

**INEQUAL CONSUMPTION OF NATURAL GAS  
IN GAS TRANSPORTATION SYSTEMS  
AND ITS INFLUENCE TO TECHNOLOGICAL PROCESSES**

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*Have been conducted the investigations according to natural gas usage in different technological processes and have been achieved below results:*

*1. In different industrial areas the natural gas consumption is formed by influence of different factors. These factors are formed according to the character of process, energy efficiency of used technology, capacity of using different type of energy courses, environmental influence, sequence of production process and etc. In the result, enterprises create daily and monthly season inequality in natural gas consumption.*

*2. The objects utilizing big volumes of natural gas are used as buffer regulators and the main factor which stays on base of this condition is the region factor. Any of big volume consumers could play a role of buffer regulator according to the demand of natural-geographic region which it is placed.*

*Keywords: gas, underground storage of gas, pipeline transport of gas, gas consumption, regulation of inequality, volume of gas consumption, "Mine-pipeline transportation-natural gas distribution" system, distribute function, season inequality*

## INTRODUCTION

The observation of expansion of natural-gas production for last years in Azerbaijan republic shows the necessity of the establishing new, science-based conception for the management of production-transportation-distribution systems. By one side it is explained mainly by dependence of gas provision systems on the work regimes of republic's gas producing objects, by other side it is explained by the expansion of the system's geographic action scale, by the consumers' structure changes and by new quality-quantity requirements for natural gas. Of course as in previous years the main purpose of gas provision systems' activity in present economical state is also safety, requested, uninterrupted and qualitative provision of consumers with gas fuel. For this reason the gas consuming is the main factor for the whole system. In this process productive and efficient activity of the system is measured by expedient and on time reaction to any

changes from consumers' side and by this way proceeding with normal activity. In this case the normal activity of the system must be followed by:

- provision of the constructive and technological reliability of system due to the transportation of natural gas in requested amount;
- increasing the system-technological reliability of Transportation Management.

It is necessary to ensure separately these directions for elements of the system and ensure both of the directions for system management as unique gas provision system. Of course the first direction could be seem very significant due to the requested volume transportation for consumers, but the investigations conducted due to the second direction liquidate the technical-technological contradictions in the system. Both of these directions play significant role in “beforehand learning” of abnormal appearances in system management by investigations unequal consumption process' of natural gas and by optimizing the transportation and distribution parameters.

#### **ABOUT “MINE - PIPELINE TRANSPORTATION - NATURAL GAS DISTRIBUTION” SYSTEM**

It is necessary to note that “Mine-pipeline transportation-natural gas distribution” system is complicated technical system and its characteristic features, demand especial approaching to this system. These features are:

- distribution to the wide geographical area;
- existence of the multiply technical and technological elements of different character which are forming the system;
- non-stationary nature of the processes proceeding in the system;
- hierarchic structure;
- next to existence of the centralized management of the technological processes in transportation system, existence also of scattered management in the distribution of the gas fuel.

Next to noted features the close character of the complex distribution system and gas extracting objects make necessary the dependence of gas field regimes on gas consumption regimes. This dependence shows itself not only from the technological side

also by strong economical connections which appear in the projection, reconstruction, building, activities, managing and planning of these systems. The nature of these connections is explained by determining the activity of distribution systems and gas extracting objects by general and unique criteria. Changing one of the parameters (the power of the gas stream between systems; annual extracted and distributed net volumes of natural gas) of the main element causes the changing of parameters of another elements in these systems. If we take into account that “Mine-pipeline transportation-natural gas distribution” system is one of the under structures of the republic fuel-energy complex, then of course the changing one of the main parameters of the system will cause the changing of working regimes of other fuel-energy complex structures.

Taking into consideration above mentioned cases and also dynamic development, mass character and existence of the different kind of inside and foreign connections, we can appreciate “Mine-pipeline transportation-natural gas distribution” system as the one of the biggest and developing understructures of the republic fuel-energy complex. It is necessary to note that this system is developed under influence of the same objective laws which is also characteristic for another understructures of the republic fuel-energy complex. These influences show themselves mainly in the centralizing of the energy provision, connecting strengths, complex usage of reserves and etc. In spite of the decisive role of these features in general developing, some times their applying in “Mine-pipeline transportation-natural gas distribution” system procreate the general energetic develop to objective laws, on the other hand creates addition conformity to natural laws which is characteristic only for this system. These addition conformities to natural laws are arising due to physical features of the natural gas; technological features of the activities of gas extracting objects and also due to distribution and pipeline transportation. In all cases it shows itself in the limitation of the opportunities of the changing pipeline transportation parameters and in instant changing of the natural gas volumes extracted from gas fields.

