

CHROMOS

engineering

OIL & GAS

Refinery & petrochemicals solution

Natural, associated petroleum & liquified
Gas solutions



Laboratory Gas Chromatography System

CHROMOSGC for oil & gas

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Chromos GC is Gas Chromatograph for analysis of natural, associated petroleum and liquified gas



Excellent performance and metrological characteristics of Chromos GC-1000 are confirmed by long-term utilization by different departments chromatographs produced by other manufacturers, Chromos offers customizable options in accordance with analytical tasks and requirements of each client.

Chromos specialists consider isothermal devices to be the most suitable to meet the needs of the most clients.

This is due to the fact, that isothermal devices are designed for analysis of variable compositions gases, Therefore, allowing to perform tests in the continuous mode and reducing the overall test time.

Such devices are also of excellent performance and metrological characteristics.

Chromos GC gas chromatograph has been designed with enhanced characteristics in comparison with other nationally-produced chromatographs.

For example, detection limit of a streaming current thermal conductivity detector (TCD) installed in Chromos GC is three-times better.

A flame ionization detector (FID) is two times better; relative standard deviation in respect of peak heights is 5 times better than of other chromatographs.

Moreover, when using an updated version of a streaming current thermal conductivity detector (TCD), detection limited of Chromos GC has become 10 times better.

Enhanced technical characteristics of Chromos GC allow to acquire consistent results and metrological characteristics by wide margins in comparison with requirements of GOST 31371.7-2008, ASTM D1945, ASTM 2163 and GPA 2286.

This fact has been specified under Operational Test Report of Chromos GC by Gazprom Moscow, LLC.

Analysis of Benzene and detection of individual and group concentration in accordance to (ASTM D6729 & D6730).

Overview:

- Method D6729: detection of individual composition of naphtha to N-nonane.
- Method D6730: detection of individual composition of automobile Benzene including hydrogen up to C13.
- Method D6729 covers liquid hydrocarbon mixes, including straight-run gasoline, reformates and alkylates (naphtha) free from olefin hydrocarbons (under 2% of olefin volume), and is intended for analysis of specific content of hydrocarbons up to N-nonane by means of capillary columns.
- Method D6730 as well as ASTM D 6729 covers automobile benzines and benzines, used as blending components (straight-run, reformates, alkylates, hydrocrackers, and hydro-treatment products, as well as catalytic and thermal cracking), and are intended for analysis of specific hydrocarbons (up to C13inclusive) and groups of n-paraffins, iso-paraffins, aromatic, naphthene, olefine hydrocarbons (PIANO), and oxygenates by means of high-efficient capillary gas chromatography in the weight range from 1.0% to 45%.
-
- ASTM D 6730 method is intended for analysis of characteristics of specific hydrocarbon constituents for different types of fuel used in internal combustion engines and their blends, containing oxidizing additives (MTBE, ETBE, ethanol, etc.) with the boiling temperature up to 225C. Besides that, certain liquid hydrocarbon blends can also be analyzed, the ones which are commonly present during oil-processing operation and which include such blending stocks as ligroin, reformat, alkylate, etc.
-
- In order to perform the analysis, the following capillary columns are used pre-capillary column, the length of 5 m, i.d -0.25 mm, the thickness of the film:0.5 um, connected in sequence.

System Configurations:

- Flame ionization detector (FID),
- Split/splitless inlet.
- Cooling oven.
- Analytical capillary column ASTM D6729.
- Analytical capillary column with pre-capillary column ASTM D6730
- Chromos SW, with additional calculation for Detailed hydrocarbon analysis (DHA)

Carrier Gas:

He gasses.

CHROMOS-GC secures:

- Temperature setup up to the column heating oven in the range from 0 to 300°C with the speed of 1°C per minute.
- Maintenance of constant speed and pressure of a carrier gas, hydrogen and the air.
- Discharge from the capillary column of up to 1000 ml/min (for helium).
- In order to maintain low temperature of the column heating oven we developed a special Chromos cooling system, which operates simultaneously with the chromatograph. Chromos cooling system keeps the temperature of the column heating oven within the preset values in the range from (-5°C) to (+300°C) for an unlimited period of time. Along with that, in order to efficiently utilize the system no additional equipment is required.

DETAILED HYDROCARBON ANALYSIS OF BENZINES" ALLOWS TO PERFORM:

- Calculation of certain hydrocarbon concentrations (Mass, Molar or Volume) percent.
- M Group composition and calculation of concentrations (Total Mass, Molar or Volume) percent.
- Total group composition per hydrocarbon classes (N-paraffins, iso-paraffins, Aromatic, Naphthene, and Olefins)
- Benzine density at 20°C (kg/m³), Saturated vapor pressure (kPa)
- Octane number in accordance with the research and the motor methods.

Measurement conditions as per ASTM D6729:

Parameter	Value
Detector temperature (°C)	280
Vaporizer temperature,	250
Initial column oven temperature (°C)	0
Initial temperature holding time (min)	15
Programming speed T _c (°C/min)	1
Intermediate column oven temperature (°C)	50
Intermediate temperature holding time (min)	0
Programming speed T _c (°C/min)	2
Intermediate column oven temperature (°C)	130
Intermediate temperature holding time (min)	0
Programming speed T _c (°C/min)	4
Final column oven temperature (°C)	270
Final temperature holding time (min)	40
Carrier gas (CG)	Helium grade A (4.5)
CG pressure before the capillary column (atm)	3.4
CG discharge in the vaporizer (mL/min)	500
Injection load (µL)	0.2

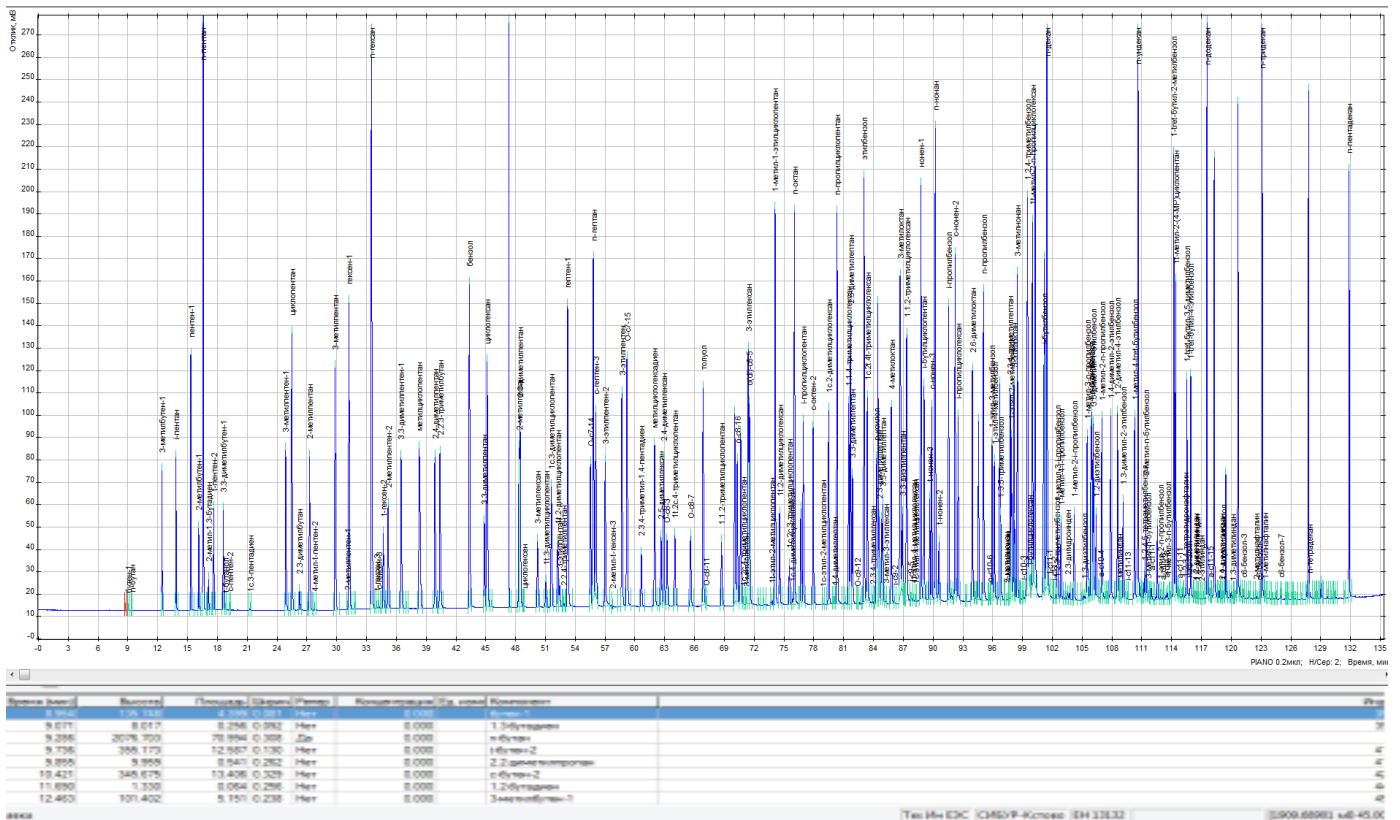


Fig.1. Chromatogram of benzene (Lukoil AI-92) in accordance with Method ASTM D6730

Results and discussion:

- The calibration solution containing a list of n-alkanes from C5 to C15 is used to determine the reference peak retention times. The relative retention times of all other mixture components are calculated in accordance with the reference peak retention times. They are provided in the form of Kovats indices. The calculated Kovats indices of the mixture components are compared with the indices of hydrocarbons in the database and, in case they match, the peak is assigned the name of the hydrocarbon.
- Oxygenate additives require special attention. Even a slight change in the chromatography conditions can result in a major change in the oxygenate retention time. Therewith, the change in the yield time is not critical - it is critical that the oxygenate peaks overlap with the hydrocarbon peaks.
- Detailed Gasoline Hydrocarbon Analysis software allows the user to customize the report. In general, the report includes information on all individual components and group composition of the sample, hydrocarbons are combined into the corresponding groups of paraffin, isoparaffin, naphthenic, aromatic, olefin hydrocarbons and oxygenates. In each group, the components are distributed as per the carbon atom count. The database stores information about all the properties of individual components. Using the initial data from the analysis chromatogram and the properties of the components from the database, the program recalculates the values from % wt to % vol and mol %. Additionally, the fractional composition, octane value, saturated vapor pressure, density and yield percentage by weight and volume are calculated. All database information can be edited. The edited database is saved under a new name, the original database remains unchanged.

Determination of oxygenates in petroleum products and benzene concentration by CHROMOS GC complex system.

