

# INTERNATIONAL STANDARD

**ISO  
10715**

First edition  
1997-06-01

---

---

## Natural gas — Sampling guidelines

*Gaz naturel — Lignes directrices pour l'échantillonnage*

**iTeh STANDARD PREVIEW**  
**(standards.iteh.ai)**

ISO 10715:1997

<https://standards.iteh.ai/catalog/standards/sist/8f7ddf1-6c54-44b0-aaa9-9c7fcd457963/iso-10715-1997>



Reference number  
ISO 10715:1997(E)

**Contents**

<b>1 Scope</b> .....	<b>1</b>
<b>2 Definitions</b> .....	<b>1</b>
<b>3 Principles of sampling</b> .....	<b>3</b>
<b>4 Safety precautions</b> .....	<b>5</b>
<b>5 Technical considerations</b> .....	<b>7</b>
<b>6 Materials used in sampling</b> .....	<b>10</b>
<b>7 General preparation of equipment</b> .....	<b>11</b>
<b>8 Sampling equipment</b> .....	<b>12</b>
<b>9 Spot sampling</b> .....	<b>18</b>
<b>10 Direct sampling</b> .....	<b>19</b>
<b>11 Incremental sampling</b> .....	<b>21</b>
<b>ITeH STANDARD PREVIEW</b> <b>(standards.iteh.ai)</b>	
<b>Annexes</b>	
<b>A Use of a block valve in direct sampling</b> .....	<b>23</b>
<b>B Cleaning of steel sampling cylinders</b> .....	<b>25</b>
<b>C Procedure for low-pressure sampling into glass cylinders</b> .....	<b>26</b>
<b>D Procedure for sampling by the fill-and-empty method</b> .....	<b>28</b>
<b>E Procedure for sampling by the controlled-rate method</b> .....	<b>30</b>
<b>F Procedure for sampling by the evacuated-cylinder method</b> .....	<b>32</b>
<b>G Guidelines for the calculation of the residence time</b> .....	<b>34</b>
<b>H Student's <i>t</i>-table</b> .....	<b>38</b>
<b>J Bibliography</b> .....	<b>39</b>

© ISO 1997

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Organization for Standardization  
Case postale 56 • CH-1211 Genève 20 • Switzerland  
Internet: central@iso.ch  
X.400: c=ch; a=400net; p=iso; o=isocs; s=central

Printed in Switzerland

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 10715 was prepared by Technical Committee ISO/TC 193, *Natural gas*, Subcommittee SC 1, *Analysis of natural gas*.

Annexes A to J of this International Standard are for information only.

## iTeh STANDARD PREVIEW (standards.iteh.ai)

ISO 10715:1997

<https://standards.iteh.ai/catalog/standards/sist/8f7ddf1-6c54-44b0-aaa9-9c7fd457963/iso-10715-1997>

## Introduction

This International Standard provides guidance on all aspects of the sampling of processed natural gas. Unless otherwise stated, all pressures up to 15 MPa in this International Standard are given as gauge pressures.

The determination of the composition and the properties of the gas is highly dependent on the sampling technique. Also of great importance are the design, construction, installation and maintenance of the sampling system as well as the conditions of sample transfer and transport.

These guidelines cover sampling strategy, details of sampling methods, the choice of sampling method and sampling equipment.

This document is intended for use in those cases where sampling is not described as part of the analytical procedure.

This document concentrates on sampling systems and procedures. Analyses from the samples collected using these systems and procedures may be utilized in many different ways, including calculations to determine the calorific value of the gas stream, identification of contaminants contained in the gas stream, and compositional information to determine whether or not the stream meets contractual specifications.

## iTeh STANDARD PREVIEW (standards.iteh.ai)

[ISO 10715:1997](https://standards.iteh.ai/catalog/standards/sist/8f7ddf1-6c54-44b0-aaa9-9c7fcd457963/iso-10715-1997)

<https://standards.iteh.ai/catalog/standards/sist/8f7ddf1-6c54-44b0-aaa9-9c7fcd457963/iso-10715-1997>

# Natural gas — Sampling guidelines

**WARNING** — The use of this International Standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability or regulatory limitations prior to use.

All sampling activities shall comply with local safety regulations.

## 1 Scope

The purpose of this document is to provide concise guidelines for the collection, conditioning and handling of representative samples of processed natural gas streams. It also contains guidelines for sampling strategy, probe location and the handling and design of sampling equipment.

