Installation & Operation Manual

Mechanical Temperature Volume Compensators

Models D5010, D5025, & D5120

LIQUID CONTROLS
A Unit of IDEX Corporation
IDEX CORPORATION

Installation: M500-30

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Table of Contents

Introduction

Mechanical Temperature Volume Compensators are installed on liquid meters as part of the register stack to automatically adjust for product volume changes due to temperature changes. It is characteristic of liquid products to increase in volume as temperature rises and decrease in volume as temperature lowers. For example, a temperature change of 20ºF for LPG results in a 3.4% change in volume.

The extent to which a liquid increases in volume per one degree Fahrenheit or Centigrade is defined as it's coefficient of expansion. For example, the coefficient of expansion of gasoline is approximately 0.0006 per one degree Fahrenheit (depending on the additive content). The coefficient of liquid LP-Gas is approximately 0.0017 per one degree Fahrenheit.

The Temperature Volume Compensator is designed to:

1. Permit maximum accurate calibration of the meter and therefore maximum accuracy in delivery.

2. Reduce incidences of overfilling of large storage tanks when delivery is made in hot weather.

3. Prevent accidental overcharging or undercharging for delivered product since volume increases or decreases with temperature and price per unit volume is always a fixed amount (generally based on volume at 60ºF (15ºC)).
   NOTE: Not all Weights & Measures allow TVC on gasoline or fuel oil.

4. Provide maximum precision in the input feed of various liquids in an industrial batching process when such precision is necessary.

Three models of Temperature Volume Compensator are available:

- **D-5010** Variable Gravity (for multiple product use)
- **D-5025** Fixed Gravity (for single product use)
- **D-5120** Fixed Gravity (for single product use)

How the Temperature Volume Compensator (TVC) Works

The TVC compensates for changes in product volume based on temperature through the interaction of three subsystems: a thermal sensing device, a lever arm assembly, and a speed change mechanism.

The fluid in the temperature sensing bulb expands or contracts with changes in product temperature. Any change in volume of the sensing fluid causes the product bellows in the TVC to expand or contract. The lever arm assembly transmits the bellows motion to the speed change mechanism. The speed change mechanism changes the drive ration between the meter and the register.

When the temperature is 60ºF (15ºC), a 1:1 output ratio is supplied to the register. When temperature rises, the TVC compensates for the increase in volume supplying the register with a ration less than 1:1. If the metered liquid temperature falls below 60ºF (15ºC), the TVC will supply a ratio greater than 1:1.

Features

- Heavy duty, heat treated, positive ratchet drive assures zero slippage and long life of the speed change mechanism.

- Can be used for LPG with specific gravities ranging from .500 to .510.

- Operating temperature range from -30º to 120ºF (-35º to 48.8ºC). Consult factory for high temperatures.

- The TVC is factory set for LPG to a liquid base temperature of 60ºF (15ºC) and a specific gravity setting of .505 unless a different specific gravity is requested.

The TVC is shipped with a bellows assembly installed. The bellows assembly is specified at the time the TVC is ordered. (Refer to Price List G, Section 0565 for a current listing of available bellows assemblies).

This system is calibrated so the TVC and the sensing bellows are a matched set. For this reason, the bellows cannot be replaced in the field. Should the bellows become damaged or fail, the TVC assembly must be removed and sent back to the factory or an authorized service center to have a replacement bellows installed and calibrated to the TVC.

Use the following procedures when installing a TVC to an existing meter. (If adapting to a meter not previously supplied with a TVC, a thermowell and a gear plate change may be required).

1. Remove the four bolts holding the register to the meter. Be careful not to damage the register or TVC drive shafts.

2. Line up the TVC's input driver with the slot in the meter adjuster before lowering the TVC onto the meter. Attach the TVC to the meter with the four bolts provided.