Overview:

- This Standard specified quantitative analysis of individual organic oxygenate compounds in the range from 0.17% of the mass to 15.00% of the mass and the total organically bound oxygen up to 3.7 % of the mass in the unleaded petrol with the final boiling point not exceeding 220°C by means of gas chromatography using column switching.
- Method of gas chromatography using column switching in order to analyze benzene contents in the range from 0.05% vol. to 6% vol. in the unleaded petroleum with the final boiling point not exceeding 220°C. The method may also be used in order detect benzene contents in oxygenate-containing petroleum.

EQUIPMENT OF THE COMPLEX:

- Two flame ionization detectors (FID),
- Split/splitless inlet.
- Analytical capillary column 60 mx0.25 mm x 0.4 um with the polar stationary liquid phase (TCEP).
- Analytical capillary column 25 mx0.25 mmx0.4 um with the non-polar methyl-siloxane phase.
- Chromos SW,

Sample type:

- Organic oxygen-containing substances or aromatic compounds in a petrol sample.
- Oxygen-containing or aromatic substances.

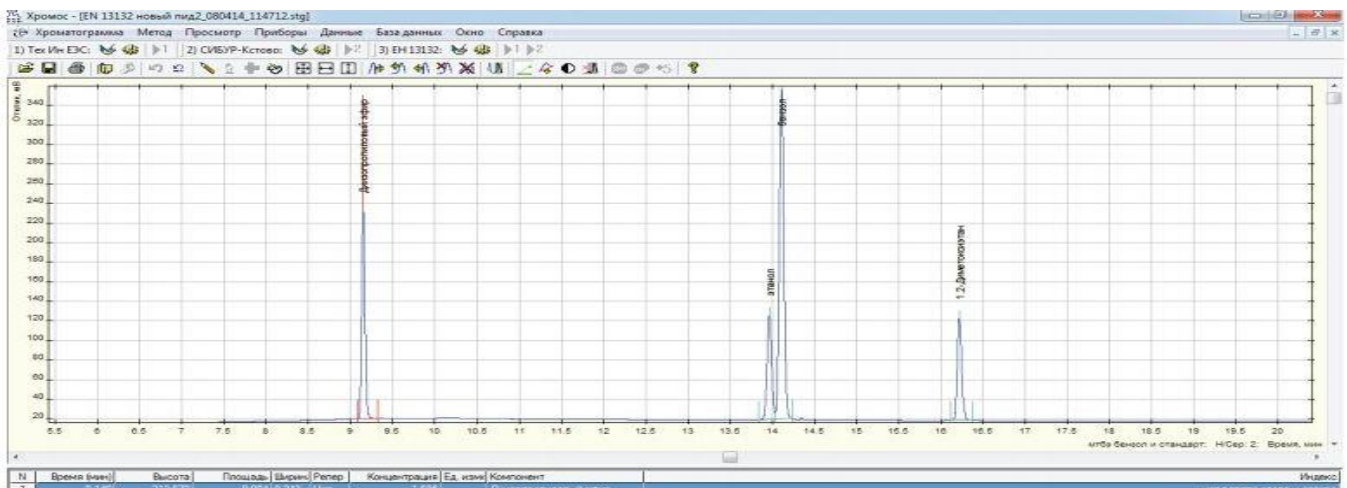


Fig. 1. Chromatogram of component "cutting" from the standard Supelco blend: di-isopropylether, ethanol, benzene, and the internal standard (1.2. dimethoxyethane)

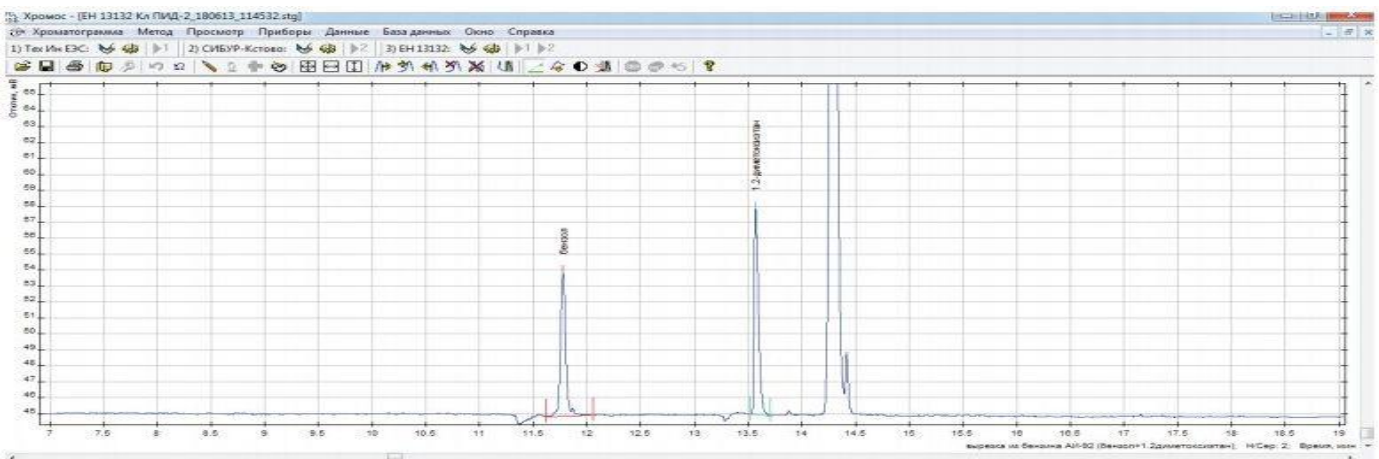


Fig.2. Chromatogram of benzene and the internal standard (1.2.di-methoxy-ethane) from RON-92 petrol)

Solution for Determination of aromatic compounds complies with ASTM D5580 & Oxygen-containing ASTM D4815.

Overview:

- Determination of aromatic hydrocarbons in benzene. ASTM D5580 allows the registration of Benzene, Toluene, Ethylbenzene, m/P-Xylene, O-Xylene and Aromatic Hydrocarbons in Commercial Gasoline.
- The D5580 requires the performance of two consecutive analyzes. The first allows recording of the quantitative content of benzene and toluene; The second analysis ensures the detection of ethylbenzene, m/b-xylene, & o-xylene, and some heavier aromatic hydrocarbons. By summarizing the results obtained according to the two tests, the total aromatic hydrocarbon content can be calculated.
- ASTM D4815 is used to specify oxygen additives in gasoline. It is not possible to perform chromatographic separation of oxygen-containing compounds containing a complex hydrocarbon matrix of benzene, using only a single capillary column.
- Both methods use the principle of 2D gas chromatography which involves operations using a TCEP (separates hydrocarbons from aromatic and oxygen-containing compounds) small packed column and a VB-1 capillary column. switching of gas flows within the columns is secured by a 10-port automatic switching valve. Switching times are set using special software

EQUIPMENT OF THE COMPLEX:

- Flame ionization detectors (FID),
- A streaming current thermal conductivity detector (TCD)
- Split/splitless inlet.
- Analytical capillary column 60 m x 0.25 mm x 0.4 um with the polar stationary liquid phase (TCEP).
- Analytical micro-packed column TCEP.
- Chromos SW

Chromatogram:

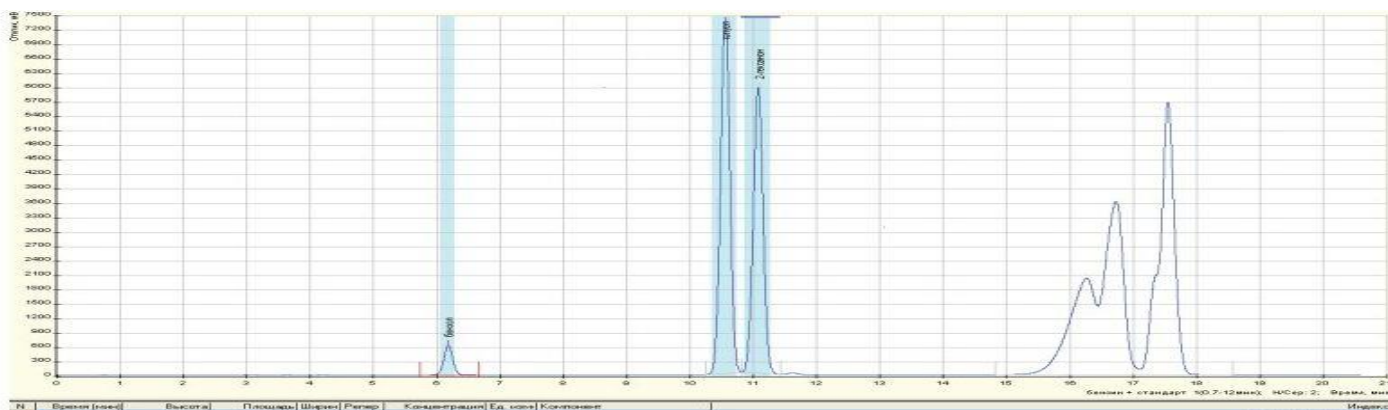


Fig. 1. A chromatogram in compliance with ASTM D5580, acquired as a result of one analysis of a petrol sample.

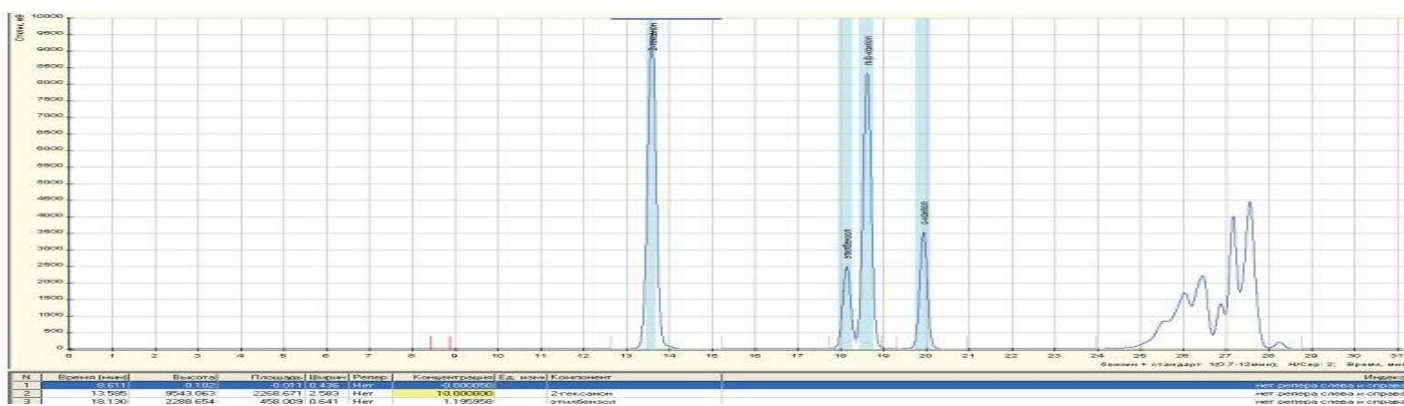


Fig.2. A chromatogram in compliance with ASTM D5580 acquired as a result of re-testing 2-hexanone, ethylbenzene, m/p-xylene, o-xylene, and aromatic substances C9+. Contained in petrol oxygenates

