Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 5 [10] September 2016: 28-34

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804

ORIGINAL ARTICLE **OPEN ACCESS**

Diagnosing of Structural Modes of Gas Flow In The Pipeline Systems

G.G. Ismailov, R.A. Ismailov, E.H. Iskenderov,V. H. Nurullayev
The Azerbaijan State University of Oil and The Industry, Baku

ABSTRACT
In this article the modes of change of basic parameters of a gas flow (pressure, flow rate and temperature) on various lines of a gas pipeline for the purpose of the producing of diagnostic criterion for revealing of liquid inclusions as a part of transported gas are investigated in this article. It is established, that in the presence of liquid inclusions at movement of gas flows there are the structural changes peculiar to fluid systems, systems which can be identified by variations of fractal dimensions of flow characteristics.
Keywords*: gas pipeline, gas flow, diagnosing, flow characteristic, structure form.*

Received 22.06.2016 Revised 16.07.2016 Accepted 11.08.2016

INTRODUCTION

The pipeline system represents the difficult dynamic system consisting of various components which it is possible to present formally in the form of an alternating chain: a gas well -system of gathering and gas treatment - the main gas pipeline - distributive gas pipelines - end users. Transportation of production from with gas or gas condensate fields or associated gases from oil fields is interfaced to increase of the energy expenditure, caused by multiphase flows.
The analysis of existing systems of gathering and transportation of gas condensate mixes shows, that increase of efficiency demands the knowing of the rheological nature and complexity of internal structure of transported fluids at a choice of modes and calculations of pipelines. High flow rates in gas pipelines can provide a so-called dry mode of operation, i.e. carrying out of liquid inclusions with gas if the pipeline has rather equal profile. Thereby formation possibility in it of so-called stagnant zones is excluded. When depth of processing of gas does not provide its transportation to a single-phase condition, we deal with condensing gas. Presence up and down streams in the marine pipelines complicates their hydraulic characteristic, horizontal and elevating sites of gas pipelines are often filled in with a condensate and water. As a result, pressure in the pipeline raises.
The analysis shows, that unlike a single-phase stream, range of gathering of condensing gas cannot increase is boundless with increase in diameter of the pipeline. As shows long-term experience of arrangement of sea deposits on Caspian sea, transportation of such streams to coastal terminals and points of gathering of production is interfaced to considerable difficulties. So on a movement course on trade pipelines in these systems there are the phase transitions accompanied by branch of a liquid and a condensate. Accumulation in the lowered sites of a line of the pipeline of the separated liquid and a condensate leads to formation of clogging in the pipeline and considerably complicates transportation of production [1,2].

MATERIALS AND METHODS

In view of range of points of gathering from an extraction place, the above-stated problems arise on a course of movement of production, not reaching to them. One of ways of the decision of this problem is the choice of an optimum mode of the swapping excluding the beginning of formation of a liquid phase on all length of the pipeline to point of gathering and preparation of production. This problem is reduced to a choice of optimum diameter of the pipeline.
Long-term operating experience of the main gas pipelines shows, that owing to insufficiently effective gas dewatering the problem of formation of a liquid phase and the complications connected with it remain essential and for these gas pipelines. Presence of a liquid phase leads to formation of the adequate

structural form of the current peculiar to modes of gas-liquid systems which consistently alternate in process of change of the basic gas-dynamics parameters (pressure, flow rate and temperature).
Let's present a gas stream as the system having the characteristic ordered structural form of a current at a certain combination of values of gas dynamics parameters, describing its current condition. Change of a mode of transportation leads to transfer to other structural form and the system is as though reconstructed on other structure form with other measure of orderliness. Differently alternation of various structural forms of a current is accompanied by consecutive change of the ordered structures with the measure of orderliness. Thus, on change of a measure of orderliness of system as a whole it is obviously possible to identify the beginning of formation or transition to other structural form.
For an estimation of a measure of disorder of various structural systems the estimation technique fractal measures [3,4] which has been used at carrying out of researches of the presented work is effectively used. According to this technique, dynamics of gas dynamics parameters on the basis of operating data on various sites of main gas pipeline Azadkend-Astara (the Azerbaijan Republic) first of all has been investigated. Metering have been made on the various sites differing not only the extent, but also character of a profile of a line, that also makes changes to character of a current of gas streams in the presence of liquid inclusions.

