Leak Testing Pipes and Vessels using Druck DPI705E

April 2025

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1   Overview

This application note details a method of performing an accurate medium or long-term leak test on a pipeline or other pressure vessel. Note that all references to DPI705E are also valid for DPI705E-IS if hazardous area equipment is required.

2   Introduction

Gas pipes and vessels must be leak tested on installation to ensure correct operation and safety during their service life. Gas pipelines must be thoroughly tested prior to being buried to prevent very costly repairs. The testing regime for each pipeline or vessel is typically mandated by either an industry body and/or by company policy to ensure consistent and safe testing and can include extended duration of leak tests of several hours. With certain types of test equipment this extended duration testing can be a challenge due to the need to compensate for possible changes in atmospheric pressure. However, these challenges can be avoided and the need for multiple pieces of pressure test equipment can be avoided by using the DPI705E pressure indicator series with the method described below.

3   Terminology

Pressure measurements take one of three forms:

- **Gauge**: This is a measurement taken with respect to atmospheric pressure. Typically, the "back" (reference port) of the pressure sensor is open to atmosphere so that the sensor reads the pressure above (or below) atmospheric pressure as a relative measurement. This type of measurement is typically used to "set" the pressure in a vessel, e.g. a car tyre where the required pressure might be 2.2bar gauge usually abbreviated to 2.2barg.

- **Absolute**: This is a measurement taken with respect to vacuum. Typically, the "back" (reference port) of the pressure sensor is pumped to vacuum and sealed during manufacture. The sensor will read atmospheric/barometric pressure (e.g. 1013mbar absolute) when left open to atmosphere. This type of measurement is typically used where readings need to be independent of atmospheric pressure. The measurement value is usually abbreviated to 1013mbara.

- **Differential**: This is a measurement taken where both ends of the sensor are ported out for connection, so the resultant reading is simply the pressure difference between the ports. This type of measurement is typically used for reading pressure across a flow device (e.g. Venturi, orifice-plate), and is sometimes considered a form of gauge measurement, so may be reported as 10mbarg, or simply as 10mbar.

4   Measurement Tasks

There are two fundamental tasks when performing a leak test. The first is to pump/inflate the vessel to the desired working pressure and the second is to seal the system prior to performing the leak test.

The first task is likely to be specified as a gauge measurement e.g. pump/inflate the vessel to 350mbar above atmospheric pressure so 350mbarg.

The second task is unlikely to be specified as to how it should be performed, however complications can arise if the leak test is longer than a few minutes. This is because any changes in atmospheric pressure either must be compensated for after taking the measurements or the actual measurement must be unaffected by these changes. For this reason it is necessary to use an Absolute pressure sensor (measurement referred to vacuum) rather than a Gauge pressure sensor (measurement referred to atmospheric pressure, which may be changing).

The method below shows how these two tasks can be achieved, simply and accurately using a single Absolute sensor DPI705E pressure indicator.
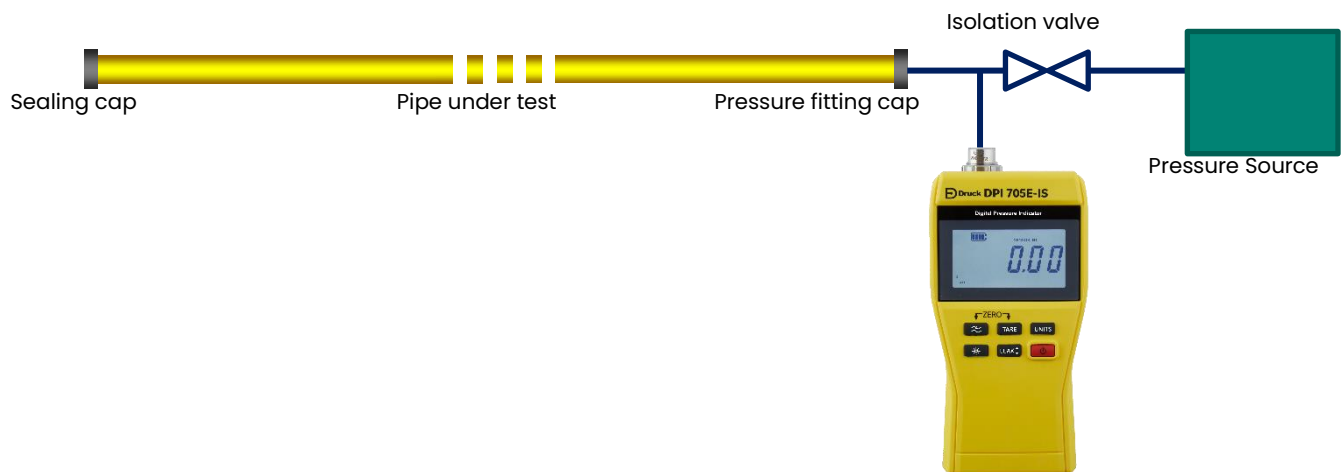
5   DPI705E Solution

5.1   Suggested Measurement Sequence

An example sequence is shown below for a 350mbarg test, using a 2bara DPI705E.

1. NB: All relevant safety working instructions must be followed.
2. Connect the DPI705E and the means of pressurising the pipe in a configuration as per the diagram below:

Figure 1:

3. If the proposed leak test duration exceeds 10 minutes then the auto power-down feature of the DPI705E must be disabled – see *Auto Shutdown* section below.

4. Select the desired pressure unit (choice of 23) by pressing the [UNITS] button.

5. Power up the DPI705E. It will display the atmospheric pressure e.g. 1013mbara, although the actual reading is unimportant and need not be noted.