Determination of benzene and toluene by gas chromatography method:

Overview:

- This Standard specifies a method for determination of benzene and toluene in commercial automobile and aviation gasoline, including oxygen-containing benzenes (such ethers as methyl tertiary butyl ether, ethyl tertiary butyl ether, and tert-amyl methyl ether) using gas chromatography. This method is not applicable for ethanol and/or methanol benzenes, which perform as disturbing factors.
- Benzene is detected in the range from 0.1% to 5% in volume, toluene: from 2% to 20% in volume.
- For the analysis the following equipment is used: a thermal conductivity detector (TCD), a packed evaporator and a 6-port automatic heated valve for back purging, and two packed columns.
- a non-polar column 0.8 mx2 mm, filled with 10 % OV-101 with chromosorb P-AW (column A).
- a polar column 4.6 mx2 mm with a packing 20% 1,2,3 tris (2-cyanoethoxy)propane (TCEP) with chromosorb P-AW (column B).
- In the beginning a sample passes through the non-polar column, which separates components by their boiling temperatures. Upon coming out of octane the backpurging mode of the non-polar column is turned on, which allows to wash off all constituents heavier than octane. Octane and some lighter components pass through the column with a highly-polar phase, which separates aromatics and non-aromatic constituents. Methyl ethyl ketone (MEK) is used as internal standard

Configurations:

- Two Thermal conductivity detectors (TCD), 10-port heated gas sample valve, tow sampling loop two analytical columns Porapak R & NAX. Chromos SW, with additional calculation for physical & chemical of NG

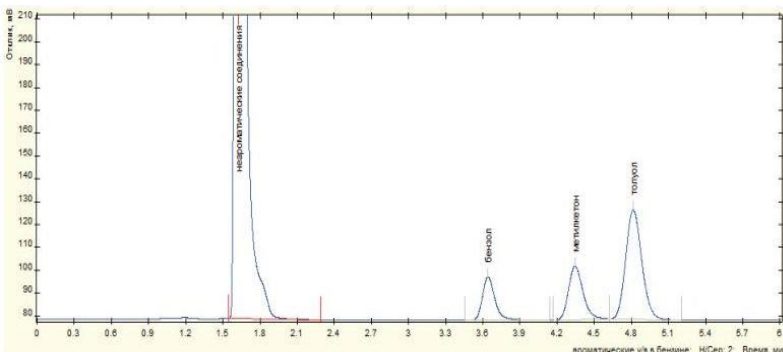
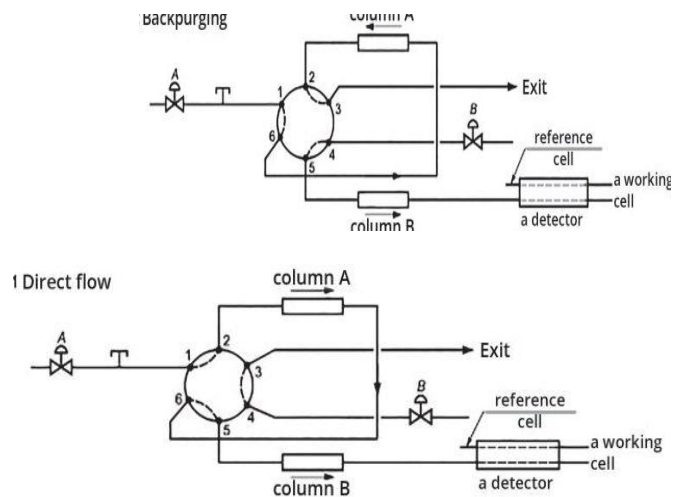


Fig.2. A chromatogram of separation of benzene and toluene



Determination of hydrogen sulfide, Methyl and ethyl mercaptans:

Overview:

- Petroleum is a complex mixture of hydrocarbons with different molecular weight and some other chemical compounds, (including sulfur-containing ones). A flame-photometric detector (FPD) is selective to sulfur-containing compounds (SCC), but an overlap of the hydrocarbon peak and the SCC peak results in a so-called "suppression" of a SCC signal, that's why in order to solve the task of determination of hydrogen sulfide, methyl and ethyl mercaptan in petroleum it is required to separate the said components from each other and to separate them from hydrocarbons.
- Clause 5.2. of GOST R 50802-95 specifies that "in order to acquire reliable results a chromatographic column with any sorbing agent may be used; the sorbent shall be able to secure separation of sulphur-containing compounds and their separation from hydrocarbons C1-C7; along with that, separation degree (R) for the following components: hydrogen sulphide - methylmercaptan and methylmercaptan -ethylmercaptan, as well as C1-C7 and SCC hydrocarbons shall not be less than 1". A 100m long capillary column (diameter -0.53 mm, film layer 5 μm) with a polymethylsiloxane phase meets the said requirement to the fullest extent, unlike the packed columns specified by the GOST. Besides that, by using the capillary column it is possible to determine in petrol some other mercaptans and SCC of other classes.

Configurations:

- Two Thermal conductivity detectors (TCD),
10-port heated gas sample valve, tow sampling loop
two analytical columns Porapak R & NAX.
Chromos SW, with additional calculation for physical & chemical of NG

Carrier Gas:

He gasses.

Analysis type:

- A direct analysis. One capillary column is used. In this case all petroleum components get into the column which results in longer time required for the test and the need to perform stripping of the column).
- Analysis using a guard column.

Compounds and concentrations:

- In accordance with GOST 50802 only 3 highly volatile components of petroleum should be analyzed, but due to the fact, that petroleum contains a large range of different substances, we suggest using a guard column in order to prevent penetration of heavy petroleum components into the main column

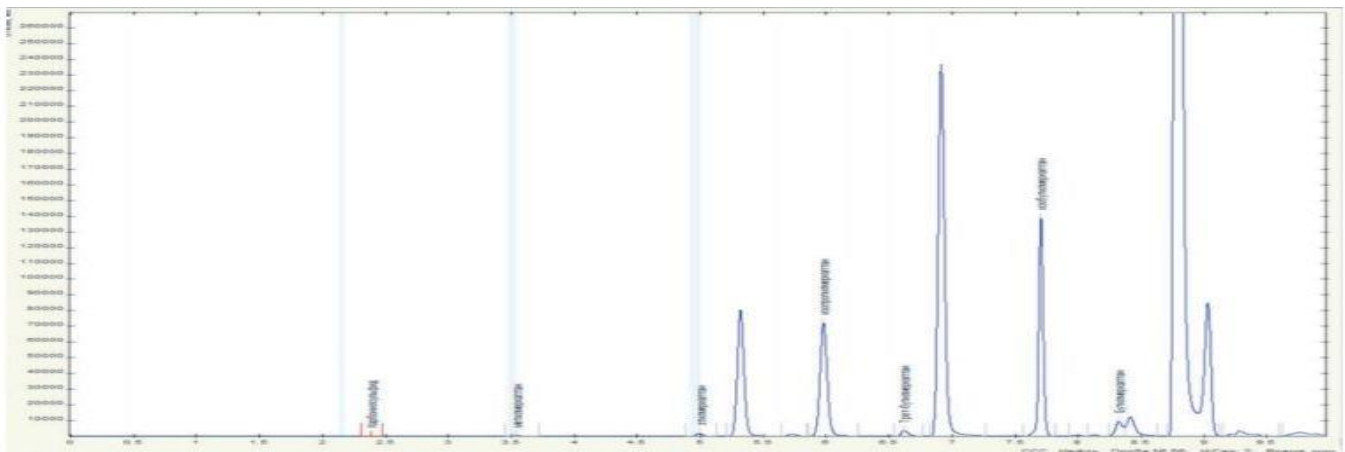


Fig.1.A direct-analysis chromatogram of sulfur-containing compounds in petroleum

- How to do that: upon sampling a sample component is introduced into the guard column, and, as soon as detectable substances (H₂S, methyl-and-ethyl mercaptans) get into the main column, a back purging mode is switched on, therefore, excluding penetration into the column of other petroleum components. In the main column complete separation of detectable components from hydrocarbons takes place in the main column. Then detection of the said target components is performed. The guard column allows to reduce the total time for analysis down to 7-10 minutes. The need to condition the capillary column upon each analysis is eliminated. A chromatogram using a guard column is shown on Fig.2.

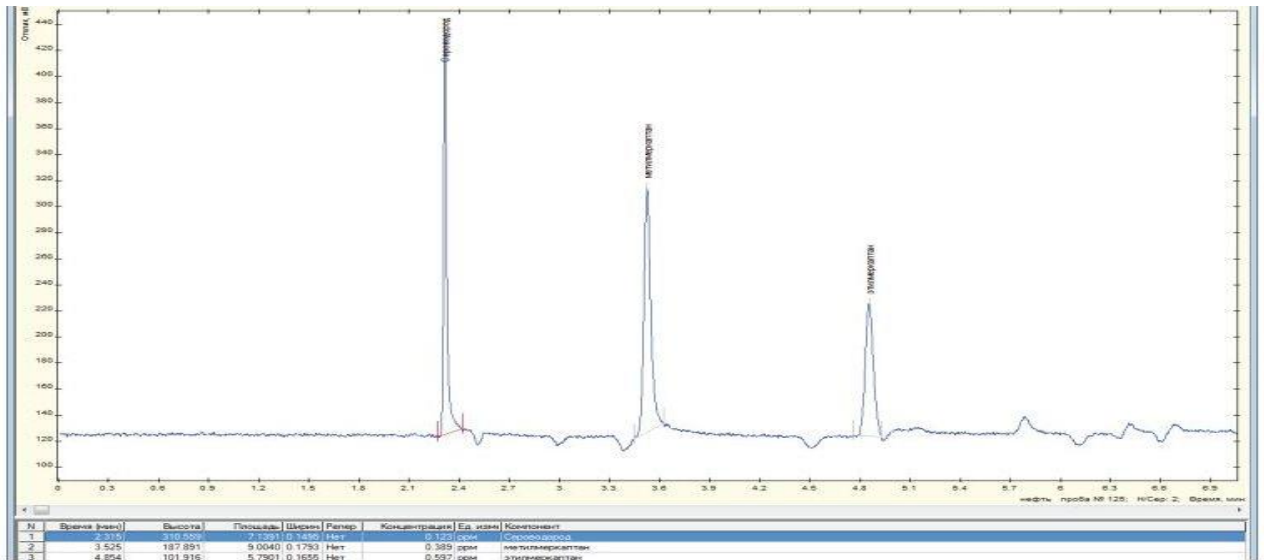


Fig.2. Achromatogram of analysis of sulfur-containing compounds in petroleum using a guard column

Determination of C1-C6 hydrocarbons in oil:

methods:

- The method specifies that C1-C5 hydrocarbons should be detected using a 3 m long packed column, packed with aluminum oxide and covered in paraffin oil (in diagram: column 1), and C2-C6 hydrocarbons should be detected in the other column with BFI modified by dibutyl phthalate (column 2).
- In order to identify all hydrocarbons, from C1 to C6, a gas chromatography with two thermal conductivity detectors (TCD) and two different columns is required. In order to regulate the backwashing process of the columns, 4-port automatic valves are used.

