Application note Natural gas and natural gas blended hydrogen

This application note evaluates the performance of the DynamiQ-X NG2210 and DynamiQ-X NG2220 gas chromatographs, designed for rapid and precise natural gas analysis within just 45 seconds. The NG2210 features two GC units for measuring C1-C6+, carbon dioxide, and nitrogen, while the NG2220 includes an additional unit for hydrogen and oxygen.

Both instruments are certified for OIML R140 accuracy class A, ensuring reliable quantification of components and physical properties. The advanced on-chip dual channel TCDs and integrated backflush technology ensure exceptional repeatability and accuracy across a wide temperature range.

1 Introduction

Natural gas consists of methane, different hydrocarbons, and inert gases such as nitrogen and carbon dioxide. Optionally, hydrogen can be blended with natural gas to cut emissions. The composition and therefore the calorific value differ per source. Since natural gas is traded based on its energy content, the calorific value is of high importance. The DynamiQ micro GC gas analyzers are the ideal instruments to provide fast and accurate on-line monitoring of natural gas and deliver calorific values for composition control and custody transfer purposes.

The DynamiQ micro GC is equipped with several MEMS micromachined chip components, which are connected by a patented chip to chip connection technology. This enables not only a compact instrument in an explosion proof design but also short analysis times of only 45 seconds. DynamiQ analyzers come equipped with a backflush-to-detector configuration, which increases the lifetime of the columns and reduces the total analysis time. The compact instrument has a volume of only 10 L and a low carrier gas consumption of one gas bottle for over one year.

The DynamiQ-X NG2210 contains two GC units, each performing in parallel a different GC analysis under individually optimized conditions using thermal conductivity detectors (TCD). The two unit GC measure C1-C6+, nitrogen and carbon dioxide. The DynamiQ-X NG2220 is equipped with a third GC unit to measure hydrogen and oxygen. Pre-calibrated at the factory, both instruments are field-ready, delivering calorific value accuracy better than 0.5 % and type approved for OIML R140 class A.

2 Materials and methods

The configuration and parameters of the DynamiQ-X NG2210 and DynamiQ-X NG2220 are detailed in *Table 1.* The first GC unit features a U-type column designed for separating and measuring methane, carbon dioxide and ethane. Additionally, the DynamiQ-X NG2210 measures nitrogen on this GC unit. *Figure 1* illustrates an example chromatogram, generated with the included software.

Table 1 The configuration of DynamiQ-X NG2210 and DynamiQ-X NG2220

	GC unit 1	GC unit 2	GC unit 3 (NG2220 only)
Analysis time		45 seconds	
Carrier gas	Helium	Helium	Argon
Injector and detector temperature	120 °C	120 °C	120 °C
Column temperature	70 °C	70 °C	80 °C
Carrier pressure	95 kPa	170 kPa	160 kPa
Injection time	60 ms	60 ms	80 ms
Backflush time	11 s	12.5 s	8 s
Measured components	Nitrogen (NG2210 only) Methane Carbon dioxide Ethane	Propane i-Butane n-Butane neo-Pentane i-Pentane n-Pentane Hexane+ (backflush)	Helium (added by user) Hydrogen Oxygen Nitrogen Carbon monoxide (added by user)