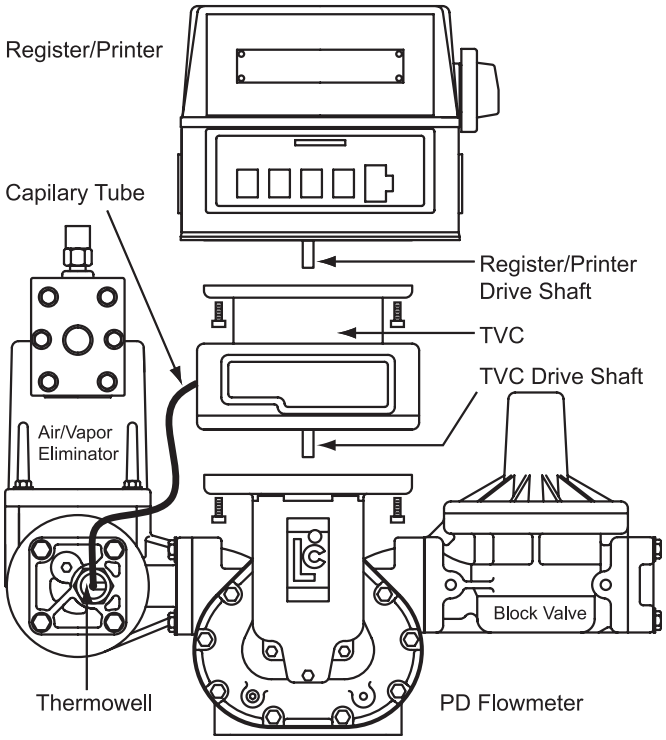
3. Line up the register's input driver with the slot in the TVC output driver before lowering the register onto the TVC. Attach the register to the TVC using the four bolts provided.

4. When handling the temperature sensing bellows assembly, be careful not to form sharp bends in the capillary tube. Slide the thermowell cap over the temperature sensing bellows. Remove the plastic bag from the sensing bellows to expose the thermally conductive grease. Insert the sensing bellows into the thermowell.

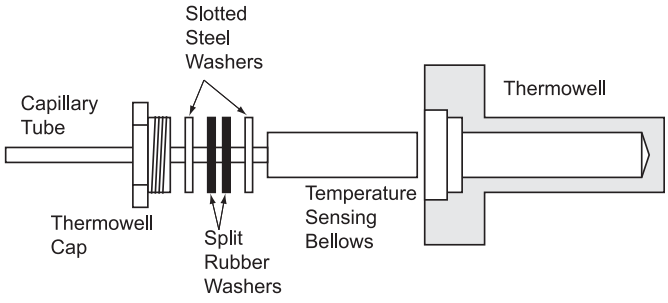
5. Install the two slotted steel washer and the two slit, rubber washers on the capillary tube. Push the washer into the thermowell.

6. Thread the thermowell cap into the thermowell until it is hand tight. Pack the thermowell cap with caulking putty (3M 8575 or equivalent).

7. Perform the normal meter proving procedures as outlined in "Field Adjustment" on Pages 4-6.



System Components



Thermowell and Bellows detail.

Field Adjustment

Every TVC is calibrated before shipment at the coefficient of expansion and base temperature specified by the customer. Typically this is set to 60ºF (15ºC) with a specific gravity of .505. For LPG, the following steps cover the procedure for providing meters equipped with a TVC and making adjustments that may be indicated during proving.

1. Operate the system and observe whether the register is running smoothly (without hesitation and in a normal manner). If the register is running smoothly, proceed to Step 2. If not, determine the cause of the problem and make corrective action. Refer to the register manual supplied with the meter for troubleshooting suggestions.

2. Deactivate the TVC. This is accomplished in one of two ways depending on the model number.

Model D5120:

Remove the three cover screws. Move the lockout pin from Position A to Position B. This locks the TVC input-to-output ratio at 1:1

Models D5010 & D5025:

Remove the Threaded Seal Plug. With the TVC running to assure proper engagement of the mechanism, turn the Indicator Arrow Point clockwise from the "ACTIVATE" to the "DEACTIVATE" position. The Arrow Point is mounted on a slotted shaft and may be turned with a slotted screw driver in the slot.

With the TVC deactivated, the meter can now be tested for accuracy.