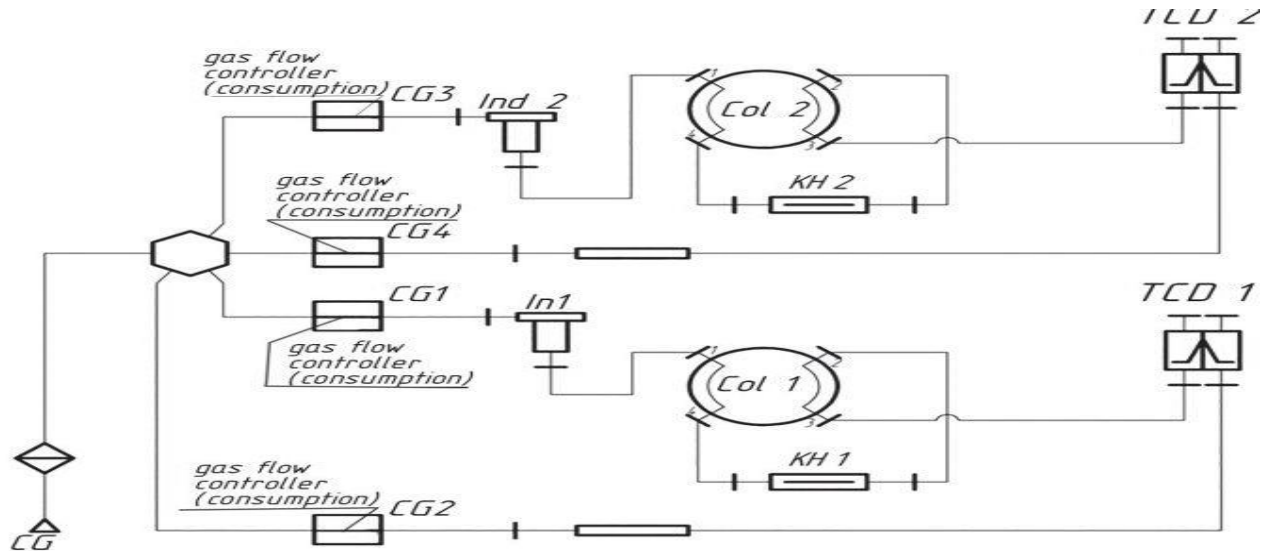


Fig.1. Gas diagram of a chromatogram

Configurations:

- Two Thermal conductivity detectors (TCD),
10-port heated gas sample valve, tow sampling loop
two analytical columns Porapak R & NAX.
Chromos SW, with additional calculation for physical & chemical of NG

Carrier Gas:

- Modern packing materials allow to determine C1-C6 hydrocarbons using only one separating column. Therefore, the device itself becomes less complicated and cheaper. For example, using a packed column filled with Porapak-Q packing material, and a guard column for separation and discharge of heavy hydrocarbons.
- It is possible to perform a complete analysis of petroleum for determination of C1-C6 within 20-25minutes.

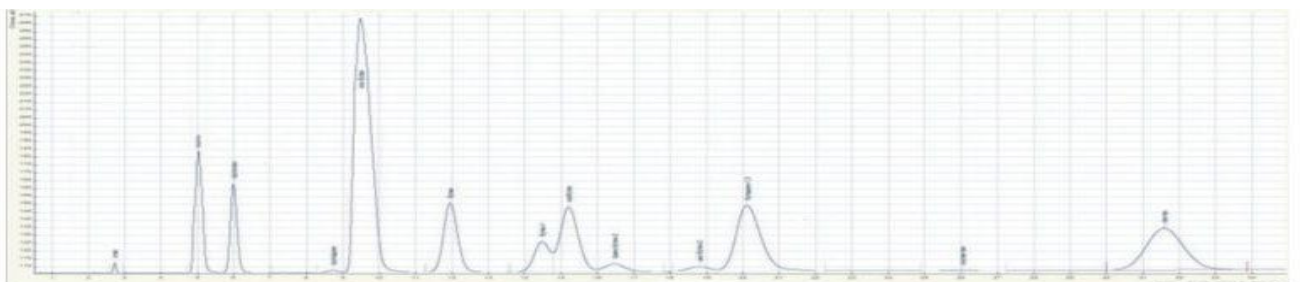


Fig. 2. Chromatogram for separation of components

Determination of the fraction and group components hydrocarbon composition.**Overview:**

- Gas condensate is a valuable chemical raw material which is similar to petroleum, but free from resins and asphaltenes. Gas condensate is extracted from natural gases during their extraction at gas-condensate fields.
- There are two types of gas-condensates: a stable and an unstable one. Unstable condensate is a wide fraction of light hydrocarbons and is characterized by higher pressure of saturated vapors.
- It contains dissolved gases of methane-butane fraction (the stable condensate contains only C5 hydrocarbons and the higher ones). Gas condensate is used in order to produce motor fuels and for the purposes of organic synthesis.

Analysis type:

- Analysis of unstable gas condensate (UGC) at subsidiary companies of Gazprom, OJSC is performed in accordance with Gazprom Industry Standard 5.5-2007. The standard specifies two methods for determination of UGC.
- **Method A:** based on preliminary de-gassing of UGC samples followed by analysis of separated gas and de-gassed condensate.
- **Method B:** introduction of a sample into a chromatograph is performed under pressure without preliminary de-gassing.

System Configurations:

- Device 1 Flame ionization detector (FID),
- Split/splitless inlet.
- Analytical capillary column ASTM D2887.
- Device 2 Flame ionization detector (FID), Thermal conductivity detector (TCD)
- 6 and 8 gas sample valves
- Two Packed columns (Porapak Q & molecular sieves NaX)
- Chromos SW, with additional calculation for Distillation Fraction (Simdist.) Software" Calculation in accordance with requirements of GAZPROM.

Carrier Gas:

He gasses.

Reference documents:

- ASTM B 2887-08 "Standard Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography
- Gazprom Industry Standard 5.5-2007 "Unstable Gas Condensate. Method for Determination of Component-Fraction and Group Hydrocarbon Composition.
- Methodological documentation of Tumen NII Giprogas, LLC: MM 51-00159093-004-04"Unstable Liquid Hydrocarbons. Method for Determination of Component-Fraction Composition.

Two-Dimensional Gas Chromatography GC*GC:

- Device 1: for analysis of de-gasses condensate (the stable part) for determination of C6-C44 hydrocarbons.
- Device 2: for analysis of de-gassed condensate for determination of C1-C5 light hydrocarbons and component analysis of separated gas (N₂, CO₂ H₂S & C1-C7).

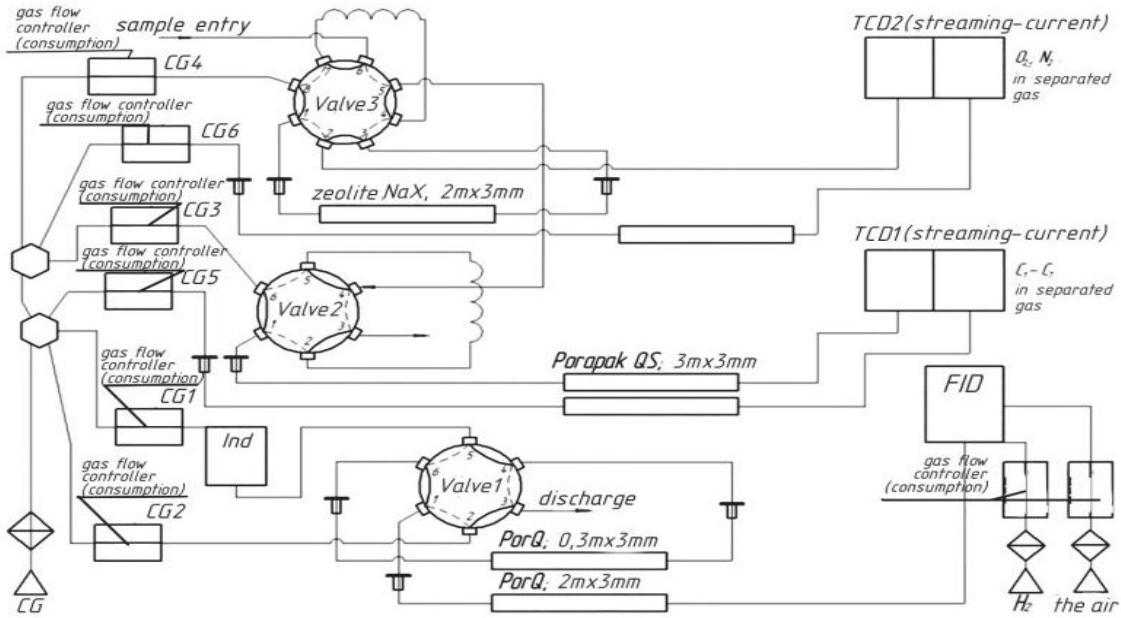


Fig. 1. Diagram for analysis of separated gas and C1-C5 hydrocarbons in de-gassed condensate.

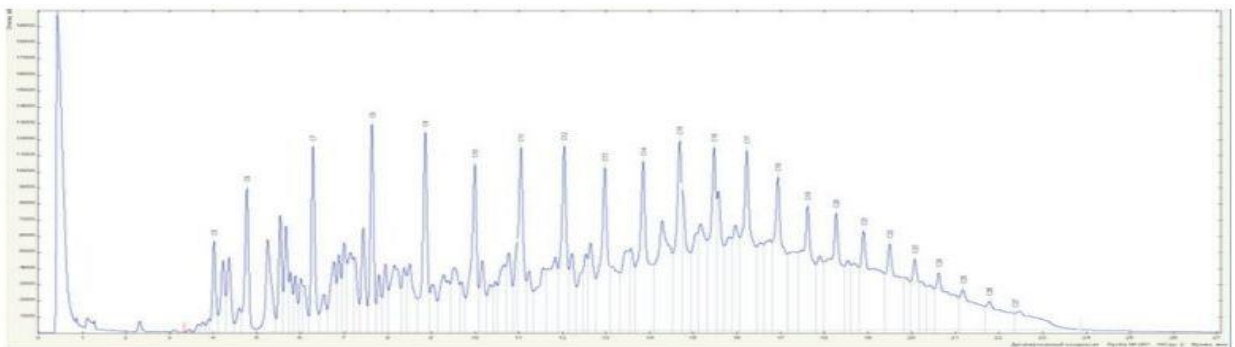


Fig.2. Chromatogram of a de-gassed condensate

Determination of Dry gas composition analysis.

