TECHNICAL REPORT

# ISO/TR 15403-2

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# Natural gas — Natural gas for use as a compressed fuel for vehicles —

## Part 2: Specification of the quality

*Gaz naturel — Gaz naturel pour usage comme carburant comprimé pour véhicules —*

*Partie 2: Spécification de la qualité*

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# 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 15403-2 was prepared by Technical Committee ISO/TC 193, *Natural gas*.

ISO/TR 15403 consists of the following parts, under the general title *Natural gas — Natural gas for use as a compressed fuel for vehicles*:

— *Part 1: Designation of the quality*

— *Part 2: Specification of the quality* (Technical Report)

# Introduction

In 2000, ISO 15403, *Natural gas — Designation of the quality of natural gas for use as a compressed fuel for vehicles*, was published.

The word “designation” was used in the title of this International Standard as no range of values, or limits could be stated as specifications or requirements for natural gas components in quality standards. This question was resolved during development of ISO 13686, *Natural gas — Quality designation*, which pertains to natural gas as supplied through transmission and distribution piping systems. The rationale for this stance is that, since natural gas is a natural product and does not need the sophisticated processing such as applied to crude oil, it is not possible to specify an exact gas quality. This is especially applicable to natural gas engines as enabled by precise fractionating in crude oil distillation (petrol/diesel).

During the review of ISO/CD 15403-1, comments regarding the need for “specifications” instead of “designation” were received from several countries including the Netherlands, Sweden and the United States. In addition, the text was circulated to CEN/TC 326, *Gas Supply for Natural Gas Vehicle*s, which concluded that “the actual version is too general and does not help in the matter”.

Therefore, ISO/TC 193 decided to prepare a Technical Report as ISO/TR 15403-2 to give the existing information on specifications of compressed natural gas.

# Natural gas — Natural gas for use as a compressed fuel for vehicles —

# Part 2: Specification of the quality

## 1 Scope

This Technical Report addresses the specifications of natural gas as a compressed fuel for vehicles as an addendum to ISO 15403-1. Specifically, it is intended to satisfy requests for quantitative data.

The following are critical items regarding gas composition:

— water content;

— sulfur compounds;

— particulate matter;

— higher hydrocarbons;

— $CO_2$;

— free oxygen;

— glycol/methanol;

— oil content

— corrosive components;

This Technical Report pertains only to compressed natural gas as it enters the fuel containers on the vehicle. It does not apply to the natural gas delivered to a refuelling station. Any alteration of the natural gas supply composition to meet these specifications is clearly the responsibility of the refuelling station operator.

## 2 Normative references

The following referenced documents are indispensable for the application 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 15403-1:2006, *Natural gas — Natural gas for use as a compressed fuel for vehicles — Part 1: Designation of the quality*

ISO 18453:2004, *Natural gas — Correlation between water content and water dew point*

SAE J1616, *Recommended Practice for Compressed Natural Gas Vehicles*

## 3 Water content

ISO 15403-1 clearly requires that the dew point of the compressed natural gas in the containers shall be low enough to preclude the formation of liquid under any circumstances of pressure and temperature. It gives refuelling station operators the opportunity to meet this condition in accordance with local geographic conditions. A graph of water content of natural gases as a function of absolute pressure and temperature is provided in ISO 15403-1:2006, Figure E.1. From this graph, the dew point and water content, expressed in grams per cubic metre, can be determined for any pressure up to 25 000 kPa and ambient temperature from − 30 °C to + 40 °C.

Reference is made to ISO 18453.

A refuelling station operator can determine the lowest ambient temperature recorded for his area and set a water content accordingly. The formation of hydrates in the container or piping should be prevented.

In a Note to Figure E.1 in ISO 15403-1:2006, a water content of less than 30 mg/m$^3$ is stated as a satisfactory level for expected pressure and temperature. This can be considered a specification and the system shall be fitted and maintained with dryers to achieve such a condition.

