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Natural gas — Online gas chromatograph for upstream area

Gaz naturels — Chromatographe en phase gazeuse en ligne pour zone amont

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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.

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 193, *Natural gas*, Subcommittee SC 3, *Upstream area*.

Introduction

Online Gas Chromatograph (GC) is widely used to determine hydrocarbon components in natural gas because of its “Real time” measurement and ease of use. It has become a powerful tool for both custody transfer and upstream process gas monitoring. Especially for the custody transfer which the calorific value and others gas properties such as, relative density, compressibility factor, etc. are needed for energy determination. Therefore, accuracy and reliability of the equipment are crucial.

With proper maintenance and handling, GC can provide an accurate result with a minimum manpower as it analyzes and provides results continuously. With technology today, the unit can do auto-calibration, alarm setting, diagnostic, troubleshooting and configuring through Human Machine Interface (HMI). Its outputs can be linked directly with Flow computer, Distributed Control System (DCS) or any remote personal computer (PC).

The Natural Gas in upstream petroleum industry is normally wet. Then this Technical Report provides recommended application to handling GC focus on design, selection, operation, maintenance and verification of GC and its peripheral. The purpose is to provide the whole process to proper handling the GC until getting the accurate and reliable results. It is also included the sampling system to get the representative sample, data verification, alarm, diagnostic and troubleshooting including how to deal with the data in case of being used for custody transfer purpose. Some acceptance criteria are also identified in this paper based on our historical record and performance of the equipment.

Natural gas — Online gas chromatograph for upstream area

1 Scope

This Technical Report concerns the determination of hydrocarbon components up to C7+ in natural gas in upstream petroleum industry, which describes the principle of operation of GC and provides guidelines for selection, evaluation, and factors impacting upon its performance such as sample probe, sample conditioning, installation, operation and troubleshooting.

2 Principle of measurement

2.1 General

The GC is a technique for separating and analysing compounds that can be vaporized without decomposition in a continuous and automatic manner of sample injection, separation, data integration and reporting. A precise volume of sample gas is injected into the column which contains a stationary phase (packing) that is either an active solid (adsorption partition) or an inert solid support that is coated with a liquid phase (absorption partitioning). The gas is moved through the column by means of a mobile phase (carrier gas). Selective retention of the components of the sample takes place in the column and causes each component to move through the column at a different rate. This action separates the sample into its gaseous constituents.

A detector detects the elution of component from the column and produces electrical outputs proportional to the concentration of each component. Output from the detector are amplified in the electronics, then transmitted to the controller for further processing.

2.2 Gas composition

Natural gas is composed primarily of methane with smaller amounts of higher hydrocarbons and of non combustible gases. Major, minor and trace components are as indicated in Tables 1, 2 and 3:

Table 1 — Major components

Component	Units
Methane	mole %
Ethane	mole %
Propane	mole %
Butanes	mole %
Pentanes	mole %
Hexanes	mole %
Heptanes plus	mole %
Nitrogen	mole %
Carbon dioxide	mole %

Table 2 — Minor component

Component	Units
Hydrogen	mole %
Oxygen	mole %
Carbon monoxide	mole %
Helium	mole %

Table 3 — Trace component

Component	Units
Hydrogen sulfide	mg/m^3
Mercaptan sulfur	mg/m^3
Dialkyl (di) sulfide	mg/m^3
Carbonyl sulfide	mg/m^3
Total sulfur	mg/m^3