Above mentioned mutual “reason-result” connections demand the creation of the science-based strategy which considers the effective, productive, safety managing of “Mine-pipeline transportation- natural gas distribution” system not just as separate under system, but as the unity system which is in the relation with the whole complex.

One of the significant tasks is the creation of conceptual new models of the optimum managing of mentioned system - which possess predictable topological structure - by applying modern information technology and considering the influence of technological processes to the current system, which in its turn is gained by regulation of inequality.

One of the main features of “Mine-pipeline transportation-natural gas distribution” system is its being an open system. This feature is determined by existence of the system’s different internal-external connections with the other systems of power combustible complex, by dynamic processes proceeding in system, by uninterrupted character of the system and mainly by existence of indefiniteness in system due to the influence of external factors and inaccuracy of the primary information. Mentioned features are characteristic for the normal activity of the system. But it is very necessary taking into account the accidents in managing process arising due to disorder of normal activity of one of the system’s elements. Managing tasks of the system should be solved including the indefinite circumstances. If one part of indefiniteness has got stochastic character in this case, but in other cases it is formed under influence of factors of probable nature.

#### **MODELLING OF MANAGING PROCESS IN “MINE-PIPELINE TRANSPORTATION-NATURAL GAS DISTRIBUTION” SYSTEM**

During the modeling of managing process the investigations should be carried on the following directions:

- should be created the information maintenance of managing of “Mine-pipeline transportation-natural gas distribution” system;
- should be created sciences-based optimum models of the technological, economical-organizing activities of of “Mine-pipeline transportation-natural gas distribution” system by regulation of in equal gas consumption;
- should be created the managing strategy of “Mine-pipeline transportation-natural gas distribution” system’s work regimes based on model of regulation process of in equal gas consumption.

The creation of information maintenance of regulation process should be conducted in all levels of management and supervision. In this case the main point is the creation of mutual straight connection between data base of parameters of technological objects and technological schemes of gas extracting, transportation, distribution objects.

The following principles should be stand on the basis of creation of the information base of the “Mine-pipeline transportation-natural gas distribution” system:

1. receiving information should not be depend on source and in all cases the same reliability should be considered;
2. receiving information should be separated due to the levels;
3. exact methods of information entrance must be determined.

By realization first principle below matters are being solved:

- reliable statistical valuing of the measuring parameters and “trust interval” are determined;
- direct statistical valuing of the measuring parameters and their filtration are being possible;
- there is aroused opportunity of the controlling of adequacy levels of real regime parameters by using conclusions of accepted model.

By guarding second principle there is aroused the opportunity of the creation of open data base which doesn't depend on possible changes of technological scheme structures of “Mine-pipeline transportation-distribution of natural gas” system.

Third principle gives opportunity to including new objects into data base with their possible parameters, renew the parameters of available objects even by none structure change of date base, make changes in parameter list.

There has been conducted investigation in direction of creation science based optimum models of system's technological-economical–organization activities by regulation of in equal gas consumption of “Mine-pipeline transportation-distribution of natural gas” system. The purpose of this investigation is complete, safety and uninterrupted provision of consumers by natural gas within the technological limits and optimum technical-economical criteria. Demand for natural gas in limited time interval put the necessity of selection of power selection for oil-gas mines and transportation systems by providing technological conditions, from other side it causes an irregular work regime of “Mine-pipeline transportation-natural gas distribution” system due to the hard technological connections between consumers, transportation system and mines. The main reason of irregular work of mines and transportation system is the in equal changes in natural gas consumption volumes which are formed due to the temperature changes, the civil state of population and other factors.

There is no hourly and daily in equal changes in whole system due to the low speed of “technological process substituting” of “Mine-pipeline transportation-natural gas distribution” system’s elements. This kind of inequality happens only in separate elements of the system. From this kind of view season inequality in natural gas consumption is subject to investigations regarding to the influence to work regimes of mine and gas transportation system. In the base of arising of season inequality in natural gas consumption stands gas fuel which is used for thermal purposes. For example the duration of heating period for Baku city is mainly four months and adopts 30 percent of annual consumption.