3. With the TVC deactivated, carry out the normal procedures for proving a meter. If prover runs indicate that the meter itself is not accurate, consult the meter manual for meter adjustments. Once the meter is proved in the uncompensated mode, proceed to Step 4.

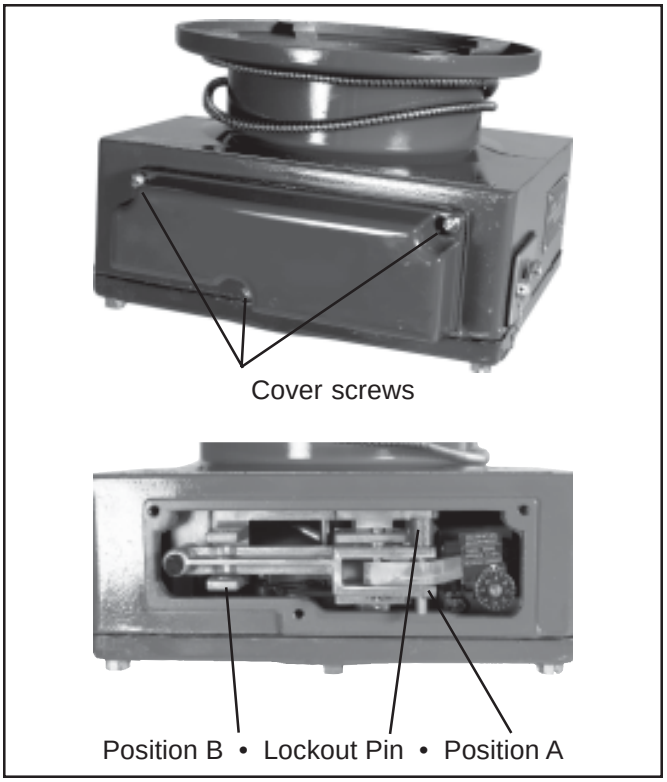
4. With the meter proved, the next step is to adjust the TVC if necessary. To begin this step the TVC must be reactivated.

Model D5120:

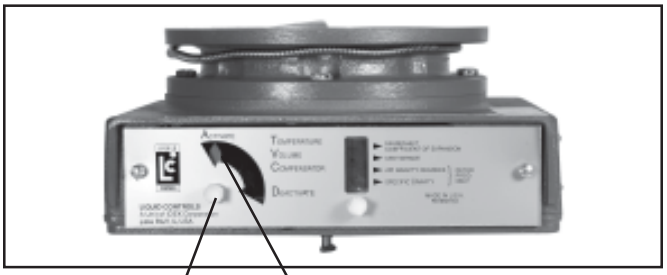
Move the lockout pin from Position B to Position A.

Models D5010 & D5025:

Turn the Indicator Arrow Point counterclockwise from the "DEACTIVATE" to the "ACTIVATE" position.



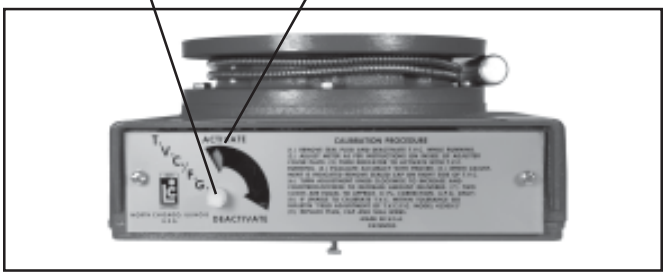
Model D5120



Model D5010

Threaded Seal Plug

Indicator Arrow Point



Model D5025

5. **NOTE**: Before making a prover run with the TVC activated, be sure to check the following carefully:

   a. **Model D5010**, make sure the Variable Gravity scale has not been accidentally moved out of position.

   b. **Models D5025 & D5120**, no scale change can be made to Fixed Gravity models. The Coefficient of Expansion setting was made by the factory and is fixed.

   c. Check the thermometers used in the prover tests to be sure they agree, repeat, and are graduated under a fine enough scale to reduce error in calculations.

   d. Be sure the Temperature Sensing Bulb and Capillary Tube have no leaks. Sharp bend in the tube can create leaks. If damage is indicated, replace the TVC. Replacement of the temperature sensing elements require shop recalibration of the TVC.