Overview:

- Chromos specialists for hydrogen detection recommend the use of a semi-thermal diffusion detector (TCD) and argon as the carrier gas, since in this case there is a linear dependence of the detector response from the hydrogen concentration.
- This is very important because dry gas samples contain broad dispersed hydrogen concentrations (ie, from 0.1% to 90%).
- In the case of helium as a carrier gas for the determination of H, not only is there a linear dependence of the response from concentration, but also the peak shape of hydrogen becomes non-standard.

System Configurations:

- Thermal conductivity semi-diffusion detector (TCD) with Argon Gas).
- two streaming current thermal conductivity detectors (TCD) (with helium as carrier gas).
- 10 and 8 gas sample valves
- Three Packed columns (Porapak Q & molecular sieves NaX)
- Chromos SW, with additional calculation for Distillation Fraction (Simdist.) Software" Calculation in accordance with requirements of GAZPROM.

Carrier Gas:

He or Ar. gasses.

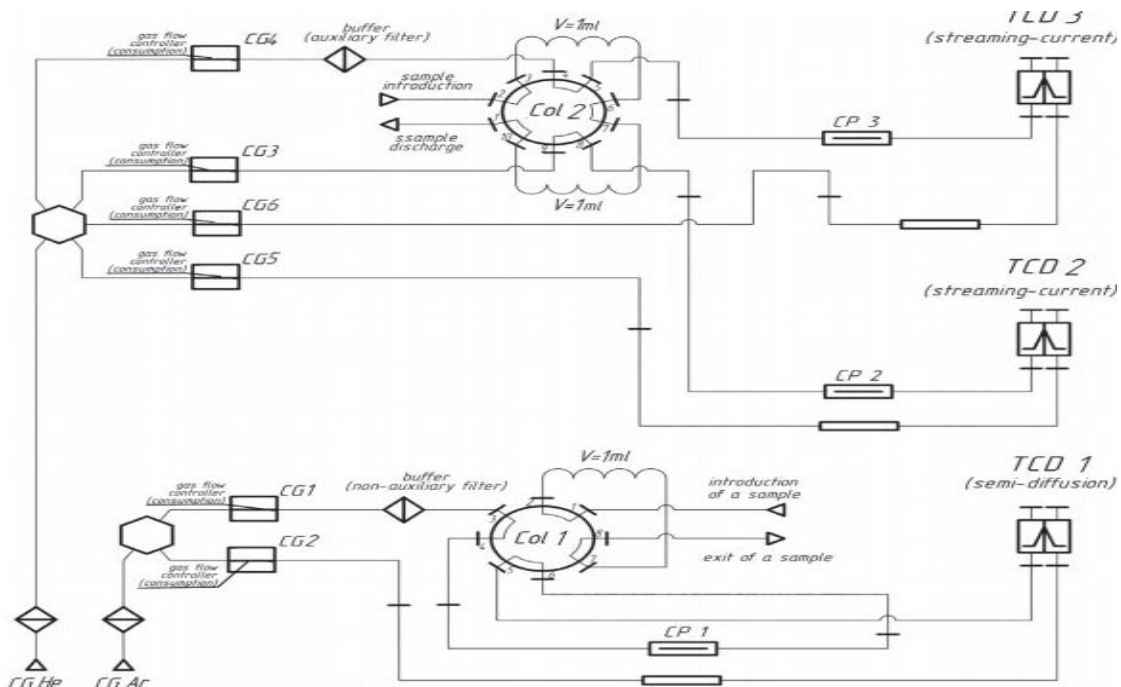


Fig. 1. Equipment diagram for dry gas composition analysis

Determination of aromatic hydrocarbons in diesel fuel by HPLC.

Components:

- Non-aromatic petroleum products with a retention time between points A and B.
- Mono-aromatic petrochemicals with a retention period between points B and C.
- Di-aromatic petrochemicals with a retention time.
- Tri-aromatic petrochemicals with a retention time between points D and E.

System Configurations:

- Pump for HPLC.
- Autosampler.
- Column oven for HPLC
- Refractive index detector RID
- Analytical column with guard column for aromatic components.

Method analysis:

- Column: Chromasil NH2 250x4.6mm 5mcm
- Separation mode: Isocratic
- Eluent: heptane
- Consumption:1 ml/min
- Column temperature: 30°C
- Sample volume: 5 ul.
- Detector: RID
- Test subject: petrochemicals
- Groups of substances: aromatic hydrocarbons
- Sample: Lukoil diesel fuel.

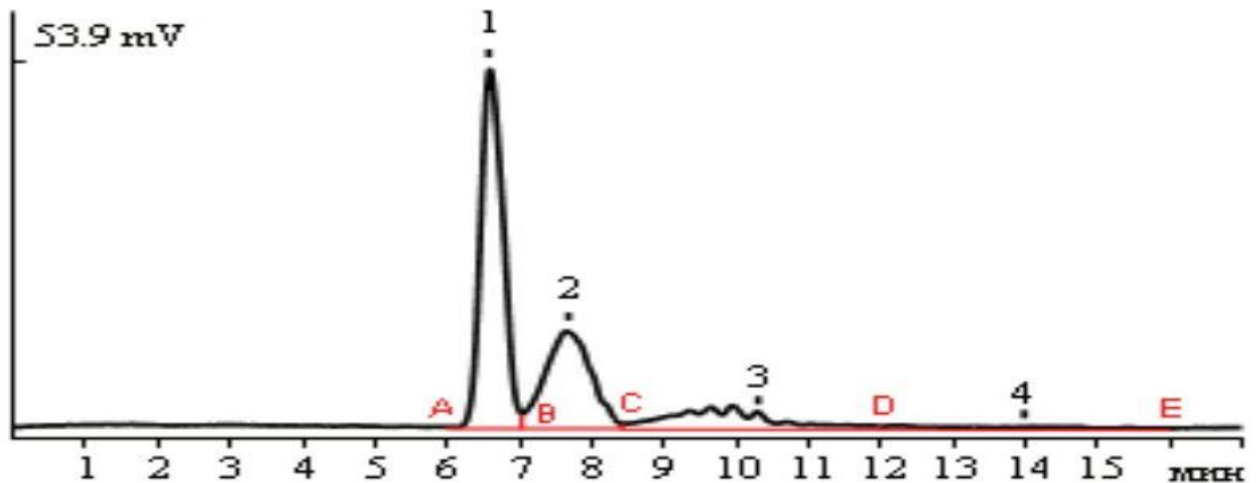


Fig.1.Chromatogram of Lukoil diesel fuel.

Analysis of composition of natural and associated petroleum gas with temperature programming accordance with GOST 31371.3-2008 (ISO 6974-3:2000):

methods:

- GOST 31371.3-2008, in accordance with ASTM D1945.
- ISO 6974-3:2000.

Configurations:

- Two Thermal conductivity detectors (TCD),
- 10-port heated gas sample valve, tow sampling loop
- two analytical columns Porapak R & NAX.
- Chromos SW, with additional calculation for physical & chemical of NG

Carrier Gas:

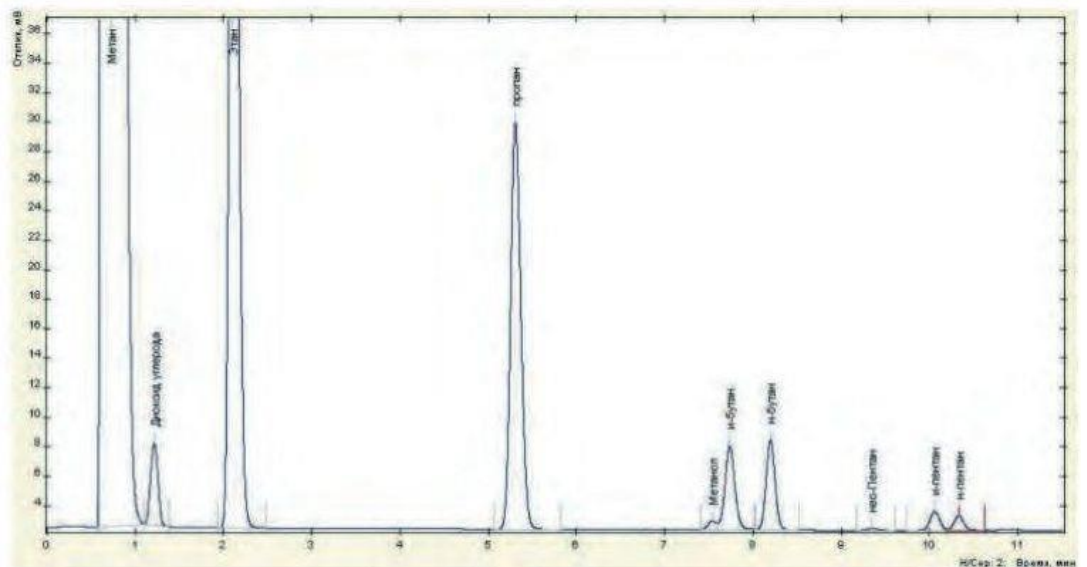
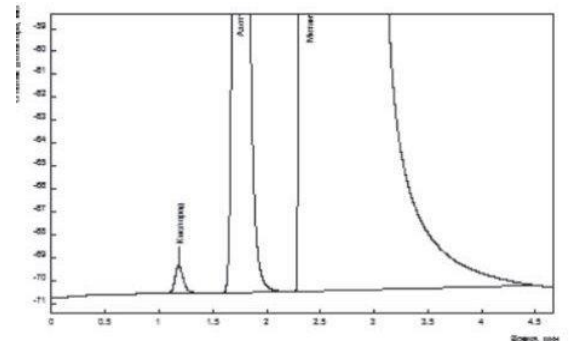
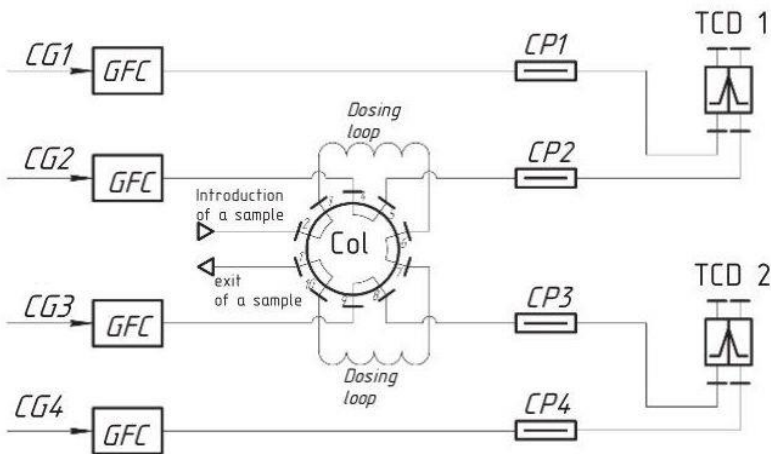
He gasses.

