



Standard Practice for Obtaining LPG Samples Using a Floating Piston Cylinder¹

This standard is issued under the fixed designation D3700; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This practice covers the equipment and procedures for obtaining a representative sample of liquefied petroleum gas (LPG), such as specified in ASTM Specification D1835, GPA 2140, and comparable international standards. It may also be used for other natural gas liquid (NGL) products that are normally single phase (for example, NGL mix, field butane, and so forth), defined in other industry specifications or contractual agreements, and for volatile (higher vapor pressure) crude oils.

NOTE 1—Some floating piston cylinders have such tight piston seals that the vapor pressure of some high vapor pressure crude oils may not be sufficient to allow sampling without a handle to move the piston. An alternative sampling practice for UN Class 3 liquids (under 300 kPa at 52 °C) is Practice D8009, which utilizes a Manual Piston Cylinder (MPC) sampler.

1.2 This practice is not intended for non-specification products that contain significant quantities of undissolved gases (N_2 , CO_2), free water or other separated phases, such as raw or unprocessed gas/liquids mixtures and related materials. The same equipment can be used for these purposes, but additional precautions are generally needed to obtain representative samples of multi-phase products (see Appendix X1).

1.3 This practice includes recommendations for the location of a sample point in a line or vessel. It is the responsibility of the user to ensure that the sampling point is located so as to obtain a representative sample.

1.4 The values stated in SI units are to be regarded as standard.

1.4.1 *Exception*—The values given in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.*

¹ This practice is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.H0 on Liquefied Petroleum Gas.

Current edition approved Oct. 1, 2016. Published October 2016. Originally approved in 1978. Last previous edition approved in 2014 as D3700 – 14. DOI: 10.1520/D3700-16.

2. Referenced Documents

2.1 ASTM Standards:²

D1265 Practice for Sampling Liquefied Petroleum (LP) Gases, Manual Method

D1835 Specification for Liquefied Petroleum (LP) Gases

D8009 Practice for Manual Piston Cylinder Sampling for Volatile Crude Oils, Condensates, and Liquid Petroleum Products

2.2 GPA Midstream Association Standards:³

GPA 2140 Liquefied Petroleum Gas Specifications and Test Methods

GPA 2174 Obtaining Liquid Hydrocarbon Samples for Analysis by Gas Chromatography

3. Terminology

3.1 Definitions:

3.1.1 *floating piston cylinder (FPC), n*—a high pressure sample container, with a free floating internal piston that effectively divides the container into two separate compartments.

3.1.1.1 *Discussion*—A floating piston cylinder is used to collect a sample of liquid under pressure without the formation of a gaseous phase which can result in changes in the composition of the liquid sample.

3.1.2 *maximum fill volume (reduced fill volume), n*—the volume of a container occupied by the sample, usually expressed as a percentage of the total capacity.

3.1.2.1 *Discussion*—Some regulatory agencies use the expressions “maximum fill density” and “reduced fill density.”

4. Summary of Practice

4.1 A liquid petroleum gas (LPG) sample is transferred as a liquid under pressure from a sample point to a floating piston cylinder. The floating piston cylinder (FPC) is designed to collect liquid samples with no vaporization by displacing a piston against a pressurizing fluid (preferably an inert gas). The piston serves as a physical barrier between the sample and the

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from GPA Midstream Association, 6526 E. 60th St., Tulsa, OK 74145, www.gpaglobal.org

*A Summary of Changes section appears at the end of this standard

pressurizing fluid, at the sampling pressure. The position of the piston at the end of sampling indicates the percent fill of the sample cylinder.

4.2 It is the responsibility of the user of this practice to locate the sample point at a suitable location and orientation where the product being sampled is a representative, single phase, homogeneous liquid.

5. Significance and Use

5.1 This practice allows the collection of a representative sample of LPG that may contain trace volatile dissolved components such as methane, ethane, and nitrogen. Sampling by Practice **D1265** can result in a small, but predictable, loss of these lighter components. Practice **D1265** is suitable for collecting samples for routine specification testing, as the small loss of light components is not significant under Specification **D1835** specification requirements. Practice **D3700** is recommended whenever highly accurate determination of light components is required. For example, compositions determined on samples collected according to Practice **D3700** may be used to establish the product value of NGL mixtures (see **Appendix X1**).

6. Interferences

6.1 An interference in a sampling procedure is anything which compromises the integrity of the sample.

6.2 Incorrect choice of a sample point location can result in a non-representative sample due to solid or liquid contaminants, two phases, storage tank stratification, and so forth.

6.3 Reactivity of steel surfaces can remove or chemically alter trace reactive components such as H₂S, COS, and mercaptan.

6.4 A lubricant used on the floating piston or other internal wetted parts that is soluble in LPG can contaminate the sample.

6.5 Pre-charge (inert) gas can leak into the sample due to worn or damaged piston seals or poor surface finish (see **8.1**).

6.5.1 Consult the manufacturer's guidelines for suitable procedures to verify a leak-free cylinder, such as pressure testing each side of the cylinder. It is also possible to analyze the sample for inert gas, or the inert gas for hydrocarbon, to detect leakage in either direction.

6.6 Failure to flush sample lines and *dead volumes* can result in contaminants in samples.

6.7 Sampling from stratified tanks, *dead zones* in flowing systems, or inappropriate time periods in composite sampling systems can result in non-representative samples.

6.8 Any material that can create carryover contamination from one sample to the next has to be removed from the cylinder and the cylinder shall be thoroughly cleaned. In addition to cleaning the interior metal surfaces and cleaning the soft parts (O-rings, for example), consideration should be given to replacing the soft parts if they might have absorbed any contamination. Examples of contaminants include glycol, amine, lubricants, sulfur species, solvents, methanol, etc.

7. Apparatus

7.1 Floating Piston Cylinder (FPC):

7.1.1 *Construction*, typically fabricated from corrosion resistant 316 stainless steel, in accordance with the pressure vessel certification requirements in the jurisdictions in which it is to be used, and through which it will be transported. Protective internal coatings or surface treatments are acceptable provided that they do not adversely affect the free movement of the piston, or effectiveness of the seals (see **Fig. 1**).