It considers spot, composite (incremental) and continuous sampling systems.

This document gives consideration to constituents such as oxygen, hydrogen sulfide, air, nitrogen and carbon dioxide in the gas stream.

This document does not include sampling of liquid streams or streams with multiphase flow.

Traces of liquid, such as glycol and compressor oil, if present, are assumed to be intrusive and not a part of the gas to be sampled. Their removal is desirable to protect the sampling and analytical equipment from contamination.

This document can be used for custody transfer measurement systems and allocation measurement systems.

## 2 Definitions

For the purposes of this International Standard, the following definitions apply:

### 2.1 direct sampling:

Sampling in situations where there is a direct connection between the natural gas to be sampled and the analytical unit.

### 2.2 floating-piston cylinder:

A container which has a moving piston separating the sample from a buffer gas. The pressures are in balance on both sides of the piston.

### 2.3 flow-proportional incremental sampler:

A sampler which collects gas over a period of time and at a rate that is proportional to the flow rate in the sampled pipeline.

### 2.4 high-pressure natural gas:

Natural gas with a pressure exceeding 0,2 MPa.

NOTE — The maximum for this International Standard is 15 MPa.

**2.5 hydrocarbon dew point:**

The temperature, at a given pressure, at which hydrocarbon vapour condensation begins.

**2.6 incremental sampler:**

A sampler which accumulates a series of spot samples into one composite sample.

**2.7 indirect sampling:**

Sampling in situations where there is no direct connection between the natural gas to be sampled and the analytical unit.

**2.8 liquid separator:**

A unit, in the sample line, used to collect liquid fall-out.

**2.9 low-pressure natural gas:**

Natural gas having a pressure between 0 and 0,2 MPa.

**2.10 purging time:**

The period of time during which a sample purges a piece of equipment.

**2.11 representative sample:**

A sample having the same composition as the natural gas sampled when the latter is considered as a homogeneous whole.

**2.12 residence time:**

The time it takes for a sample to flow through a piece of equipment.

**2.13 retrograde condensation:**

Retrograde behaviour describes the non-ideal phase properties of hydrocarbon gas mixtures, such as natural gas. Retrograde condensation is the production of a liquid phase of heavy hydrocarbons at a particular pressure and temperature where, at that same temperature, the gas stays in a single phase at a higher pressure as well as at a lower pressure.

<https://standards.iteh.ai/catalog/standards/sist/8f7ddfe1-6c54-44b0-aaa9-9c7fd457963/iso-10715-1997>

NOTE — See also 5.2.

**2.14 sample container:**

A container for collecting the gas sample when indirect sampling is necessary.

**2.15 sample line:**

A line provided to transfer a sample of the gas to the sampling point. It may include devices which are necessary to prepare the sample for transportation and analysis.

**2.16 sample probe:**

A device inserted into the gas line to be sampled and to which a sample line is connected.

**2.17 sampling point:**

A point in the gas stream where a representative sample can be collected.

**2.18 spot sample:**

A sample of specified volume taken at a specified place at a specified time from a stream of gas.

**2.19 transfer line:**

A line provided to carry the sample to be analysed from the sample point to the analytical unit.

**2.20 water dew point:**

The temperature, at a given pressure, at which water vapour condensation begins.

### 3 Principles of sampling

#### 3.1 Sampling methods

The main function of sampling is to take an adequate sample that is representative of the gas.

The main distinction in sampling is between direct and indirect sampling methods.

In the direct sampling method, the sample is drawn from a stream and directly transferred to the analytical unit.

In the indirect sampling method, the sample is stored before it is transferred to the analytical unit.

The main classifications of the indirect sampling method are spot sampling and incremental sampling.

