

Specificity of environmental problems in industrial regions in context of new industrialization and ways to solve them

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Abstract – The specificity of the environmental situation in the industrialized region with the predominant economic activity "mining" is characterized in the article. The environment monitoring on two components of the assessment - the state of air and water resources - was carried out. The main problems in the sphere of environmental protection in conditions of new industrialization and the discrepancy between the environmental and the economic component of well-being of the territory are revealed, the solution of which in the context of the transition of the national economy to the new industrialization seems very significant. The relationship between industrial development, the exploitation of natural resources, the state of the environment, the financing of nature protection measures and the health of the population living in the region is traced. The directions for improving the state of the environment are proposed.

Keywords – industrial region; environmental problems, new industrialization

I. INTRODUCTION

The Kemerovo Region is one of the most industrialized regions of the Siberian Federal District. In general, the share of industrial production in the structure of social production of the Kemerovo region accounts for about 48-50%. The basis of industrial production of Kuzbass is fuel and energy, which occupies more than 50% in the structure of industrial production of the region.

The coal industry is the leading branch of the economy of the Kemerovo region, and therefore largely determines the outlines of its economic development. Kuznetsk coal basin is one of the largest in the world. The total coal reserves at a depth of up to 1800 m are estimated at more than 700 billion tons. According to the mining output, the Kemerovo region is more than 1.5 times ahead of such

industrial regions as the Krasnoyarsk Territory and the Irkutsk Region and 4 times higher than the average value for the Siberian Federal District. In the structure of GRP of the Kemerovo region, coal mining accounts for about 25%. Taking into account the relatively small area (10th in terms of area among the regions of the SFO), the intensity of the use of mineral wealth of the region is extremely high.

Analyzing the dynamics of mining of recent years, as well as the share of this industry in the structure of social production and GRP, one should speak of a noticeable increase in the distortion in the structure of the economy of the Kemerovo region, which is directed towards the extraction of raw materials and its primary processing. Such a situation inevitably leads to an increasing growth of the environmental load and requires close attention in conditions of new industrialization.

II. LITERATURE REVIEW

Despite the close attention on the part of federal and local authorities to the issues of ensuring environmental safety and, in particular, to the problem of creating a system of rational nature use, which was reflected in the implementation of various environmental and compensation measures within the framework of the year 2017 declared "the year of ecology in Russia", the environmental problems in the Kemerovo region, unfortunately, did not become less. The relevance of the subject of the study is testified by the number of works of Russian and foreign scientists on various issues of anthropogenic impact of industrial enterprises on the environment, the critical level of accumulated waste from their activities, as well as the negative impact on the quality of life of the population and therefore the need for the enhancement of innovative environmental activities [1-6].

Due to the intensive nature of mineral management, as well as the specific features of the current development of the coal industry in the region, testifying to the low social and environmental responsibility of owners and business management, both at the stage of exploitation of natural resources and at the stage of conservation of waste massifs, the solution to the environmental problems accumulated at present time cannot be limited to only one year of ecology, systemic work in this direction is required. Environmental activities should be aimed both at reducing the scale of negative impact of coal mining enterprises on the ecosystem of the region, and on implementing compensatory measures designed to reduce the environmental damage from already accumulated waste and produced emissions.

The predatory nature of the exploitation of natural resources, the lack of interest of the management of many coal-mining enterprises in using environmentally friendly productive forces, the reluctance to finance the introduction of non-waste technologies for the extraction and utilization of accumulated waste, as well as the failure to comply with the established environmental standards, are considered by some scientists as the most important deterrents to the increase in the effectiveness of environmental protection measures [7-10].

Offering the directions for improving the environmental safety of coal mining regions, the authors, among other things, proceeded from the successful world and regional experience described in the studies of such scientists as Vishnevsky V., Aleksandrov I., Polovyan A., Qixing Zhou, Steinecke K., Chuturkova R., Simeonova A., Bekyarova J., Ruseva N., Yaneva V. and others [11-15].

