INTERNATIONAL STANDARD

**ISO
9931**

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Coal — Sampling of pulverized coal conveyed by gases in direct fired coal systems

Charbon — Échantillonnage de charbon pulvérisé transporté par des gaz dans des systèmes à combustion directe de charbon

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9931 was prepared by Technical Committee ISO/TC 27, *Solid mineral fuels*.

Annexes A, B and C of this International Standard are for information only.

Introduction

This International Standard was developed for use in determining the distribution of pulverized coal between separate burners in a coal-fired power station.

Sampling in accordance with this International Standard can give information about performance characteristics of a pulverized coal firing system, for example

— when commissioning fuel distribution systems and firing systems with a view to equal fuel distribution to the burners;

— when monitoring and adjusting the performance of dividers and baffles in fuel distribution systems;

— when monitoring pulverizer performance for specified particle size.

NOTE 1   The sampler and the sampling method described in this International Standard were developed for the sampling of pulverized coals. However, this does not preclude this International Standard from being suitable for sampling pulverized material other than coal, conveyed by air or other gases in circular pipes. At present, however, no experience or experimental results for pulverized materials other than coal are available.

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Coal — Sampling of pulverized coal conveyed by gases in direct fired coal systems

1 Scope

This International Standard specifies a method which, subject to limitations imposed by the geometry of the pulverized-coal pipe, is applicable to multipoint sampling of pulverized coal suspended in air or other gases conveyed in circular pipes between pulverizer and burners in direct fired coal systems in power stations. The samples collected are used for deriving the mass distribution of coal between the burners and the particle size distribution of the coal, with the object of determining the performance of a pulverizer.

The method is suitable for sampling from vertical circular pipes at, or beyond, a specified distance from a flow disturbance when

— the maximum particle size to be sampled is less than one-third of the diameter of the sampler tip aperture, i.e. less than 1,5 mm (to ensure representative sampling and to avoid clogging of the sampler);

— sampling takes place in a circular pipe with an internal diameter between 250 mm and 700 mm;

— the air/coal ratio in the pipe is within the normal range of direct fired pulverized coal systems.

NOTE 2   If sampling access can only be made at an unsuitable position, depending upon the purpose of the measurement, the equipment may still give satisfactory results. In such positions a more detailed investigation may be necessary. This may involve taking individual samples covering the full cross-section of the pipe using some other method, including a single tip sampler.