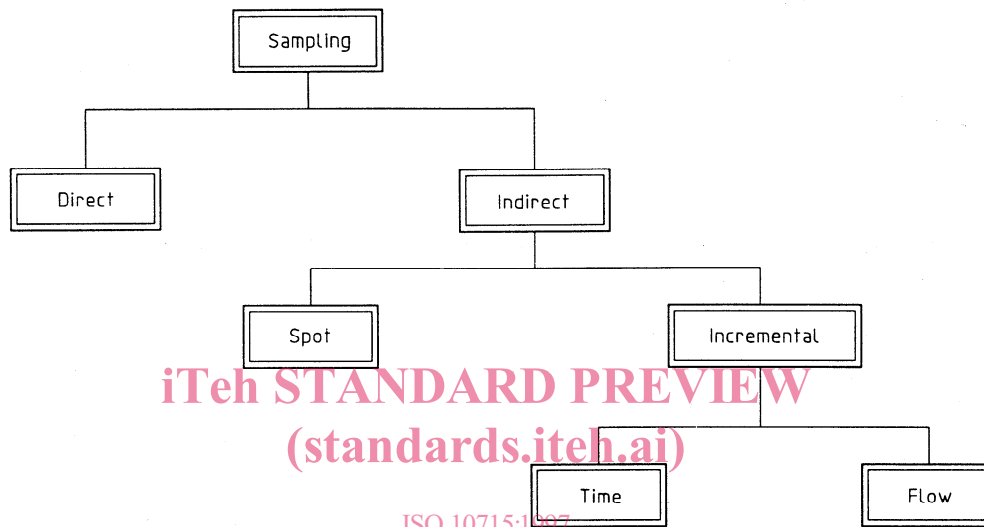


Figure 1 — Survey of direct and indirect sampling methods

The information needed from the analysis of natural gas falls into two basic categories: averaged and limit values.

##### 3.1.1 Averaged values

A typical example is the calorific value. Custody transfer requires the time- or flow-averaged calorific value. Commercial agreements determine the period and method of averaging.

##### 3.1.2 Limit values

Most gas custody transfer contracts contain specification limits on composition or on gas properties. Direct sampling can be applied, but often the requirements are such that also indirect sampling has to be applied.

#### 3.2 Sampling frequency

This subclause gives guidelines for the establishment of the sampling frequency. Mostly the sampling frequency is a matter of common sense. Information on the properties of the gas stream in the past and about expected (systematic) future changes determines the sampling frequency.

Generally, pipeline gas composition will have daily, weekly, monthly, semi-annual and seasonal variations. Compositional variations will also occur because of gas treatment equipment and reservoir changes. All of these environmental and operational considerations shall be taken into account when selecting a sampling interval.

The statistical approach in this paragraph is only intended to support the common-sense approach.

In this context, the required sampling frequency is the number of samples to be taken in a certain period of time in order to obtain meaningful results.

The formula for calculating the number of samples is:

$$n^{\frac{1}{2}} = t \times \frac{s}{d}$$

where

$d$  is the error margin required;

$n$  is the number of samples;

$s$  is the standard deviation;

$t$  is Student's  $t$ -factor (see table H.1 in annex H).

This equation shall be solved by iteration: an initial value of  $t$  is estimated, and used to calculate a revised value of  $n$ , which is used, in turn, to give a new value of  $t$ . The error margin, the number of samples and the standard deviation shall be taken over the same period of time.

### 3.2.1 Error margin

There are two different cases of error margins. One case is related to the determination of averaged values. In most custody transfer contracts, these values are given as an indication of the accuracy.

The other is related to the determination of limit values. Custody transfer contracts specify the limits but rarely give an indication of the accuracy. In these cases, the difference between the last measured value, or the last year's average, and the limit value is the error margin.

### 3.2.2 Number of samples

The number of samples is the number of samples to be taken in a defined period. It is equivalent to the number of partial samples in incremental sampling.

### 3.2.3 Student's $t$ -factor

Student's  $t$ -factor allows for the finite sample size, and is to be found in standard statistical tables. The value depends on the claimed certainty (typically 95 %) and the "degrees of freedom", here to be taken as the number of measurements minus one ( $n-1$ ).

#### EXAMPLE 1

##### Determination of the monthly average caloric value

$d = 0,4 \%$  (error margin required from custody transfer contract for monthly averaged value)

$s = 0,6 \%$  (estimated variation over a one-month period)

First estimate, taking  $n = 7$ :