In the presence of free water, the following metal components, unless they are manufactured from corrosion-resistant materials, are prone to corrosion:

a) storage cylinder in the vehicle;

b) stationary storage cylinder in the refuelling station;

c) piping;

d) refuelling coupling;

e) valves in general;

f) regulator;

g) injection system.

Another safety feature is the fact that a refuelling compressor breaks down if liquid water is present.

See Table 1 for general specifications.

## 4 Sulfur compounds

In the presence of sulfur, the following metal components, unless they are manufactured from corrosion-resistant materials, are prone to corrosion:

a) storage cylinder in the vehicle;

b) stationary storage cylinders of the refuelling station;

c) piping;

d) refuelling coupling;

e) valves in general;

f) regulator;

g) injection systems.

If there is water present, any amount of sulfur can increase corrosion. The limit value for mass concentration of total sulfur is 120 mg/m$^3$. This amount of total sulfur avoids excessive exhaust-catalyst poisoning. The limits for the sulfur in specific sulfur components should be sulfur in the form of $H_2S \leqslant 5$ mg/m$^3$ and sulfur in the form of mercaptans $\leqslant 15$ mg/m$^3$.

See Table 1 for general specifications.

## 5 Particulate matter

Pipeline gas is technically free of dust and dirt, but it is a long-standing practice to incorporate filters into gas appliances. Many utilities use filters or screens upstream of meters for debris protection. Good practice dictates the installation of filters or screens in advance of compressors at refuelling stations.

It is essential to keep debris out of the vehicle containers. To this purpose, SAE J1616 recommends at least a 5 µm filter on the fuel line feeding the vehicle container. This usage constitutes a specification for debris control. Of course, such filters shall be maintained and changed as necessary.

Recommended filters include the following:

— refuelling connector 40 µm;

— injection system/regulator 5 µm;

— injectors 1 µm.

See Table 1 for general specifications.

## 6 Higher hydrocarbons

A safety feature is the fact that a compressor can break down if hydrocarbon liquid is present. All rubber components can be affected.

The maximum allowable mole fraction of propane and butane that corresponds to 1 % of the original gaseous volume gives an indication for the liquid condensation volume for various low ambient temperatures and worst-gas-storage pressure conditions. This is given in ISO 15403-1:2006, Annex A.

See Table 1 for general specifications.

## 7 $CO_2$

In the presence of liquid water, any $CO_2$ can be converted to an acid compound that can cause corrosion. All metal components can be affected, especially the storage cylinder. A volume-fraction limit of 0,03 is recommended.

See Table 1 for general specifications.

## 8 Free oxygen

The volume-fraction limit of free oxygen is put at 0,03.

See Table 1 for general specifications.

## 9 Glycol/Methanol

The natural gas in the vehicle shall not contain glycol or methanol.

## 10 Oil content

Studies have shown that some level of oil content (carried over from compressors) is beneficial, if not essential, to lubricate the fuel system. However, too much oil is detrimental, since it can clog up elements of the fuel system and even displace volume in the container. The build-up of oil in the container can lead to possible large oil circulation in the fuel circuit of the vehicle.

NOTE Just exactly what is the minimum and maximum range of oil content, and how, in fact, to measure the oil content has not yet been determined. As of the publication date of this Technical Report, studies are underway on this problem in the United States and Europe. Thus, no specifications can be given at the time of publication of this Technical Report. However, years of OEM-experience suggests a range of (70 to 200) %(V/V) $\times 10^{-4}$.

Refuelling station operators shall pay attention to the use of oil by their compressors. Any increase in usage can be cause for concern. A build-up of oil in station holding tanks can be detrimental, especially if high flow volumes tend to draw oil into vehicle containers. Filters and dryers can retain oil as well as water and shall be maintained regularly by station operators.

