

The information and data contained in this document were prepared by a technical committee of the Association. The committee and the Association assume no liability or responsibility in connection with the use of such information or data, including but not limited to any liability under patent, copyright, or trade secret laws. The user is responsible for determining that this document is the most recent edition published.

Sampling procedures for biomass fuel for boiler performance testing

Scope

The Procedure described in this Technical Information Paper provides a systematic method of sampling biomass fuel to obtain a sample that is representative of the fuel to be fired during a boiler performance test conducted in accordance with TIP 0416-18 “Performance Test Procedure for Boilers Using Biomass as Fuel.” The method describes correctly performed sampling that will obtain a sample from a larger stock of fuel in such a way that (1) systematic errors will be avoided and (2) random errors will be equalized as much as possible. The representative sample of fuel is for the purpose of analysis to determine the ultimate analysis, gross heating value and moisture content of the fuel. Described are the fundamental sampling principles and their application to sampling from a conveyor belt, sampling from trucks, and sampling from a biomass fuel pile

Definitions

Biomass – Biomass is defined for purposes of this procedure to be wood chips, hog fuel, milled peat, pelletized peat or similar solid fuel for a boiler.

Hog fuel – fuel consisting of by-product process wastes recovered for their calorific value, such as bark from wood pulping, that is sized for feed to the boiler by passing it through a chipper, or “hogger”

Steam generating unit – a defined envelope boundary over which heat inputs and heat credits cross

Safety precautions

This TIP may require the use, disposal, or both, of chemicals which may present serious health hazards to humans. Procedures for the handling of such substances set forth on Material Safety Data Sheets must be developed by all manufacturers and importers of potentially hazardous chemicals and maintained by all distributors of potentially hazardous chemicals. Prior to the use of this technical information sheet, the user should determine whether any of the chemicals to be used or disposed of are potentially hazardous and, if so, should follow strictly the procedures specified by both the manufacturers, as well as local, state, and federal authorities for safe use and disposal of these chemicals.

The boiler performance test will normally be carried out in an industrial installation that has established safety procedures, which should be complied with by any and all persons involved with the testing. In the instance of a facility having Material Safety Data Sheets for biomass that describe procedures for sampling, use and disposal, and the protective attire to be worn, these should be strictly adhered to. As a minimum, personnel doing the sampling should use a dust mask. The application of the information in this TIP requires personnel to come in contact with operating mechanical equipment and/or pneumatic conveying systems to take samples manually. Safety must be carefully considered and a procedure established for the specific installation.

General sampling guidelines

When sampling biomass fuel for the purpose of boiler performance testing, it is important to sample fuel at regular intervals during each test run and as frequently as practical for post-test sample transport.

It is imperative that the fuel sample be representative of the fuel fired during the test period. The time delay between truck unloading, pile reclaim and firing is quite large. Therefore, it is recommended that the fuel sample be collected as close to the boiler as possible. In most cases, this will be the conveyor feeding the fuel metering equipment.

Properties of wood, bark and peat fuels (i.e.: Btu value, moisture content, ash content and ultimate analysis) vary for different reasons. These fuel variations can be caused by season of the year, handling and storage methods, hogging methods, transportation conditions and geographic origin. Determination of these properties may also be affected by analysis errors, which means that the variation in the obtained results will increase.

Correctly performed sampling will obtain a sample from a larger stock of fuel in such a way that (1) systematic errors will be avoided and (2) random errors will be equalized as much as possible.

Systematic errors are avoided by distributing the samples from fuel delivery over time and place. If delivery comes in several truck loads, one sample should be taken from each load.

Random errors are reduced by taking a large number of samples such that the average of the samples with a given probability will deviate from the "true" average by no more than a pre-determined value.

A basic requirement is that the whole content of a fuel load is available for sampling and that all parts of it have the same probability to be sampled.

Systematic errors (the results are either higher or lower than the true value) occur easily when sampling and can be very difficult to discover. The two most common reasons for systematic errors are (1) the individual sample is taken from a non-representative part of the fuel load, for example from one side of a belt conveyor, and (2) the individual sample is taken in such a manner that it will not be representative for the fuel, located at the sampling device which is too small to admit larger fuel pieces, or by sampling from the surface which is exposed to heat, wind or precipitation.

In order to avoid systematic errors, it is essential that the dimensions of the sampling apparatus and the size of the sample are suitable for the maximum fuel size. If systematic errors occur, they can sometimes be eliminated by changing sampling location or the design of the sampling device. It can also be accomplished by completely changing sampling strategy. Normally, accuracy and precision cannot be improved by only increasing the sample size. However, precision in the analysis results can be improved by increasing the number of individual samples, but this will not eliminate possible inherent systematic errors associated with the sampling method.