Sample type:

- Natural gas streams and similar sample),

Compounds and concentrations:

- CO, CO₂, N₂, O₂, C₁, C₈



Analysis of composition of natural and associated petroleum gas with temperature programming accordance with GOST 31371.4-2008 (ISO 6974-4:2000):

methods:

- GOST 31371.4-2008, in accordance with ASTM D1945.
- ISO 6974-3:2000.

Configurations:

Thermal conductivity detectors (TCD),
 10-port heated gas sample valve, tow sampling loop
 two analytical columns DC 200 & PAW chromosorb.
 Chromos SW, with additional calculation for physical & chemical of NG

Update channel:

The diagram may be supplemented with channels for helium, hydrogen, oxygen, and nitrogen.

Carrier Gas:

He gasses.

Sample type:

- Natural gas streams and similar sample),

Compounds and concentrations:

- CO, CO₂, C₁, C₆+
- He, H₂, N₂, O₂, as option

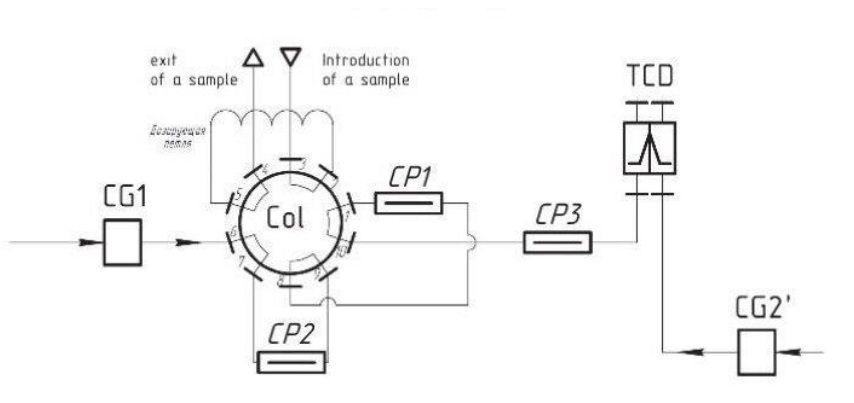


Fig.1 Diagram of the instrument.

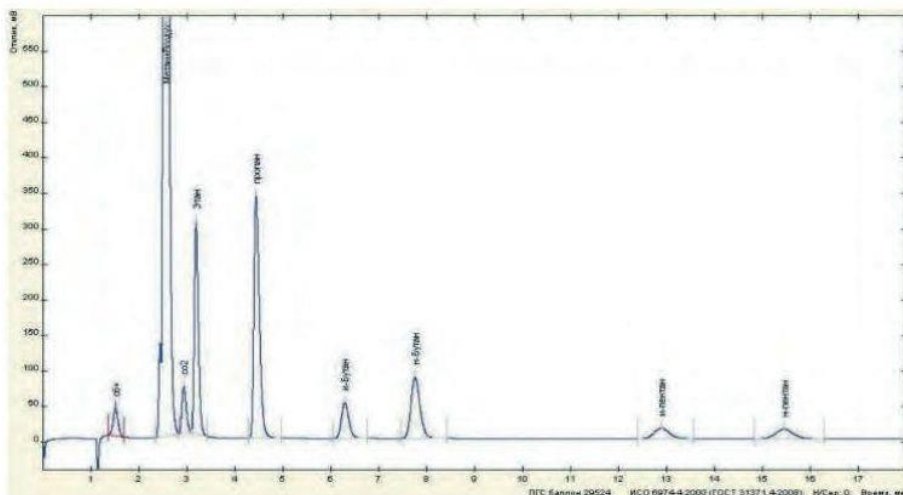


Fig.2. Chromatogram of analysis of the hydrocarbon part in a state standard reference sample

Analysis of composition of natural and associated petroleum gas with temperature programming accordance with GOST 31371.5-2008 (ISO 6974-5:2000):

methods:

- GOST 31371.3-2008, in accordance with ASTM D1945.
- ISO 6974-3:2000.

Configurations:

- Two Thermal conductivity detectors (TCD),
- Two 10-port heated gas sample valve,
- 6-port gas sample valve, tow sampling loop
- Three analytical packed columns are low volatile.
- Chromos SW, quantitative calculation is performed using the absolute calibration method

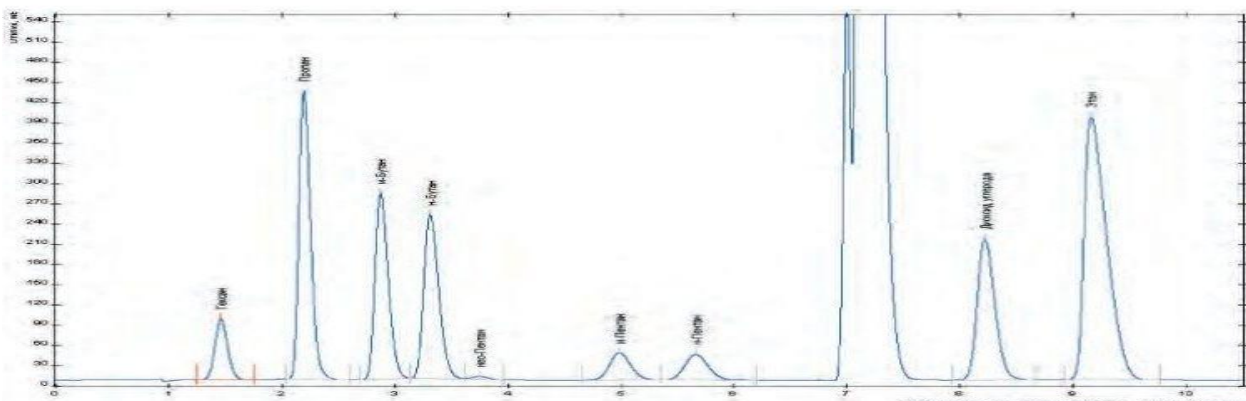
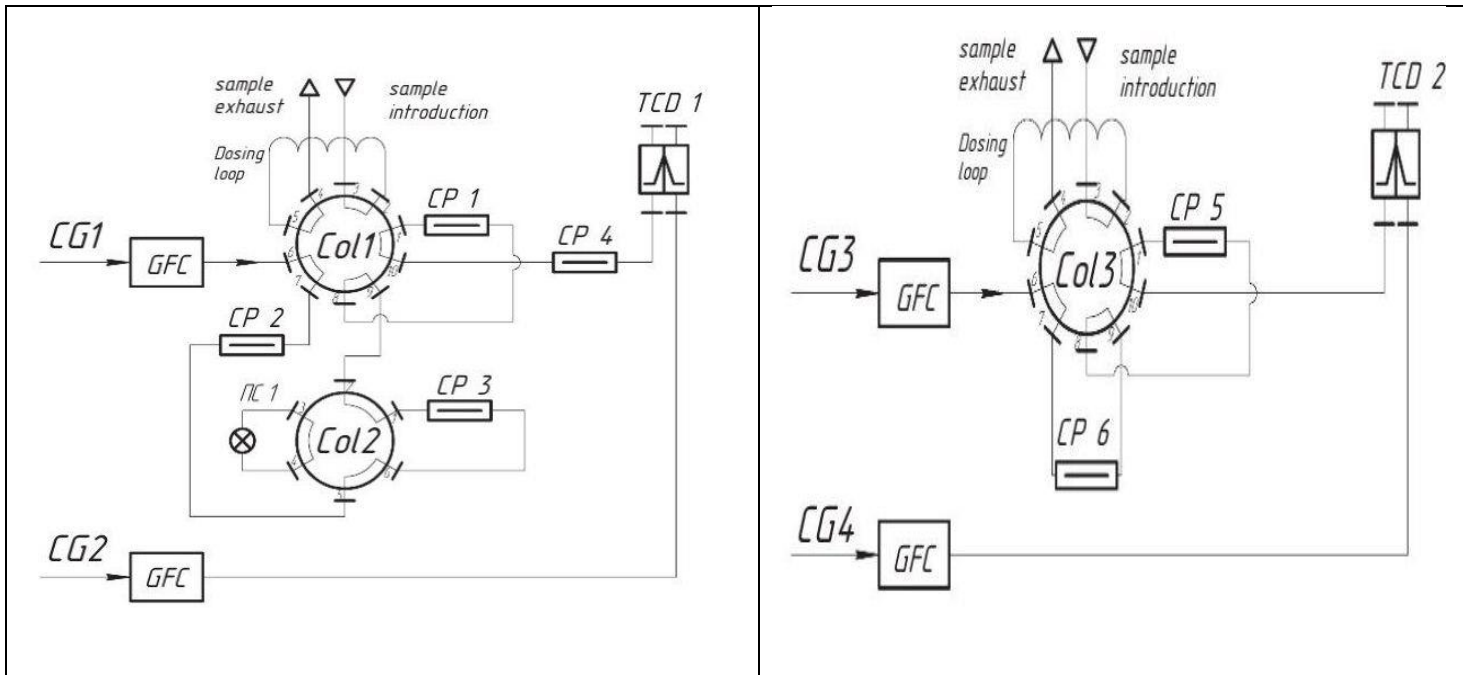
Carrier Gas:

He gasses.

Sample type:

- Natural gas streams and similar sample),

Compounds and concentrations: CO₂, N₂, O₂, C₁, C₆+



Determination of hydrogen, helium, oxygen, nitrogen, carbon dioxide, & C1- C8 in

Accordance with GOST 31371.5-2008 (ISO 6974-5:2000):

methods:

- GOST 31371.6-2008, in accordance with ASTM D1945.
- ISO 6974-6:2000.

Configurations:

- Two Thermal conductivity detectors (TCD), flame ionization detector (FID)
- Two 10-port heated gas sample valve,
- 6-port gas sample valve, tow sampling loop
- Three analytical capillary columns.
- Chromos SW, quantitative calculation is performed using the absolute calibration method

Carrier Gas:

He & Ar gasses.

Sample type:

- Natural gas streams and similar sample,

Compounds and concentrations: CO₂, N₂, O₂, H₂, He, C₁, C₈ or higher.