RESULTS AND DISCUSSION

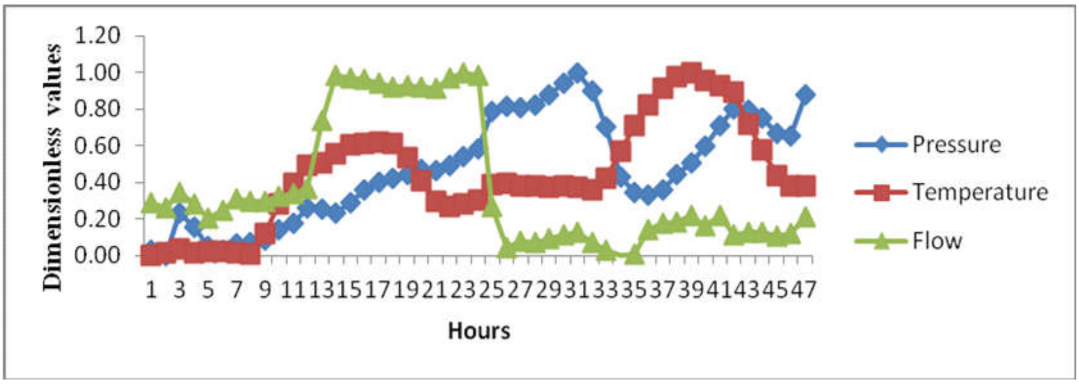
By results of metering (table. 1 and 2) have been constructed curves in dimensionless sizes for change of pressure, temperature and flow rate on various sites of a gas pipeline and these curves have been processed by a method of a covering for an estimation Hausdorf's fractal dimensions [4].
Results of processing of curves on various sites of a gas pipeline are presented on figure 1 and 2. As have shown results of the analysis of data curves of dynamics for these parameters, carry strongly pronounced fractal character. This conclusion proves to be true good enough flattening of the curves received by a method of a covering for an estimation of Hausdorf's dimension on all samples taken for the analysis.

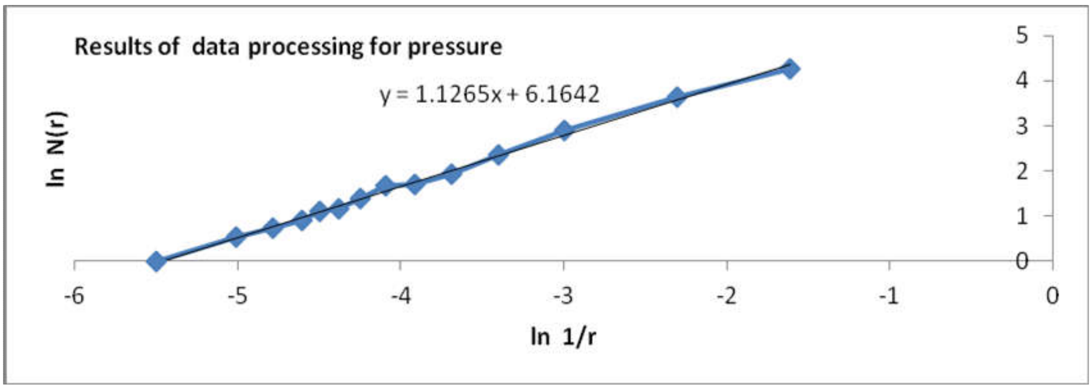
Table 1. Metering data for Azadkend line

