OIL AND GAS

APPLICATION NOTE

chromatec

Determination of He, H2, O2 (or O2+Ar), N2, CO2, hydrocarbons C1–C5, C6+ (or C1–C8+) concentration in natural gas as per ISO 6974, GOST 31371

Summary

Chromatographic systems produced by CJSC Chromatec are designed to perform the analyses according to ISO-6974, GOST 31371 and identify the quantitative blend composition of natural gas. Normally, the obtained results are used to calculate the physicochemical parameters as per ISO 6976, GOST 31369. The present system stands out for its high automatization level. The system software ensures the monitoring of all chromatographic conditions, plotting and tracking of calibration curve, drawing up the analysis summary. The advanced equipment of the system is used to determine the concentration of He, H2, O2 (or O2+Ar), N2, CO2, individual hydrocarbons from C1 to C5 including neo-C5, hydrocarbons C6 + higher hydrocarbons both individually and as one total peak-component.

Overview

Natural gas is one of the main energy sources on the Earth both for industry and domestic needs. Unlike other energy sources natural gas requires minimum treatment before delivering to the final consumer from gas-transmission line or storage facilities. Natural gas mainly consists of methane admixed with some hydrocarbons and certain non-hydrocarbon combustible and non-combustible gases.

Natural gas analysis enables:

- calculate physicochemical parameters for commercial accounting;
- monitor the consumer quality;
- keep track of the changes during recovery, transportation, storage, and etc.;
- calculate the best “gas-air” ratio required for regular combustion.

The main consumer-oriented characteristic of natural gas which determines its price is the amount of energy per unit of volume – calorific value. The calorific value along with other characteristics such as density, compressibility factor, dew point, content of hydrocarbon liquid fraction and etc. depends on the gas composition. Each natural gas field has its own specific characteristics.

The present recommended practices are ment for analysis on Chromatec chromatograph according to the norms and regulations of ISO 6974 and GOST 31371.

Analysis methods

1. ISO 6974. Natural gas. Determination of hydrogen, noble gases and hydrocarbons up to C8. Gas chromatographic method.
2. ISO 6976. Natural Gas – Calculation of calorific values, density, relative density and Wobbe index from blend composition.
3. GOST 31371. Natural gas. Composition analysis by gas chromatography with estimated uncertainty.
4. GOST 31369. Natural gas. Calculation of calorific values, density, relative density and Wobbe index from blend composition.

Equipment

As specified in ISO 6974 and GOST 31371 natural gas analysis system includes gas chromatograph (GC) with electronic flow and pressure regulators (DFC), heated automatic switching taps, heated sample injection device, sample flow and pressure meters, packed columns and thermal conductivity detectors (TCD). Chromatograph may also be supplemented with auxiliary equipment. The list of component groups drawn up as per ISO 6974 and GOST 31371 is given in Table 1.

The software designed to monitor GC operation and draw up summaries in Microsoft® Windows® is also a part of chromatographic system. This software provides the complete automatization starting from calibration procedure to the final summary.

Measurement method

GC is equipped with a certain number of columns, automatic taps and detectors. The overall analysis diagram is given on the Figure 1.