7.1.1.1 Users should consult with the manufacturer of these sample cylinders and sample collection systems any time ambient or product temperatures, or both, exceed the range of $-29\text{ }^{\circ}\text{C}$ ($-20\text{ }^{\circ}\text{F}$) to $60\text{ }^{\circ}\text{C}$ ($140\text{ }^{\circ}\text{F}$). Extreme temperature effects upon metal, O-rings, valve seats, seals, gauges, relief devices, sample pump components and other devices and components in the system should be assessed in a hazards analysis before any sampling takes place.

NOTE 2—At present, there is no international approval process for pressure cylinders. Cylinders require appropriate approval in each jurisdiction in which they are used or transported.

7.1.2 *Volume of Sample*—The minimum volume required is determined by the combined volumes required by each of the tests to be performed, typically 400 mL (that is, 80 % of a 500 mL sample cylinder at $15\text{ }^{\circ}\text{C}$).

7.1.2.1 For safe handling of these cylinders under extremes of product or ambient temperatures, or both, the user shall consider the effects of thermal expansion on the volume of product in the cylinder. For example, if a product is sampled at $-40\text{ }^{\circ}\text{C}$ ($-40\text{ }^{\circ}\text{F}$), the user shall plan for the cylinder and sample to warm considerably during transport and before analysis is performed in the laboratory. During summer months, the temperature of the cylinder and product could reasonably be expected to rise to as high as $46\text{ }^{\circ}\text{C}$ ($115\text{ }^{\circ}\text{F}$) in hot environments. A cylinder initially filled cold to 80 % of its capacity will, upon warming, be over-pressured and the relief device(s) will activate under these conditions. Hydrocarbon releases of this type are unexpected and dangerous. In such an extreme, but not uncommon case, the cylinder should not be filled more than approximately 60 % of its capacity during the initial fill. Users should review ASTM/API/GPA Midstream volume correction factor calculations, or data from similar samples, or both, to determine the maximum fill for the product and conditions being sampled, but should always leave at least 10 % vapor space after allowing for the worst likely case of thermal expansion.

NOTE 3—The appropriate tables for conversion of LPG volume or density as a function of temperature are: MNLTP27, Manual on Petroleum Measurement Standards, Chapter 11—Physical Properties Data, Section 2, Part 4—Temperature Correction for the Volume of NGL and LPG Tables 23E, 24E, 53E, 59E, and 60E;² or GPA Midstream Technical Publication TP-27.³

7.1.3 *Piston Position Indicator*—The FPC shall be equipped with a piston position indicator such as a magnetic follower, piston rod, or equivalent which indicates the sample volume to comply with the maximum percent fill (maximum fill volume) allowed for storage and transportation. An outage chamber with indicating level device may also be used.

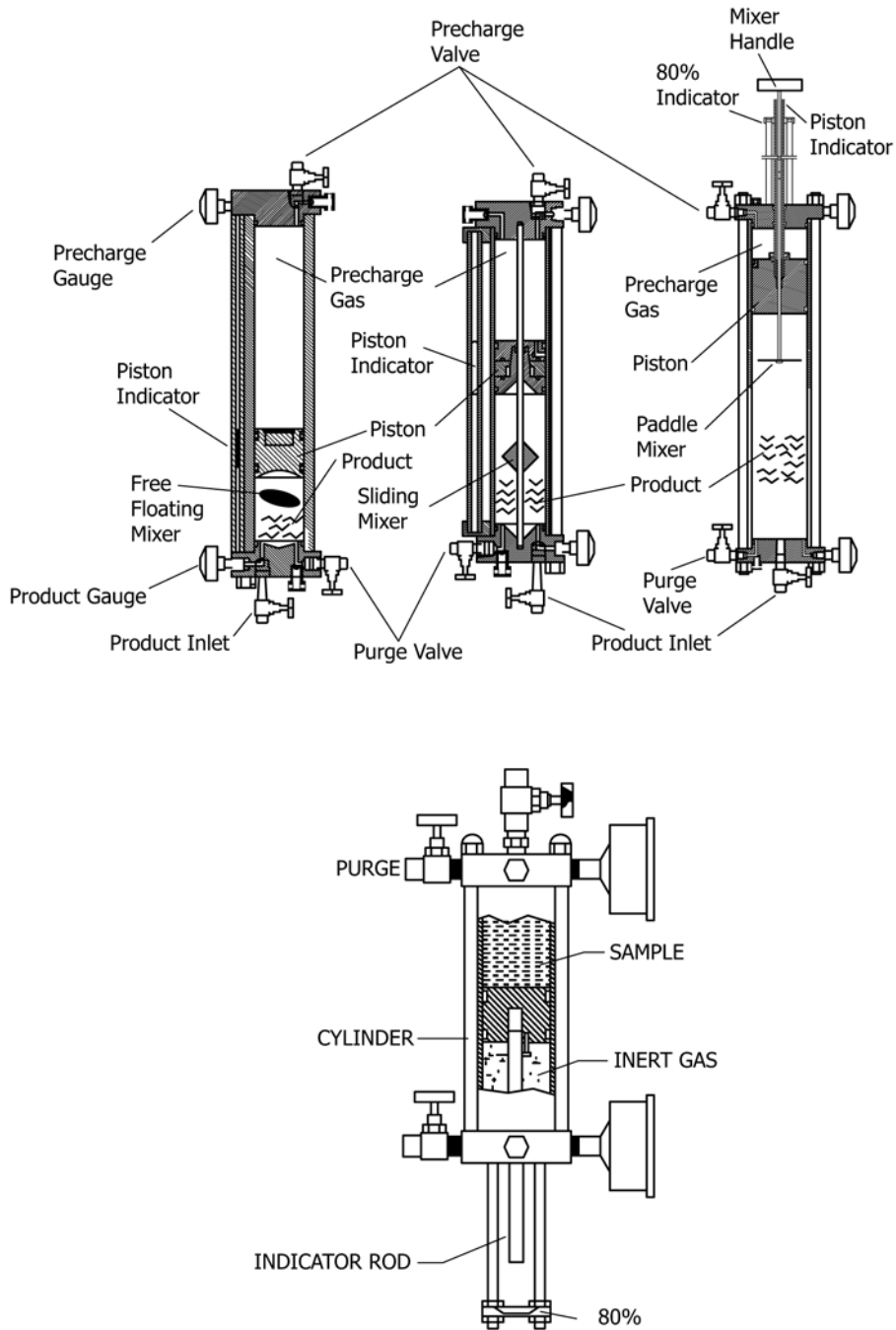


FIG. 1 Typical Floating Piston Cylinder Designs

7.1.3.1 Floating piston cylinders that are not equipped with a piston position indicator shall not be used without a procedure to allow the operator to verify fill volume immediately after sampling and prior to transport. Consult the authority having jurisdiction for acceptable procedures.