$t = 2,45$  for 6 degrees of freedom and a certainty of 0,975 single-sided (equals 0,95 double-sided)

$$n^{\frac{1}{2}} = 2,45 \times \frac{0,6}{0,4}$$

$$n = 14$$

First iteration, taking  $n = 14$ :



recalculate for

$t = 2,16$  for 13 degrees of freedom, and a certainty of 0,975 single-sided (equals 0,95 double-sided)

$$\frac{1}{n^2} = 2,16 \times \frac{0,6}{0,4}$$

$$n = 11$$

Second iteration, taking  $n = 11$ :

recalculate for

$t = 2,23$  for 10 degrees of freedom, and a certainty of 0,975 single-sided (equals 0,95 double-sided)

$$\frac{1}{n^2} = 2,23 \times \frac{0,6}{0,4}$$

$$n = 11$$

## EXAMPLE 2

### Total sulfur determination

Last measured concentration  $20 \text{ mg/m}^3$  and the contract limit value  $50 \text{ mg/m}^3$

$d = 30 \text{ mg/m}^3$  (difference between limit value from custody transfer contract and last measured value)

$s = 10 \text{ mg/m}^3$  [standard deviation in spot sample results (in the past year)]

$t = 4,30$   $n - 1$  taken as 2, level of certainty 95% <https://standards.iteh.ai/catalog/standards/sist/8f7ddf1-6c54-44b0-aaa9-63/iso-10715-1997>

$$\frac{1}{n^2} = 4,3 \times \frac{10}{30}$$

$$n = 2$$

Three samples are enough. Recalculation indicates that two samples are not enough.

## 4 Safety precautions

### 4.1 General

Sampling and sample handling shall follow all relevant national and company-related safety regulations.

In the case of inadequate regulations, those responsible for sampling shall establish detailed procedures. Specifications for equipment shall also be established.

Personnel involved shall be properly trained and educated to a level such that they are able to take necessary responsibility.

### 4.2 Personnel

The person responsible for the department/section which is to perform the sampling shall be satisfied that the sampling can be performed within relevant safety regulations.

Those performing sampling or installing sampling equipment shall have the necessary training and education to evaluate potential safety hazards in general.

The above personnel shall have the authority to prevent sampling or installation of sampling equipment which is unsuitable or unsafe.

### 4.3 Equipment

Equipment used in the sampling of high-pressure natural gas shall be inspected and recertificated if required regularly.

Documentation shall be available and up to date.

Equipment shall be designed to meet relevant sampling conditions, e.g. pressure, temperature, corrosivity, flow, chemical compatibility, vibration, thermal expansion and/or thermal contraction.

Glass cylinders shall not be exposed to pressure.

If provided for, end caps shall be installed on cylinders during transportation and storage.

Cylinders shall have volume, working pressure and test pressure permanently stamped.

Cylinders shall have a test pressure of at least 1,5 times the working pressure.

Cylinders shall be protected against damage during transportation and storage. Transportation boxes or cartons designed for the individual type of cylinder shall be available.

Cylinders shall be accompanied by labels or paperwork with relevant information protected against damage.

Cylinders and associated accessories shall be inspected and leak-tested periodically.

Permanent transfer and sampling lines shall be properly secured. Breakable connections shall have easy access for leak-testing. Outlets shall be equipped with double block and bleed valves. End caps shall be connected to fittings when the cylinders are not in use.

The use of flexible high-pressure tubing shall be limited and manufacturers' instructions for safe application shall be strictly followed. Transfer lines can be blocked by solid or liquid contaminants. Special precautions shall be employed when trying to "reopen" such lines. Only qualified personnel may do this.

Transfer lines shall have shut-off valves located as close to the source stream as possible. The sampling probe shall be equipped with a shut-off valve.

Electrical equipment shall be approved for the relevant sampling application.

Equipment which can create static electricity shall be avoided.

Use of equipment or tools which may create sparks shall be avoided.

### 4.4 Flammability

In order to prevent fire or explosions, the following restrictions shall be followed within areas where flammable concentrations of gas (about 4% to 16% for natural gas) may be found:

No open fire

No smoking

No use of equipment and tools which may create sparks

No use of equipment which operates at temperatures above the self-ignition temperature of gas mixtures, mostly above 400 °C (for natural gas)

No use of chemicals which can react vigorously with gas

No running spark ignition motors

Ventilation shall be sufficient to prevent the build-up of a flammable atmosphere.

Purging of transfer lines shall be directed to a "safe area" (e.g. flare). Release of gas during manual (spot) sampling shall be limited to a minimum at the sampling location.

Gas detectors shall be used at strategic locations relative to sampling locations.

Manual and/or automatic firefighting equipment shall be easily available.

Personnel performing sampling shall be trained to react appropriately in the event of a fire.

