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Hydrometry — Functional requirements and characteristics of suspended-sediment samplers

Hydrométrie — Spécifications de fonctionnement et caractéristiques des appareils d'échantillonnage pour la détermination des charges sédimentaires en suspension

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 113, *Hydrometry*, Subcommittee SC 6, *Sediment transport*.

This second edition cancels and replaces the first edition (ISO/TS 3716:2006), which has been technically revised. The main changes compared with the previous edition are as follows:

— the Scope has been clarified to include samplers for collecting water-sediment mixtures of rivers, streams, lakes and reservoirs and exclude equipment for sampling closed conduits and wastewater discharges;

— clauses on sampling techniques have been removed;

— the types and models of samplers have been expanded.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Suspended-sediment samplers are used to collect a representative sample of the water-sediment mixture of streams, rivers, lakes and reservoirs. Ideally, the sampler should be able to collect samples that represent the mean concentration of suspended sediment or define the horizontal and vertical variation of suspended-sediment concentration so that the mean concentration can be determined. There are different types of samplers available for collecting suspended sediment, including some that are appropriate for sampling in lakes and reservoirs and others that are used for sampling in streams and rivers. Open containers, vertical and horizontal cylinders, bottle samplers and pumping samplers are used primarily in lakes and reservoirs. Point-integrating samplers, depth-integrating samplers, single-stage samplers and pumping samplers are used primarily in streams and rivers. Only samplers that operate isokinetically can collect unbiased, representative samples of suspended sand-size particles in streams and rivers. Some samplers have also been adapted to enable the collection of clean (uncontaminated) samples of trace metal and organic compounds that are commonly associated with suspended sediment in streams and rivers.

Hydrometry — Functional requirements and characteristics of suspended-sediment samplers

1 Scope

This document specifies the functional requirements and characteristics of the different types of suspended-sediment samplers used for collecting water-sediment mixtures from streams, rivers, lakes and reservoirs.

This document does not include equipment for collecting samples in closed conduits and wastewater discharges.

NOTE The units of measurement used in this document are SI units.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 772, *Hydrometric determinations — Vocabulary and symbols*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 772 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
isokinetic sampling
method of sampling where the intake velocity of the suspended-sediment sampler equals the ambient stream velocity

4 Requirements of samplers

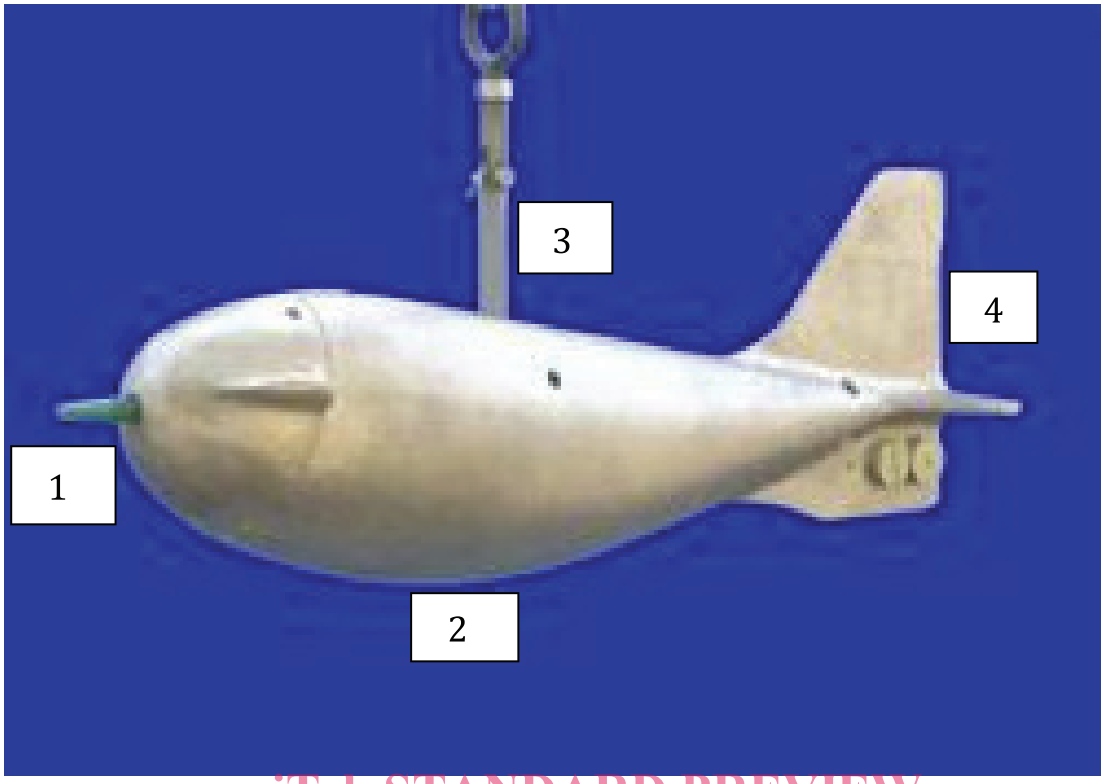
To ensure that the samples taken by a sampler are truly representative of the sediment concentration of a stream at a point of sampling, the ideal sampler shall fulfil the following technical requirements.

