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Volumetric Flyash Procedure

1.0 Volumetric Flyash Sample Collection and Analysis

1.1 Introduction

Flyash Loss on Ignition (L.O.I.) or unburned Carbon is typically indicative of combustion efficiency. For this reason, an "in-situ" flyash sample is frequently extracted for diagnostic or quantitative reasons. One of the most efficient means we have found for collecting a representative sample is with the Volumetric Flyash Sampler. The Volumetric Flyash Sampler, also known as a High Volume Sampler, has numerous advantages over other methods of ash sampling; such as the Isokinetic Flyash Sampler or "hopper" samples:

- Operation of the sampler is simple. Training on the use of the sampler is quick and easy; consequently, it does not require a highly skilled test person to operate.
- The fact that the sampler pulls an "in-situ" sample guarantees that the results are more accurate than "hopper" samples. Due to the low collection efficiency of carbonaceous particles, flyash L.O.I.'s burned using hopper samples are inherently lower than the true value due to the fact that some of the carbon in ash is not collected by the precipitator.
- Actual sampling time is greatly reduced over that of an isokinetic sampler. Typically, 45 - 60 minutes per duct is adequate to collect enough sample for composite and fine particle analysis with the Volumetric Sampler.

The 304 SS sampler is designed to use 0.3 micron, high temperature filter paper. Aspiration pulls flue gas into the sampling tip at approximately 3,000 ft/min. The dust-laden gas passes through the filter paper, leaving the ash particulate behind. A sketch of a volumetric sampler is below:

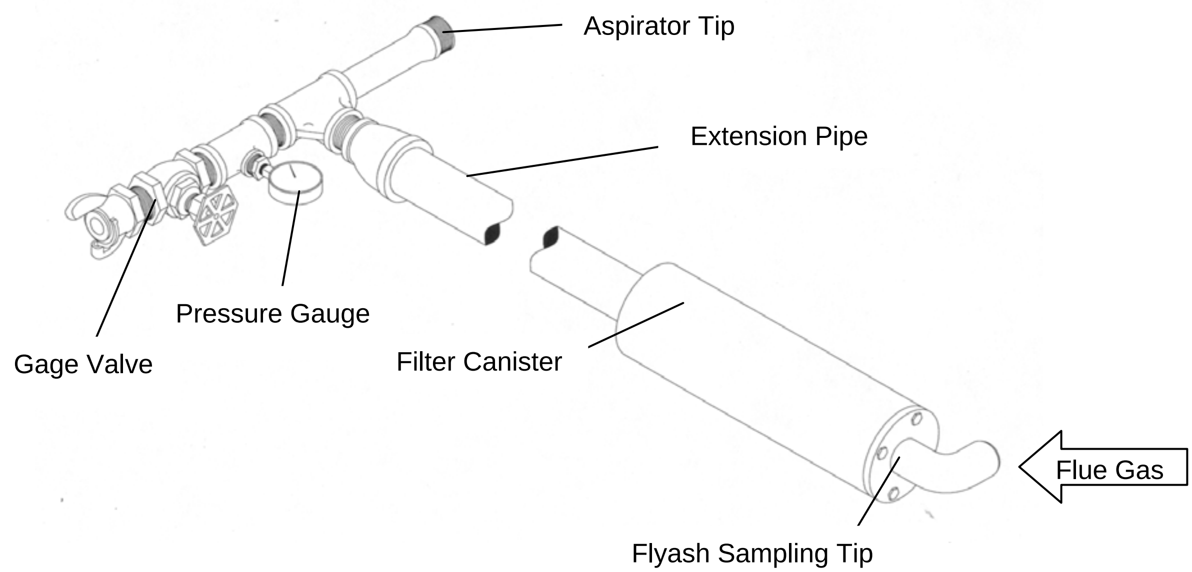

Figure 1 - Volumetric Sampler

1.0 VOLUMETRIC FLYASH SAMPLE COLLECTION AND ANALYSIS

1.2 Performing a Volumetric Flyash Traverse

1.2.1 Test Tap Location and Lay-out

According to the ASME Test Code PTC 38 "Determining the Concentration of Particulate Matter in a Gas Stream"; ideally test tap layout should be such that sampling access ports and traverse points are selected to permit sampling in zones of equal areas. The traverse grid should facilitate a minimum of one traverse point for every 9 ft^2 of duct area. For example a 12' × 18' duct with a cross-sectional area of 216 ft^2 will require a minimum of (24) traverse points. The traverse grid should be located in a straight run of ductwork (constant cross-sectional area), preferably a vertical run in order to minimize stratification of the medium. In addition, the traverse grid should be located a minimum of eight (8) duct diameters downstream and two (2) duct diameters upstream from the nearest flow disturbance. Since these criteria are often impossible to meet, test taps are generally located in the "best possible" location. This is acceptable if all parties involved in the testing agree. Adequacy of probe access, lighting, power facilities, etc. should also be considered when choosing a location.