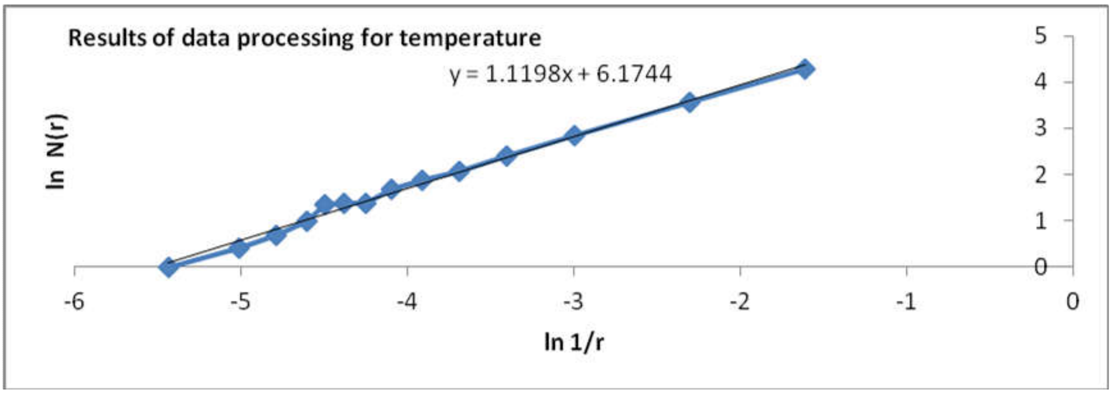
№	Pressure	Temperature	Flow	№	Pressure	Temperature	Flow
	kPa	°C	m^3/hour		kPa	°C	m^3/hour
1	1655,186	27,002	60,962	26	1715,947	27,470	55,285
2	1652,770	27,023	60,222	27	1715,192	27,456	56,111
3	1670,949	27,049	62,178	28	1716,023	27,459	56,066
4	1665,044	27,024	60,748	29	1720,352	27,446	56,434
5	1656,630	27,031	59,014	30	1725,690	27,453	56,902
6	1655,329	27,033	59,974	31	1730,005	27,449	57,269
7	1658,010	27,024	61,335	32	1722,182	27,433	55,970
8	1658,286	27,016	61,022	33	1706,837	27,508	55,065
9	1659,486	27,150	61,052	34	1685,762	27,678	54,367
10	1663,511	27,340	61,641	35	1679,537	27,851	54,644
11	1666,604	27,474	61,957	36	1678,369	27,981	57,659
12	1672,937	27,586	62,669	37	1680,631	28,088	58,313
13	1672,614	27,605	71,148	38	1686,984	28,165	58,612
14	1670,894	27,665	76,618	39	1691,721	28,193	59,303
15	1675,369	27,719	76,302	40	1698,902	28,140	58,002
16	1680,389	27,730	76,125	41	1707,710	28,107	59,377
17	1684,004	27,741	75,622	42	1714,846	28,062	56,989
18	1685,560	27,733	75,296	43	1714,046	27,860	57,221
19	1687,301	27,639	75,390	44	1710,916	27,686	57,252
20	1689,027	27,487	75,247	45	1704,611	27,518	56,858
21	1688,848	27,355	74,999	46	1703,348	27,459	57,152
22	1690,604	27,318	76,301	47	1720,630	27,454	59,201
23	1694,555	27,338	77,025	-	-	-	-
24	1697,735	27,362	76,688	-	-	-	-
25	1713,316	27,465	60,478	-	-	-	-