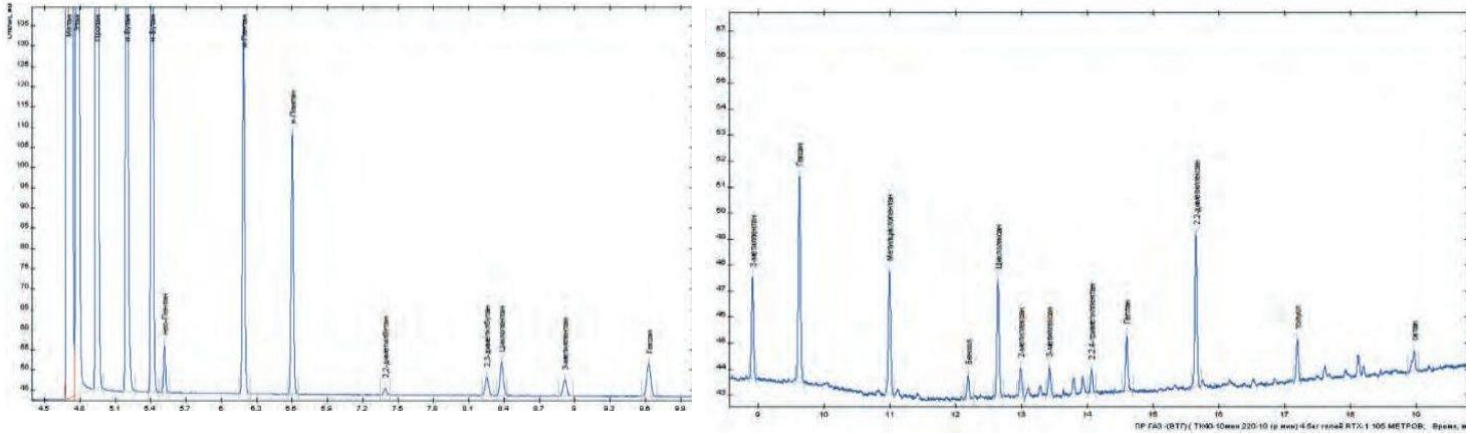
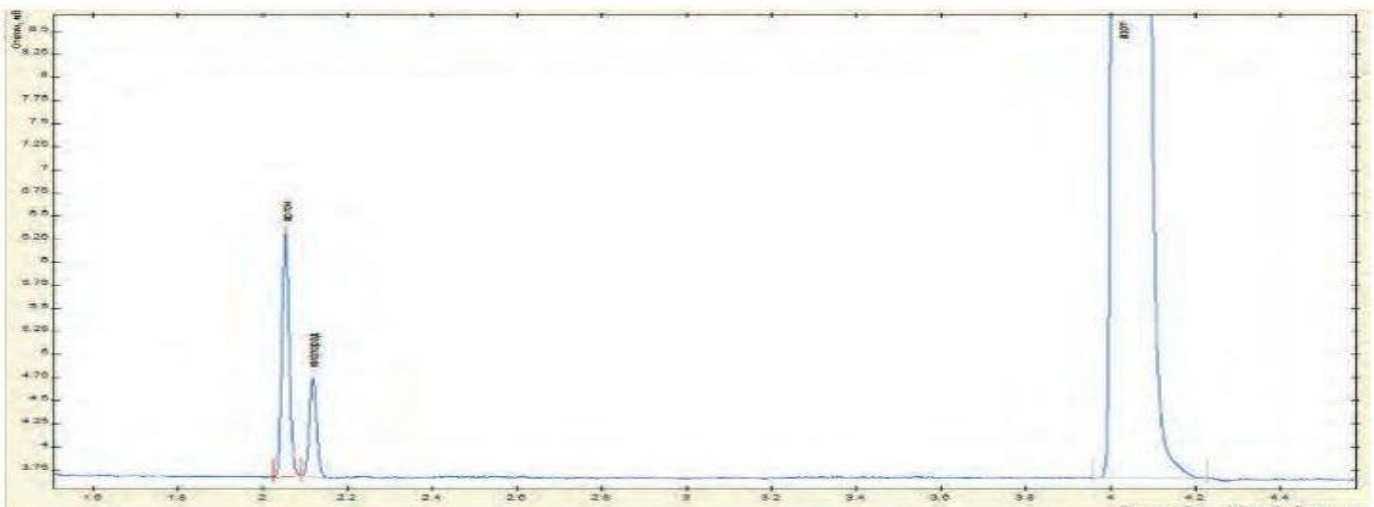


Fig.1.Flame ionization detector (FID): analysis of natural gas sample using a capillary column Rtx-1



g.2.A micro TCD: a chromatogram of separation of argon, oxygen, and nitrogen in natural gas sample using a capillary column MOLESIEVE

Complete component analysis of natural Gas accordance with GOST 31371.7-2008 up to 4 detectors:

methods:

- GOST 31371.7-2008, in accordance with ASTM D1945 & GPA 2286

Configurations:

- Three Thermal conductivity detectors (TCD), flame ionization detector (FID)
- Three 8-port heated gas sample valve,
- 6-port gas sample valve, tow sampling loop
- Three analytical packed columns & capillary column.
- Chromos SW., Quantitative calculation is performed using the absolute calibration method

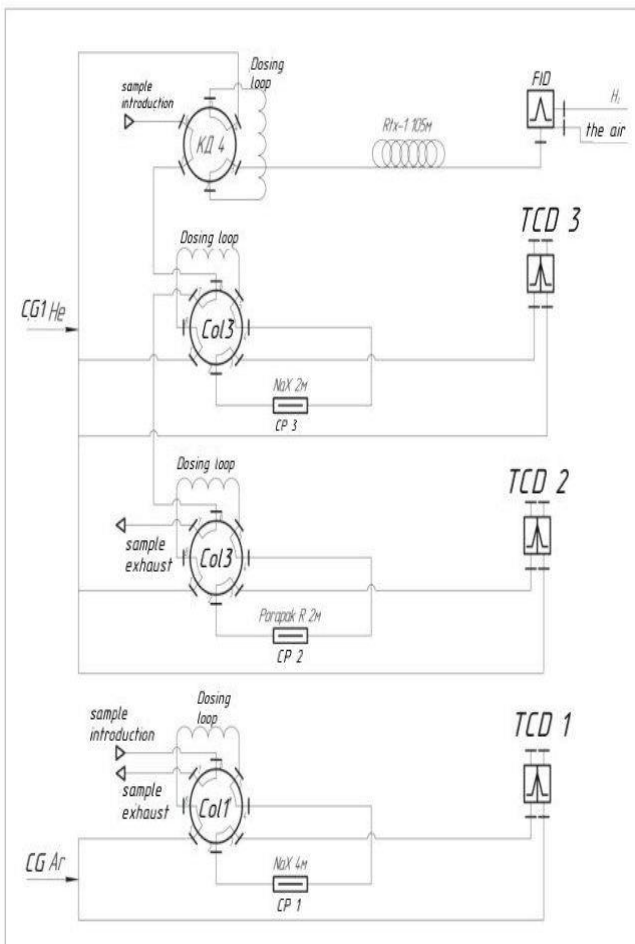
Carrier Gas:

He & Ar. gasses.

Sample type:

- Natural gas streams and similar sample),

Compounds and concentrations: CO₂, N₂, O₂, CO, H₂S H₂, He C₁, C₁₄



Channel 4: (FID) Detect hydrocarbons, 6-port dosing valve is used for sampling. A capillary column a polymethyl siloxane is used for separation of hydrocarbons from C₅ to C₁₄

Channel 3: (TCD-3) is used to detect oxygen and nitrogen. Helium is used as carrier-gas. An 8-port valve is used as in channel 1.

Channel 2: (TCD-2) is used to detect CO₂ and C₁ to C₅. Helium is used as carrier-gas. An 8-port valve is used as in channel 1.

Channel 1: (TCD-1) Detect He and H₂. Argon is used as carrier-gas. An 8-port valve is used as a dosing and a switching valve. Upon extraction of helium and hydrogen, the valve is switched, and the direction of the carrier-gas flowing through the column is flipped.

Analysis of composition of natural and Composition analysis of natural gas in accordance with GOST 31371.7-2008 including H2 & He:

methods:

- GOST 31371.7-2008, in accordance with ASTM D1945.

Configurations:

- Thermal conductivity detectors (TCD), FID and TCD-2 detectors are connected in sequence
- 10-port heated gas sample valve,
- Two 6-port gas sample valve, tow sampling loop
- Three analytical packed columns are low volatile.
- Chromos SW, quantitative calculation is performed using the absolute calibration method

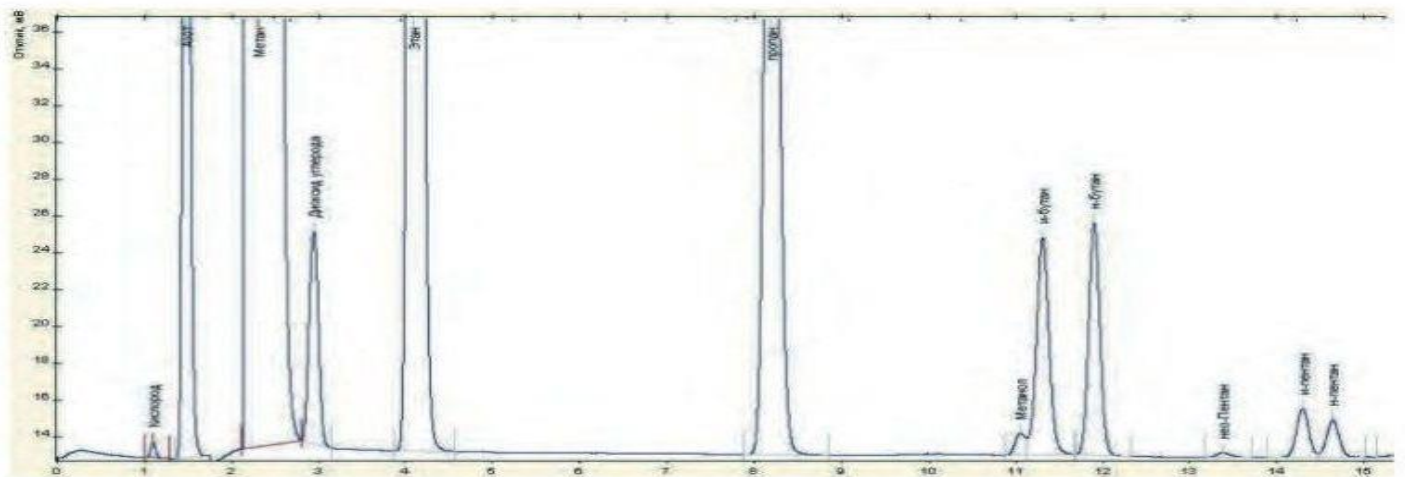
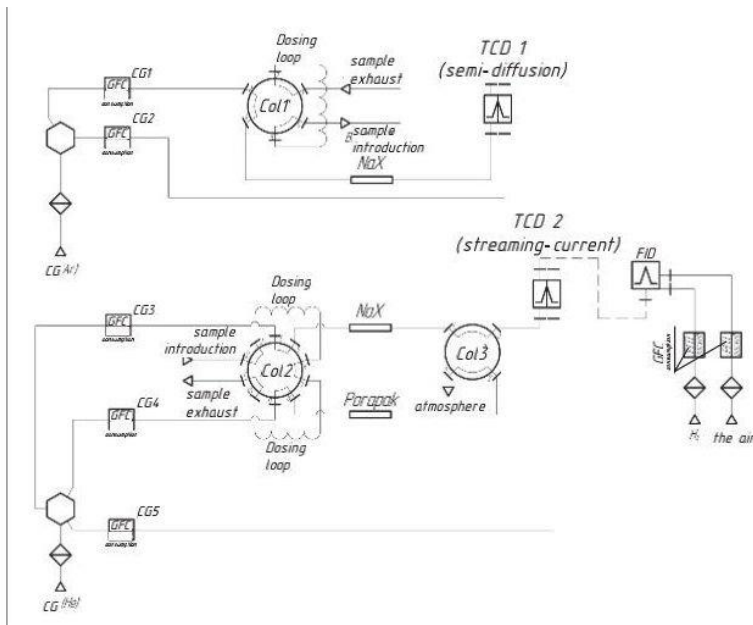
Carrier Gas:

He gasses.