7.1.4 The cylinder shall include a mechanism to mix the sample in the sample chamber in case of stratified mixtures or water haze that can settle after sampling. This mechanism may be a mechanical mixer/vortex plate on a movable rod, a freely moving rolling ball or slider, magnetically coupled stirrer, or

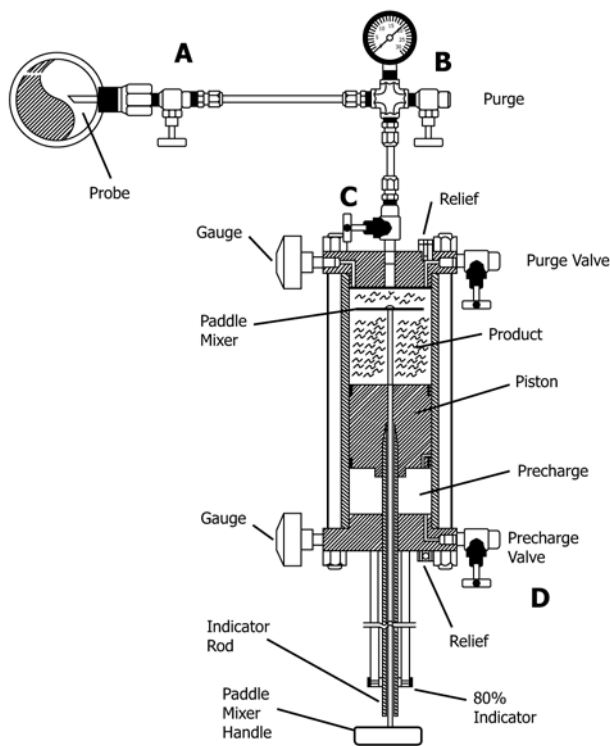


FIG. 2 Typical Sampling System with Valving

similar mixing device. It is the responsibility of the user to provide sufficient mixing with the mechanism used to allow a representative sample to be withdrawn.

7.2 Lubricants used to lubricate or seal the floating piston, O-ring seals, and other components shall be inert and insoluble in LPG.

7.2.1 DuPont Krytox (trademarked) AC or AD^{4,5} have been found to be suitable. DuPont Krytox General Purpose Lubricants GPL 107 (viscous oil) and GPL 201 (light grease)^{4,5} have been found to be suitable in floating piston cylinders, and are less costly than the aerospace grades [AC and AD] of PTFE lubricants. These lubricants are insoluble in aliphatic/aromatic hydrocarbons, water, caustic, amines, and glycols.

7.2.2 Some common grades of silicone based ‘O’ ring lubricants have been successfully used for LPG due to the low solvency of light paraffinic hydrocarbons such as propane and butanes. However, these lubricants are quickly removed by aromatic hydrocarbons and crude oils, and are not recommended for this service.

NOTE 4—The use of lubricants that are soluble in hydrocarbon samples will result in contamination of the sample and loss of sealing integrity of the floating piston.

7.3 A safety relief device is required to prevent overpressure in the event that a cylinder becomes fully liquid filled

(hydraulically locked) from either overfilling or liquid thermal expansion from excessive temperature increase.

7.3.1 A rupture disk or a self-resetting pressure relief valve shall be fitted to the cylinder to prevent overpressure from hydraulic filling due to temperature increase. A self-resetting pressure relief valve (“popet valve”) is preferred.

7.3.1.1 DuPont KEL-F^{4,5} has been found to be suitable.

7.3.1.2 Polytetrafluoroethylene (PTFE) or other materials that are prone to *creep* under pressure, and metal-to-metal valve seals are not recommended.

7.3.2 Users may not alter valves or safety relief devices that are required as part of a cylinder permit or exemption.

7.3.2.1 The USA has an exemption system and Canada has a permitting procedure for non-ASME or DOT cylinders.

7.4 *Sampling System*—It is not possible to provide a single procedure that will be applicable for all sampling situations. Different procedures and sampling equipment may be required for sampling pipes, storage tanks, rail cars, trucks, and smaller storage vessels in order to obtain a representative sample (see 4.2).

7.4.1 Sample equipment and procedures shall be designed and used to obtain representative samples of a product, and to maintain sample integrity for the tests being performed. A typical sampling system for LPG flowing in a pipe is shown in Fig. 2.

NOTE 5—While not required by this practice, the use of a sample probe in a flowing line is recommended. The sample probe should be located on the top or side of a line, extending into the center third of the flowing stream. Sample points should not be installed on the bottom of a line, unless provisions are made to flush any accumulated debris from the sample point immediately prior to sampling. The sample probe should not

⁴ Registered trademarks of E. I. du Pont de Nemours and Company, Wilmington, DE.

⁵ The sole source of supply of the apparatus known to the committee at this time is E. I. du Pont de Nemours and Company, <http://www.dupont.com>. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,¹ which you may attend.

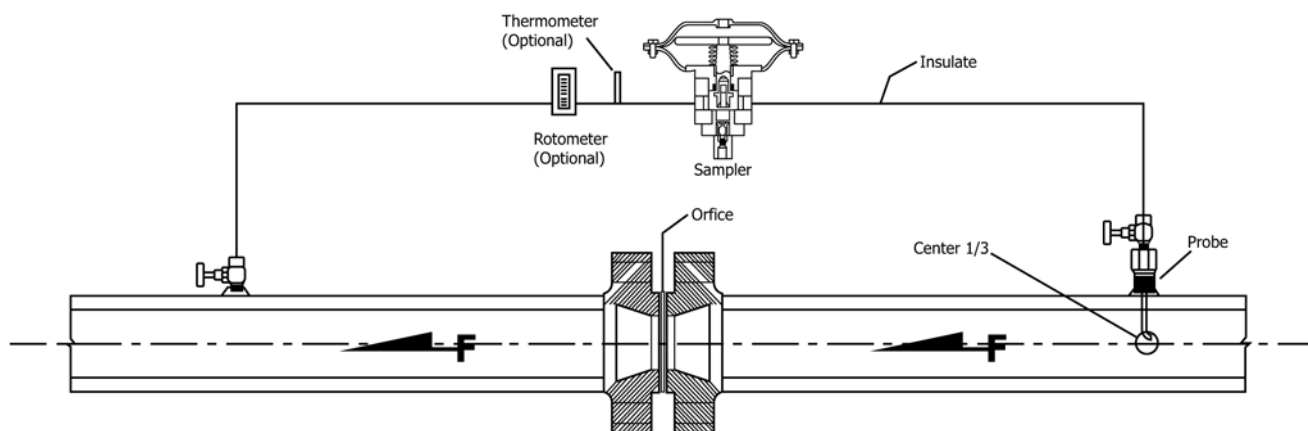


FIG. 3 Typical Sample Probe Installation on Orifice Fitting

be horizontal; rather it should have enough elevation to be sure any heavy contaminants that might be encountered, including water, will tend to drain out of it. The probe should be placed in a horizontal piece of pipe and within 45 degrees of vertical for ordinary sampling.