**Table 1 — Recommended specifications**

| Device [a] | Water content<br>< 30 mg/m$^3$ at 20 MPa and − 20 °C | Sulfur compounds<br>total S < 120 mg/m$^3$ | Particulate matter<br>µ | Oil<br>%(V/V) × $10^{-4}$ | Hydro-carbons liquid<br>< 1 % liquid at lowest temperature | $CO_2$<br>< 3 %(V/V) | Free oxygen | Methanol/ Glycol |
|---|---|---|---|---|---|---|---|---|
| Check valve | a | a | 200 | na | a | na | na | 0 |
| Manual valve | a | a | 200 | na | a | na | na | 0 |
| Cylinder valve | a | a | 200 | na | a | na | na | 0 |
| Service valve | a | a | 200 | na | a | na | na | 0 |
| Gas air mixer | a | a | 40 | na | na | na | na | 0 |
| Pressure-measurement device | a | a | 40 | na | a | na | na | 0 |
| Pressure regulator | a | a | 40 | na | a (important) | na | na | 0 |
| Automatic valve | a | a | 200 | na | a | na | na | 0 |
| Miscellaneous components | a | a | na | na | na | na | na | 0 |
| Gastight housing | a | a | na | na | na | na | na | 0 |
| Ventilation hose | a | a | na | na | a | na | na | 0 |
| Fuel tube | a | a | na | na | na | na | na | 0 |
| Fuel hose | a | a | na | na | na | na | na | 0 |
| Pressure relief device | a | a | 200 | na | a | na | na | 0 |
| Cylinder | a | a | na | na | na | na | na | 0 |
| Gas flow adjuster | a | a | 200 | na | na | na | na | 0 |
| Pressure relief valve | a | a | 40 | na | a | *na* | na | 0 |
| Filter | a | a | na | na | a | na | na | 0 |
| Excess flow valve | a | a | 40 | na | a | na | na | 0 |
| Injector | a | a | 1 | 70 to 200 | na | na | na | 0 |
| Receptacle | a | a | 400 | na | na | na | na | 0 |
| Nozzle | a | a | 400 | na | na | na | na | 0 |

[a] a = applicable, na = not applicable

# Annex A
(informative)

# Corrosive components

Natural gas can contain certain components e.g. carbon dioxide, sulfur compounds and oxygen, that, when combined with free water, form corrosive components. The quantities of $CO_2$, $H_2S$, and $O_2$ vary from one natural gas composition to another. No specifications or requirements have been established internationally, or even within countries, with some exceptions.

Thus, a basic premise of ISO 15403 (all parts) is to prevent corrosive compounds from forming in the vehicle container and fuel system by eliminating liquid water. Ergo, the very stringent limitations on dew point and water content.

The make-up of natural gas varies considerably around the world and within countries. Removal of corrosive compounds to some minimal level would be a very expensive and impractical approach. Experience over the decades of natural gas usage has resulted in general, rule-of-thumb, maximum acceptable values, but they are not universally applied. From the German Code of Practice 260/1, the 2nd gas family (natural gas), Table of Gas Secondary Substances, the maximum guide values are listed:

— Mist, dust, liquid — Technically free;

— Oxygen concentration by volume — 3,0 % in dry supply networks, 0,5 % in damp supply networks;

— Total sulfur — 120 mg/m$^3$ (short-term, 150 mg/m$^3$);

— Mercaptan sulfur — 6 mg/m$^3$;

— Hydrogen sulfide — 5 mg/m$^3$ (short-term, 16 mg/m$^3$).

NOTE The guide value for mercaptan sulfur content of 6 mg/m$^3$ cannot, at present, be maintained for all natural gases.

Now these are “guide” values, and only applicable in Germany. Some other countries have similar publications while others have nothing official at all. Some states in the U.S. have rules or regulations dealing with these items, particularly sulfur. Most contracts have some limits put on some of these components, but the values vary widely. Thus, it is apparent that specifications for these components cannot be cited and the best way to handle corrosive components is through the elimination of liquid water.

**ICS 75.060**

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