2 Principle

A multipoint sampler extracts, in 4 min, one representative sample from 64 sampling points evenly distributed over a cross-section of a circular pipe. Suitable sampling positions are described. The sampler is inserted through a dustless connection into the pulverized fuel pipe. Before and after the sampling period, the sampling equipment is kept clean and heated by backblowing of heated air. The sampling gas velocity is kept constant during the sampling period. The sampled pulverized fuel is separated in a high-efficiency cyclone.
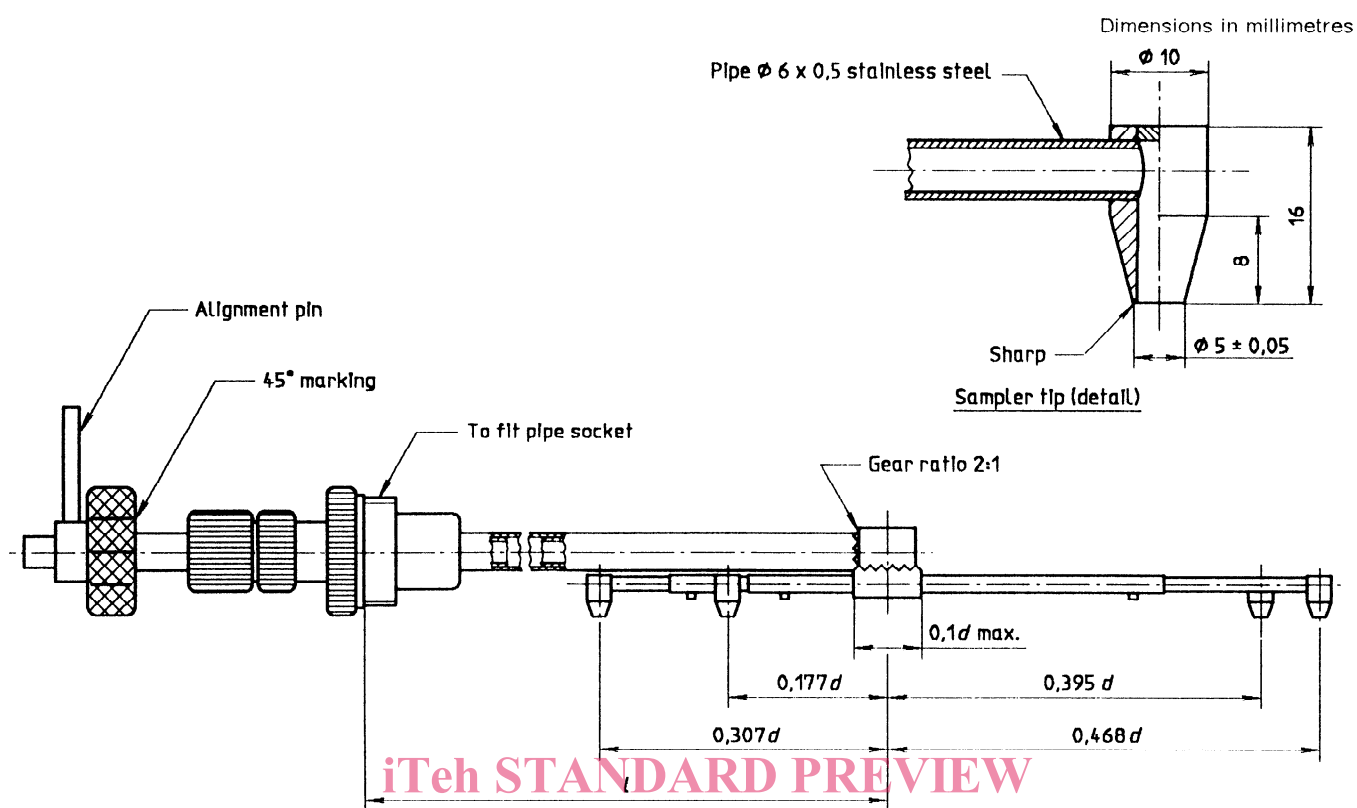
3 Sampling

3.1 Sampling equipment

The sampling equipment consists of a sampler and auxiliary equipment which shall ensure proper taking, separation and collection of the samples.

3.1.1 Sampler

The sampler (see figure 1) is equipped with four sampling tips through which sample material can be simultaneously extracted. The tips are exchangeable, and if a tip is damaged, it shall be replaced.

By means of an angular gear mechanism with a gear ratio 2:1, the sampler tips can be rotated in concentric circles around the sampler head. A dial with eight equally distributed (45°) marks indicates the angular positions of the sampler tips at every 22,5°. When the dial is rotated twice, it gives one full turn of the sampler tips, thus giving 16 angular positions.

The radial positions of the four sampling tips will ensure sampling from equal areas of the cross-sectional area of the pipe (see figure 2). The use of equal time sampling, with the sampler set at the 16 indicated angular positions, thus results in a representative sample being extracted from a total of 64 equal-sized areas of the sampling plane of the pipe.

Dimensions in millimetres

Pipe Ø 6 x 0,5 stainless steel

Ø 10

16

8

Sharp

Ø 5 ± 0,05

Sampler tip (detail)

Alignment pin

45° marking

To fit pipe socket

Gear ratio 2:1

0,1*d* max.

