PART I

ENGLISH NARRATION

Sampling for Environmental Monitoring

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SAMPLING FOR ENVIRONMENTAL MONITORING

Analysis Video Series for Environmental Technology Transfer, No. 2

PROLOGUE

Explanation 1

Environmental survey and analysis is among the methods used to obtain objective information on the environment around us. The collecting of appropriate samples which meet survey objectives in an environmental analysis is the key to the obtaining of accurate environmental data.

Explanation 2

Samples which are collected for use in environmental analysis include water, solid material and air samples.

Water samples are collected from rivers, lakes, the ocean, underground water, industrial waste water which is discharged from factories and household waste water.

In addition, various solid samples are collected such as soil, bottom sediment, sludge and solid waste.

Gaseous samples include airborne dust, noxious gases in the atmosphere, soot and dust released from factories, and exhaust from motor vehicles.

This video will focus primarily on the taking of air and water samples, and sampling at the source will also be touched upon.

Explanation 3

It is important to understand the sampling objectives when setting up a sampling plan. For example, is a survey being conducted to comply with regulatory requirements or is it designed to monitor the present pollution conditions.

The survey site must be carefully considered, making sure it is appropriate to meet the survey objectives.

A survey season and period then needs to be set down so that representative samples can be obtained.

The parameters of analysis and the corresponding measurement methods must also be carefully considered to make sure that all requirements are covered without any redundancy.

The success of a survey will depend largely on the accuracy of the sampling design.

Explanation 4

The collection methods and tools to be used will depend on the characteristics of the targeted sample, and it is important to conduct the sampling in accordance with established procedures.

On-site observations can also represent important information for use in later evaluations, and you should make sure to take detailed field notes.

SAMPLING OF WATER

Explanation 5

Let's first look at the sampling methods used in water quality surveys.

Explanation 6

The water quality in rivers and streams is affected by daily human activity, industry and the natural environment itself.

The basic water quality indicators include pH, BOD, COD, dissolved oxygen and turbidity. Cyanides and pesticides can also be considered toxic substances. Important indicators related to eutrophication are nitrogen and phosphorous compounds. Another areas of concern are heavy metals originating from factories and mines.

Explanation 7

Thorough preparation is essential to smooth sampling work on-site. You should bring whatever backups you can. There have been cases where a job could not be completed simply for the lack of a single tool, spare part or reagent. Prepare properly to avoid such incidents.

Explanation 8

The type of sample containers should be selected corresponding to the type of analyses planned.

For example, as can be seen here, plastic and glass bottles of all sizes corresponding to the materials to be analyzed are brought to the site. Samples are placed in the containers and taken back to the laboratory.

Polyethylene bottles are widely used in the collection of COD, BOD and metal samples because they are light and shock resistant. However, the concentration of gases and some liquids can change slightly if stored for a long time in polyethylene containers because they can pass through polyethylene. Also minute amounts of metals and oils can adhere more readily to polyethylene in comparison to glass.

Glass has the drawback that it breaks easily, but it is suitable for use with minute amounts of organic substances and the analysis of trace heavy metals. Amber colored

glass bottles are used for substances which breakdown under exposure to light such as pesticides.

Commercially pre-sterilized bottles are used to collect samples for micro-biological testing such as for coliforms.

When glass containers in stock are used, they are first sterilized in an autoclave.

Explanation 9

Next let's look at the general procedures for collecting river water.

Water samples ideally should be taken on both banks of the river and in the center of the water flow. However when only one sample from a single location is taken, the water should be collected close to the center of the flow from an accessible spot such as on a bridge.

Explanation 10

You should get into the habit of concisely recording the on-site conditions that you observe. Information on the weather and sunlight conditions, condition of the embankments and river bottom together with information on flora and fauna will later serve as a valuable resource for evaluation.

You should measure the flow velocity, as necessary, and the width and depth of the river.

Explanation 11

Equipment which is easy to use on-site such as a bucket with a rope attached or scoop should be used to collect surface water. Make sure to collect water that does not contain mud when the river bed is shallow.

Record the color, turbidity, and the presence of suspended solids and sediment in the collected sample.

Explanation 12

Water temperature is normally measured with a glass thermometer immediately after the sample is collected or by directly measuring the sampled body of water on-site. A large sample should be collected when using a bucket to avoid the effects of air temperature. The thermometer should be inserted up to the upper edge and allowed to stand five minutes before taking a reading.

Explanation 13

A basic water quality parameter is the hydrogen ion concentration index or pH. pH is often measured these days with a portable pH meter.

These on-site measurements will constitute the basic parameters used to evaluate whether an appropriate water sample has been taken. So let's make sure everything is done correctly.

Explanation 14

Rinse out the inside of the bottles on-site several times using a small amount of the collected water. The amount of water to be collected will be determined based on the survey objectives and the amount required for analysis. More than enough water should be collected just in case an analysis has to be redone.