To determine sediment and water in a condensate sample, the probe tip should be placed after a static mixing system to ensure it samples the mixed stream and collects a representative sample of the full stream. In general, it is recommended that these sample systems are in a vertical run of pipe following a static mixer, with downward flow through the mixer and then the sample point. In this case, with a vertical piping run, a horizontal probe is recommended.

NOTE 6—Reactive materials should be tested as soon as possible after they are collected. When accurate determinations are absolutely critical, consideration should be given to use of portable or online analytical equipment to test the product directly at the source, rather than potentially compromising the integrity of the sample during transportation and handling.

7.4.2 Transfer lines, valves, pressure gauges and so forth in the transfer system shall be corrosion resistant (typically stainless steel) and designed consistent with maximum anticipated pressure. Experience has shown that the transfer lines should have a minimum internal diameter of 3 mm nominal ($\frac{1}{8}$ in.) and be as short as practical to minimize line blockage or sample vaporization, or both. The use of filters, dryers, needle valves and so forth are not recommended, unless provisions are made to prevent excessive flow restriction and pressure drop. A “T” junction with a purge valve at the sample connection point is recommended to allow purging of the dead volume at the sampler connection. Flexible hose or tubing with adequate pressure rating may be used.

NOTE 7—While not required by this practice, the use of non-reactive and non-absorptive materials is recommended, especially when sampling to determine trace levels of reactive or polar materials such as H_2S and water.

7.4.3 Other piping arrangements may be acceptable, but may require different flushing procedures prior to sample collection. Typical sample loops are shown in Figs. 3 and 4.

7.4.4 Sample loops that are closed side stream samplers designed to minimize volatile light end losses during sampling may be used. The sample loop system shall be connected to on-line analyzers or composite samplers in a manner that ensures sample integrity is maintained for the tests being performed.

7.4.5 Sample loops should preferably be installed around pumps, valves, or other sources of pressure drop to minimize atmospheric emissions from purging of sample lines.

7.4.5.1 Do not install sample loops around a meter, as bypassing the meter can create a bias in measurement and error in indicated volume.

7.4.6 Sampling pumps or other means of controlling pressures higher than the vapor pressure of the sample may be acceptable, and may be used to flush the lines or the cylinder dead volume, or both, if any, prior to sample collection. The cylinder may be partially filled and then emptied prior to collection of the sample as an alternative to venting hydrocarbon to flush lines.

7.5 Composite Sampler:

7.5.1 A composite sampler (also called a proportional sampler) is a device that is used to obtain a representative sample from a flowing product stream by accumulating small portions of product over a period of time. The sampling system consists of a sample probe, a means of collecting repetitive small portions, and a floating piston cylinder to accumulate the total sample. Figs. 5 and 6 show typical sample systems using a probe-mounted sample pump (Fig. 5), or a flow-through sample injection valve (Fig. 6).

7.5.2 Thorough purging of sample lines, pumps, and connections to the sample cylinder is necessary to avoid contamination of the sample. A suitable purging arrangement at the point of sampling shall be provided. This purging arrangement may take the form of a “T” connection and purging valve, or an operating procedure that allows slight loosening of the connection to vent the dead volume at the sample connection (if allowed by the local jurisdiction). Composite sampler systems shall be designed to minimize dead end lines that could result in the sample not being representative of the LPG source.

7.5.3 Take precautions to avoid vaporization in sample loop lines when operating near the equilibrium vapor pressure of the LPG. To control the pressure or temperature of sample containers, it may be necessary either to cool or insulate the sample line and sample container, or both.

7.5.4 Ensure that the pressure at the sample point is above the vapor pressure of the sample to avoid vaporization in the