0,177 *d*

0,395 *d*

0,307*d*

0,468 *d*

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Key

d Internal diameter of the pulverized-coal pipe
l Sampler length

Figure 1 — Sampler
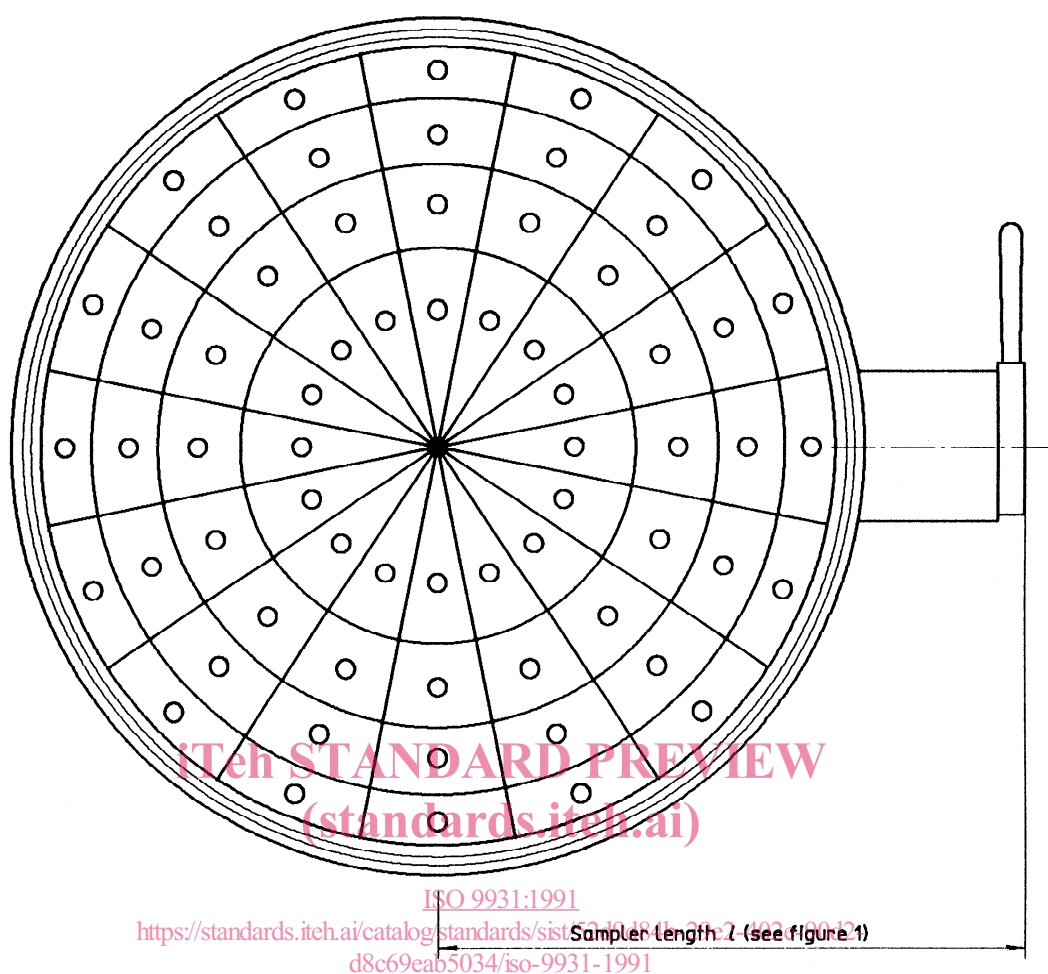
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Sampler length l (see figure 1)

Figure 2 — Sampling network

The sampler is equipped with an adjusting device to ensure that the sampler head can be correctly positioned in the pipe axis during sampling. It is also equipped with extraction pipes that can be adjusted in length, in accordance with the actual pipe diameter to ensure correct sampler tip path.

In addition, the sampler is provided with an outside alignment pin perpendicular to the sampler tip plane. Thus, alignment of the pin with the pipe axis ensures a sampling plane perpendicular to the pipe.