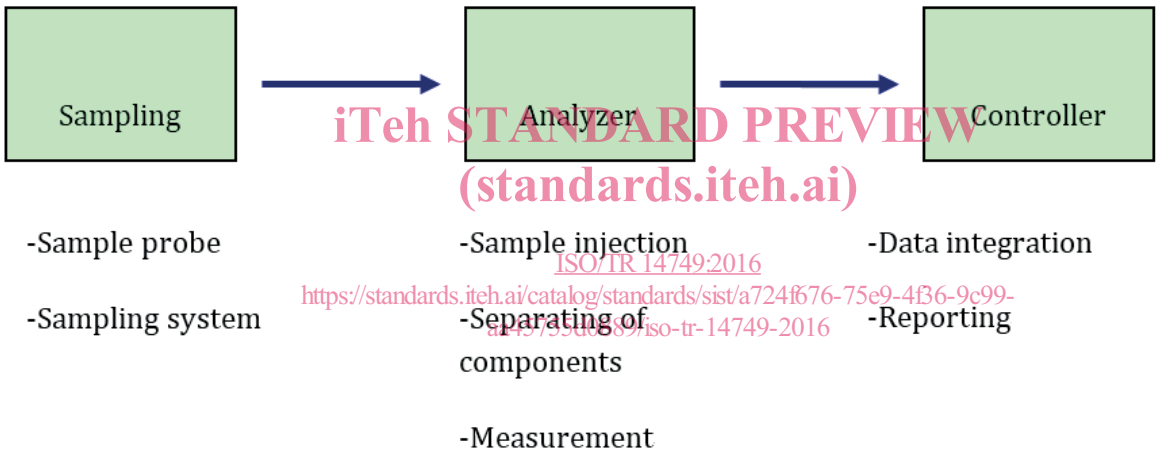

Figure 1 — Online Gas Chromatograph Functional Block Diagram

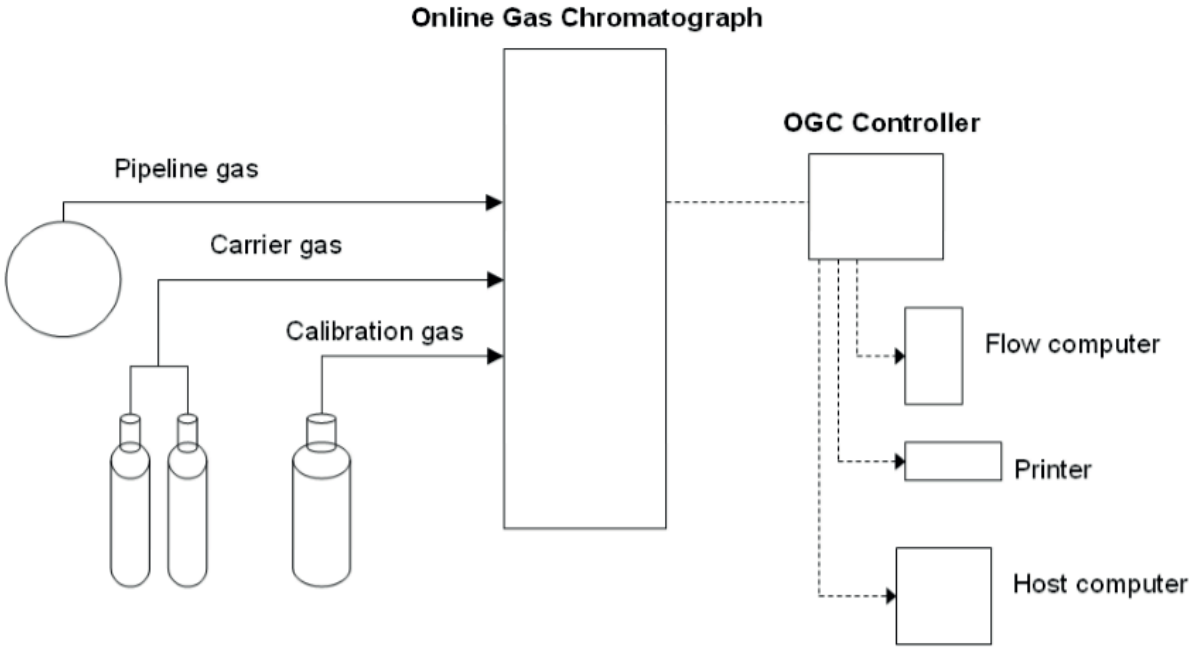

Figure 2 — Online Gas Chromatograph Equipment Diagram

Output from the controller is normally linked to flow computer, DCS, remote personal computer (PC) or a printer. Connection between the GC Controller and others can be accomplished via a direct serial link or Ethernet link.

The GC today has features to report alarm and ignore any fault (report last good value) and also provides good diagnostic and troubleshooting data. To verify the GC performance, repeatability check with Standard gas and baseline check are recommended.

3 Sampling and conditioning

The nature of gas processing in upstream petroleum industry is relied on gas separation and gas dehydration units. There is potential of small liquid droplets in Natural Gas which are able to get into GC causing lots of problems such as incorrect data, failure of GC, etc.

Sample probes and sample conditioning unit have to be properly designed and installed to address liquid carry over and condensing issues. A well designed, installed and maintained sampling system is vital to ensure the provision of a representative sample for GC analysis.

The purpose of the sample handling system is not to transfer an exact sample of the process fluid to the GC. Rather, the purpose is to transfer a representative sample of the fluid after it has been conditioned that is compatible with GC sample requirements.

The sampling system consists of sample probes, pressure regulators and sample line.

The sample probe design should take into account the possibility of resonant vibration being induced by high flow velocities in the pipeline. The probe construction can be either a straight tube probe or a regulated probe. An extraction probe should be considered for maintenance purpose without depressurizing shutdown.