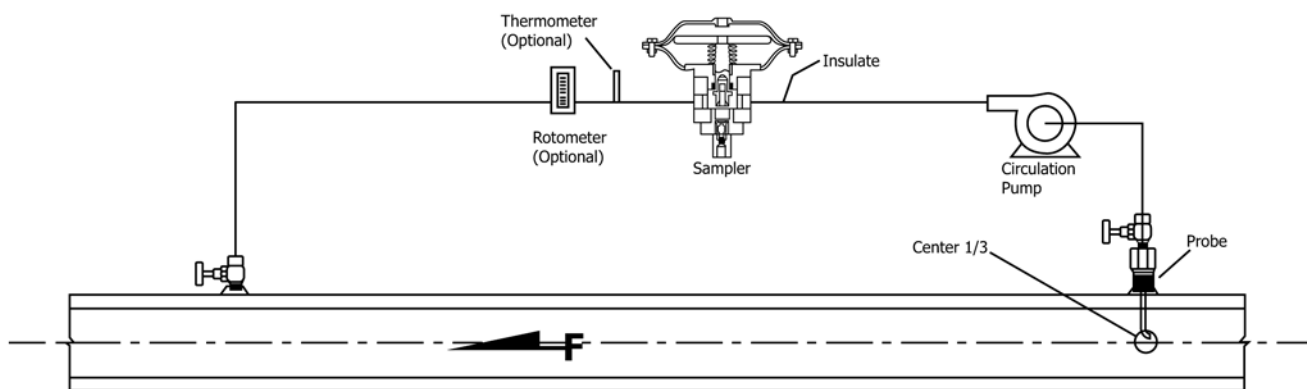


FIG. 4 Typical Sample Probe Installation for a Pump-Assisted Sample Loop System

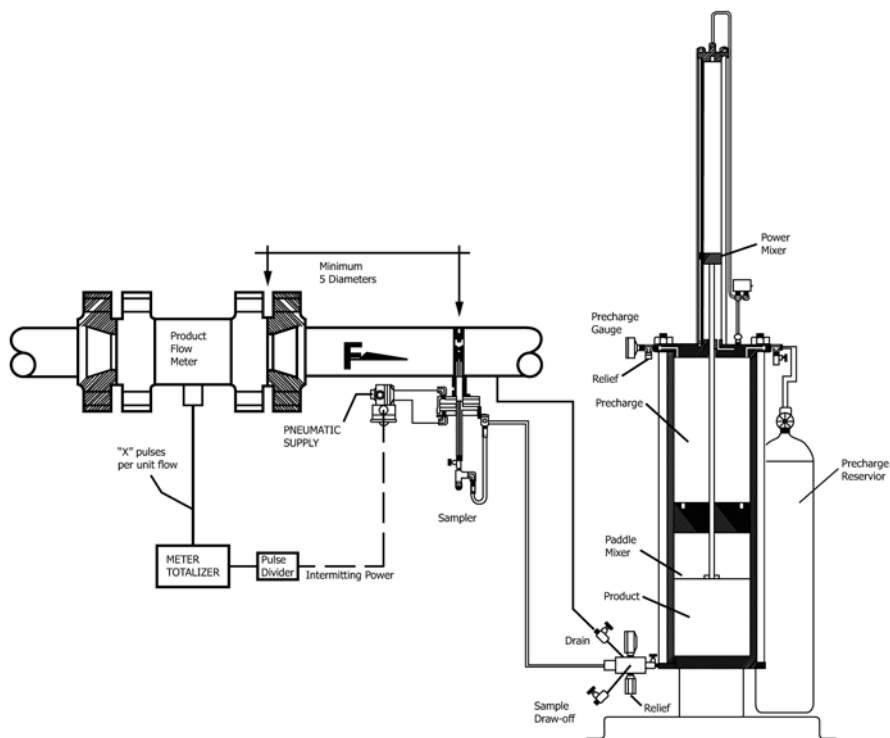


FIG. 5 Typical Sampler Using an Injection Pump for Composite Sampling

pipe or sampling lines when using a device such as an orifice plate or valve to create a pressure differential for sampling.

7.5.5 The floating piston cylinder shall be connected to the purged sample line of the composite sampler. Apply inert gas pressure (pre-charge gas) to the cylinder to force the piston to the sample point end of the FPC. Maintain the inert gas pressure at a pressure that exceeds the equilibrium vapor pressure of the fluid sampled under the expected temperature conditions by about 350 to 1400 kPa (50 to 200 psi). At pressure differences less than about 350 kPa (50 psi), there is an increasing chance of non-representative samples. Transient pressure fluctuation below the vapor pressure can result in non-representative samples.

7.5.6 Adjust the automatic sample injection valve to obtain incremental samples at a rate such that the floating piston cylinder will have adequate capacity to hold the combined sample aliquots during its period of sampling. Set the sampling

rate to prevent overfilling of the sample container, considering the sample size, maximum anticipated flow rates and time periods. Incorrect operation can result in a liquid filled cylinder that does not have a representative sample, since sampling might have stopped prior to the end of the sampling period, or preferential release of light ends occurred (depending upon venting configuration).

7.5.7 Adjust the total volume taken over the sampling period in proportion to the flow rate of the product by adjusting each incremental sample volume taken by the sampling valve, or adjusting the frequency of incremental samples, or both.

7.5.8 The floating piston cylinder used in the above system may be removed from the composite sampling device after the desired sample has been collected.

7.5.9 Do not take outage or reduce pressure on the cylinder. Check valves for leaks, cap valves with the correct fittings, and use pipe tape on pipe threads to protect threads. Prepare the

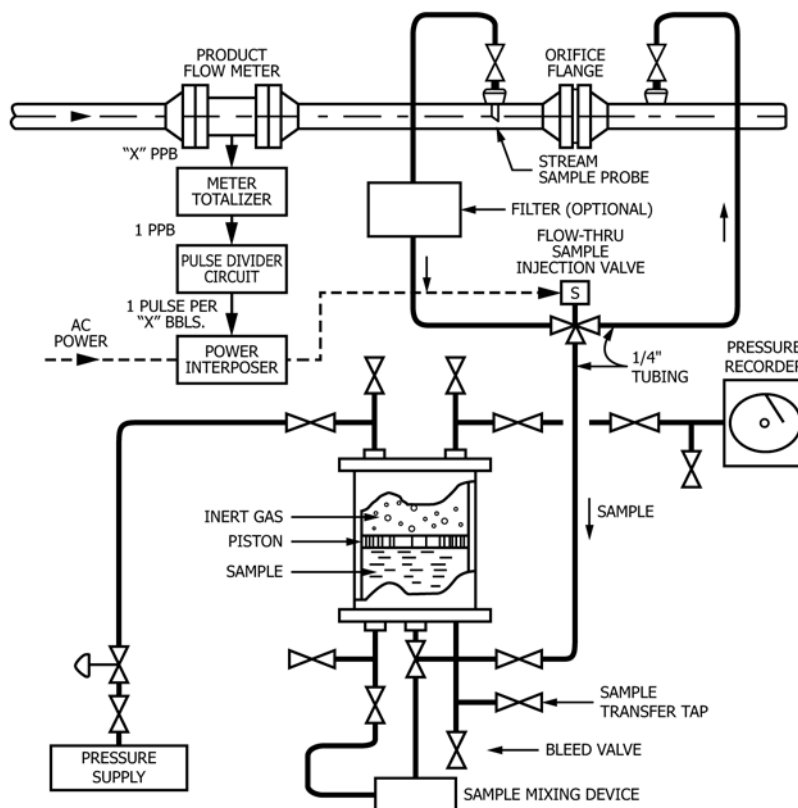


FIG. 6 Typical Automatic Proportional Sampler for Composite Sampling

sample information tag and box for transport according to the Department of Transportation or other applicable requirements of the authority having jurisdiction.