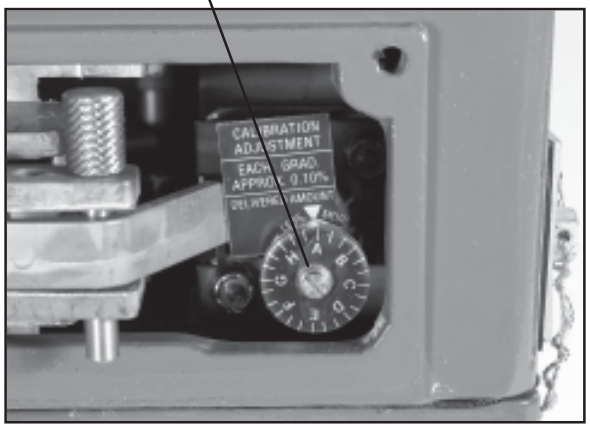
6. With the TVC in the activated position, make several prover runs. The % error need not be within acceptable tolerance, but the difference between maximum and minimum results should be in tolerance. If the results do not repeat with tolerance, replace the TVC. If the runs repeat, but are not within compensated meter tolerances, adjust as follows:

Model D5120

a. Compute the required adjustment per the formula:

$$\%\text{Error} = \frac{\text{(Prover Qty - Meter Qty)}}{\text{Prover Qty}} \times 100$$

Calibration Adjustment Screw



Model D5120

b. Adjust the "CALIBRATION ADJUSTMENT" screw to eliminate the error. Each graduation on the adjustment screw represents a 0.10% change in volume. Turning the screw clockwise increases the volume delivered; counterclockwise decreases the volume delivered. If adjustments exceed one full revolution in either direction (2.5%), consult the factory.

c. After the adjustment has been made, replace the cover.

Models D5010 & D5025

a. Compute the required adjustment per the formula:

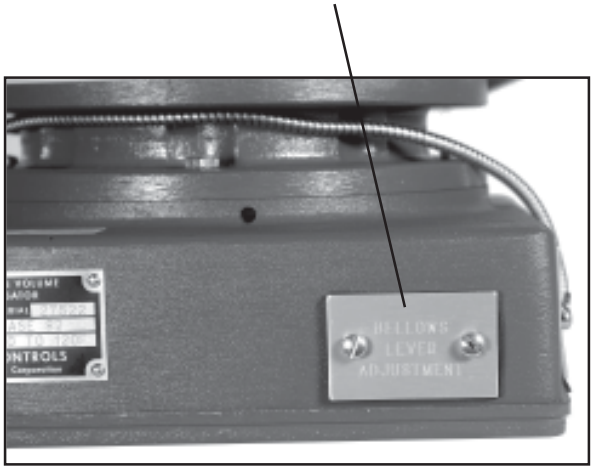
$$\text{Adjustment} = \frac{\%\ \text{Error}}{200 \times \text{Coefficient}} \times 7$$

For example: Error computed from prover run = plus 0.9% in prover. Product = LPG with 0.0016 Coefficient of expansion per degree Fahrenheit.

$$\text{Adjustment} = \frac{0.9\%}{200 \times 0.0016} \times 7 = 20$$

b. Remove the two screws from the cover plate 'BELLOWS LEVER ADJUSTMENT" to expose a knurled shaft. If the meter installation interferes with access to the cover plate or the knurled shaft, the TVC may be rotated after removing the four cap screws under the supporting flange of the meter.

Cover Plate: "BELLOWS LEVER ADJUSTMENT"



Models D5010 & D5025

c. The adjustment is made by rotating the knurled shaft. Turning the shaft clockwise increases the volume to the prover; counterclockwise decreases the volume to the prover.

   In the above example, the prover had received an excess volume of 0.9% and the formula results was an adjustment index of 20. The knurled shaft rotates in individual arc increments and each increment can be heard as a “click” and can also be felt as a resistance point.