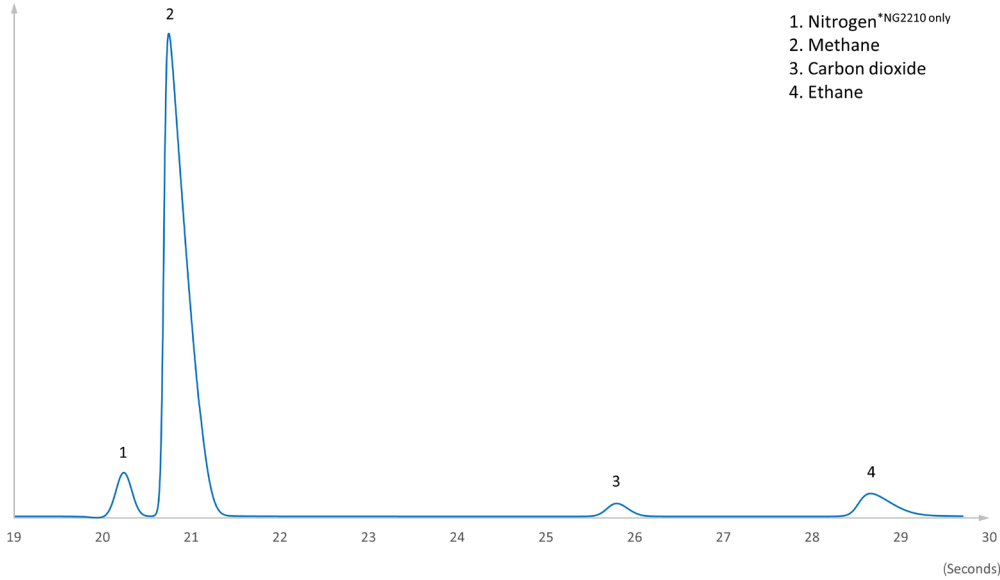

Figure 1 Example chromatogram of nitrogen, methane, carbon dioxide and ethane

For the analysis of the heavier hydrocarbons, the second GC unit is used, equipped with a P-type column. This column effectively separates propane, butanes and pentanes, an example chromatogram is given in *Figure 2 (see page 3).* N-butane and neo-pentane are well separated with a resolution of at least 1.5. All hexanes and higher hydrocarbons are backflushed to another detector, resulting in a combined peak shown in *Figure 3 (see page 3).* This sample gas contains 0.1 mol % C6+ components, comprising a total of 12 different hydrocarbons, which can easily be integrated into a single composite peak.

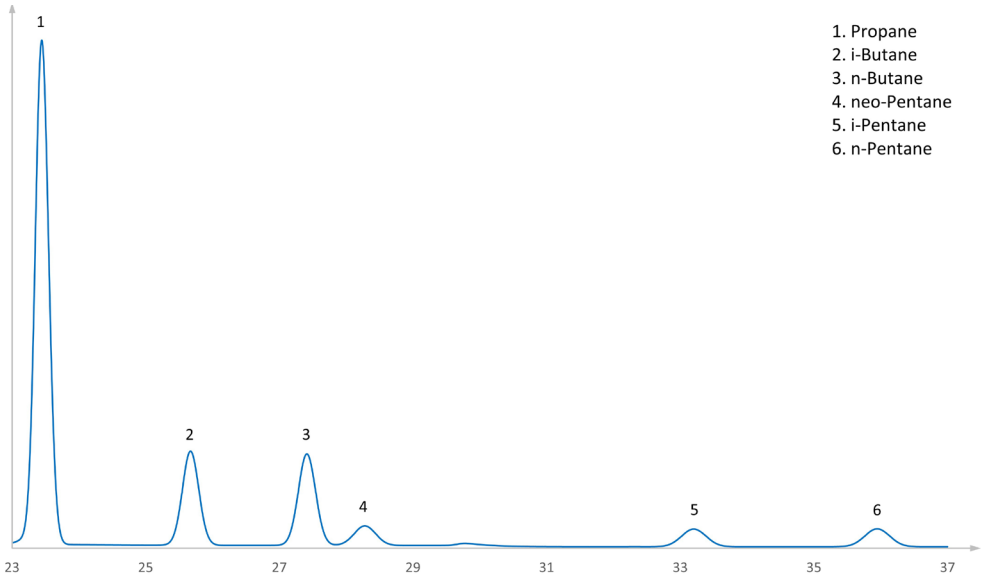

Figure 2 Example chromatogram of propane, i-butane, n-butane, neo-pentane, i-pentane and n-pentane