Mainly two principle approaches are used for controlling the negative appearance of the seasonal inequality:

- regulation of work graphics of definite groups of workers which influence to the maximum level of natural gas consumption in distribution system or regulation of in equal gas consumption by the changing the kind of fuel;

- regulation of in equal natural gas consumption by using especial regulation means-accumulation abilities of gas pipelines or by using “underground storehouses”.

Season inequality created by different consumers in distribution system causes the serious charge differences due to the increasing of energy losses in natural gas consumption, gas mines and pipeline transportation system. By placing especial object-“underground gas storehouse” among these consumers and by regulation the work graphic of storehouse according to the changes in gas consumption volumes it is possible to conduct both of above mentioned principles which are necessary for system’s activity. So when there is a low gas consumption in the distribution system then underground gas storehouse accumulates remained gas volume and gives it to consumers in case of increasing of gas consumption. The regulation of season inequality in natural gas consumption is ensured by this way.

It is important to remark below characteristic feature of regulation system :

- if “distribute function” of natural gas consumption volume is known then it is possible to conduct the regulation process even by allowed volume capacity of underground gas storehouse and by little power of “mine - transportation system”.

From economical point of view this feature is interpreted as forming of contrary expenses in “Mine-pipeline transportation-natural gas distribution” system. In this case

the remained part of expenses not spent for natural gas production and transportation is used for keeping the underground gas storehouse in good form.

The model of regulation of in equal gas consumption process should be given on base of above mentioned principles and approaches as typical optimization model which includes parameters and variation elements by different technical and technological indexes. The limits put onto “border conditions” and “variation elements” should be defined according to “Mine-pipeline transportation-natural gas distribution” system’s structure and work regimes.

The economical parameters of natural gas transportation system and production objects in regulation model should be improved, also the regulator system and regulated system should be united in one system due to the regulation of consumption inequality on investigated season. During this process the technical capacity and economical expediency of mutual activity of regulator system and regulated system, in our case “underground gas storehouse” and “mine-pipeline transportation-natural gas distribution” systems should be taken into account. So the connection conditions between regulator and regulated systems should be based on technical and technological capacities of each system.

### **MINIMIZING ENERGY EXPENSES IN ENTERPRISES WHICH ARE CONSUMING BIG NATURAL GAS VOLUMES**

In republic economy the natural gas is used either technical and energetic fuel or as raw material in chemical industry. The reason is that the natural gas fuel has got technical superiority and economical productivity in comparison by other solid and liquid fuel species. But the rapid economical development in our republic requires taking of urgent measures in gas industry also. It is to provide the consumers by uninterrupted, safety and by demanded natural gas and to minimize the energy expenses by conducting the effective and productive gas transportation.

Of course, from point of view minimizing energy expenses gas industry doesn’t differ from other structures of fuel-energy complex. But here it is possible to achieve the minimizing energy expenses not only by physically equal distribution of weights to area, also by organizing the effective distribution in fixed time segment. In this case the main purpose is to achieve maximum equal conditions by taking into account the time factor in natural gas consumption for enterprises and organizations which got different

economical aims and orientation. Of course, the problem must surround not all the natural gas consumers spread to area, but mainly the objects which possess high power of productivity. Only due to the activities of these objects it is possible to achieve the effective work of transportation system - especially main gas pipeline system. It could be in its turn realized by energy provision of the mutual activity of these objects. If the manufacture activity of these objects is not subject to time changes, then inequality in consumption is explained only by environmental influence and its relative weight in general consumption is insignificant. In other enterprises where the time factor is significant the price of inequality index of natural gas consumption is high. Logically, for non stopping of enterprise's work regime and continuing the normal production there must be used other kind of fuel, other case gas expenditure must be decreased by limitation of production volumes. These kind of big enterprises around republic which consume great gas volumes divides into two groups: industry enterprises and heating-electric stations. They are chemical industry objects in Sumgait (Azerbaijan), clayey soil and aluminum factories in Ganja (Azerbaijan), "Garadagh" cement factory in Baku (Azerbaijan). The natural gas in these objects is mainly used for technological purposes, for that reason consumption mainly remains constant.