The sample containers should be labeled with a number or affixed with a label that cannot be removed so that the collection site and sample number can be identified on site.

Explanation 15

Water samples that are to be used to measure dissolved oxygen should be collected in such a way that contact with air is minimized.

The sample is poured in so as not to form air bubbles and the inside of the bottle is washed out.

Next the sample is gently poured into the container so that bubbles on the sides of the bottle are removed. Also tap the side of the bottle to fully ensure that all bubbles are disappeared.

A magnesium sulfate solution and potassium iodide-sodium azide solution are added to fix dissolved oxygen in the sample.

The solution is overflowed to remove air, a stopper is inserted, and the bottle repeatedly turned upside down to mix the solution.

Explanation 16

Since metals can adhere to the side of the sample containers, nitric acid or hydrochloric acid is added to set the pH at 1 and the sample is stored.

In addition, a small amount of sodium hydroxide is added to samples to be used in the analysis of cyanides.

Samples to be used in the analysis of BOD, COD, nitrogen oxides and phosphorus compounds should be transported in a cooler or polystyrene box containing ice or a coolant. These samples should be analyzed immediately after delivery to the laboratory.

Explanation 17

Turbidity can be measured using a variety of methods. The simplest way is to measure the transparency.

First put the water sample into a transparency meter. Then slowly release the water sample while observing it from directly above.

Stop draining the water when the two lines which form a cross on the bottom can be clearly distinguished. The depth at this moment should be recorded in centimeters. This method is appropriate for use when the turbidity is relatively high.

Explanation 18

An Ekman Barge dredger is used in the sampling of the river bottom and three or more samples are collected.

The collected samples taken back to the laboratory should weigh about 1 kilogram.

Explanation 19

Next let's take a look at collecting bottom layer water in lakes and seas.

A Vandorn water sampler which is lowered to the desired depth is used in the collection of bottom layer water. Next a messenger is dropped and the lid of the water sampler is closed.

After retrieving the water sampler, the cock on the rubber tube is opened and the sample transferred to another container.

Explanation 20

The transparency of lake and sea water is determined by immersing a white secchi plate with a diameter of about 25 to 30 centimeters in the water, and recording the depth in meters at which it cannot be seen.

Explanation 21

The sampling of water discharged from plants and businesses is generally conducted in drainage channels, pits and discharge ducts just prior to the release of the water into the river or sewer system.

The tools, containers and procedures used in the collection of these samples is almost the same as those used in environmental water sampling. The collection time should be set, taking into consideration the plant operation, and a typical discharge sample should be collected.

SAMPLING OF AMBIENT AIR

Explanation 22

A wide variety of pollutants are present in the air that we breathe. These pollutants include both those generated by the natural world and those generated by human activity. Some are present in the form of gases and others are suspended in air in the form of particulate matter.

Explanation 23

Sampling of noxious gases found in small amounts in the atmosphere is usually conducted either by collection using an absorbing solution or collection using a solid adsorbent. Let's look at the guidelines for basic on-site handling.

Explanation 24

Different absorbents are placed in a gas absorption bottle such as an impinger corresponding to the targeted compounds.

The suction tube is connected to a trap, pump and gas meter, and a fixed amount of air is drawn into the system.

Explanation 25

A method employing an adsorbent-packed cartridge tube is often used in the capture of gases such as hydrocarbons and formaldehyde.

A moisture absorption tube is attached in front of the cartridge tube during sampling and air is sucked in using a pump.

Explanation 26

Gases that are difficult to capture with an adsorbent are collected with a vacuum canister.

Collection via a bag using a pump is also an option.

Explanation 27

Different types of pumps such as a diaphragm pump, linear pump and rotary pump are used in the collection of air samples.

Explanation 28

The volume of air, which has been sampled, must be measured when determining the concentration of matter in air. Air volume data is an important factor which determines the final concentration value.

An integrating gas meter and a float flow meter are used in the measurement of air volume.

There are two types of gas meters available, wet and dry.

The wet gas meter is highly precise, and is often used as a reference device. However it is fragile and takes some effort to use because it contains water.

The dry gas meter is easy to operate and widely used in actual sampling. However it must be regularly calibrated using a reference device.

Explanation 29

If a reading of the gas meter is taken when sampling is started, then the volume can be calculated by determining the difference with the final reading.

To calculate the suction flow rate, you should measure the number of seconds required for the needle to rotate once several times using a stopwatch.

Explanation 30

In the regulation of the suction flow rate, a direct reading can be obtained for the flow rate if a float rotor meter is installed.

The rotor meter gives different values based on the pressure conditions or the pulsation depending the suction pump which is used. A scale calibration must be conducted in advance under the same conditions and using the same devices as the actual sampling.

Explanation 31

Particulate matter is sampled by filtration using a filter paper. The simplest method is inserting circular filter paper to the filter paper holder and drawing in air.

This is where the filter paper is inserted in the low volume air sampler filter holder.

The filter holder is normally set up at 1.2 meters above ground.