The sketch below shows an example of a typical test tap layout. When marking off the probe, remember to add in the length of the test port nipples.

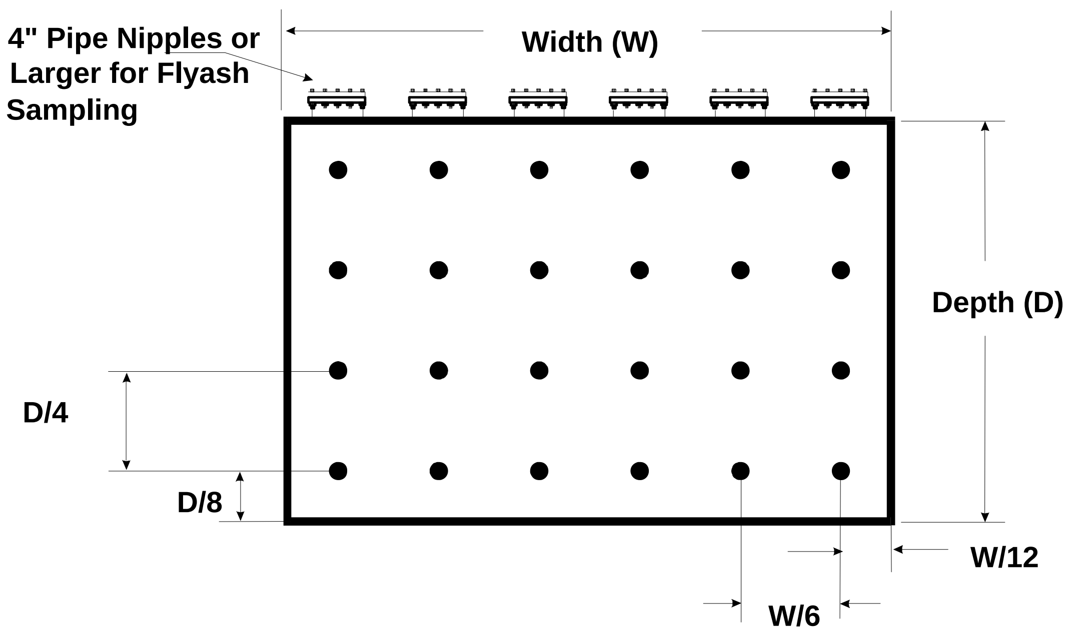

Figure 2 - Example of Equal Area Sampling Grid

1.0 VOLUMETRIC FLYASH SAMPLE COLLECTION AND ANALYSIS

1.2 Performing a Volumetric Flyash Traverse

1.2.1 Test Tap Location and Lay-out

Flyash samples are typically collected at the air pre-heater's gas inlet or gas outlet ducting. The air heater gas outlet is usually the preferred sampling location due to lower gas temperatures, making probe handling easier. Stratifications in ash are also less prominent at the air heater gas outlet due the homogenization effect of the air heaters basket type heating surface. The volumetric flyash sampler's head is 3" in diameter and will require test ports of 4" pipe or larger. Figure 3 illustrates typical locations for collecting a flyash sample.