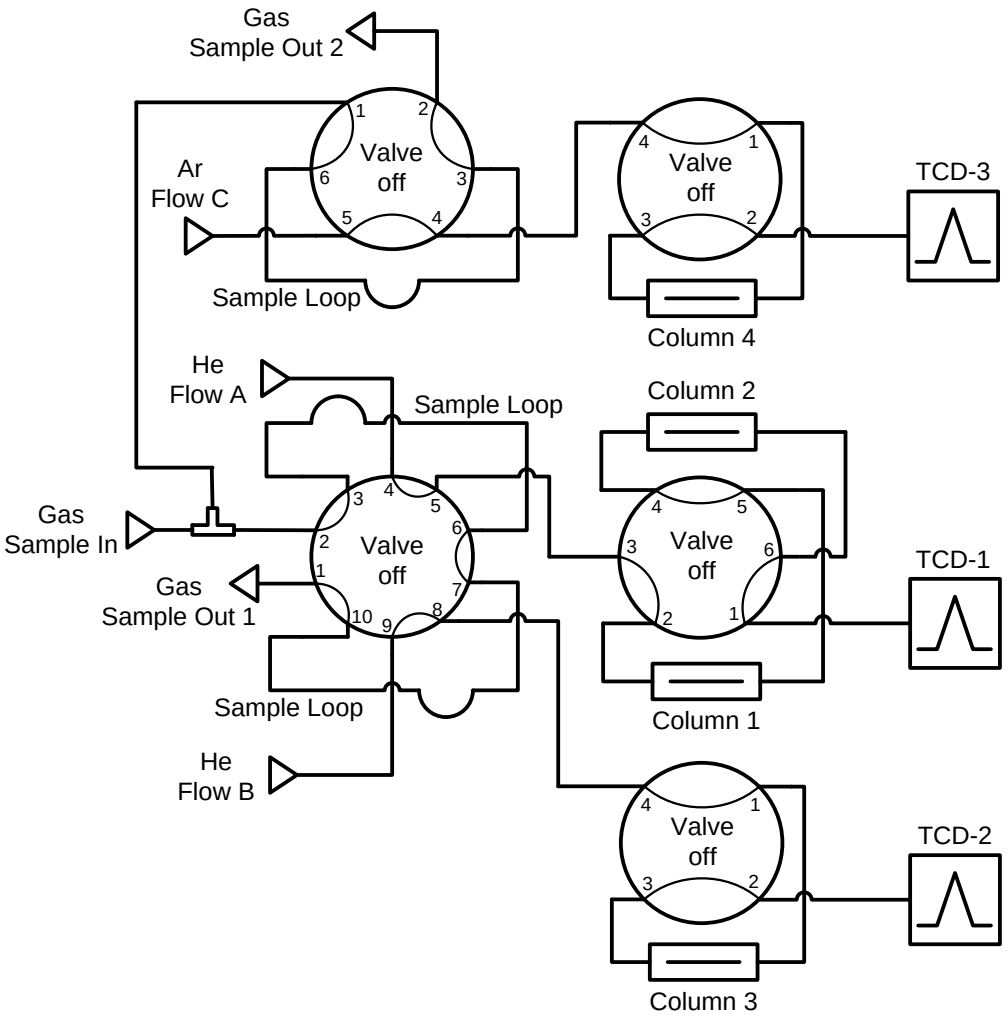


Figure 1 – Analysis diagram

The gas sample under analysis is transfered via the heated tube to the sampling valve. Flow meter controls the flow rate. From the sampling tap the sample is injected into the column.

Column 1 separates the fraction C_{6+} from the air, CO_2, C_1–C_5.After the complete elution of the n-C_5 from column 1 into column 2 the tap is switched and C_6+ components start to move in column 1 in the opposite direction and combine into one peak-component. At the same time air, CO_2 and C_1–C_5 fraction is separated in column 2. After that all the components are detected at TCD. Peak C_{8+} and fraction C_1-C_8 can be obtained in a similar way.

Column 3 with molecular sieves separates O_2+Ar and N_2 from hydrocarbon fraction. Then the components are detected at TCD. After N_2 is eluted the column is switched into the backpurging mode. If there is no need to determine O_2+Ar the respective analytical channel is absent.

Column 4 with molecular sieves separates He, H_2, O_2, N_2 from hydrocarbon fraction. Then the components are detected at TCD. After N_2 is eluted the column is switched into the backpurging mode. If there is no need to determine He, H_2, O_2 the respective analytical channel is absent.

The checkout chromatogram is shown on the Figure 2. The analysis time is about 20 min.

Table 1 contains the component groups under analysis, Table 2 contains typical content ranges of components in natural gas.