#### 4.5 Personal protective equipment

Necessary personal protective equipment shall be available. The need for protective equipment will vary from place to place. The following factors shall, however, be considered:

Toxic or irritant components in the gas (H<sub>2</sub>S, radon, Hg, aromatics, etc.) may require the use of breathing filters, a fresh-air supply, gloves and monitors for toxic components.

Sampling of high-pressure gas may require the use of goggles or face shields. Pressure indicators (gauges) shall be used to indicate the system pressure. Leak detector spray or a portable leak detection device shall be used to check that the system is leaktight.

For fire protection, personnel shall wear flame-resistant clothing (aprons, coveralls, lab dress). Personal smoke protection masks shall also be available.

#### 4.6 Transportation

Sample cylinders containing gas under pressure shall be transported in accordance with relevant regulations.

Constant-pressure-type cylinders shall always be protected in some kind of transportation container. Damage to the cylinder itself and/or to valves, gauges, etc., may otherwise occur.

During transportation, the cylinder shall also be protected against conditions of temperature which could create overpressure or condensation of sample.

The container shall be properly labelled in accordance with applicable regulations.

### 5 Technical considerations

#### 5.1 Flow characteristics

Flow in a pipeline may be laminar or turbulent. However, in the sampling system, laminar flow shall be avoided. It can be single-phase or multiphase. Most gas streams operate with turbulent single-phase flow. Two-phase turbulent flow may also be found in gas lines where the fluid is near saturated conditions.

For example, the flow from a gas/liquid separator will be near the gas dew point, and a reduction in line temperature will cause some condensation to occur, resulting in two-phase flow.

It can also happen that, after a mixing station, the combined gases are not completely mixed in the pipeline.

If the composition is not completely homogeneous, a static mixer will improve the homogeneity.

### 5.1.1 Laminar flow

Laminar flow will not normally occur in a gas line because the gas viscosity is low and the flow velocities are high enough to ensure that this will not happen. However, the design of the sampling system shall be such that laminar flow is avoided.

### 5.1.2 Turbulent flow

In general, turbulent flow is advantageous in a sampling system and in the gas line to be sampled because the turbulence creates a well-mixed fluid.

### 5.1.3 Two-phase flow

Sampling of two-phase (gas/liquid) mixtures is not covered by these guidelines and shall be avoided if at all possible.

Current technology of natural-gas sampling is not sufficiently advanced to accomplish this with reasonable accuracy.

## 5.2 Condensation and revaporization

The condensation behaviour of natural gas is rather complicated. Figure 2 gives an example of a pressure/temperature phase boundary diagram for a natural gas. The shape of the curve depends on the composition of the gas.

As figure 2 shows, the phase boundary is a complex function between the critical point and normal operating conditions. Retrograde condensation can occur when the phase boundary is encountered in an unexpected manner while adjusting the pressure or temperature of the gas.

Before starting the analysis, the sample shall be heated to at least 10 °C above the source temperature. If the source temperature is not known, the sample shall be heated to at least 100 °C. To ensure revaporization, this heating shall be applied for a period of 2 h, or longer if necessary.