#### **ANALYSIS OF NATURAL GAS CONSUMPTION IN "GARADAGH" CEMENT FACTORY**

In "Garadagh" cement factory coal is used as solid fuel and black oil is used as liquid fuel. But to use the natural gas is more productive for our republic (twice more usage than black oil). Low consumption in "Garadagh" cement factory in 2004-2006 heating years-mainly in January-March period is connected with limitation of gas provision due to the providing of population and strategic consumers with natural gas. The average monthly consumption strength of this object is about 10-12 mln. cub. meters and it is 5-10 percent (less significant) of average monthly consumption of Baku city. For that reason this object in general doesn't play a role as buffer regulator. Indeed, the investigation of "in equal natural gas consumption index" for this institute is shown that in heating period this index is changed within 0.8-1.1. The intensity of "in equal natural gas consumption index" for this institute is not more than 0.3 (Fig. 1).

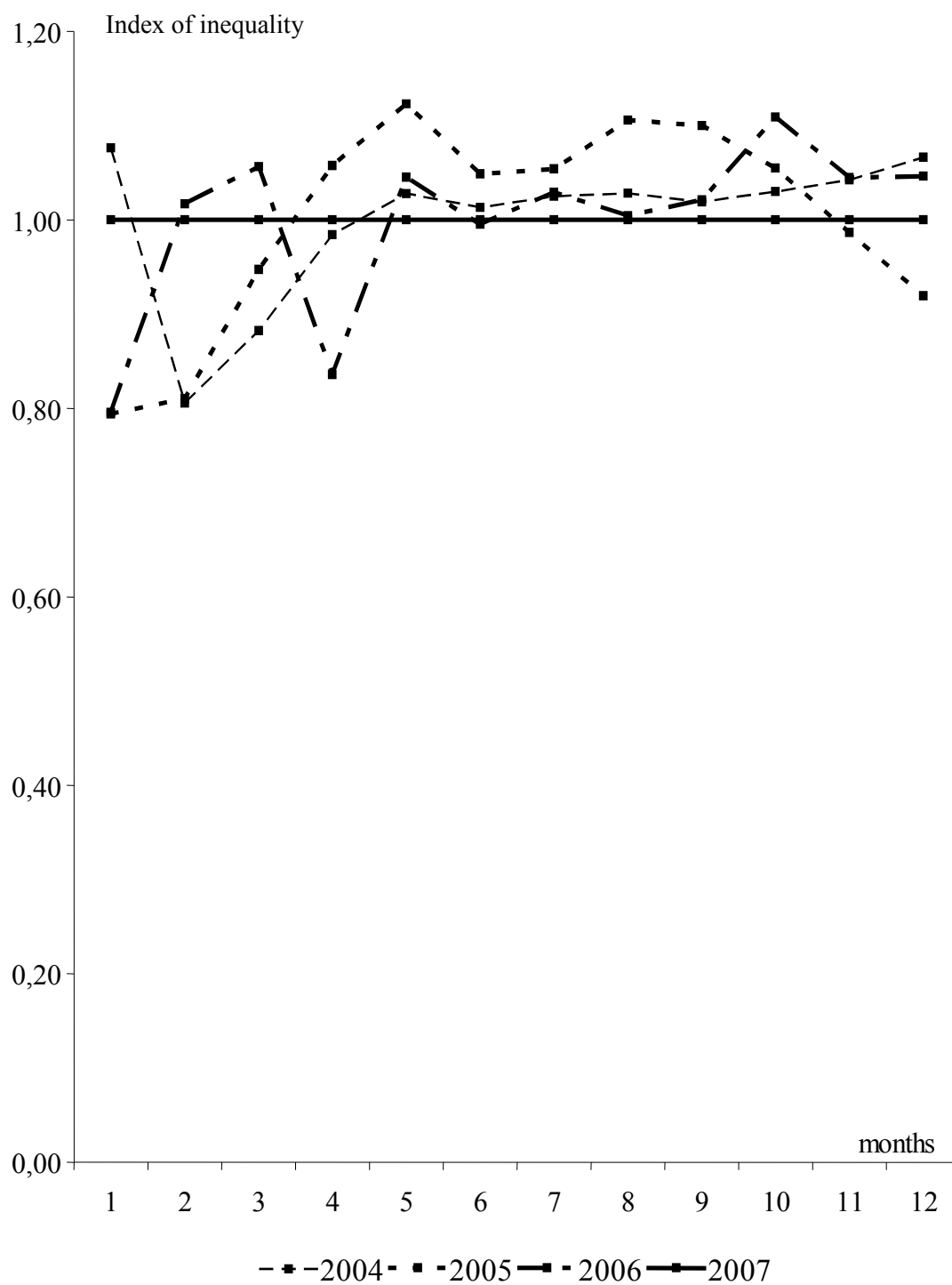


Figure 1. Dynamics of inequality index in natural gas consumption for "Garadagh" cement CSS in 2004-2007