3.1.2 Auxiliary equipment

The auxiliary equipment shall have the following performance characteristics.

a) It shall measure and control the amount of extraction gas taken out during sampling.

b) It shall ensure a well-defined sampling period.

c) It shall be able to separate coal particles from the extracted sample stream with high efficiency.

d) It shall have a receiver for the separated coal sample, the receiver being just adequate to receive the maximum expected volume of sampled coal.

e) It shall ensure that no condensation takes place in the sampling system during sampling.

Suitable auxiliary equipment which meets all these requirements is described in annex A.

3.2 Conditions for sampling

3.2.1 Selection of sampling positions

The precision of the sampling with respect to both mass and particle size distributions depends on the degree of segregation (roping) and swirling in the pipes. The occurrence of both phenomena is significant immediately downstream of a change in flow direction which happens, for example, in bends and pulverizers.

In long horizontal pipe sections, the pulverized coal will tend to separate from the carrier gas thus

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causing the concentration to be much higher along the bottom of the pipe, with a risk of settlement.

These phenomena require careful selection of sampling positions.

The sampling positions in all pipes belonging to the same pulverizer should, if possible, be established in similar places and at the same distances from components which may create disturbances, in order to get the same bias in each of the pipes. See annex B.

The minimum distance from an upstream disturbing component to a sampling position shall be five times the internal diameter of the pipe. The minimum distance to a downstream disturbing component shall be equal to the internal diameter of the pipe. If, because of the configuration, such a sampling position is not attainable, another sampling location, using another sampling method, may be appropriate.

The pulverized coal suspension flow shall not swirl at the sampling position. Swirling can, for example, be caused by a pulverizer classifier.

Where sampling positions have been chosen, the pipes shall be equipped with a pipe socket. The socket axis shall be mounted on the pipe with a maximum deviation of ± 0,35° from radial direction. The socket shall be threaded to suit the plug and the sampler. In the case of positive pressure in the pipe, the socket should be of the dustless connection type to ensure dustfree insertions and removals of the sampler. A suitable dustless connection is described in A.1.1.

3.2.2 Stability of operating conditions

During the total sampling period, the quality of the coal fed into the pulverizer and the gas and coal flow rate to the pulverizer shall be kept constant.

When sampling successively from all pipes belonging to one pulverizer, the results will only be valid if the flow conditions in all pipes are stable during the total sampling period.

3.2.3 Extraction velocity

The sampling shall be carried out at a gas flow through the sampler, to give an average gas velocity through the sampling tip apertures in the range 1,1 ± 0,1 times the mean gas velocity in the coal pipe.

NOTE 3   Due to differences in particle and gas velocities, a sampling gas velocity higher than the mean carrier gas velocity is required. Experience has shown that observance of the requirement given in the previous paragraph results in better samples, both regarding mass and particle size distribution.

3.3 Sampling procedure

3.3.1 Establishing the extraction velocity

First, calculate the mean gas velocity in the pipe at the sampling position. The calculation should be based on

— measurement of the quantity of gas supplied to the pulverizer;

— measurement or estimate of the temperature at the sampling position;

— measurement or estimate of the static pressure at the sampling position;

— estimate of the quantity of evaporated water from the coal-drying process in the pulverizer.

3.3.2 Conditioning and preparation of the sampling equipment

Connect the sampler and auxiliary equipment. Clean and, to avoid condensation, heat the sampling equipment by backblowing (blowing a warm air stream in the direction opposite to that used when sampling).

Adjust the extraction pipes to the correct length according to figure 1.

3.3.3 Insertion of the sampler

During insertion and fastening and until sampling starts, the intrusion of coal particles into the sampling system shall be avoided by continuous backblowing.

Adjust the sampler length (l in figures 1 and 2) so that the sampler head centre is located at a distance of not more than 0,3 % of the pipe internal diameter from the pipe axis when sampling.

Before inserting the sampler, turn the sampler handwheel until the four suction pipes with the sampling tips are aligned with the sampler shaft.

Remove the plug of the sampling pipe socket. If this is a dustless connection, the plug should be removed only after compressed air has been supplied to the connection.