Table 1 – Groups under analysis

Hydrocarbons	C1–C8, C8+ (or C1–C5, C6+)
Noble gases	He, H2, O2 (or O2+Ar), N2, CO2

Table 2 – Typical content ranges of components in natural gas

Component	Range (mol. %)
Hydrogen	0.0005–1
Helium	0.005–1.5
Oxygen	0–1
Argon	0.001–0.05
Nitrogen	0.1–40
Carbon dioxide	0.005–30
Methane	50–100
Ethane	0.1–15
Propane	0.001–5
Hydrocarbons C4–C8	0.001–1

Results and discussions

The suggested equipment is fully suitable for natural gas composition analysis according to the norms and regulations described in ISO 6974 and GOST 31371. This equipment stands out for its high retention time stability, high precision and repeatability of results. This is possible due to electronic gas flow regulators, heated taps, sample flow rate, and pressure meters used in a sampling valve loop. On the top of this to prevent the sample condensation during injection the heated injection device is used.

Calculations

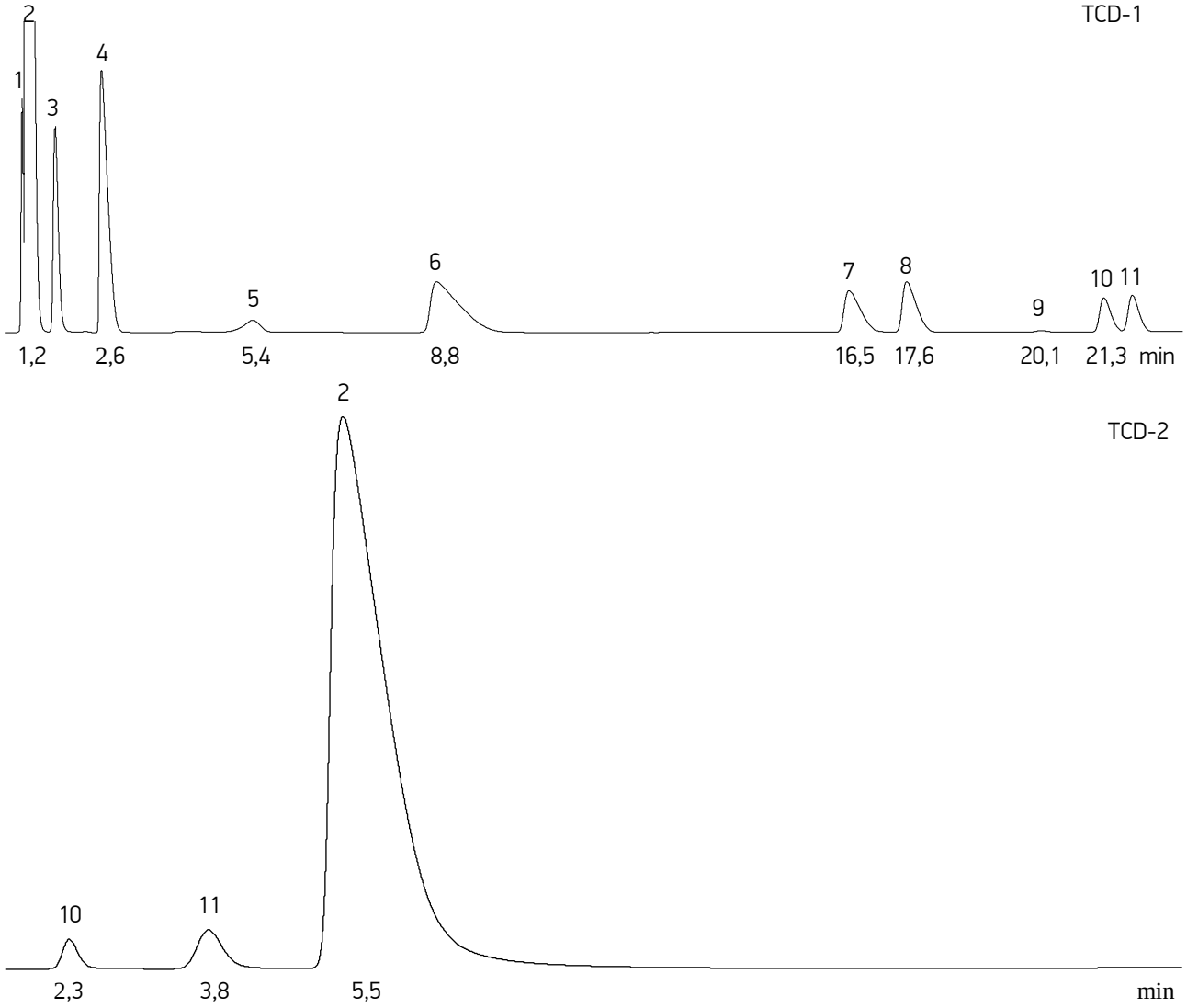
Chromatographic system includes the dedicated software used to calculate the physicochemical parameters according to ISO 6976 (GOST 31369) and to draw up analysis summary.