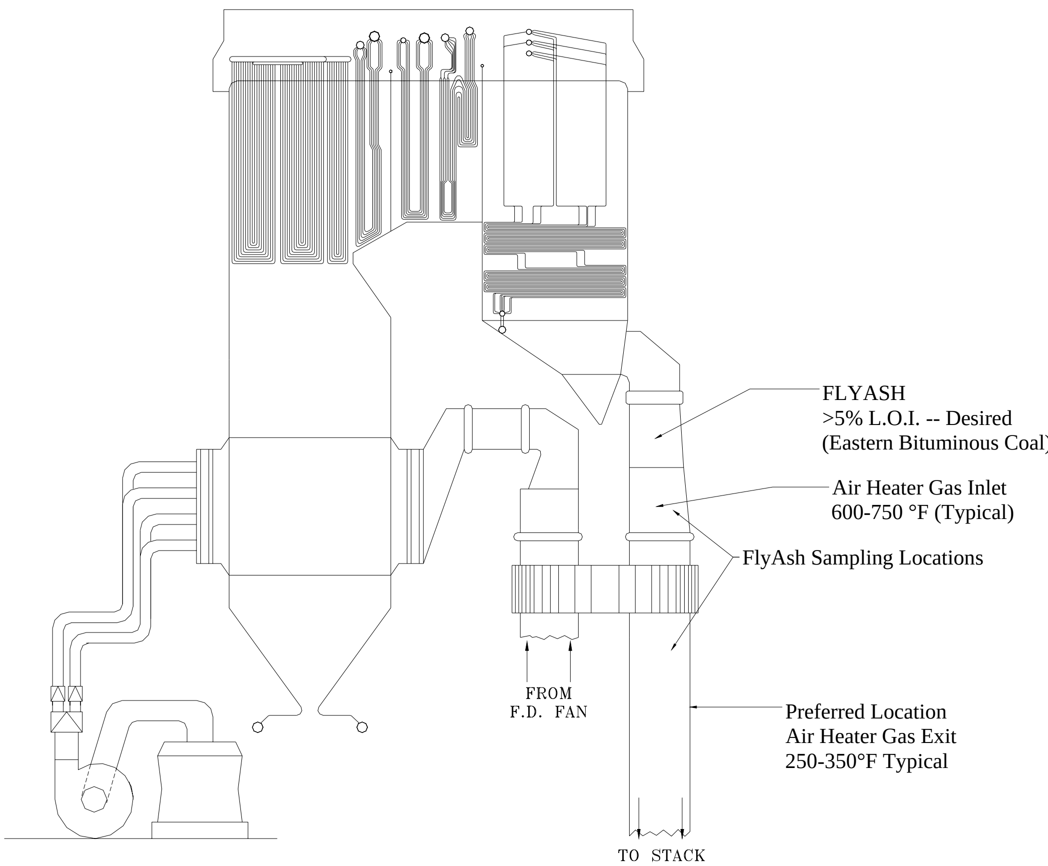

Figure 3 - Typical locations for collection of a flyash sample

1.0 VOLUMETRIC FLYASH SAMPLE COLLECTION AND ANALYSIS

1.2 Performing a Volumetric Flyash Traverse

1.2.2 Equipment

	Quantity	Description
1.	1	Volumetric Flyash Sampler Head w/sampling tip
2.	1	1-1/4" standard pipe threaded on both ends, suitable in length for traversing the depth of the duct - Not provided in kit.
3.	1	Aspirator Assembly (Jet Pump, Bell Reducer, Pressure Gauge, Gate Valve)
4.	Sufficient Number	High Temperature Filter Paper
5.	Sufficient Number	Standard Filer Paper
6.	1	Positioner w/ locking "T-bar"

1.2.3 Equipment Set-up

Assembly of the Probe and Test Equipment

The first step in the procedure is to assemble the probe. The 1¼" pipe is first threaded into the welded coupling on the sampler head. Slide the positioner with locking "T-bar" onto the pipe with the flat edge of the positioner nearest the sampler head. The aspirator assembly is then connected to the other end of the pipe and tightened until either the jet pump tip or chicago fitting end is visually lined up with the sampling tip opening (to be used for referencing the alignment of the tip when the probe is inserted into the duct). All threaded junctions should be effectively sealed by using Teflon tape or similar substitute on the threads. Since the aspirator assembly is out of the duct at all times, we will use it as a reference for keeping the sampling tip directed into the gas flow at all times during sampling.

The final step of the assembly is the loading of the filter paper into the perforated cylinder of the nozzle and inserting the nozzle assembly into the sampling head. Two types of filter paper are supplied with the probe, high temperature Pall filter paper and standard fiberglass filter paper. The Pall filter paper is extremely fragile and as such, we have included standard filter paper to be used as a backing medium in addition to the Pall paper (optional). We have found that by rolling the two filters together, with the high temperature filter paper inside of the standard paper, it is much easier to handle. The standard filter provides strength while the high temperature paper is more efficient in collecting particulate due to its smaller pore openings. Place one sheet of Pall high temperature filter paper lengthwise on top of a piece of standard filter paper, roll the two lengthwise, and insert the rolled papers into the perforated cylinder of the nozzle assembly, making sure that no gaps are present between the bottom of the cylinder and the paper.