7.5.10 If it is not possible to disconnect the primary floating piston cylinder from the automatic system, mix the sample in the primary cylinder to homogenize it and transfer sample to a secondary floating piston cylinder. Proceed as in 9.2.1, treating the primary cylinder as a flowing source. In this particular transfer situation, as sample is withdrawn, the master sample container will partially depressurize. Maintain the pre-charge (inert gas) pressure above the product vapor pressure at the existing master sampler temperature to prevent flashing. (**Warning**—The cylinder shall not be filled beyond 80 % of its capacity with sample. In the event of an inadvertent over fill, sample shall be vented out to the required reduced fill volume (typically 80 %) prior to transport. See 7.1.2 for further guidance. Where immediate venting is not possible; for example, inside hazardous locations or with toxic materials (especially H₂S), provisions shall be made to prevent a temperature increase prior to venting in a safe location, such as: transfer to a larger cylinder, or perform an immediate analysis then vent the sample, or complete an alternate procedure in accordance with the jurisdiction having authority. It is the responsibility of the user to establish safe procedures.

7.5.11 Transfer and venting operations require careful control to maintain the cylinder pressure well above the vapor pressure of the sample to prevent changes in sample composition from *flashing* of the contents.

7.5.12 *Sample Filters*—The sample filter is an optional device used to protect the sampling valve from scoring due to the presence of foreign contaminants such as metal shavings, dirt, and so forth. If a filter is used, the filter should be of a small total volume, of an inline-type design, and contain a replaceable/disposable element. (**Warning**—Be aware that using filters or strainers can entrap water and other components which could result in an inaccurate analysis. Avoid use of filters or strainers if possible.)

7.5.12.1 *Water Accumulation*—Filters or other devices shall be oriented so that any free water passes with the sample and is not accumulated in the filter housings and equipment, leading to false low collection if water is present. This is critical for butane, where accumulation of water in the sampling system can cause false pass of the butane dryness criteria (no free water by visual inspection of the sample). Since specification propane has to be sub-saturated with water to pass the dryness criteria, any free water in propane will cause failure of the dryness criteria.

8. Reagents and Materials

8.1 The pre-charge gas should be an inert gas such as helium, nitrogen, or argon. Use of air, which would support combustion, is strongly discouraged. Oxygen shall not be used.

8.1.1 The preferred pre-charge gas is one that is not normally present in the sample (such as helium, nitrogen, or argon) or one that will not be detected should it leak into the sample. For example, helium and nitrogen are often used as

carrier gases for GC analysis, and depending upon the detector in use, can interfere with subsequent analyses.

8.1.2 The use of natural gas (methane) or ethane as a pre-charge gas is not recommended because any leakage would increase the methane/ethane content and the vapor pressure of the sample. This will give erroneous results that are not easily recognizable, due to the normal trace presence of these materials in LPG.

9. Procedure

9.1 Preparation of Sample Cylinder:

9.1.1 Thoroughly clean cylinders prior to initial use or after *change of service* or repair, with an appropriate cleaning agent, following the manufacturer's recommendations. Remove any traces of cleaning agent by evacuation, gas purge, or solvent wash, as appropriate. The use of steam is not recommended for the cleaning of floating piston cylinders.

9.1.2 Cylinders used in continuous service with specification LPG products do not normally require disassembly or cleaning before each use. Vent the previous sample as a liquid to prevent accumulation of low or non-volatile components, and remove remaining sample from dead volume by solvent rinsing, evacuation, gas purge, or equivalent procedure.

9.1.3 In the event that an unacceptable test result is obtained, the cylinder shall be liquid vented and thoroughly cleaned or flushed with LPG conforming to Specification **D1835** or equivalent, to ensure that test results on the next sample taken with the same cylinder are not adversely affected.

9.1.4 Disassembly of floating piston cylinders.

9.1.4.1 Consult the manufacturer's instructions for the maintenance and safe disassembly instructions for an FPC. (**Warning**—Disassembly of the piston cylinder for maintenance requires special precautions. If either end cap is removed while pressure is on the cylinder, the end caps and the piston can be ejected with such a force as to cause serious injury to personnel and damage to equipment.)

9.2 Sampling Procedure—Manual Procedure:

9.2.1 Referring to **Fig. 1**, with the sample side of the cylinder empty or evacuated (from the cleaning operation) and valve C open, fill the pre-charge end with inert gas to a pressure that is at least 70 kPa (10 psi) above the pressure at the sample point.

9.2.2 Open process valve A briefly to flush any debris that may be present in the sample point.

9.2.3 Connect the cylinder to the sample point (see **Fig. 2** or **Fig. 3**).

9.2.4 Thorough purging of sample lines, pumps, and connections to the sample cylinder is necessary to avoid contamination of the sample. With cylinder valve C closed, open sample point valve A, and then vent valve B to flush out sample line upstream of the cylinder valve C. The flow should be fast enough to flush any debris from the line, but short enough duration to minimize venting. Preferably, the vent line should be piped to a flare line or elsewhere in the process to minimize emissions to the atmosphere. Close vent valve B. The dead volume between the sample point connection should be minimized, or other provisions made to flush this section of the line. This may be accomplished by installing a second vent

value close coupled to cylinder value C, by loosening a threaded fitting, or by a partial fill and empty procedure prior to collection of the sample.

9.2.5 Verify that the pressure in the pre-charge, inert gas chamber of the FPC is higher than the pressure at the sampling point. (**Warning**—Do not attempt to fill a floating piston cylinder when there is little or no pressure on the pre-charge side of the cylinder, because the piston and attached indicator rod can move with extreme speed and force.)

NOTE 8—If the diameter of the indicator rod is of sufficient size compared to the piston, then the pressure on the pre-charge, inert gas side will be slightly higher than the samples side.

9.2.5.1 Exercise care when sampling LPG to prevent vaporization (flashing) of lighter components when transferring product from the source to a sample cylinder.

NOTE 9—Theoretically, the product in the vapor state will return to liquid phase upon increasing pressure, but the physical restrictions of the piston cylinder design (for example, valve dead space and stirring assembly design) can slow this process.

9.2.5.2 It is recommended that cylinder valves with pipe threads be taped with PTFE tape and capped or plugged in preparation for safe transport and handling. This will prevent leakage, protect the valve threads, and prevent contamination inside the valve body. Swaged fittings on cylinder valves should be capped with the appropriate swaged plugs. The user should ensure that any remaining residue liquid is drained, blown down, or absorbed from the accessible exterior dead volume of the valve body (downstream of the seat) prior to plugging or capping the valve. Thermal expansion of these trapped liquids could cause the cap or plug to fail.