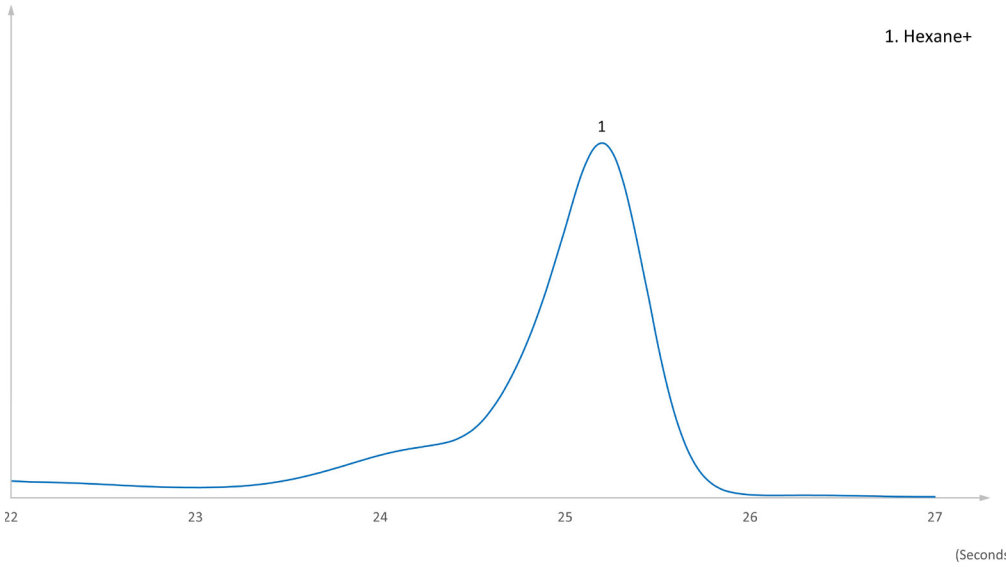

Figure 3 Example chromatogram of hexane+. Composite peak consists of 12 different hydrocarbons.

The DynamiQ-X NG2220 includes a third GC unit to measure permanent gases using an M-type column. This column can measure hydrogen, oxygen and nitrogen, as depicted in *Figure 4 (see page 4)*. Helium in the sample gas does not interfere with the hydrogen measurement due to their separation with a resolution of at least 1.5. This GC unit is capable of measuring helium and carbon monoxide as well, though these components are not factory-calibrated and must be added manually by the user.

To measure hydrogen on this GC unit, argon carrier gas is required, necessitating a separate carrier gas inlet for this column. The integrated backflush technology is crucial for this GC unit, as the Molesieve column can become contaminated with water or carbon dioxide, leading to a decrease in retention of analyte components, poor repeatability, and lower resolution of gas compounds.

The contaminants will get backflushed to prevent them from reaching the Molesieve column, ensuring stable results over a long period of time.

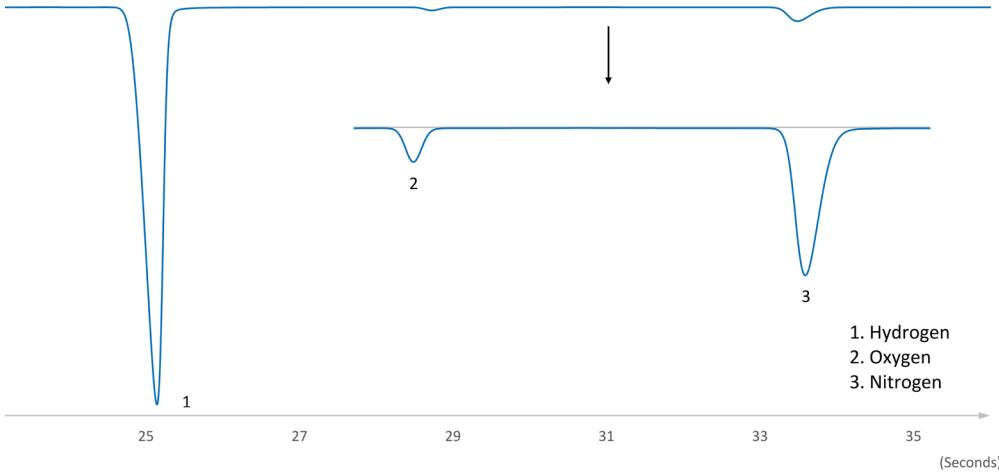

Figure 4 Example chromatogram of hydrogen, oxygen, and nitrogen

3 Results and discussions

Measurements are done in only 45 seconds using a method that is optimized in the factory for optimal separation.

The instrument is designed for calculating the calorific value and other physical properties in compliance with ISO 6976, AGA8, ASTM D3588 and GPA 2172 standards. Using DynamiQ software, combustion and metering conditions as well as the calculation units can be selected. The natural gas analysis panel from the DynamiQ software is shown in *Figure 5*.