Place the cylinder over the nozzle tip assembly, insert the end cap, and tighten the associated wingnut. Insert the "nozzle assembly" into the "sampler head". Align the opening of the nozzle tip with the jet pump tip or chicago fitting and secure with the bolts provided. Traverse points on the probe are to be marked according to PTC 38 for rectangular ducts if possible. Once this is complete, the probe is ready for use.

1.0 VOLUMETRIC FLYASH SAMPLE COLLECTION AND ANALYSIS

1.2 Performing a Volumetric Flyash Traverse

1.2.4 Traverse Procedure

Prior to the test, it is recommended that all test taps be loosened and the interior surface of the ports cleaned to remove any accumulations that could bias the results.

1. The first step in testing is to establish steady state conditions for the unit. All sootblowing should be completed prior to commencement of the testing. The unit will need to remain steady for the duration of the test (approximately 1 hour per duct sampling time will be required).
2. Turn on the air supply and regulate it to maintain approximately 25 psi of pressure at the jet pump inlet. This prevents the negative pressure inside the ductwork from damaging the filter paper once the probe is inserted into the duct. Insert the probe into the duct and position it on the mark providing the deepest depth. By starting at the deepest mark, the probe has some time to cool as it is worked out of the duct and is generally easier to handle when moving between ports. At no time once the air has been turned on, should the tip of the nozzle come in contact with the ground or another surface. The aspirating effect could pick up foreign matter that would contaminate the ash sample.
3. Once the probe is positioned at the first mark, start the stopwatch. Sampling time for each point in the traverse duct will depend on the total number of points and the agreed upon “total” sampling time for each duct. Generally, one hour/duct is adequate time to collect enough sample for analysis. Take care to make sure that the sampling tip is positioned into the flow as the probe is inserted (the direction of the aspirator tip will also help to give relative position and help to keep the probe directed into the flow).

   Note: Never turn off the aspirating airflow while the probe is inserted into the duct. The negative suction on balanced draft units is sufficient to pull all or a part of the sample out of the probe. The probe can be moved from port to port without adjusting the airflow.
4. After all points have been sampled, extract the probe and allow it to cool sufficiently before attempting to dismantle it. Remove the four bolts securing the nozzle assembly to the head. Make sure that you are in a relatively “draft-free” environment before taking the nozzle assembly apart. With the assembly horizontal, remove the wing nut securing the perforated cylinder to the nozzle tip and remove the end cap. Dump the perforated cylinder contents into one of the baggies (labeled with the test number, date, duct sampled, and time). Carefully remove the filter paper from the perforated cylinder, making sure not to tear the paper significantly. Lightly scrap the inside surface of the paper to loosen any ash accumulation that may have bonded to the paper and empty this into the bag. Reload the cylinder with new filter paper, secure the cylinder, and replace the nozzle assembly in the probe head. The probe is then ready for use on the next test.

1.0 VOLUMETRIC FLYASH SAMPLE COLLECTION AND ANALYSIS

1.3 Collection of a dust/gas sample on an "Oil-fired" boiler

Flyash/dust sampling is often useful on "oil-fired" boilers since it provides relevant information on particulate emissions and emission pH levels. The pressure at the inlet of the aspirator is simply set to 25 psi, the probe inserted, set to the first point, nozzle opening directed into the flow, and the stopwatch started. The preparation, test procedures, layout, and number of traverse points for collection of a dust/gas sample from an oil-fired boiler is identical to that of a coal fired boiler. Only the duration of sample times is different. For dust/gas sampling on "oil-fired" boilers, the duration of the sampling is increased to a minimum of two (2) hours for each duct sampled in order to collect enough sample.

One sheet of fiberglass filter paper(Gelman type AE) is place in a Ziploc "baggie" and weighed. The filter paper is then removed, rolled lengthwise, and inserted in the perforated cylinder. The cylinder is then attached to the nozzle tip and the entire nozzle tip assembly inserted into the probe head. The probe is then ready for use.

Once the sampling is complete, the assembly steps are reversed and the filter paper removed from the nozzle tip assembly and bagged. The filter paper, baggie, and sample are then weighed and the difference between the initial and final weights is the amount of dust/gas sample collected. The analysis of the deposits on the filter paper is a means of obtaining a quick overview of combustion characteristics in the furnace. Differences in dust/gas loading between ducts can give a relative indication of combustion efficiencies between furnace left and right sides. In addition, a heavy black deposit of ash on the paper may indicate poor combustion characteristics at the burner front; usually a product of one or more of the following: poor secondary air balance, improper register settings, atomizer pressures, worn, damaged, or clogged oil gun tips, etc. Any of these possibilities would warrant further "specific" testing in order to pinpoint the problem.