Table 2. Metering data for Bilesuvar

№	Pressure	Temperature	Flow	№	Pressure	Temperature	Flow
	kPa	°C	m^3/hour		kPa	°C	m^3/hour
1	251,809	20,004	0,656	26	252,567	18,352	0,620
2	251,904	19,132	0,620	27	252,775	19,308	0,581
3	251,981	18,506	0,597	28	252,697	19,347	0,596
4	251,917	18,307	0,589	29	252,786	18,934	0,590
5	251,820	17,808	0,592	30	252,808	19,027	0,599
6	251,806	17,773	0,596	31	252,389	18,599	0,657
7	251,694	18,871	0,625	32	251,150	18,142	0,876
8	250,374	18,087	0,862	33	251,036	19,556	1,028
9	250,079	19,475	1,031	34	251,860	24,337	0,951
10	250,907	23,533	0,965	35	251,971	29,409	0,946
11	251,106	28,738	0,965	36	251,459	32,922	1,039
12	250,600	33,885	1,037	37	250,513	35,447	1,103
13	249,644	37,847	1,061	38	249,963	37,471	1,061
14	248,972	40,847	1,015	39	250,285	38,818	0,915
15	249,137	42,790	0,880	40	250,170	37,153	0,885
16	249,061	43,462	0,827	41	250,637	36,166	0,839
17	248,962	42,592	0,833	42	249,443	34,823	1,014
18	248,806	39,853	0,890	43	249,216	30,458	1,099
19	248,758	34,786	1,000	44	249,258	27,485	1,141
20	248,825	30,301	1,082	45	249,033	23,833	1,219
21	248,327	25,194	1,249	46	250,118	21,698	1,081
22	249,717	22,374	1,063	47	251,379	21,092	0,876
23	251,090	21,690	0,853	-	-	-	-
24	251,807	20,221	0,762	-	-	-	-
25	252,334	18,860	0,675	-	-	-	-