### **ANALYSIS OF NATURAL GAS CONSUMPTION IN “AZERKHEMIA” PRODUCTION UNITY ENTERPRISES**

Differently from “Garadagh” cement factory in “Azerkhemia” Production Unity the natural gas is used not only for conducting technological processes, also it is used as raw material in production of chemical products. For example in Sumgait chemical refineries the natural gas is used as raw material for ammonia, methanol and acetylene which by their turn are used as raw material for fertilizer, synthetic and chemical products. In 2007 in these enterprises the average annual gas consumption has been in its lowest level. The comparative analysis of years 2004 and 2007 shows that the changes of production amount mainly affects the average annual consumption. The investigation of in equal natural gas consumption according to these enterprises shows that the highest intensity in year 2007 has been 1.25 (Fig. 2). The reason is minimum providing of enterprises with natural gas in March of the same year. If this year will not be involved to investigations then the intensity of “in equal natural gas consumption index” will be changed averagely within 0.5-0.8. High consumption capacity of these enterprises (three times more consumption volume in comparison with “Garadagh” cement factory) and their placing near the city Sumgait which has got the republic importance make possible to use these objects as buffer regulators.

### **ANALYSIS OF NATURAL GAS CONSUMPTION IN “AZER ALUMINIUM” PRODUCTION UNITY ENTERPRISES**

One on the biggest natural gas consumers is “Azer Aluminium Production Unity”. These enterprises group consists of “Ganja” aluminum and clayey soil plant. In these enterprises the natural gas is used in melting and clayey soil calcination stoves for technological purposes. For this reason the natural gas consumption is not being subject to environmental influence. The analysis of natural gas consumption in 2004-2007 years (Fig. 3) shows that the consumption has been increased here differently from “Azerkhemia” institutions.

Decreasing of consumption in heating period-November-March and limitation of natural gas provision in these institutions is for the purpose of effective natural gas provision of other consumers – mainly population group. The increasing of consumption out of heating period indicates that these institutions are playing buffer regulator role in

geographic area which they are placed. Intensity of inequality index of natural gas consumption in these institutions is approximately 0.5. Another interesting point is that the inequality index in natural gas consumption is distributed approximately proportional. It means that the prices of this index which are smaller than 1 (one) (little consumption than average monthly norm) are belonged to first five months and to last month of investigated year.