The best sampling situation occurs when the entire fuel source is easily accessible, such as, when the fuel is conveyed on a belt conveyor. If the belt is stopped and a large enough section, covering the full width of the belt, is used as a sample, the possibility for systematic errors per (1) and (2) above is largely eliminated. Sampling from a stopped belt conveyor is thus preferable in order to avoid systematic errors. This method should, if possible, be used as a reference method to check other test methods against.

Often it is not practical to stop belt conveyors, but other sampling methods must be used, which are based on some kind of device that will divert the fuel stream from the conveyor belt.

Satisfactory sampling quality can also be obtained from stationary fuel sources (such as, trucks, piles, etc.) if a suitable method is used. Since stationary fuel tends to become very non-homogeneous, it is essential that the sampling points be distributed in a suitable manner and that a greater number of samples be taken than would be the case when sampling from a belt conveyor.

Sample preparation

When a sample has been taken, two laboratory samples are to be prepared: one sample for moisture analysis and another sample for analysis of ash and other chemical and physical properties. The purpose of sample preparation is to reduce the sample size to what is required for laboratory analysis while still maintaining representation of the original sample quantity.

This is facilitated by not mixing individual samples together. Sampling errors are minimized if each individual sample is analyzed separately.

Treatment of sample after sampling

When a sample has been taken for moisture analysis, it should be weighed as soon as possible. If storage of samples is necessary, the individual samples should be transferred to sealed, air tight containers. The samples should preferably be stored at a temperature lower than where the samples were taken.

Determination of physical and other properties

Results obtained from various physical analyses depend on the particle size distribution of the fuel; if the samples are handled gently, the sampling methods described in this standard can be used for this purpose. The minimum individual sample size is then determined by what is required for both ash and moisture analysis.

The total sample volume required for determining other physical properties may be regulated in future standards. If the total sample volume required is larger than what is required for ash and moisture analysis, the individual sample size can be increased or, which is preferred, a greater number of individual samples can be taken, which are then combined to a collective sample.

Instructions for sampler

It is essential that the sampler is given simple and explicit instructions. These instructions, which should be in writing, can be based on this TIP. In Table 1, instructions are shown that apply for various sampling situations with reference to the applicable section in this TIP.

Table 1. Precision Reference Value for Sampling

<i>Parameter</i>	<i>Reference Value</i>
Ash content	± 0.2 percentage points (See Note 1)
Moisture content	± 2.0 percentage points (See Note 2)

Notes:

- 1) If the ash content is 2.0%, the result will be between 1.8 and 2.2%. All ash content figures are based on the dry weight of the fuel sample.
- 2) If the moisture content is 50%, the result will be between 48 and 52%.

Before final instructions can be established, the following questions have to be answered:

- For what purpose is the sample required?
- What is the maximum fuel size and what is the ash content of the fuel?
- What analyses are to be performed (moisture, ash, physical properties)?
- Are common samples or separate samples to be taken for moisture analysis?
- Where are samples to be taken (conveyor, truck, pile)?
- Is the fuel to be treated as a single delivery or is it part of a bigger delivery?
- How big is the total delivery and is information available on fuel consistency?
- Is the precision according to this standard sufficient or should other limits be used?

Fundamental sampling principles

Precision of the sampling principles is as follows:

1. *Confidence Interval.* In this procedure, all requirements relating to precision are given with a 95 percent confidence interval. This means that the result of an analysis can be expected to fall within the specified precision limits 95 times out of 100.
2. *Precision and number of individual samples.* With the limitations that are mentioned below, the desired precision can be obtained by adjusting the number of individual samples.
3. *Precision, reference value.* The reference value which applies for the precision when sampling for ash content is ± 0.2 percentage points and for moisture content is ± 2.0 percentage points. These deviations include errors that may occur during sampling, sample preparation and analysis.

NOTE 1: For special conditions, such as pulverized wood, higher precision requirements must be established as needed on a case by case basis.

Number of individual samples

Principle

The number of individual samples required from a fuel delivery in order to obtain a certain precision depends on how the analyzed property (moisture or ash content) varies within and between the various parts of the delivery (the non-homogeneity of the fuel). The non-homogeneity depends on fuel type, particle size and the amount of separation between the fuel particles (segregation rate).

Variations are typically greater in a large delivery than in a small one. Deliveries over 1000 tons are dealt with according to the alternatives outlined later in Item 3 of this Section..

Number of individual samples for a certain precision

The number of individual samples that are required in order to obtain the reference level of the precision for different sampling conditions are given in Tables 2 and 3.

Table 2. Guidelines for number of individual samples for determining ash and Btu content in a delivery of 1000 tons, or less, when sampling from the various sources indicated

<i>Fuel</i>	<i>Fuel Flow</i>	<i>Trucks</i>	<i>Piles</i>
Wood chips	18	24	40
Hog fuel	18	24	40
Milled peat	11	15	30
Pelletized peat	22	30	55