1.4 Procedure for Sieving a Flyash Sample

Generally, the ash collected from each duct is divided into two samples. One sample is set aside as the composite sample. The other sample is to be sieved through a 200 mesh screen. Provided there is an adequate amount of total sample, place 40 to 50 grams on top of a stack of 200 mesh and pan and shake on a "Ro-tap" for 20 minutes.

Once the sample has been sieved, the ash passing 200 mesh is to be burned for an L.O.I. (loss on ignition), along with the composite sample. The procedure for burning an ash sample will be discussed later. As a rule of thumb, L.O.I.'s for the ash passing 200 mesh should be no more than 2.0%. L.O.I.'s greater than 2% usually indicate a combustion problem, i.e., insufficient secondary airflows, secondary air imbalance, poor mixing at the burner front, etc.

1.0 VOLUMETRIC FLYASH SAMPLE COLLECTION AND ANALYSIS

1.4 Procedure for Sieving a Flyash Sample

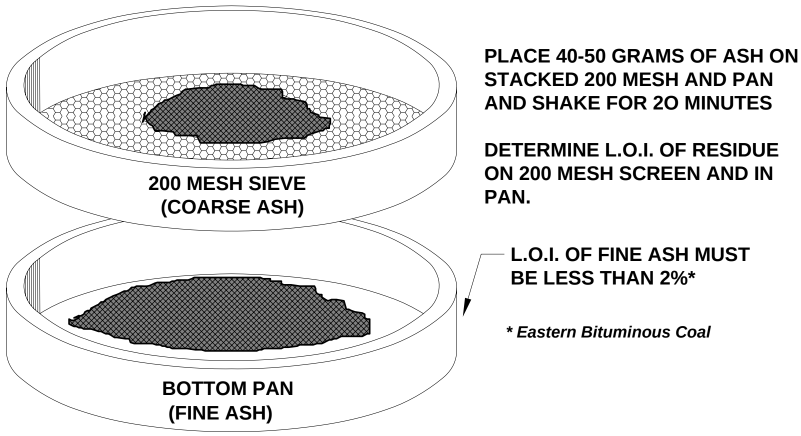

Figure 4 - Sieving of Ash for Fine Particle L.O.I. Determination

1.5 Procedure for Burning a Flyash Sample for L.O.I. Determination

Equipment

- A small oven capable of maintaining temperatures between 300 - 1500 °F
- A set of ceramic crucibles for burning the ash
- A set of pincers or tongs for handling the crucibles
- A highly accurate scale(balance) for measuring the ash samples; the scale should have a readability of 0.1 mg with a repeatability of ± 0.1 mg.

Label each of the crucibles. Then preheat the crucibles to 300 °F for approximately 15 minutes. Weigh each crucible while hot(W_c). Add one gram of the ash to be burned to the crucible as it remains on the scale and record the “sample and crucible” weight. Insert the crucible with the sample into the oven and leave it for 1 hour at between 300 - 500 °F. Remove the crucible with sample and reweigh and record it, comparing the weight to the initial weight. Any difference in the two is the amount of water driven off. Replace the crucible w/sample in the oven at 300 - 500 °F and leave it for 30 minutes. Remove, weigh, and record the crucible w/sample. Continue this process until the weight remains constant. RECORD THIS WEIGHT(W_{CSD}). Replace the crucible w/sample in the oven and cook the sample at 1500 °F for three (3) hours. Remove, weigh, and record the crucible w/sample weight. Replace the crucible w/sample and cook at 1500 °F for 30 minutes. Remove, weigh, and record the crucible w/sample weight. Any difference indicates that there is still carbon present in the ash. Continue this procedure until the weight remains constant(W_{CSFW}). Once the weight no longer changes, the flyash L.O.I. can be calculated using the following equation:

W_{CSD} = Crucible w/sample (dried) weight
W_{CSFW} = Crucible w/sample (final weight)
W_C = Crucible weight

$$\%\ \text{Flyash L.O.I.} = \{[(W_{CSD} - W_C) - (W_{CSFW} - W_C) \times 100]\} \div W_{CSD}$$