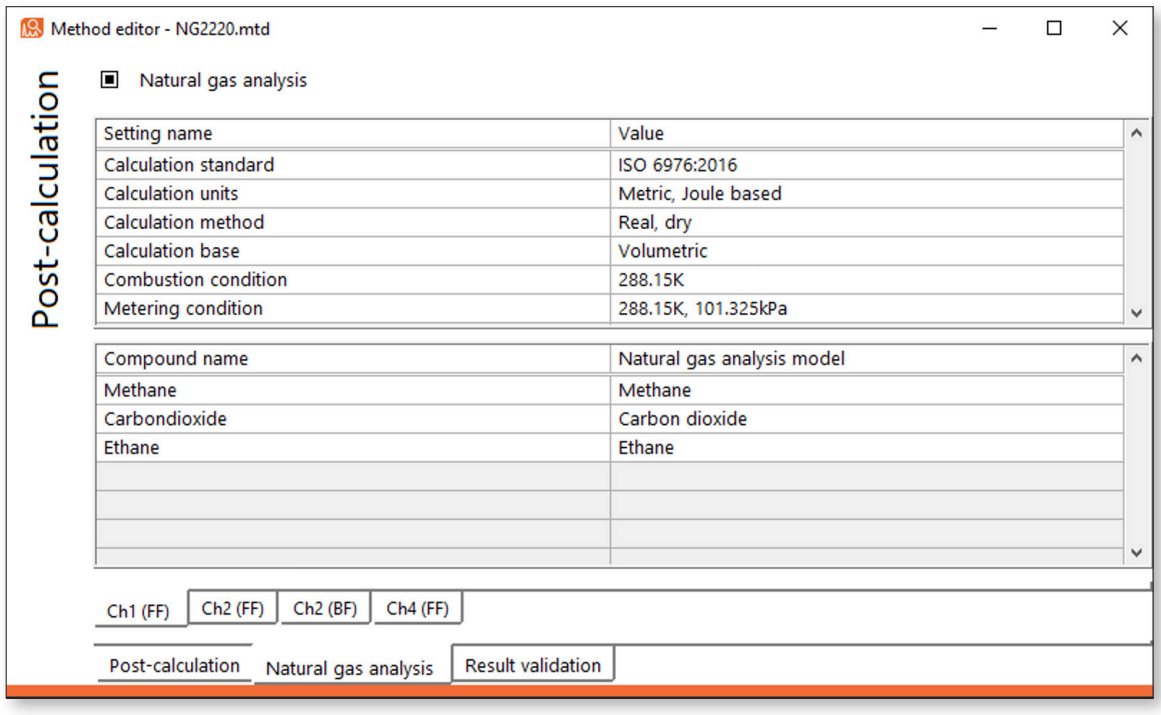

Figure 5 Selection panel for natural gas analysis

The instrument is designed for continuous monitoring and works therefore stand-alone. In addition, dedicated DynamiQ PC software can be used to analyze the collected data in further detail and to change operation settings. The ATEX / IECEx certified DynamiQ-X analyzers are housed in an explosion-safe marine-grade aluminum IP65 enclosure. The ambient operating temperature is between –20 °C to 55 °C. Other technical specifications are given in *Table 2*.

Table 2 Technical specifications

Specifications	
Detection limit	< 500 ppb (Pentane)
Dimensions	289 × 258 × 122 mm / 11.4 × 10.2 × 4.8 “
Weight	<15 kg / 33 lb.
Ambient operating temperature	–20 °C to 55 °C / –4 °F to 131 °F
Ambient storage temperature	–25 °C to 70 °C / –13 °F to 158 °F
Ambient relative humidity	5% to 95% non-condensing
Carrier gas	Helium and Argon (NG2220 only) Consumption: <15 ml/min Input pressure: 450 ±5% kPa
Sample gas inlets	4 sample streams Input pressure: 10 kPa to 90 kPa
Communication	LAN, RS 232, RS 485 Protocol: Modbus

The test results for a natural gas composition with added hydrogen are presented in *Table 3*. These tests were performed at the Netherlands Metrology Institute (NMi). The Notified Body carried out a conformity assessment to certify both the DynamiQ NG2210 and NG2220 for accuracy class A in OIML R140.[1]

The relative standard deviation (RSD) were calculated over five measurements. The retention time RSDs ranged from 0.002% to 0.010%, while the response area RSDs ranged from 0.01% to 0.21%, depending on the concentration in the gas. Subsequently, the repeatability comfortably falls within the limits set by the natural gas standards GPA 2261 and ASTM D1945. The repeatability of the concentrations and their comparisons with the standards are detailed in *Table 4*. Here, repeatability is defined as the difference in concentration between two successive results.

Table 3 Retention time and area repeatability for a composition of natural gas with hydrogen

Component	Range (mol%)	Concentration (mol%)	Retention time RSD%	Area RSD%
Methane	60–100%	80.4%	0.010%	0.01%
Ethane	0.1–15%	4%	0.010%	0.02%
Propane	0.1–7%	1%	0.003%	0.06%
i-Butane	0.01–1.5%	0.2%	0.002%	0.06%
n-Butane	0.01–1.5%	0.2%	0.002%	0.06%
neo-Pentane	0.005–0.1%	0.05%	0.003%	0.07%
i-Pentane	0.005–0.5%	0.05%	0.004%	0.14%
n-Pentane	0.005–0.5%	0.05%	0.004%	0.06%
Hexane+	0.005–0.35%	0.05%	0.003%	0.21%
Carbon dioxide	0.1–12%	1.5%	0.010%	0.02%
Nitrogen	0.1–20%	4%	0.003%	0.03%
Hydrogen	0.1–20%	8%	0.004%	0.05%
Oxygen	0.1–3%	0.5%	0.004%	0.06%