9.2.6 Open cylinder valve C, and *slowly* vent inert gas from the pre-charge, inert gas balance chamber through cylinder valve D. When the pressure at the balance side approaches the pressure at the sample point, the sample will begin to flow into the floating piston cylinder, pushing the floating piston back. (**Warning**—Vent the inert gas slowly when approaching the sample point pressure. Rapid venting can result in excessive vaporization or cause the piston to move abruptly (especially if it sticks), or both.)

9.2.7 Monitor the piston position indicator and stop at the desired fill level (or fill volume), not to exceed 80 % at 15 °C (59 °F). (**Warning**—When filling a floating piston cylinder below about -5 °C, the maximum fill density shall be reduced below 80 % to account for the additional thermal expansion and accommodate increased outage or reduced fill volume.)

NOTE 10—Joint ASTM/API/GPA Midstream volumetric temperature correction factors are available as GPA Midstream Technical Publication TP-27,³ and can be used to calculate maximum fill volume at low temperatures.

9.2.8 Close valves D, C and A, and open vent valve B to vent the sample line.

9.2.9 Disconnect the sample cylinder.

9.3 *Sampling Procedure—Composite Sampler*—The sample is collected automatically in a primary floating piston cylinder. This cylinder may be removed and transported for analysis, or it may be used, after mixing, as a sample point to fill a

secondary cylinder (either floating piston or 80 % fill by Practice **D1265**). See **7.1.2** for further guidance.

9.3.1 Operate the composite sampler according to manufacturer's instructions so that a valid, representative sample is obtained.

9.3.2 Drain and clean or flush the primary floating piston cylinder between sample collections.

9.3.3 The batch size or batch volume represented by the sample may be used to define the time period over which a composite sample is collected with an automatic composite sampler.

9.3.4 Sampling volume or frequency, or both, is usually proportional to the flow rate (commonly called a proportional or volume weighted sample). Time increments may be used if the flow rate is constant or can be factored in using continuous flow measurement.

9.4 *Sample Withdrawal from Floating Piston Cylinders:*

9.4.1 At the end of sampling, the sample in the FPC is at the same pressure as the sample point, which may not be appropriate for subsequent use in the laboratory. It is good laboratory practice to adjust the pressure in the FPC by using the inert gas pre-charge to a suitable pressure prior to analysis.

9.4.2 If the sample was taken under cold conditions from static storage (at the product vapor pressure), ensure that the charge pressure is subsequently increased consistent with the

pressure/temperature relationship to maintain a single liquid phase in the cylinder upon warming. Certain test methods may require the charge pressure to be increased to a sufficient level to obtain reliable injection into transfer lines or instruments that may be above ambient temperature.

9.4.3 Attach the pre-charge inert gas side of the FPC to a pressure-regulated source of inert gas to maintain a constant charge pressure during sample withdrawal for analyses.

9.4.4 External calibration analytical methods may require that both samples and calibrants be stored and injected at the same pressure. LPG is more prone to this source of analytical error due to the much larger liquid compressibility of LPG relative to other fuels.

9.4.5 Excessive pressurization during extended storage can result in leakage of inert gas into the LPG sample chamber (for example, passing by worn or damaged seals) which can affect some test methods, such as vapor pressure.

9.4.6 Vent LPG liquid sample from an FPC prior to venting the inert gas to completely remove the liquid sample and avoid vaporization and collection of low volatility components in the sample chamber.

10. Keywords

10.1 floating piston cylinder; hydrocarbon fluid sampling; LP-gas; sampling

APPENDIX

(Nonmandatory Information)

X1. SAMPLING GUIDELINES FOR NATURAL GAS LIQUIDS AND NON-SPECIFICATION LIQUEFIED PETROLEUM GASES

X1.1 Refer to GPA 2174 for further information on sampling NGLs.

X1.2 The sampling procedures described in Practice D3700 are suitable for specification LPG products such as Specification **D1835** and GPA 2140 products (special duty and HD-5 propane, butane, and propane/butane mixtures) that are normally single phase liquids. It may also be used for other natural gas liquid (NGL) products that are normally single phase liquids (NGL mix, field butane, and so forth), defined in other industry specifications or contractual agreements.

X1.3 These procedures can be unsuitable and inadequate for sampling natural gas liquids (NGL's) and field mixes of LPG, or semi-processed samples from within a production process because these samples can be two or three phase materials contaminated with water, amine, heavier hydrocarbons (natural gasoline) as well as light gases such as methane, nitrogen, carbon dioxide, and hydrogen sulfide. Because of these complexities, collecting a representative sample of field NGL's and non-specification LPG's can be considerably more difficult than sampling specification LPG products.

X1.4 Accurate sampling and analysis of natural gas liquids and field mix LPG's is important because commercial transac-

tions of LPG mixtures, NGL's, and field mix are based on different and varying values of the major components (ethane, propane, iso-butane, n-butane, and C₅₊ hydrocarbons), inerts (CO₂, N₂), and contaminants (H₂O, H₂S). Without an accurate and representative sample, component mass measurement, plant and pipeline balances, and the commercial value of products to purchasers and sellers will likely be inaccurate.

X1.5 This appendix provides the user with information to design a sampling system and procedures that will help ensure representative samples can be collected, stored, transported, and analyzed. GPA 2174 describes procedures for sampling multi-phase products, or mixtures of products that are not homogeneous (not well mixed).

X1.6 Significance and Use

X1.6.1 Mass measurement of product components, correct pricing of product transfers, and pipeline and plant balances all depend on accurate and representative samples.

X1.7 Sample Point

X1.7.1 The location and orientation of the sample point for specification LPG, natural gas liquids, and the like is critical to successful sampling. The sample point should be in an area

where the product stream is as close to a single phase as possible. If there is any possibility that two phases can exist at a sample point, a back pressure regulator should be installed downstream of the sample point to ensure that the product is maintained in a liquid phase at the sample point.

X1.7.2 An effective static mixer should be installed upstream of the sample point to ensure that the product is a homogenous mixture moving across the area of the sample probe, rather than two liquids of different composition and density that are not well mixed. Internal sampling probes of various types (slotted, multi-hole piccolo tubes, and so forth), flow conditioners, mixing valves, and other specialized apparatus may be used in some situations to obtain more representative samples. Multiple sample points may be required for tanks or lines that can become stratified with products of different compositions and densities.