Carefully (to avoid damage to the tips) insert the sampler head through the socket and fasten it to the sampler shaft by means of the union nut. Check that the alignment pin is parallel to the centreline of the pipe.

Close the air supply to the dustless connection, if one is used.

NOTE 4 To ensure clearance between sampler and pipe wall, it is advisable to turn the sampler head one full turn inside the pipe and to leave the handwheel in the starting position.

3.3.4 Taking of the sample

To start sampling, simultaneously start the timer and switch from backblowing to suction at the calculated velocity (see 3.3.1). Keep the extraction gas flow constant during the sampling period by adjusting it.

Sample for 15 s in the first position, turn the handwheel to the next indication mark and continue sampling for 15 s. Repeat the turning and sampling until sampling has taken place in the 16 angular positions.

NOTE 5 If preferred, sampling may also be performed by slow continuous rotation of the sampler head, for example one complete turn in 240 s.

To stop sampling, switch from suction to backblowing.

Depending on the purpose and as appropriate, duplicate samples to assess the repeatability may be taken within close time intervals and unchanged operating conditions.

If the differential pressure of the Venturi decreases during sampling, a check for blockage shall be made by increasing the suction. If the differential pressure does not increase, a blocked tip is confirmed. Abort the sampling test and clear the blockage.

3.3.5 Removal of the sampler and sample

Turn the handwheel to the next indication mark in order to align the four suction pipes with the sampling tips and the sampler shaft.

When using a dustless connection, supply compressed air to it. Unscrew the sampler union nut and remove the sampler carefully. Plug the sampling socket. If this is a dustless connection, stop the air supply to it.

Stop the backblowing and remove the sample bottle from the sampler. If the sample bottle is an integral part of the sampling system, empty it carefully into a sample container.

Close the sample bottle or container with an airtight lid, and mark it for later identification.

Clean the sampling system by backblowing.

The next sample can be taken by starting the procedure from 3.3.3.

4 Sampling report

The sampling report shall include the following information:

a) a reference to this International Standard;

b) time and place of sampling;

c) identification of the operator;

d) sampling conditions, for example coal type, pulverizer operating conditions and readings necessary to calculate the extraction gas flow;

e) sample identification;

f) any unusual and irregular features noted during sampling.

Annex A

(informative)

Description and operation of suitable auxiliary equipment

This annex contains a description of suitable auxiliary equipment which meets the requirements specified in 3.1.2. It also describes the operation of the auxiliary equipment when sampling according to the procedures given in 3.3.

A.1 Description of auxiliary equipment

The auxiliary equipment used should be suitable to withstand the pressure in the pipe at the sampling position.

The arrangement of the sampling equipment is shown in figure A.1. The sampler is described in 3.1.1.

The auxiliary equipment consists of the following parts (the numbers in parentheses refer to those used in figure A.1):

a) dustless connection (1);

b) cyclone (2);

c) sample bottle (3);

d) reinforced hose (4);

e) Venturi nozzle (5);

f) water gauge (6);

g) control valve (7);

h) ejector (8);

i) shut-off valve (9);

j) bypass valve (10);

k) filter (11);

l) air filter (12);

m) electric air-heater (13).

A.1.1 Dustless connection

When sampling from a pipe with positive pressure, a dustless connection should be installed to ensure dustfree insertion and removal of the sampler. A suitable dustless connection is shown in figure A.2.

A.1.2 Cyclone

To ensure the separation of small particles from the sampling stream, a high efficiency cyclone can be used. A suitable cyclone is shown in figure A.3.

The cut-size for the cyclone can be calculated after Perry[1] for the actual air flows. For coal particles with a density of 1 400 kg/m^3, the results are shown in figure A.4.

The efficiency for other particle sizes is calculated after Leith and Licht[2], and the results are shown in figure A.5.