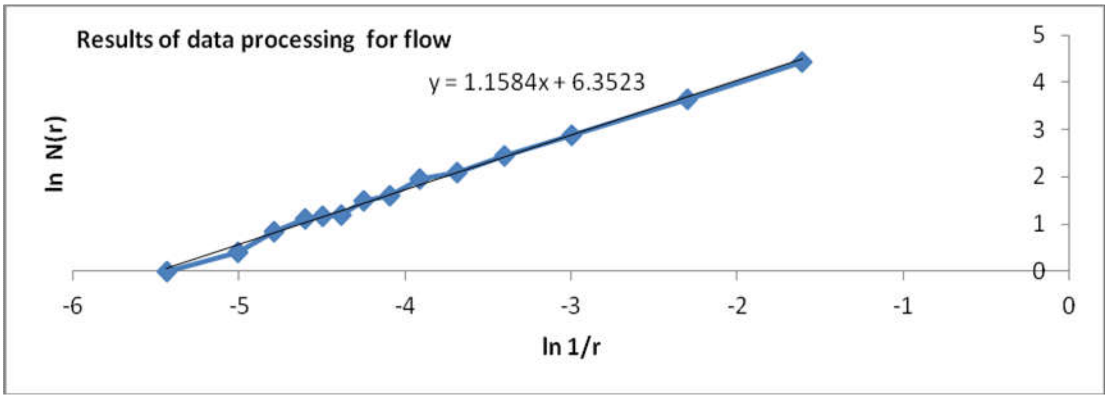
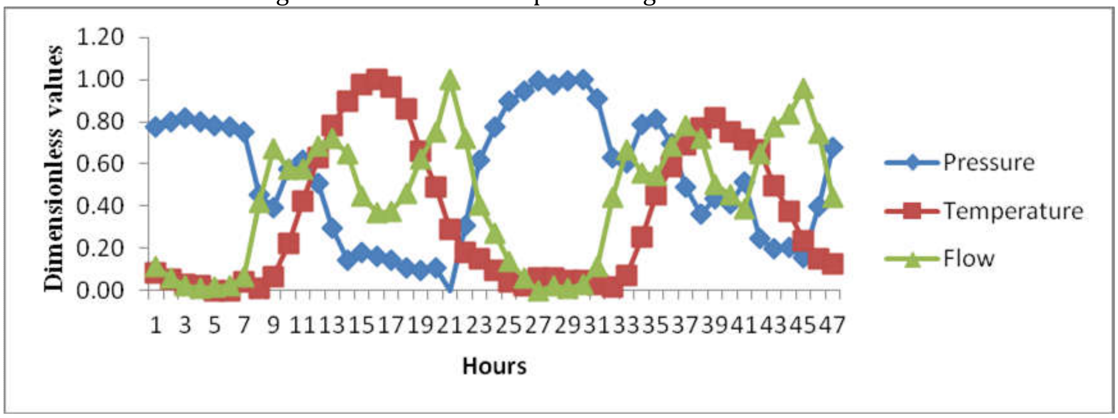
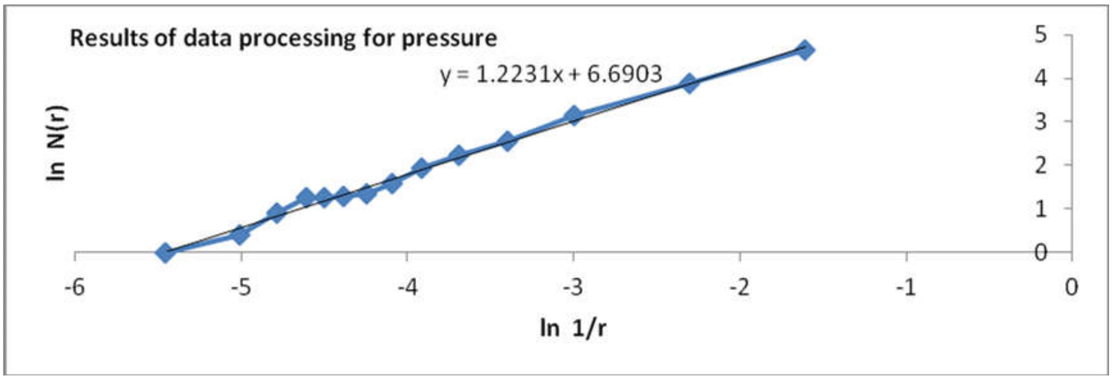
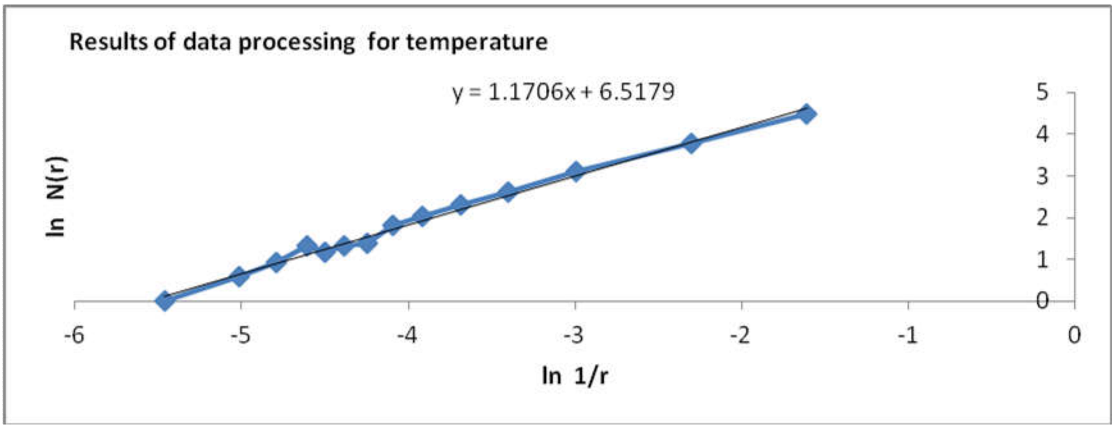


