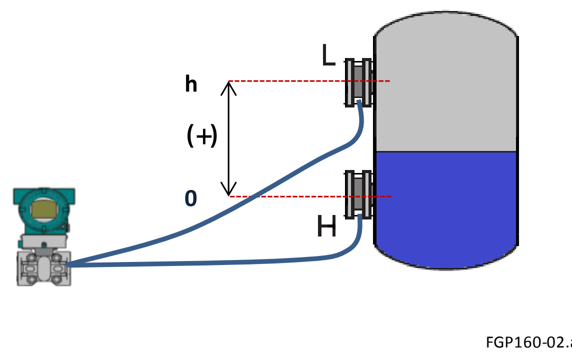
$$K = \frac{-(h)xB}{Span} X\ 100$$

Where:

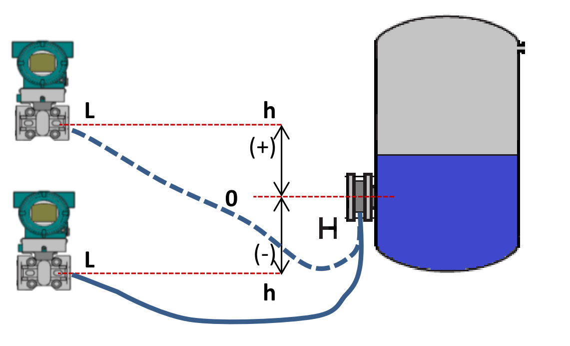
B	=	Density constant value of Fill Fluid (Table A)
Span	=	|URV - LRV|
h	=	Distance from installation

Note: **B** and **Span** must match in units of measure.
h must be in meters and is defined as:

EJA118E or EJX118A: Distance from high pressure side diaphragm seal to low pressure side diaphragm seal.



EJA438E or EJX438A: Distance from high pressure side diaphragm seal to low pressure side of the transmitter.



Note: When the transmitter is positioned lower than the diaphragm seal, the value of **h** must have a negative sign.

Table A: *Density Constant Value of Fill Fluid* [B]

Unit of Measure	Fill Fluid Code*				
	A	B	C	D	E
mmH_2O	0.76	0.87	0.76	1.45	0.75
Kgf/cm^2	0.000076	0.000087	0.000076	0.000145	0.000075
kPa	0.00745	0.00853	0.00745	0.01422	0.00736
mBar	0.07453	0.08532	0.07453	0.1422	0.07355
atm	0.000074	0.000084	0.000074	0.00014	0.000073
inH_2O	0.02992	0.03425	0.02992	0.05709	0.02953
psi	0.00108	0.00124	0.00108	0.00206	0.00167
mmHg	0.05592	0.06401	0.05592	0.10669	0.05518

FGP160-04.a

* Fill Fluid code is obtained from the model code.
Example:

EJA118E-EMSCG-912EN-WA18B1AW40-BA25/FF1/D1

↑

Fill Fluid Code

Once **K** has been solved for, the value can be programmed into the transmitter. The transmitter will then use the information to compensate for the ambient temperature change.

▪ Programming

Once the K constant is determined, it can be programmed into the transmitter using DTM Works in FieldMate. The function can also be activated using a HART Communicator; refer to the Instruction Manual for the procedure.

First, using DTM Works in FieldMate, the function must be activated. On the same menu, the value of **K** is entered.

FieldMate™

HART 5

DTM Works
> **Configuration**
> **Pressure Sensor**
T.Z. Comp mode: on / **off**
Temp Zero: **K** Value %/degC

HART 7

DTM Works (HART 7)
> **Detailed Set-up**
> **Signal Condition**
T.Z. Comp Menu
T.Z. Comp mode: on / **off**
Temp Zero: **K** Value %/degC

FGP160-05.a

Although FieldMate is highlighted here, any Hart Communicator has access to these functions. Refer to the User's Manual for the HART programming tree.

▪ BRAIN PROTOCOL

The features described in this FieldGuide are also available for EJA-E and EJX-A transmitters with BRAIN Protocol communication.
Please refer to the Instruction Manual for details.

▪ General Notes

Note 1: This function is available with the EJA118E, EJA438E, EJX118A, and the EJX438A; with BRAIN or HART communication.
Note 2: This function is performed using a built-in temperature sensor in the transmitter body. The temperature deviation between the transmitter body and the capillaries should be minimized to achieve optimal performance of the function.
Note 3: If the **Span** changes, re-calculate the **K** value and re-enter it into the transmitter.
Note 4: The Density Constant Value of the Fill Fluid [**B**] and the **Span** must be the same unit of measure.
Note 5: **d** must be in meters.
Note 6: This function is unavailable for Fill Fluid code 1 or 4.
Note 7: The **K** value can have up to 3 decimal places.

▪ Settings when Shipped

The transmitters are shipped with this feature "**OFF**".