a) The sampler shall be streamlined to reduce drag and to minimize disturbances to normal sediment flow. Figure 1 shows an example of a typical streamlined sampler.

b) The velocity of inflow in the mouth of the sampler, nozzle or sampling tube shall be isokinetic or as close as possible to the velocity of the current at the sampling point, irrespective of what this velocity may be or irrespective of what the depth of submergence at this point may be.

c) The mouth/intake of the sampler shall always face into the current at the sampling point.

d) The mouth/intake of the sampler shall be outside the zone of the disturbances of the flow set up by the body of the sampler and its operating gear, and the flow lines shall be disturbed as little as possible, especially near the mouth.



Key

1 nozzle
2 body holding sample bottle
3 hanger
4 tail fin

Figure 1 — Typical depth-integrating sampler

e) Filling arrangements shall be smooth so that there is no sudden inrush of water-sediment mixture; the air escaping from the sampler shall not hinder the entry of the sample; this necessitates a separate port for air exhaust.

f) Point-type samplers shall be able to collect samples at the desired depth without the samples being disturbed or contaminated by the water-sediment mixture at other points while the sampler is being raised or lowered.

g) Point-type samplers shall be able to take a sample exactly when and where it is required.

h) The sampler shall be portable, yet sufficiently heavy to minimize deflection of the supporting cable from the vertical due to current drag.

i) The sampler shall be simple in design and robust in construction and shall require minimum care in maintenance and operation.

j) The removable-type container within the sampler shall be easily removed, readily capped or sealed and easily transported to a laboratory without loss of contents. Alternatively, if the container forms part of the sampler, it shall be installed to secure complete drainage of the contents.

k) The volume of the sample collected by the sampler shall be sufficient for determining the concentration and size distribution of the sediment. The minimum sample size is generally 0,5 l.

l) The sampler shall be able to collect samples of water-sediment mixtures in streams and rivers isokinetically over the depth, width, and velocity conditions to be sampled. If samples cannot be

collected isokinetically because water velocities are lower than the operating limits of sampler or the velocity of the current is not known, large errors in the concentration of sand particles can occur.

5 Characteristics of suspended-sediment samplers

Since the sampling conditions encountered in lakes, reservoirs, streams and rivers vary widely, a single sampler for all the conditions cannot be recommended. Factors such as availability, cost and specific requirements of the sampling also influence the choice of the sampler to a great extent. The different types of samplers include open containers, vertical and horizontal cylinders, bottle samplers, pumping samplers, single-stage samplers, point-integrating samplers and depth-integrating samplers. All these types of samplers can collect a representative sample of the water-sediment mixture in a river or stream under the right conditions, but many of them cannot be used in rivers with swift currents and a non-uniform distribution of sediment concentration. For general use in rivers and streams, isokinetic point-integrating and depth-integrating samplers are recommended. The use of trade, product or firm names in this document is for descriptive purposes only and does not imply endorsement.

6 Types of samplers

6.1 Open containers

This type of sampler consists of an ordinary pail, can or open bottle. The sample is collected by holding the container under the surface of the water or by lowering it to the water surface with a rope or cable. The filled container can be sealed for transport and subsequent analysis or the sample can be transferred into another container that can be sealed. Open-container samplers can only collect a sample at the water surface and do not meet most of the requirements noted in Clause 4. Representative samples are collected only if the water-sediment mixture is thoroughly mixed and contains negligible coarse silt and sand.

It is important to limit any recirculation of water-sediment mixture while obtaining the sample in order to limit sediment settling in the open container resulting in bias (high) errors.

6.2 Vertical and horizontal cylinder instantaneous trap samplers

These samplers (see Figures 2 and 3) are typically made of steel, brass or plastic. They are made in various diameters and lengths. The cylinder is lowered to the desired sampling point with the valves at each end of the cylinder in the open position. The sample is collected by closing the valves and retrieving the cylinder. The valves are actuated by an electrical impulse or by sending a weight down the suspension cable to trip spring-loaded valves. The sample is typically transferred to another container, so the cylinder can be reused.