6. Press the [TARE] button which will cause the reading to show zero (i.e. it is subtracting the previously displayed atmospheric pressure). The DPI705E display will show "TARE" in the bottom left to indicate that TARE is active.

7. With the isolation valve open, slowly apply pressure from the pressure source until the reading on the DPI705E shows the required pressure eg. 350mbar in this instance.

8. Wait at least 2 minutes for any adiabatic (heating) effects from the pressure increase to dissipate and follow your company's procedures should a longer delay period be required.

9. If necessary operate the pressure source to re-adjust the pipe pressure to the desired pressure.

10. Operate the isolation valve to disconnect the pressure source.

11. Press the [TARE] button again which will remove the atmospheric pressure adjustment, so the DPI705E should read approximately 1363mbara. The actual reading is unimportant. The DPI705E display TARE indicator will disappear.

12. Press the [TARE] button again which will cause the reading to show zero. The DPI705E display TARE indicator will re-appear.

13. This is the start of the leak test – *any change in the reading from this point onwards can be considered a leak*. This "leak" pressure change reading is entirely independent of atmospheric pressure changes, so can be performed over any desired period of minutes, hours, days or weeks.

14. At the end of the leak test period simply read the display, which will show the pressure change since the start of step 12. If the pressure has reduced (i.e. there is a leak) the reading will display as negative.

    Note: The reason for not using the in-built leak test feature of the DPI705E for this test is that it can only be configured to run for 1,3 or 5 minutes. For pipeline leak testing the duration is often specified to be longer than this, thus a method that supports any test duration is presented above.

6   Measurement Accuracy

See Druck.com/essential for further details (including the datasheet) for the DPI705E.

6.1   Pressure Ranges and accuracies

The DPI705E should be fitted with an Absolute pressure sensor of a suitable range for the required working pressure of the test procedure. Some common values for gas pipelines are shown in the left-hand column (Required pipe pressure) below.

| Required Pipe Pressure	Equivalent Absolute Pressure	DPI705E Sensor Full Scale	Precision, Grade
350mbarg	1.35bara	≥2bara	±0.8mbar, Grade 2
700mbarg	1.7bara	≥2bara	±0.8mbar, Grade 2
1barg	2bara	≥2bara	±0.8mbar, Grade 2
2barg	3bara	≥3.5bara	±1.4mbar, Grade 2
3.5barg	4.5bara	≥7bara	±2.8mbar, Grade 2
7barg	8bara	≥10bara	±1.8mbar, Grade 3
10barg	11bara	≥20bara	±3.6mbar, Grade 3
20barg	21bara	≥20bara	±3.6mbar, Grade 3

Although a wide variety of available pressure ranges exist, this application can be covered with a relatively small number of pressure ranges, due to the high accuracy of the DPI705E sensors. A DPI705E can also be used with optional external remote pressure sensors (PM700E) to give additional pressure ranges.

Druck pressure sensors have both Precision figures (i.e. non-linearity, hysteresis and repeatability) and Total Uncertainty figures (i.e. Precision plus 1-year drift plus reference uncertainty) published. Due to the measurement sequence proposed in this document any drift errors are removed, so the tighter Precision figure can be used for both the pipe pressure measurement and the leak measurement and is quoted above.

7 Auto-Shutdown

By default, the DPI705E has a 10-minute auto-shutdown timer to preserve battery life. If no key is pressed within 10 minutes the unit will switch off. For extended tests such as the above this needs to be disabled, in which case the unit will stay on until manually switched off. In this mode it is recommended that the backlight should not be left in "always on" mode to extend the battery life. To set the backlight to "On keypress" mode (i.e. illuminates for 10s after each key press) simply briefly press the [☀] button.

To disable the auto-shutdown:

1. Turn the DPI705E on, wait for it to show the measurement display

2. Simultaneously press the top three keys [≋] [TARE] and [UNITS]

3. The display will show *"Adu"* (Advanced) which indicates the unit is now in the Settings mode

4. Press the [UNITS] key 4 times to navigate to the On/Off settings:

5. Press the [LEAK⇕] key to enter the auto shutdown setting menu

6. The display will then show the default or the last saved auto shutdown value. Default option is *"OFF.10"* (Off.10) which means 10 minutes timeout on no activity. The second option is *"OFF.no"* (Off.no) which means the auto shutdown will be disabled.

7. To toggle between the options press the [TARE] key:
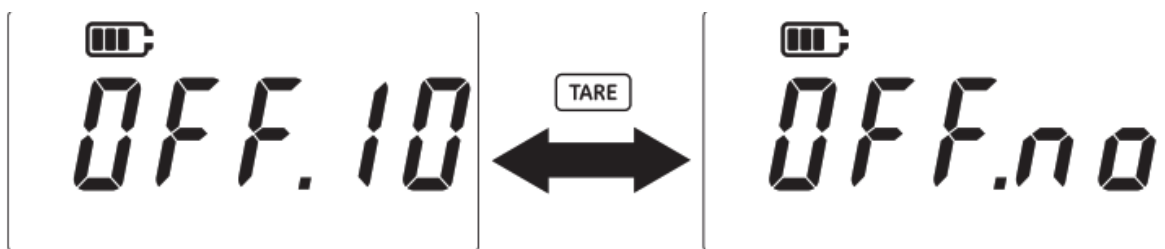
8. To accept/set the value press the [LEAK⇕] key. Press the [≋] key to return to normal operation. The shutdown timer setting is now stored and will stay as set, even if the unit is switched off.

Please do not hesitate to contact Druck if you have any questions on this application. Please email Drucktechsupport@bakerhughes.com