Explanation 32

Appropriate tubes that do not bend or break are used to connect the sampler, flow meter and pump. In addition, the tube should be firmly connected so that air does not leak at the connection points or come off during sampling.

Explanation 33

Take care to make sure that rain water does not get into the switch or connections of the electrical cords.

Explanation 34

A high volume sampler can collect a large volume of soot and dust in a short period of time, thus it is frequently used in surveys of the ambient air.

High volume air samplers come in two types. One sampler is equipped with a separator that allows only particles smaller than 10 μm or 2.5 μm to pass through. The other sampler, an open face type, allows all particles to pass through.

Explanation 35

The sampler is placed in an appropriate location where the wind passes through, and it is fixed in place with heavy weights or rope.

If the electrical cord is extended with a cord reel, make sure to fully unroll the cord because excess heat can be generated by the induced current if it is not.

Explanation 36

A glass fiber filter or quartz fiber filter are used in the collection of airborne dust.

Once a filter is inserted in the holder, the blower motor is turned on, and the volume controller adjusted to a set suction flow rate.

The pre-sampling filter and post-sampling filter are weighed on a balance after humidification for more than a day and a constant weight achieved.

Explanation 37

A diffusion sampler is an extremely effective device when there is no on-site power source or sampling is being performed simultaneously at multiple sites.

There are several different types of diffusion samplers, but in all cases the gas molecules pass through pores and fine crevices until they reach the absorbent and are collected by the chemical reaction.

These samplers are simple and compact. They do not require a pump and can be used to quantitatively collect the target material by placing it in a shed to avoid rain and direct sunlight and exposing it to the atmosphere for a fixed period.

SAMPLING OF FLUE GAS

Explanation 38

A measuring hole and work place are required in the sampling of flue gas from facilities such as factories which emit soot and smoke.

This is an example of a stack in an incinerator. The measuring hole should be placed at a straight part of the stack where it is thought that the flue gas flow is steady and uniform.

Explanation 39

The measuring hole should be set up in a location where work can safely be done and a suction tube can be inserted at a right angle into the flow of the flue gas. Normally the hole is covered with a lid.

The flange bolt on the measuring hole is removed, and the lid taken off when the flue gas is measured.

Explanation 40

Sulfur oxides in the flue gas are collected by drawing the flue gas into an absorption bottle containing hydrogen peroxide.

The sample gas is drawn for 20 to 30 minutes at a flow rate of approximately 1 liter per minute.

A ribbon heater is wrapped around the sampling tube to warm it and prevent the condensation of moisture on the inside of the tube.

Explanation 41

The sampling of nitrogen oxides in flue gas is done by collecting the gas using a vacuum flask or syringe. The vacuum flask contains acidic hydrogen peroxide with sulfuric acid for the oxidation of the nitrogen oxides.

As always, the concentration of nitrogen oxides in flue gas is converted based on the standard oxygen concentration in order to compensate for the effects of dilution through the mixing of air. The oxygen concentration in flue gas is measured for this reason.

Explanation 42

The measurement of dust and soot is performed by filtration using a filter and measuring the weight.

Circular or cylindrical filter paper is used corresponding to the amount of soot and dust to be collected.

Explanation 43

Care must be taken that the suction velocity of the collection nozzle and velocity of the flue gas flow correspond when drawing in soot and dust. This is called isokinetic sampling.

For this purpose, the flue gas flow velocity is measured with a Pitot tube and manometer.

This type of special Pitot tube is normally used in the measurement of duct flue gas.

The dynamic pressure created by the flow of the flue gas is measured using an inclined manometer and the flow velocity is calculated.

Explanation 44

The moisture content in the flue gas must be measured in the measurement of the soot and dust concentration. The flue gas is drawn in through a moisture absorption tube containing calcium chloride and the moisture is absorbed.

The weight of the moisture absorption tube is measured on a druggists' scale, and the moisture content is calculated based on the change in weight.

When collecting a sample using circular filter paper, a pre-weighed filter paper is set in the holder.

A nozzle that meets the isokinetic sampling conditions is attached and wrapped with tape to make sure it does not come loose.

A collection tube with a filter paper holder at the tip is inserted through the measuring hole to a set length within the duct and fixed into place.

A suction pump is connected and the sampling begun.

The filter holder is allowed to cool after the sampling is completed and the circular filter paper removed.

EPILOGUE

Explanation 45

Sampling is the starting point for an objective approach to environmental problems.

If sampling is not done properly, then the data gathered will be meaningless no matter how sophisticated the equipment used, how expert the laboratory technician or how accurate the analysis. It does not stop there, erroneous conclusions could be drawn and misguided decisions could be made.

Explanation 46

Above all, regular observation of the survey field and careful sampling are important. An adequate advance survey, comprehensive sampling design and in-depth preparation are critical to successful environmental analysis. Researchers themselves must be sufficiently familiar with the sampling site, and fully understand the entire process from sampling, analysis through to conclusion.