Figure 1.Results of data processing for Azadkend line







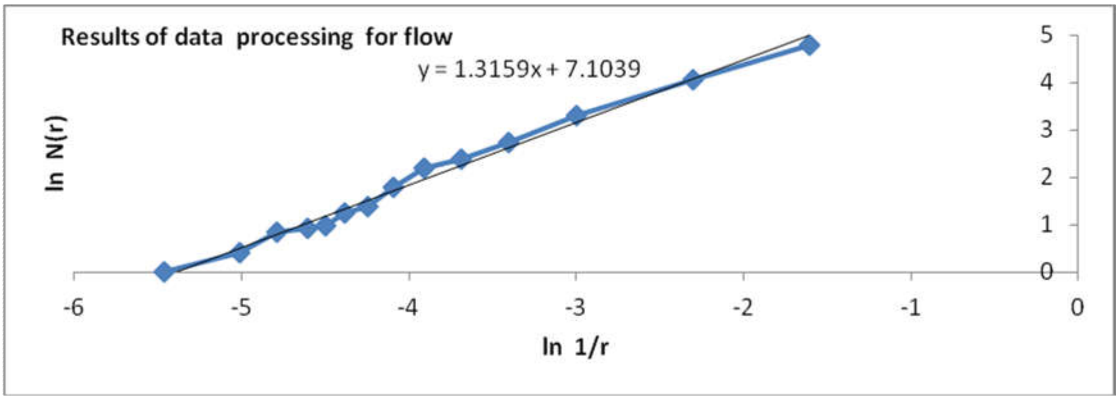


Figure 2. Results of data processing for Bilesuvar line

The fractal properties for dynamics characteristics of gas pipelines, allows us to identify structural modes of a current on change fractal measures. Moreover, data on gas structure, presence of liquid inclusions is possible, to connect with character of change fractal dimensions of the gas dynamics characteristics and to find corresponding diagnostic criterion.

That is, differently presence of liquid inclusions leads to change of the structural form of a current of a stream on the pipeline which degree of orderliness is defined by fractal measure. Hence, in a gas stream without liquid inclusions and with liquid inclusions fractal measure of structure of a stream will be various.

For the purpose of revealing of possibility of early diagnosing of formation of a liquid phase in a gas pipeline on change of component composition of gas, gas samples in operating conditions have been taken. Gas sampling points are presented on figure 3. In a point 3 on an exit of compressor station selection of test of associated gas was made, and in a point 1 after installations on preparation of gas selection of test of natural gas was made. Further these two gas streams after mixture are transported to delivery measuring station on which input in a point 3 samples already for a mix of natural and associated gases were taken. From each point have been taken two samples of gas (Test 1 and Test 2).

Results of the analysis of the taken tests, and also corresponding values of defined parameters for a mix of the natural and associated gas, calculated by the additively rule are shown in the table 3. Apparently from the table, actual values of parameters of a mix of natural both associated gases and the corresponding values calculated by additivity rule, most strongly differ on following positions: content of heavy fractions (C_{5+}); content of contamination and moisture content; dryness of gas (C_1/C_{2+}) and a dew-point (T_{dp}). For more evident picture on figure4 the picture of change of parameters C_{5+} and C_1/C_{2+} depending on parities of associated and natural gases as a part of a mix is presented. Here by arrows it is shown, to what content of associated gas in a mix there correspond actual values of parameters of a mix of gas and so differs from a mix of natural and associated gases in the ratio 85:15 %.

Thus, by results of the spent researches it is established, that diagnosing of a structural condition of a gas stream expediently in frameworks, the analysis which can serve as the tool for studying of the latent order in dynamics of disorder systems what gas mixes with liquid inclusions are. The effective mathematical apparatus for diagnosing of movement of gas streams with liquid inclusions in pipeline systems is offered enough simple, but.