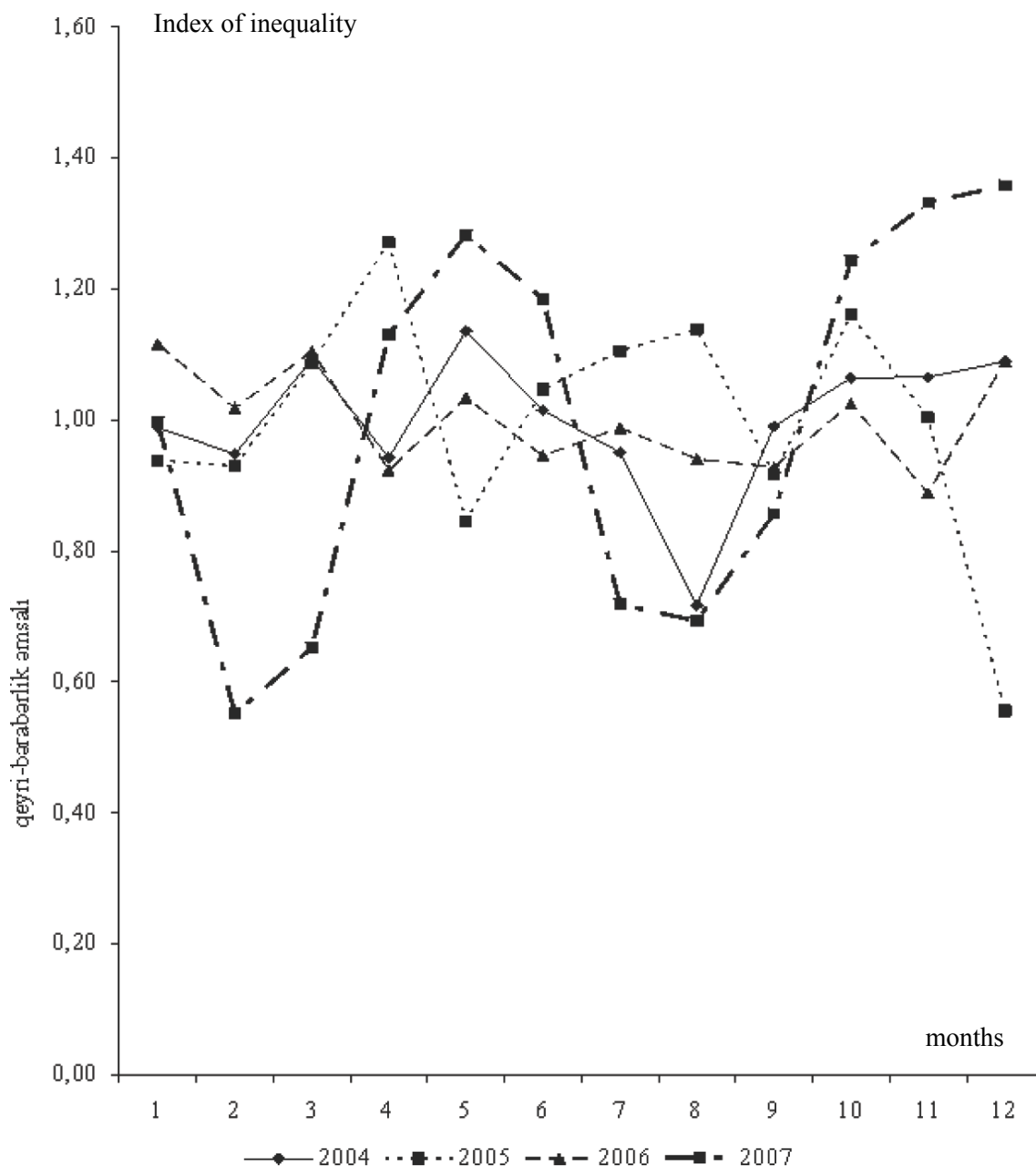


Figure 2. Dynamics of inequality index in natural gas consumption for "Azerkhimia" Production Unity in 2004-2007