Possible calculations are listed below:

- Conversion into molar, volume, mass concentration and vice versa;
- Compound molar mass;
- Compressibility factor;
- Molar calorific value (higher and lower);
- Mass calorific value (higher and lower);
- Volumetric calorific value (higher and lower) for perfect and real gas at 0, 15, 20 °C;
- Absolute and relative density for perfect and real gas at 0, 15, 20 °C;
- Wobbe index for perfect and real gas at 0, 15, 20 °C;
- Convergence of direct and indirect calculations of each indicator.

The system software includes integrated dictionary of synonyms and reference data that is used to prevent the risk of accidental interference with calculation. New user dictionary for calculations can be created, if necessary. The software offers standard summary blanks and provides a possibility to create user summary template.

Chromatograms



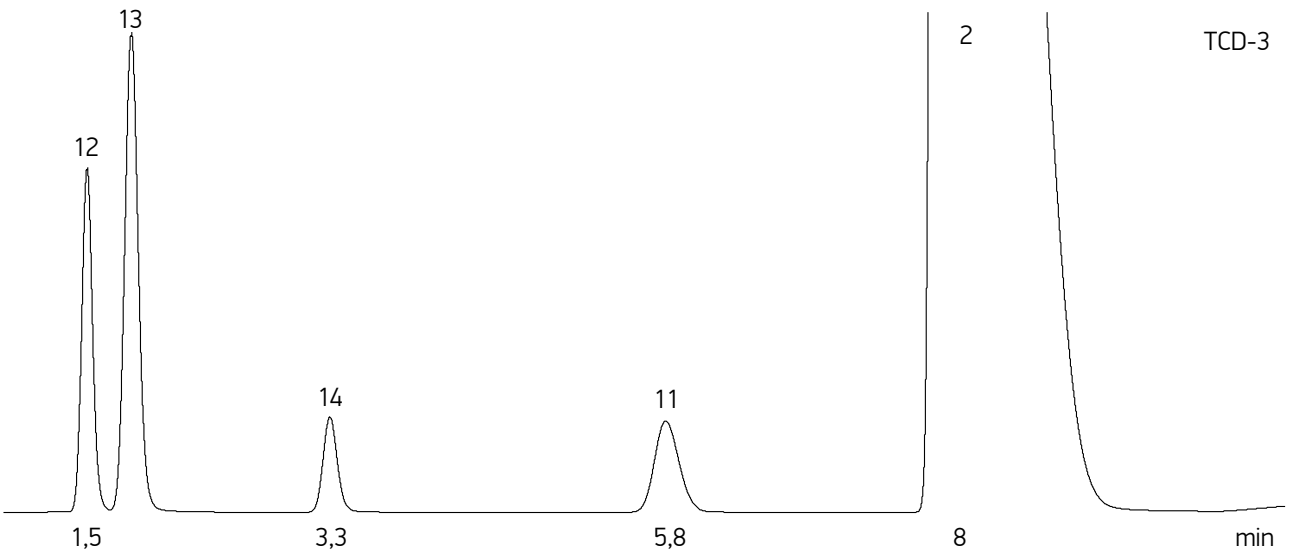


Table 3 – List of components

1	Air	8	n-Butane
2	Methane	9	Neopentane
3	CO2	10	Oxygen + Argon
4	Ethane	11	Nitrogen
5	C6+	12	Helium
6	Propane	13	Hydrogen
7	Isobutane	14	Oxygen