Table 4 Component repeatability compared to the limits in GPA 2261 and ASTM D1945

Component	Concentration (mol %)	Repeatability (mol %)	Limit GPA 2261 (mol %)	Limit ASTM D1945 (mol %)
Methane	80.4 %	0.0020	0.034	0.10
Ethane	4 %	0.0015	0.020	0.07
Propane	1%	0.0014	0.008	0.07
i-Butane	0.2 %	0.0003	0.007	0.04
n-Butane	0.2 %	0.0003	0.006	0.04
neo-Pentane	0.05 %	0.0001	–	0.01
i-Pentane	0.05 %	0.0001	0.004	0.01
n-Pentane	0.05 %	0.0001	0.006	0.01
Hexane+	0.05 %	0.0003	0.007	0.01
Carbon dioxide	1.5 %	0.0007	0.005	0.07
Nitrogen	4 %	0.0030	0.055	0.07
Hydrogen	8 %	0.0002	–	0.08
Oxygen	0.5 %	0.0002	–	0.04

The instrument's excellent repeatability ensures correct and stable quantification of components and physical properties. For this gas, the calculation of the calorific value was found to be repeatable with a relative standard deviation (RSD) of just 0.003 %. Additionally, the measurements were highly accurate with a relative error in calorific value for this gas composition of only 0.07 %. The unnormalized summed quantity of this gas was recorded at 99.4 %. The error and repeatability of the calorific value, along with other physical properties, are given in *Table 4*.

Table 5 Error and repeatability of physical properties for a composition of natural gas with hydrogen

Physical property	Value	Relative error (%)	RSD %
Gross calorific value	35.8 MJ/m³	0.07 %	0.003 %
Net calorific value	32.3 MJ/m³	0.08 %	0.003 %
Wobbe index	46.7 MJ/m3	0.12 %	0.002 %
Relative density	0.59	0.08 %	0.003 %
Density	0.72 kg/m³	0.08 %	0.003 %
Molar mass	17.0 kg/kmol	0.09 %	0.003 %
Compressibility	0.998	0.00 %	0.000 %

The instrument is certified for OIML R140 accuracy class A for the component ranges given in *Table 3* (see page 5) on. The corresponding range of the gross calorific value is 26 to 49 MJ/m3 (7.2 to 13.6 kWh/m³). Within this range, the maximum relative error of the calorific value is 0.11% for DynamiQ-X NG2210 and 0.16 % for DynamiQ-X NG2220 under room temperature conditions, easily within the maximum allowed relative error in OIML R140 class A of 0.50 %. The maximum repeatability error of the calorific value is 0.01% for DynamiQ-X NG2210 and 0.03 % for DynamiQ-X NG2220, whereas the maximum allowed error is 0.10 %. The operating ambient temperature range is −20 °C to 55 °C.

Measurements across the complete temperature range are stable with excellent repeatability and accuracy. The thermal stability was investigated using a natural gas mixture with added hydrogen. Minimal retention time shifts ensured accurate component identification and good resolution. Repeatability of retention time and component concentrations remained stable and physical

properties like the calorific value stayed easily within OIML R140 limits. A 40-day cycle test, simulating temperatures from −15 °C to 40 °C, assessed long-term repeatability, with the highest daily RSD recorded at 0.066 %, well within the 0.10 % limit. More information can be found in the white paper on thermal stability.[2]

4 Conclusion

The DynamiQ-X NG2210 and DynamiQ-X NG2220 provide the calorific value and composition of natural gas in only 45 seconds. The DynamiQ-X NG2210 consists of two GC units with on chip dual channel foreflush and backflush TCDs in compact Ex certified housing. It is capable of measuring C1-C6+, carbon dioxide and nitrogen. The DynamiQ-X NG2220 includes an additional GC unit to measure hydrogen and oxygen as well. The DynamiQ Analyzers provide excellent instrument repeatability, ensuring correct and stable quantification of components as well as physical properties.

5 References

1. Evaluation Certificate TC12537 revision 0, NMi Certin B.V., 2024.
2. Application Note – Thermal Stability version 1.0, Qmicro B.V., 2025.