Sample type:

- Natural gas streams and similar sample),

Compounds and concentrations: CO₂, H₂, He, C₁, C₈ and higher



Determination of sulfur-containing compounds in natural gas and associated petroleum with GOST R 53367-2009:

methods:

- GOST R 53367-2009, in accordance with ASTM D5.

Configurations:

- Flame photometer detectors (FPD),
6-port heated gas sample valve Sulfurinert,
sampling loop Sulfurinert
analytical capillary column.
Chromos SW, Quantitative calculation is performed in accordance with GOST R 53367-2009.

Carrier Gas:

He gasses.

Sample type:

- Natural gas streams and similar sample),

Compounds and concentrations: Sulfur compounds

The utilized columns secure:

Separation efficiency of analyzed sulfur-containing components and hydro-carbons.
Maximal sensitivity of the detector during analysis of sulfur-containing components in the presence of hydrocarbons

All communications and gas sample valves are made of sulphate-inert materials, and as a result, there isn't need to "saturate" the chromatographic system with sulfur-containing components.

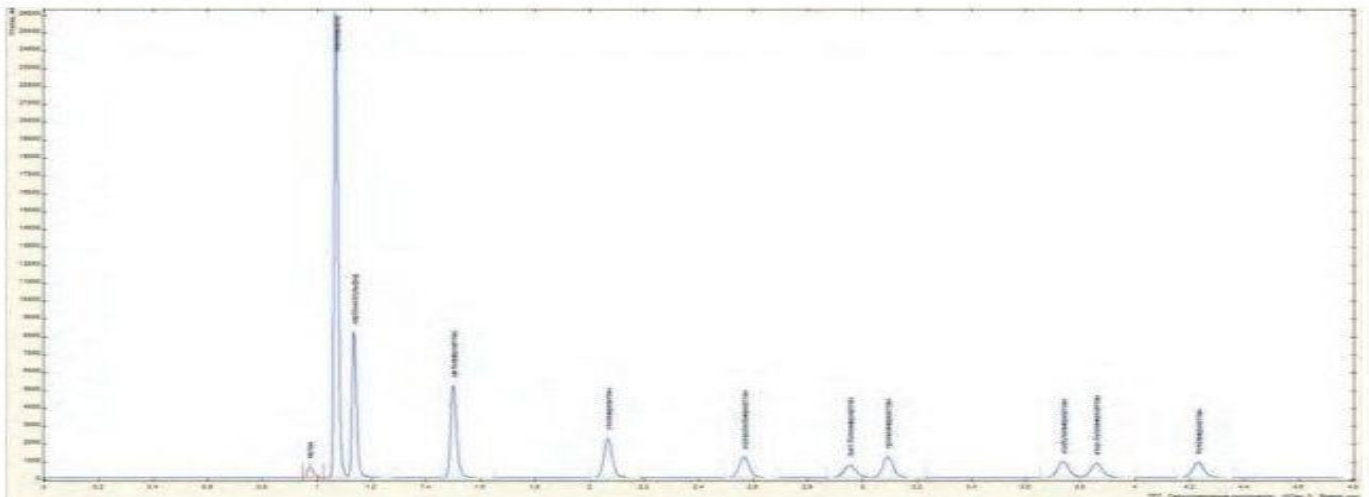


Fig.1.FPD: Chromatogram of sulfur-containing compounds

Determination of Determination of Analysis of liquified hydrocarbon gases:

methods:

GOST 54484-2011, GOST 10679-76, in accordance with ASTM D2163.

Configurations:

- Flame Ionization detectors (FPD),
Liquefied gas dosing valve,
sampling loop Sulfurinert
analytical capillary column or packed column.
Chromos SW, Quantitative calculation is performed in
accordance with GOST 54484-2011.

Carrier Gas:

He gasses.

Sample type:

- Liquefied gas sample and similar sample),
Compounds and concentrations: from C1 to C5 & C6+



liquified gas dosing valve (LGDV):

Chromos specialists developed a liquified gas dosing valve (LGDV), which is a special-purpose device for sampling of LHG, and which secures sample introduction without any de-gassing. Due to a well-thought structure of the dosing instrument for liquified gases, we were able to reach proper repeatability in respect of heights and areas of peaks during introduction of a liquid sample.

determination of hydrocarbon composition of liquified hydrocarbon gases (LHG) was performed in accordance with requirements of GOST 10679-76, The easiest way to acquire objective data related to composition of LHG is to introduce samples without any de-gassing.



Stability Assessment of the Valve during Analysis of LHG

Component	Component concentration per two parallel analyses, % mass.		Difference between two parallel analyses, % mass	
	C1	C2	Actual Value	Reference value as per GOST 10679
Methane	0.095	0.099	0.004	0.025
Ethane	2.74	2.77	0.03	0.15
Propane	42.87	42.94	0.07	0.7
Isobutane	23.20	23.16	0.04	0.5
N-butane	30.90	30.60	0.3	0.7
Isopentane	0.097	0.093	0.004	0.025
N-pentane	0.055	0.056	0.001	0.025

Chromos offers the following methods for:

- 1- Direct analysis of hydrocarbon composition of liquified gas C1-C5 and higher.
- 2- Analysis with back purging of the main column for detection of C1-C5 and the sum of hydrocarbons C6+. Aswitchingvalveis utilized in this case
- 3- Analysis of liquified gas using a capillary column without de-gassing and with sample discharge.
- 4- Analysis of liquified column without de-gassing and without sample discharge. Anano-volumetric Valco valve is used for sampling purposes

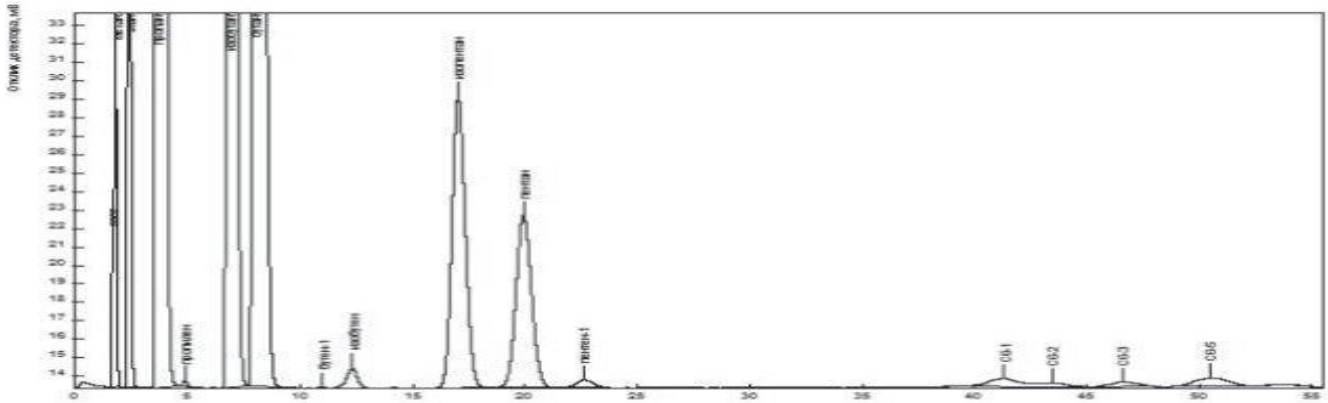


Fig. 2. Chromatogram of direct analysis of LG using a packed column

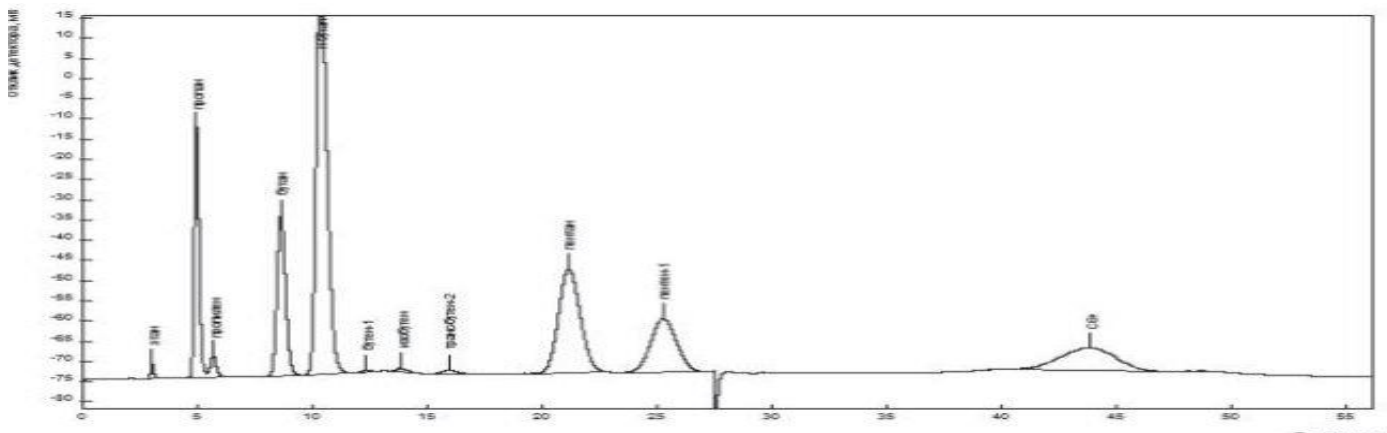


Fig.3. Chromatogram of analysis of LHG with back purging and a packed column

CHROMOS

**Electrical Measuring & Control systems manufacturing Co.
L.L.C.**

- Laboratory Gas Chromatographs
- Process Gas Chromatographs
- Control Units (oil, gas, H₂, O₂, LNG)
- Liquid Chromatographs
- Lab Furniture
- Chemicals for Clean Water and Oil