Designation: D6624 – 14

Standard Practice for Determining a Flow-Proportioned Average Property Value (FPAPV) for a Collected Batch of Process Stream Material Using Stream Analyzer Data[1]

This standard is issued under the fixed designation D6624; 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.

INTRODUCTION

The determination of an average property value that is representative of a batch of petroleum product collected and isolated in a tank or vessel has always been a challenge. Historically, the industry practice has been to follow the appropriate procedures prescribed in Practices D4057, D5842, or D4177 to extract one sample (or a limited few, taken from top, middle, and bottom) from the tank or vessel after the content is mixed by any of several means to ensure the material is homogeneous prior to sample extraction. The extracted sample is then sent to a laboratory for analysis. Depending on the property and its criticality, the average property value can also be obtained by independently analyzing each of the top, middle, and bottom samples and the results averaged, or, the three tank samples are mixed and testing for the property is performed on the mixture.

With the introduction of in-line blending and process stream analysis in the 1960s, the potential for real-time delivery to a pipeline, barge, ship, or tank car compartment was envisioned.

To determine the average property value that is representative of a batch of product from a blend or process stream, two approaches have been developed and implemented. One depends on the use of a composite sampler, a vessel into which a sample of the flowing process or blended product stream is introduced at a flow-rate proportional to the flow-rate of the product stream (Practice D4177 or D7453). This sample, collected over the period of time required to generate the batch quantity of product, is then analyzed using a primary test method in the laboratory. Multiple laboratory analyses on one or more aliquots of composite sample can be averaged to provide a more precise estimate of the property value than a single analysis.

A second technique utilizes the results produced by on-line, at-line, or in-line analytical measurement systems that test material from the process or in-line blended stream for the desired property at regular intervals as it flows to a collection tank, pipeline, or shipping compartment. To determine the average property value of all the material collected (or shipped) at any time during the production process, a unique real time flow-proportioned averaging technique evolved. By appropriate selection of a production time period or cycle, the average property value for the collected (or shipped) material at any time in the production or shipment cycle is obtained by recursively calculating a flow-proportion average using all available property values from the analytical measurement system and the measured incremental quantity of product flow associated with each cycle. The determination of this flow-proportioned average property value is the subject of this practice.

1. Scope*

1.1 This practice covers a technique for calculating a flow-proportioned average property value (FPAPV) for a batch of in-line blended product or process stream material that is collected over time and isolated in a storage tank or vessel, using a combination of on-line or at-line measurements taken at regular intervals of the property and flow rates.

1.2 The FPAPV methodology uses regularly collected on-line or at-line process analyzer measurements, flow, and assessment of other appropriate process measurements or values, to calculate a flow-proportioned average property value in accordance with flow quantity units of material produced.

1.3 When the collecting vessel contains a heel (retained material prior to receipt of the production batch), both the property value and quantity of the heel material can be predetermined and factored into the calculation of the FPAPV for the new batch.

1.4 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D3764 Practice for Validation of the Performance of Process Stream Analyzer Systems

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products

D5842 Practice for Sampling and Handling of Fuels for Volatility Measurement

D6299 Practice for Applying Statistical Quality Assurance and Control Charting Techniques to Evaluate Analytical Measurement System Performance

D7453 Practice for Sampling of Petroleum Products for Analysis by Process Stream Analyzers and for Process Stream Analyzer System Validation

3. Terminology

3.1 *Definitions:*

3.1.1 *analysis cycle time, n*—period of time required to properly obtain and analyze a representative sample of the process stream material.

3.1.2 *flow-proportioned average property value (FPAPV), n*—average property value of the collected material in the tank or vessel, calculated by using the flow-proportioned average technique described in the practice of all measurements performed on aliquots of the material while it is flowing into the tank or vessel.

3.1.2.1 *Discussion*—The term *property* as used in this practice can be the physical, chemical, or performance property measurements as provided by on-line, at-line analyzer systems, or, can be the deviation of such measurements from a desired value.

3.1.2.2 *Discussion*—The FPAPV can include a value contributed by material (commonly referred to as a tank heel) present in the collection tank or vessel before the start of delivery of the current process stream material.

3.1.3 *fit-for-use, n*—product, system, or service that is suitable for its intended use.

3.1.4 *linearly mixable, adj*—property is deemed to be linearly mixable in a mass or volume measurement unit if the property of the mixed material can be calculated from the quantities and properties of the materials used to produce the mixture.

3.1.4.1 *Discussion*—The general equations describing this linearly mixable attribute are as follows:

$$P_{MIXED} = \frac{A_1 \cdot P_1 + A_2 \cdot P_2 + A_3 \cdot P_3 + A_4 \cdot P_4 + \ldots + A_N \cdot P_N}{A_1 + A_2 + A_3 + A_4 + \ldots + A_N} \tag{1}$$

$$A_{MIXED} = A_1 + A_2 + A_3 + A_4 + \ldots + A_N \tag{2}$$

where:

A_N = quantity of material N,
P_N = property of material N,
P_{MIXED} = property of mixed material, and
A_{MIXED} = quantity of mixed material.

3.1.4.2 *Discussion*—The material being mixed can be from the same process stream over time.

3.1.5 *total analyzer system response time, n*—time interval between when a step change in property characteristic at the sample loop inlet and when the analyzer output indicates a value *c* corresponding to the 99.5 % of the subsequent change in analyzer results; the total analyzer system response time is the sum of the sample loop lag time, the same conditioning loop lag time, and the total analyzer response time. **D3764**

4. Significance and Use

4.1 Contractual or local regulation, or both, permitting, the FPAPV calculated according to this practice can be used to represent the average property of the quantity of material collected.

4.2 Due to the averaging and appropriate weighting of analysis results, the FPAPV estimate of the property for the collected material is expected to be more representative and more precise than an estimate based on a small number of analyses on a few samples.

NOTE 1—Theoretically speaking, the true property distribution for an infinite number of batches with essentially identical FPAPV's is expected to be Gaussian, centered at the FPAPV value, with a standard deviation that is no less than the long term site precision standard deviation of the analyzer system.

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[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 D02.25 on Performance Assessment and Validation of Process Stream Analyzer Systems.

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[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.