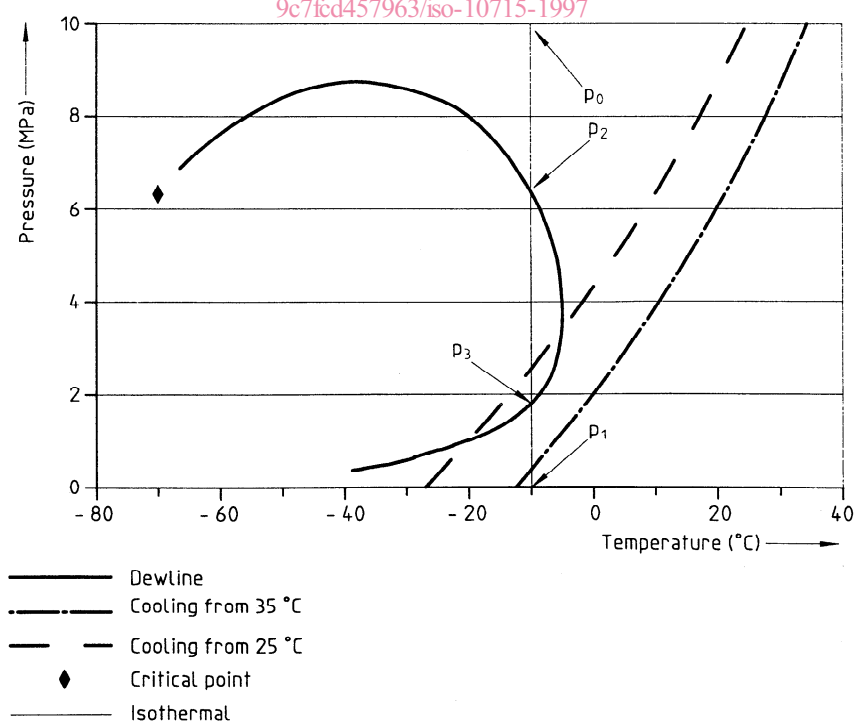


Figure 2 — Example of a pressure/temperature diagram for natural gas

### 5.2.1 Example of a condensation problem

An example of how this problem can occur is shown in figure 2. The pipeline contains gas at pressure  $p_0$ . If the initial temperature is  $-10\text{ °C}$ , and the gas is expanded (i.e. has its pressure reduced) isothermally, it will follow the vertical line in the figure as it approaches the pressure at which it can be analysed,  $p_1$ . The gas is a stable single phase at  $p_0$  and continues to be so until it reaches pressure  $p_2$ , which is on the boundary of the two-phase region.

Between  $p_2$  and the lower pressure  $p_3$ , both gas and condensed liquid are present. The relative quantities of the gas and liquid phases, and their compositions, vary continuously over this range. At pressures below  $p_3$ , and down to the analysis pressure  $p_1$ , a single-phase gas exists once more.

Conversely, a cylinder with an initial pressure of  $p_1$ , filled isothermally to  $p_0$ , will, as the pressure passes through  $p_3$ , contain two phases. These will in theory recombine at  $p_2$ , but this process is slow, and any gas sampled from the cylinder while two phases are present will be unrepresentative, and furthermore its removal will alter the composition remaining in the cylinder.

The use of pressurized piston cylinders may be a way to avoid these problems, keeping the sample in a state where no fall-out will take place.

In fact, as a gas is expanded, its temperature falls due to the Joule-Thompson effect. The gas whose behaviour is shown in figure 2, starting from a temperature and pressure of  $25\text{ °C}$  and  $10\text{ MPa}$ , will cool to below  $-10\text{ °C}$  at  $p_3$ , and hence suffer condensation. The initial temperature would need to be  $35\text{ °C}$  to reach  $p_1$  without encountering the two-phase region.

### 5.2.2 Condensation after sample has been collected

A gas sample could partially condense in the sample container when it is being transported or is awaiting analysis in a lab. High-pressure gas sample containers and the lines to an analytical unit shall always be heated prior to analysis (except for gas that will not pass through a phase boundary). Heating times and temperatures shall be sufficient to ensure that any condensed hydrocarbons are revaporized before an analysis is started.

### 5.2.3 Fall-out from the sampling probe

Liquid heavy hydrocarbons and condensation in the sample line which is returning into the main stream may reduce the measured calorific value of a gas. This will manifest itself in a day/night sine wave effect on the recorder chart, with the calorific value recording higher in the heat of the day and lower in the cool of the night.

### 5.2.4 Precautions by applying heating and insulation

In order to avoid condensation problems, the sample handling equipment temperature shall be kept above the gas dew point at any pressure in the sampling system. Also the gas may be pre-heated, as indicated in figure 2.

## 5.3 Adsorption and desorption

The process whereby some gas components are adsorbed on to or desorbed from the surfaces of a solid are called sorption effects. The force of attraction between some gas components and solids is purely physical and depends on the nature of the participating materials.

Natural gas may contain several components which exhibit strong sorption effects. Special attention shall be given to this in the case of the determination of trace concentrations of heavy hydrocarbons or impurities.

## 5.4 Leaks and diffusion

A regular check of the leaktightness of the lines and devices shall be carried out, in order to detect leaks. Minor leaks or diffusion would affect the composition in the case of trace determinations (water or atmospheric oxygen may diffuse into the tube or the container, even at high pressure: the partial-pressure difference for a constituent determines the direction in which it will diffuse). Take special care when hydrogen is present.

Leaks can be detected using detergent solutions, by pressuring the sampling line, or by more sophisticated methods such as portable leak detection equipment (e.g. mass spectrometers).