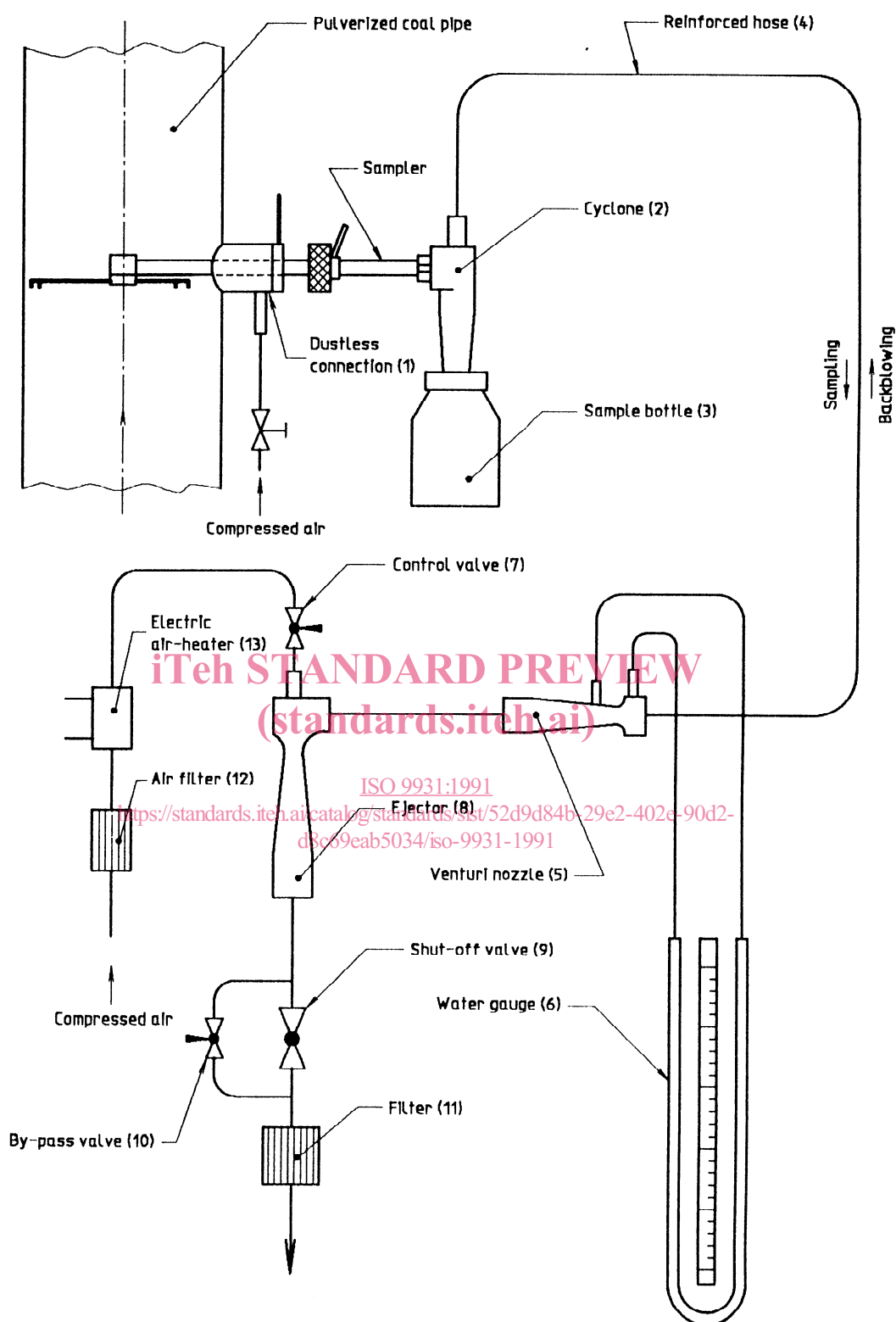A sample bottle lid is fastened to the lower end of the cyclone, enabling the sample bottle to be attached easily.

Figure A.1 — Arrangement of sampling equipment