   Since the received an excess volume, adjustment is made by rotating the knurled shaft counterclockwise to decrease the volume to the prover. The adjustment is the calculated number, 20, taken in the form of rotating the knurled shaft counterclockwise 20 “clicks”. If the adjustment exceeds 100 “clicks” in either direction, consult the factory.

d. After the adjustment has been made, replace the cover plate.

7. Additional runs and calculations may be required to obtain acceptable tolerances if the above adjustment is not made accurately.

This completes the field adjustment of the meter and Temperature Volume Compensator.

Model D5010

Model D5010 is a Temperature Volume Compensator with a Variable Gravity Scale (TVC/VG). It can be used with liquids of differing coefficients of expansion. Each time a meter is used with a different coefficient of expansion from the liquid previously metered, the Variable Gravity Scale must be adjusted and recalibrated. The base temperature is not adjustable in the field.

The scale offers four different reading categories:
1. Coefficient of Expansion per degree Fahrenheit.
2. Coefficient of Expansion per degree Centigrade.
3. Coefficient of Expansion per API Gravity Degrees.
4. Reading by Specific Gravity.

In the Fahrenheit and Centigrade scales, each division is equal to 0.0001 Coefficient of Expansion.

- The Fahrenheit scale has a range of 0 to 0.0018.
- The Centigrade scale has a range of 0 to 0.0034

The API Gravity degrees scale has a range of 0 to 150.

The Specific Gravity scale has a range of 0.5 to 1.0.

The greatest degree of accuracy in setting the Coefficient of Expansion is obtainable by using the Fahrenheit or Centigrade scale.

Remove the threaded seal plug located directly below the Variable Gravity Scale to gain access to the adjustment.

Model D5010

Coefficients of Expansion

Product	Coefficient of Expansion per Degree Fahrenheit
Acetone	.0008
Alcohol	.0006
Antifreeze	.00036
Aviation Fuel	.0005
Benzene	.0006
Bunker C	.00045
Butane	.00109
Carbontetrachloride	.0006
Caustic Soda (50% Solution)	.00015
Corn Syrup	.00017
Crude Oil	.00045
Diesel Fuel	.0005
Diethyl Ketone	.0006
Ethanol	.0006
Ethyl Mercaptan	.0006
Ethylene Glycol	.00036
Freon 11	.00085
Freon 12	.0014
Freon 21	.0018
Fuel Oil #2, #6	.0005
Gasoline	.0006
Heptane	.0006
Hexane	.0007
Iso-Butyl Alcohol	.00058
Isopropanol	.00053
JP-4 (Jet Fuel)	.0005
Kerosene	.0005
LPG	.0017
Lube Oils	.0004
Methanol	.00066
Methyl Acetate	.0007
Methyl Alcohol	.00066
Methyl Ethyl Ketone (MEK)	.00073
Mineral Spirits	.00056
Motor Oil	.0004
Naptha	.00072
Nitric Acid	.00116
Nitrogen Solution 28%	.00035
NH3	.0013
Oil & Fatty Acids	.0004
Pentane	.00084
Propylene Glycol	.0004
Resin	.0007
Sodium Chloride	.00015
Styrene	.0005
Toluene	.00061
Unleaded Gasoline	.0006
Vegetable Oil	.0004
Vinegar	.00056
Water	.0002
Xylene	.0006

Calculating Volume Change

To compute the change in volume for a temperature change for a given liquid, use the formula:

(Δt)(Coefficient of Expansion)(100) = % change in volume

For example:
NH3 = .0013/ºF Coefficient of Expansion
Temperature change (Δt) = 10ºF

(10ºF)(.0013/ºF)(100) = 1.3% change in volume

Conversion to Celsius

To convert from Coefficient of Expansion per Degree Fahrenheit to Coefficient of Expansion per Degree Celsius, multiply the value per Degree Fahrenheit by 1.8.

For example:

Kerosene = .0005 Coefficient of Expansion per Degree Fahrenheit. Multiply .0005 by 1.8 to get:
Kerosene = .0009 Coefficient of Expansion per Degree Celsius.

Backed by our Worldwide reputation for Quality, Accuracy and Advanced Design.

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