Referring to ISO 10715, sample probe should be located directly in the gas stream in such a way that problems induced by aerosols and dust are eliminated. It is recommended that the probe be located a minimum of 20 pipe diameters downstream from any flow-disturbing elements such as elbows,

headers, valves and tees. However, due to retriction in the upstream petroleum industry, a distance of at least 5 pipe diameters downstream of custody metering is accepted.

The location of the probe should be on the top of a horizontal part of the pipe. The sample probe tip insertion should be located between one-third and centre of the pipeline diameter.

The sampling pressure, especially in upstream petroleum industry is relatively high (more than 4,137 kPa, or 600 psi) but the GC inlet pressure is designed at very low level (less than 138 kPa, or 20 psi), then pressure reduction is relatively important to prevent the liquid into GC. Two different methods are considered:

— Regulated probe with pressure regulator.

— Heated pressure regulator.

The sample should be heated before reducing the pressure and the regulated probe should be equipped with fin in order to reduce liquid droplet from Joule-Thomson effect.

Sampling accessories such as aerosol and/or dust trap, coalescer filter are considered to ensure that liquid droplets are eliminated. The maintenance on the liquid eliminating system should be performed as frequently as practically possible.

The sampling line should be short and have a small diameter to shorten residence time. A bypass or fast-loop line should be considered to reduce residence time. The sampling vent should comply with hazardous area classification.

Whenever ambient temperature is below the hydrocarbon dew point of the stream, heat tracing on the sample line should be used to keep the sample line temperature 10 °C above the gas dew point. This is in order to avoid condensation problems and to provide a representative sample to the GC. The heat tracing should be either electric or steam, however the electrical parts should comply with hazardous area classification.

NOTE Typically any stream over about 38.73MJ/SCM, or 1 040 btu/scf, will need heat tracing and insulation.

If neccessary a pressure safety relief valve can be installed downstream of the pressure reducer in order to protect the GC from pressure regulator failure.

Materials being used in sampling are dependent on gas composition, in most cases stainless steel is recommended, however in some areas where high amount of H2S are present (more than 50ppm) the duplex stainless steel tubing should be considered. Seats and seals should be made of (elastic) material appropriate for the intended service.

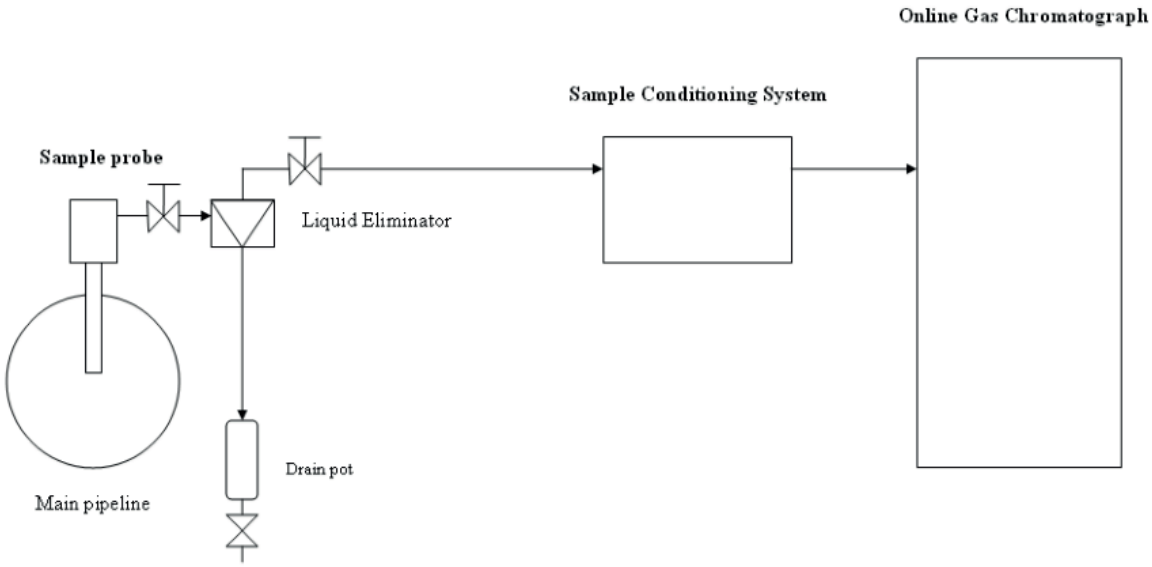

Figure 3 — Online Gas Chromatograph Sampling System Components

A Sample Conditioning System (SCS) is located between the process stream and the analyser inlet. The standard configuration SCS should be as represented in Figure 4.