X1.7.3 A sample probe should be installed *on the side of the product line* and extend into the flowing stream. Do not install a sample point on the bottom of a line where it might collect some heavier materials moving along the bottom surface of the pipe, or on the top of the line where it might collect gaseous components. The sample probe should be equipped with a ball valve to allow for unobstructed flow from the sample probe to the sample container on the sampling system.

X1.7.4 There are two sampling arrangements which may be used to collect a sample of NGL or field mix LPG: the isokinetic sampler and sample loop.

NOTE X1.1—The terms “hot loop” and “bypass loop” are also used to mean a “sample loop.”

X1.8 Isokinetic Sampler

X1.8.1 This sample system is designed to be used when the stream contains two or more phases of significantly different densities or viscosities such as water, glycols, particulates, or other heavy components. The sample head or pump (sample probe) is inserted directly into the flowing stream at the homogeneous point and a sample is trapped in the stream and pumped into the sample container. The isokinetic style of sampler will produce the most representative sample because the sample stream is not required to change direction of flow, undergo a change in pressure, or remain homogenous while undergoing changes in direction, flow rate, pressure, or temperature, as can occur in a sample loop. The isokinetic sampler may be the preferred method of sample collection by some experts, but there are few commercially available models.

X1.9 Sample Loop

X1.9.1 As the name indicates, this style of sample system brings a small flowing line of product out from the main stream to allow sampling. The system is connected back into the main stream so that product flows through the loop and back into the process stream. The sample loop, though used extensively, has historically produced a less representative sample than the isokinetic sampler. There are many critical details involved in designing a suitable sample loop sample system:

X1.9.1.1 The product stream shall be properly conditioned (adequate back pressure to give a single phase at the inlet to the sample loop).

X1.9.1.2 A drive plate may be used as the restriction to direct a portion of the conditioned stream into the sample probe to the sample loop and sample pump.

X1.9.1.3 The temperature of the product in the sample loop should be within 0.3 °C (0.5 °F) of the temperature of product in the flowing stream. Thus, there has to be sufficient flow through the sample loop to achieve this temperature.

X1.9.1.4 The product stream should move from the sample probe (equipped with a full open ball valve) through the sampler with no filters or restrictions.

X1.9.1.5 The sample loop should return the flowing stream back to the process stream on the downstream side of the restricting orifice (which generates the back pressure in the process stream).

X1.9.1.6 A back pressure regulator should be installed in the sample loop after the sampling point to maintain a single phase in the sample loop.

X1.9.1.7 A flow indicator should be installed in the sample loop to ensure that there is actually product moving through the sample loop.

X1.9.2 Restrictions such as inlet check valves on chemical pumps or samplers can cause a separation of components, rendering the sample non-representative.

X1.10 Sample Container and Transport Container

X1.10.1 The sample collection container and sample transport container should be designed and built to work above the highest possible line pressure so that the product will, during collection and storage, be maintained in the same phase as the product in the line.

X1.10.2 The sample and transport containers should have a piston and an effective mixer so the stored sample may be properly mixed prior to transfer from the sampler collection container to the transportation container. The mixer should be capable of mixing products as diverse as water and LPG. This requires rapid movement of the mixer, such as a vortex plate, through the liquid. Items such as free floating balls, wafers, sliding sieves, and other items that are not moved through the liquid with a rapid velocity may not produce a homogeneous mixture. The vortex mixer plate has been found to produce homogeneous samples which give good repeatability on analysis of consecutive samples. If poor analytical repeatability is observed, the problem can be an improperly designed and operated sampling system, including sample mixing.

X1.10.3 While stainless steel is a suitable material for the sample container for most analytical requirements, an inert coating on all internal surfaces is required if samples will be analyzed for trace amounts of reactive materials such as H₂S and elemental sulfur. Suitable inert coatings may include special glass linings (for example, silico-steel), PTFE and some epoxy materials.

X1.11 Sampling

X1.11.1 If a composite sample of a complex stream is to be collected, the preceding sample point and sample collection

system techniques should be considered and applied. Collection of a composite sample requires a control mechanism which is tied to time or product flow to ensure that the sample collected is proportional to the mass or volume of product moving through the line. The control mechanism should control periodic injection of a small portion of representative sample into the sample container.

X1.12 Sample Transfer

X1.12.1 After a sample has been collected in the sample collection container, it is normally transferred to a transportation (and storage) container.

X1.12.1.1 Install a tee with a valve on the draw-off valve of the sample container.

X1.12.1.2 Attach the transportation container to the tee on the draw-off valve.

X1.12.1.3 Actuate the mixer on the sample container with 3 to 5 vigorous strokes (rapidly but not violently).

X1.12.1.4 Immediately after mixing, purge the connection between the sample container and the transport container by filling and emptying the connection two or three times.

X1.12.1.5 Fully open both valves on the manifold (the draw-off valve on the sample container and the filling valve on the transport container).

X1.12.1.6 Slowly relieve the pressure on the pre-charge, inert gas side of the FPC transport container to allow movement of the sample from the sample container into the transport

container. Do not allow the liquid sample to change phase during the transfer. It may be necessary to increase the pressure on the pre-charge side of the sample collection container.

X1.12.1.7 *Repeat the mixing and transfer steps for each cylinder to be transported.*

X1.13 Transportation of Samples (In Floating Piston Cylinders)

X1.13.1 Determine the appropriate transportation regulations (D.O.T., local authorities, internal company safety regulations, and so forth) and adhere to these requirements when transporting samples.

X1.14 Sample Handling for Analysis

X1.14.1 The sample in the transport container should be properly prepared prior to any analyses.

X1.14.2 Maintain the pressure on the pre-charge side in the transport container at least 700 kPa (100 psi) above the original line pressure where the sample was collected to maintain a single product phase.

X1.14.3 Mix the sample by 3 to 5 vigorous strokes of the mixer (vortex plate) immediately prior to any analysis.

X1.14.4 As portions of the sample are removed from the transport container, it may be necessary to repressurize the pre-charge (back side) of the transport container to maintain a suitable pressure in the sample.

SUMMARY OF CHANGES

Subcommittee D02.H0 has identified the location of selected changes to this standard since the last issue (D3700 – 14) that may impact the use of this standard. (Approved Oct. 1, 2016.)

(1) Added new **Note 1** to Scope.

(2) Added Practice **D8009** to Referenced Documents.

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