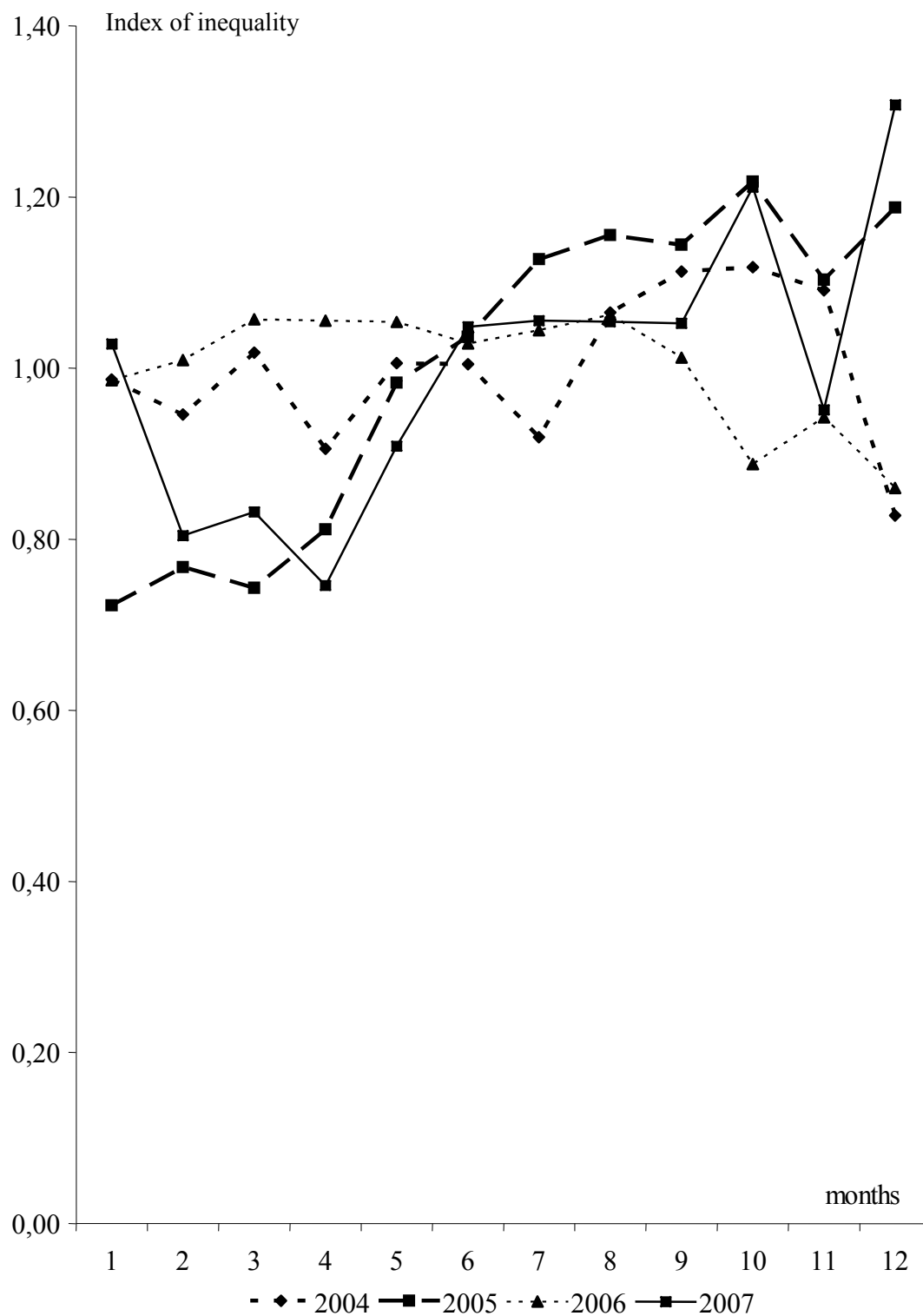


Figure 3. Dynamics of in equality index in natural gas consumption for "Azeraluminium" Production Unity in 2004-2007

## CONCLUSIONS

At present 50 percent of natural gas produced in Azerbaijan republic is used in heating-electric centers. Mainly they are Azerbaijan HES (Heating Electric Station), Ali-Bairamli (Shirvan) HES, HEC (Heating Electric Centre) in behalf of Bairamzade, "Shimal" HES and module typed electric stations which are currently used. These stations have got the capacity of functioning either with natural gas or black oil, due to this factor they could be used in regulation of season inequality.

Conducted investigations show that, the annual gas expense in these objects in 2004-2007 years has been 4.5-5 billion cub. meters and average monthly expense has been 370-430 mln. cub. meters. Fundamental changes in this sector for last years have affected the character of natural gas consumption. It has been achieved due to the applying of new technology in electric power production and by this way increasing of efficiency of natural gas consumption. In spite of the same gas consumption in 2007 the produced electric power has been more than previous years.

Intensity of inequality index in natural gas consumption for (electric) power stations has been 0.84 in 2004, but in 2007 it has been descended to 0.6. The increasing of natural gas consumption in heating period (it means that inequality index has been higher than point 1.) is connected with increasing of natural gas consumption volumes in that period.

So by generalizing the investigations conducted according to natural gas usage in different technological processes we got the below conclusions:

1. In different industrial areas the natural gas consumption is formed by influence of different factors. These factors are formed due to the character of process, energy efficiency of used technology, capacity of using different type of energy courses, environmental influence, sequence of production process and etc. In the result that enterprises create daily and monthly season inequality in natural gas consumption.

2. The objects using big volumes of natural gas are utilized as buffer regulators and the main factor stayed on base of this condition is the region factor. Any of big volume consumers could play a role of buffer regulator due to the demand of natural-geographic region which it is placed. For example "Azer aluminium" Production Unity play role of buffer regulator in natural gas providing of Ganja and neighbor regions; Azerbaijan HES play role of buffer regulator of Minghachevir, Ievlakh and neighbor regions.

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