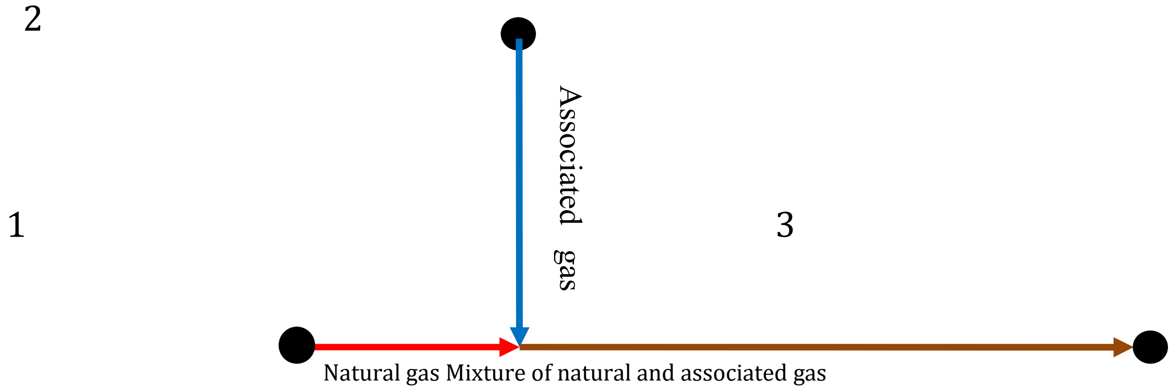
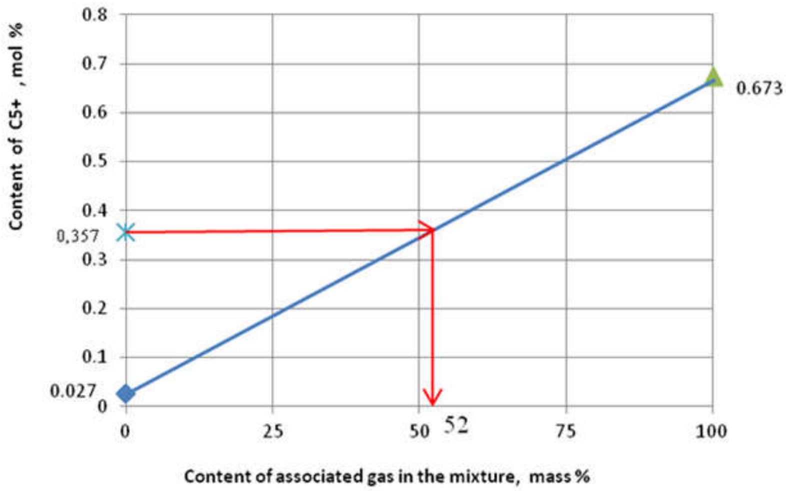


Figure3.Points of gas samples

Table 3. Results of analysis of component composition

Parameters	Natural gas (point 1)		Associated gas (point 2)		Mixture of gases (point 3)		Parameters calculated bu rule of addivity		Error, %	
	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2
O_2, mol. %	0,02	0,015	0,011	0,015	0,014	0,02	0,019	0,015	24,93	33,33
CO_2	0,071	0,071	0,53	0,539	0,157	0,163	0,140	0,141	12,26	15,44
N_2	3,452	3,449	1,562	1,572	2,994	3,048	3,169	3,167	5,51	3,77
C_1	95,484	95,648	91,64	91,5	94,634	94,617	94,907	95,026	0,29	0,43
C_2	0,352	0,35	3,482	3,459	1,009	1,041	0,822	0,816	22,82	27,52
C_3	0,583	0,447	1,176	1,197	0,618	0,597	0,672	0,560	8,03	6,70
C_4	0,007	0,004	0,912	0,953	0,211	0,206	0,143	0,146	47,81	40,76
C_{5+}	0,027	0,013	0,673	0,743	0,357	0,303	0,124	0,123	188,14	147,35
C_1/C_{2+}	98,539	117,504	14,679	14,405	43,113	44,0694	85,960	102,039	49,84	56,81
ρ^{20}, kg/m^3	0,696	0,6941	0,7518	0,755	0,713	0,712	0,705	0,703	1,18	1,20
Δ, relative density	0,578	0,5763	0,6242	0,627	0,592	0,591	0,585	0,584	1,18	1,20
Moisture content (V), mg/ l	0,248	0,223	4,7265	4,799	0,354	0,359	0,919	0,909	61,51	60,54
Dew-point, °C	-9	-10	34	35	-12	-12	-2,55	-3,25	370,59	269,23
Contamination, mg/ l	0,4115	0,5733	0,080	0,079	0,645	0,621	0,362	0,499	78,39	24,38
Burning temperature (above) (20°C), MC/m^3	36,24	36,16	39,690	39,83	37,27	37,16	36,7575	36,711	1,39	1,22
Burning temperature (under) (20°C), MC/m^3	32,65	32,58	35,850	35,98	33,61	33,5	33,13	33,090	1,45	1,24
Vobbe number (above)	47,66	47,64	50,190	50,26	48,44	48,34	48,0395	48,033	0,83	0,64
Vobbe number (under)	42,94	42,92	45,340	45,4	43,67	43,58	43,3	43,292	0,85	0,67