These samplers can collect samples at specific depths. The samples are instantaneous, rather than integrated over any time or space. Under ideal conditions, they will collect a representative sample, particularly if there is negligible coarse silt and sand. They are well suited to sampling lakes and reservoirs and low velocity conditions in streams and rivers.

These samplers, particularly the vertical cylinders, offer considerable resistance to flow and are only stable at very low velocities. Vertical cylinders cannot sample close to the streambed. Horizontal samplers can sample near the streambed.

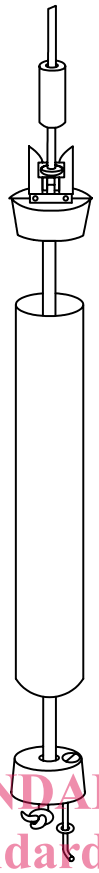


Figure 2 — Kemmerer sampler

Figure 3 — Van Dorn horizontal sampler

6.3 Weighted bottle samplers

There are many different variations of bottle samplers. They generally consist of a weighted container to hold a 0,5 l to 2 l sample bottle. The sampler is lowered to the desired depth by a rope or cable and then the cap is removed from the bottle to collect the sample. Some models have the capability of both opening and closing the bottle cap, so the sample is sealed and no intermixing of the sample with the water-sediment mixture occurs while the sampler is being retrieved.

These samplers are not isokinetic. If there is any intermixing, then concentrations can be biased high because of sediment settling within the sample container. They are sometimes able to collect a representative sample for low velocity, well mixed conditions.

These samplers offer considerable resistance to flow and are only stable at very low velocities. Samples cannot typically be collected close to the streambed. The potential for intermixing of the sample and water-sediment mixture in the river is high for those samplers that cannot be sealed at the sampling point.

6.4 Pumping samplers

6.4.1 General

There are two types of pumping samplers used for collecting suspended-sediment samples: those with a fixed orifice that are operated in automatic mode and those with a moveable orifice that are deployed from a boat, cableway, walkway or bridge.

6.4.2 Fixed-orifice pumping samplers

Fixed-orifice samplers (see Figure 4) are typically used at sites where personnel are not available to take samples manually, such as ephemeral and flashy streams or streams in isolated locations. The orifice is typically located at or near the stream bank. The samplers are powered with line power or batteries, and samples are pumped from the stream to sample containers using a vacuum pump, peristaltic pump or submersible pump.

Sampling initiation and frequency are controlled based on time, stage or a combination of both so that samples can be collected at one interval during low flow and more frequently during high flow. Some samplers can be controlled based on turbidity or discharge volume (to obtain a discharge weighted sample). Modern samplers can be controlled by remote communications where available. Discrete samples can be collected into individual bottles by a movable arm in the sampler, or samples can be composited into a single large bottle. In any case, the sampling initiation and frequency should be designed to obtain samples representative of the conditions to address the sediment issue being studied. In streams and rivers, this requires sampling during rising and falling stages over a range of seasons and flows.

The fixed-orifice samplers are an effective method of collecting samples when personnel are not available for collecting manual samples. However, the samples only represent the suspended-sediment concentration at one point in one vertical of the stream and a correction factor is required to determine the mean suspended-sediment concentration. The location of the fixed orifice should be carefully selected and evaluated to optimize the representative characteristics of samples. If possible, it should not be very close to the channel bed or banks and should be in a location of average concentration. Concurrent samples from the fixed-point pumping sampler and cross-section are needed during installation, to determine how representative the fixed-orifice location is, and periodically over the duration of monitoring to determine and verify the correction factor. Also, the sampler is not isokinetic and can introduce bias errors to sand concentrations. Samples also are subject to evaporation until they are sealed and removed for analysis.

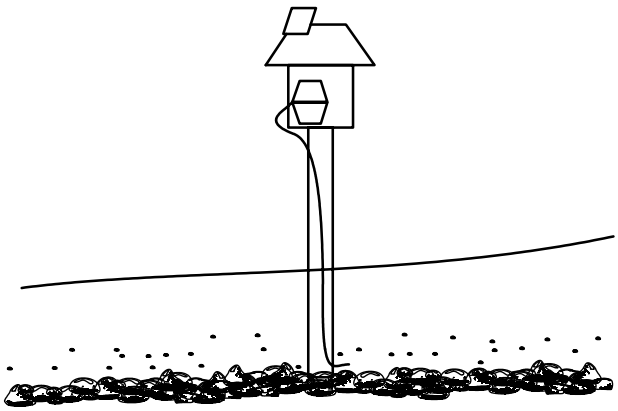


Figure 4 — Diagram of a fixed-orifice pumping sampler