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Natural gas analysis according to ISO 6974 with unsurpassed repeatability

- Natural gas analysis according to ISO 6974
- Unsurpassed repeatability exceeding method requirements
- Analysis time less than 10 minutes
- Calorific Value calculation

Keywords: Natural gas, ISO 6974, calorific value, repeatability, precision

Natural Gas

Natural gas is a naturally occurring mixture consisting primarily of methane, but commonly including different amounts of other higher alkanes, and sometimes varying levels of carbon dioxide, nitrogen, hydrogen sulfide, and/or helium. It is formed when layers of decomposing plant, micro-organisms and animal matter are exposed to elevated temperature and pressure under the surface of the Earth over millions of years.

Natural gas extracted from wells varies from almost pure methane with traces of nitrogen to very complex mixtures containing inert components like He, Ar, CO2 and low levels of higher hydrocarbons. After processing, including clean-up and separation (and possibly liquefaction to liquified natural gas or LNG) the dry gas is transported by pipelines to distribution companies and eventually to end-users.
Liquefied natural gas (LNG) is natural gas that has been cooled to a liquid state (about -160 °C). In its liquid state, natural gas is 600 times smaller than in its gaseous state. This allows natural gas to be transported to places pipelines cannot reach.

Value of measurement

Natural gas is used for a variety of applications like chemical feedstock, fuel for vehicles but most importantly as a source of energy for heating, cooking, and electricity generation.

Although it is a non-renewable fuel, natural gas is seen as the most environmentally friendly fossil fuel and is considered to be a so-called “transition fuel,” the bridge to renewable energy.

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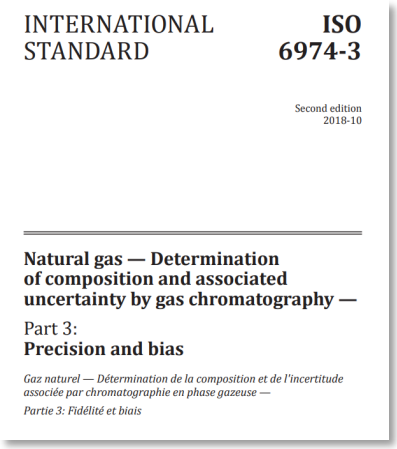
The value of natural gas (and LNG) is based on the calorific value, which is calculated from the composition. Because of the vast volumes that are being traded on a global scale, inaccurate measurement result in errors in the calculated calorific value which add up to millions of dollars and legal efforts to settle disputes.
Excellent precision and accuracy in the compositional analysis is therefore of great importance for all stakeholders in the natural gas industry.

Method description

There are various industry standard–methods (ISO, ASTM, GPA, etc.) describing how to analyze the composition of natural gas using a gas chromatograph, a so-called Natural Gas Analyzer (NGA). A common and globally used method is ISO 6974 - *Determination of mole fractions and uncertainties of natural gas components by GC*. This method consists of multiple parts. Part 1 gives "general guideline and calculation of composition", while part 3 traditionally describes the analysis method: "Determination of hydrogen, helium, oxygen, nitrogen, carbon dioxide and hydrocarbons up to C8 using two packed columns".


INTERNATIONAL STANDARD
ISO 6974-3
Second edition 2018-10
Natural gas — Determination of composition and associated uncertainty by gas chromatography —
Part 3:
Precision and bias
Gaz naturel — Détermination de la composition et de l'incertitude associée par chromatographie en phase gazeuse —
Partie 3: Fidélité et biais

In 2018 part 3 of the method was revised and changed from a "hardware based" method to a "performance-based" method, and "describes the precision that can be expected from a gas chromatographic method that is set up in accordance with ISO 6974-1". The repeatability specified in the new version of the method has been improved significantly. The 2018 version of the method allows the users to use an NGA which is tailored for the application as the only limitations are the performance criteria.

ISO 6974 is often used in conjunction with ISO 6976 (Natural gas – Calculation of calorific values, density, relative density and Wobbe indices from composition).

Hardware description

AC Analytical Controls (one of the PAC brands) has taken this opportunity and re-engineered its "NGA ISO 6974", which has been in the market for a long time already. The aim was to make sure it delivers the best possible repeatability within a short analysis time, as better repeatability translates to less uncertainty and thus improved precision for calorific value. The performance of the newly designed NGA exceeds the performance of the method at an unsurpassed level.