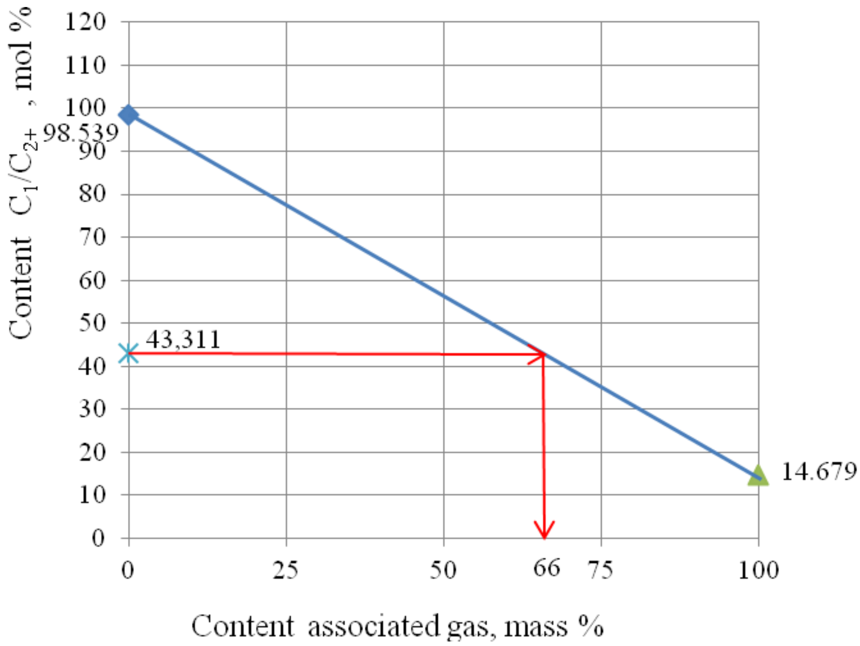


Figure4. Variations of parameters C_{5+} and C_1/C_{2+} from ratios of associated and natural gases.

REFERENCES

1. R.I. Vyahirev, B.A. Nikitin, D.A. Mirzoev Arrangement and development of sea oil and gas deposits. M, Academy of mountain sciences, 1999. -373 p.
2. A.I. Grichenko, A.M. Sirotin etc. Energy safety technologies at production of natural gas. 1996.235 p.
3. A.H. Mirzadzhanzade, M.M. Hasanov, R.N. Bahtizin Modeling of processes (nonlinearity, non-uniformity, uncertainty). Moscow-Izhevsk, 2004. 368p.
4. R.A.IsmailovThermo Thermo-gas dynamics researches of natural gases with fractal properties at movement in the pipelines// The Azerbaijan Oil Economy, №4-5. - Baku-2007. p. 47-50.

CITATION OF THIS ARTICLE

G.G. Ismailov, R.A. Ismailov, E.H. Iskenderov,V. H. Nurullayev. Diagnosing of Structural Modes of Gas Flow In The Pipeline Systems . Bull. Env. Pharmacol. Life Sci., Vol 5 [10] September 2016: 28-34