In addition, another goal set was to achieve much lower detection limits for the hydrocarbons. Which will allow the calculation of the hydrocarbon dewpoint at lower levels.

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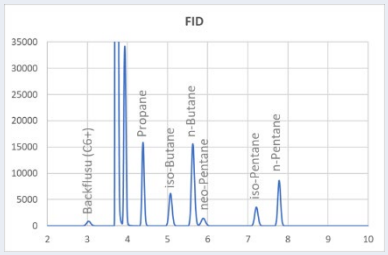
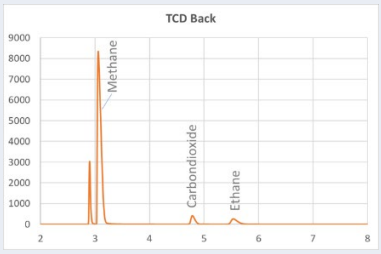
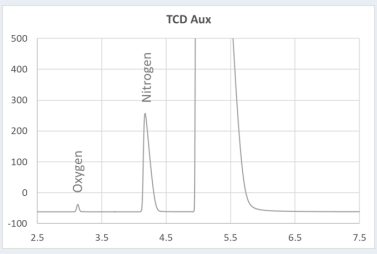
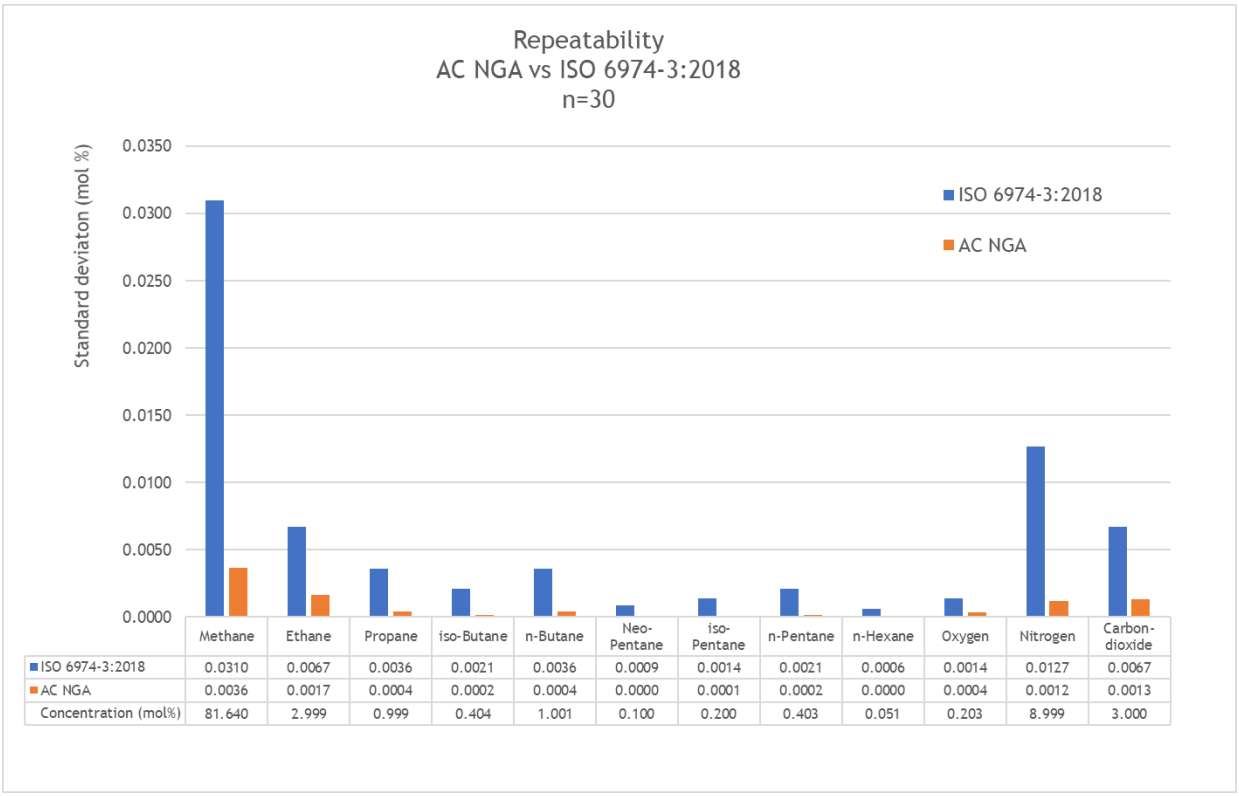
The newly designed AC NGA ISO 6974, based on the Agilent 8890 GC, is configured with three independent channels:

Channel 1	Channel 2	Channel 3
		
C3 – C6+ hydrocarbons backflush for C6 and heavier HC's	Methane, Carbon-dioxide, Ethane	Oxygen, Nitrogen (Helium & Hydrogen)
capillary in GC oven	micro-packed in isothermal oven	micro-packed in isothermal oven
FID	TCD	TCD

The micro-packed columns are mounted in an isothermal oven which contributes to the overall system repeatability. Also, the sample shut-off valve contributes to an excellent repeatability. This valve stops the sample flow at the moment an analysis is started. Thereby ensuring that the pressure inside the sample loops are atmospheric at the moment these valves are switched and introduce the sample onto the columns. This removes the "user variability factor" of manually closing the sample cylinder and then activating the sampling valves.

Results

The below results show the system repeatability of a calibration gas (concentrations listed in the graph) in comparison with the ISO requirements:



	Methane	Ethane	Propane	iso-Butane	n-Butane	Neo-Pentane	iso-Pentane	n-Pentane	n-Hexane	Oxygen	Nitrogen	Carbon-dioxide
ISO 6974-3:2018	0.0310	0.0067	0.0036	0.0021	0.0036	0.0009	0.0014	0.0021	0.0006	0.0014	0.0127	0.0067
AC NGA	0.0036	0.0017	0.0004	0.0002	0.0004	0.0000	0.0001	0.0002	0.0000	0.0004	0.0012	0.0013
Concentration (mol%)	81.640	2.999	0.999	0.404	1.001	0.100	0.200	0.403	0.051	0.203	8.999	3.000

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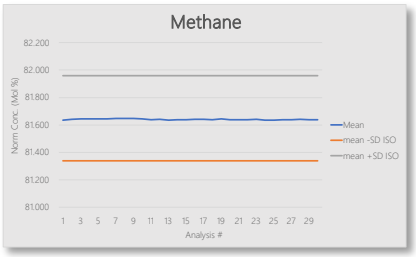
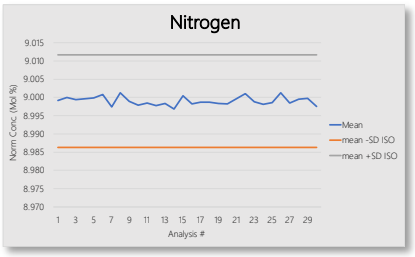
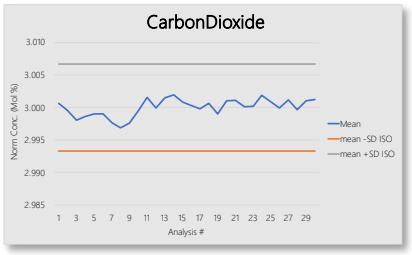
Repeatability for Methane, Carbon dioxide & Nitrogen (components from all three analysis channels)







Conclusion

With the new "AC NGA ISO 6974", AC Analytical Controls has introduced a Natural Gas Analyzer to the market, which has an unsurpassed repeatability and exceeds the performance requirements of ISO 6974 1 & 3 at all levels.

Companies that are producing and trading natural gas at various locations around the globe value a robust, fast and very repeatable analysis of the gas composition. Therefore they often evaluate a system performance to test whether it can be used to assess and have the measurement capabilities meet the requirement of any sales gas agreements, tender document enquiries, procurement specifications or requirements of fiscal energy metering.

These evaluations include determination of "errors", "uncertainties" and "overall bias (mean error)" for the calorific value calculations. With the system being able of reaching an absolute mean error of less than 0.1 MJ/m3 it is clear that the AC NGA has an excellent performance and it is considered to be acceptable for the use of natural gas composition analysis and calorific value calculation.

Part number: AN-2021-C-005