III. RESEARCH METHODOLOGY

As part of the assessment of the anthropogenic impact of coal mining enterprises on the ecosystem, it is advisable to provide the continuous information and statistical monitoring of the environmental indicators of the region, on the basis of which the relationships between their current values and thresholds are assessed and the trends threatening environmental safety are identified. In this connection, the methods of statistical observation, summaries and classification of statistical observation materials, absolute and relative statistical quantities, as well as analytical and synthetic methods, were used in the work.

The methods for the assessment of the environmental component of economic security in terms of indicators of air pollution and the state of water resources was used in the work. These methods provide for the use of a system of threshold values that differentiate the values of the analyzed indicators according to the risk degree:

- N – a normal state, in which the values of the indicators characterizing the state of the environment, are beyond the limits that threaten the environmental safety of the region;
- PC – a pre-crisis state characterized by tangible, but generally reversible effects on the environment, for the prevention of which it is often sufficient to apply preventive measures;

- C – a crisis state, characterized by severe consequences for the environment, in order to overcome the consequences of which, as a rule, preventive measures are insufficient, but complex structural measures are required (subtypes "K1", "K2" and "K3", which correspond to an ever increasing risk degree, are marked).

The environmental peculiarity of the Kemerovo region is that in a limited area of about 95.5 thousand km² there are more than 60 underground and 55 open-pit mines with a production capacity of 220 million tons, as well as 34 concentration plants for the processing of 130 million tons of coal. Their production activity has an intensive anthropogenic impact on the ecosystem, which is intensified by the impact of chemical enterprises, as well as ferrous and non-ferrous metallurgy enterprises - more than 775 thousand and more than 285 million tons of waste respectively are accumulated as a result of the functioning of the latter. The negative influence of industry on the environmental situation in the region is obvious: on average, there is 1 industrial enterprise for every 27 km² of the area of the Kemerovo region, and there is one coal mining and primary coal processing enterprise for every 640 km². In general, the intensive nature of mineral resource management leads to significant environmental problems in the region. The zone of anthropogenic impact occupies about 1/3 of the area of the Kemerovo region.

The environmental situation in the Kemerovo region remains steadily unfavorable for a long period of time. Analysis of statistical data characterizing the state of air and water resources makes it possible to assess the scale of the destructive impact of industry on the environment, the results of which are not comforting.

The extraordinary "K3" level of the crisis is observed in terms of the level of emissions of pollutants discharged into the atmosphere by stationary sources. The average value for the period from 2010 to 2016, taking into account the industrial production index, was 14.65 t/km², while even the value of 5.0 t/km² is classified as pre-crisis one. Appeal to earlier data reveals that the crisis state in this aspect of environmental situation in the region has been observed in Kuzbass at least since 1991 (the dynamics of states are shown in Fig. 1).

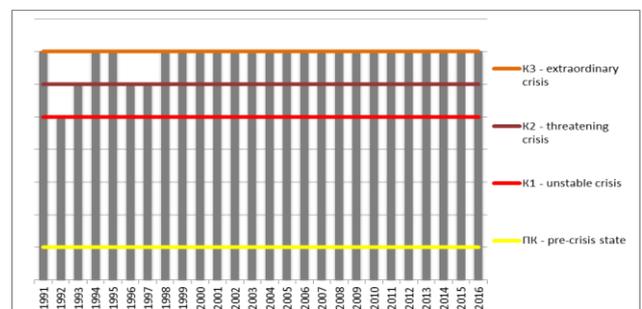


Fig. 1 – The dynamics of states of the environmental component of Kuzbass's economic security in terms of specific emissions of pollutants discharged into the atmosphere by stationary sources for the period of 1991-2016.

The state of water resources in the same period is also characterized by crisis values of the indicator of specific discharges of polluted effluents (from "K1" to "K3"), not overcome since 1991 (the dynamics of states is shown in Figure 2). The average for the period 2008-2016 accounted for 6.32 thousand cu m/km²; the boundary of the pre-crisis state being at the level of 2.0 thousand cu m/km².

Thus, despite the fluctuations of the two indicators separately, their combined analysis allows drawing a conclusion about the state of the emergency crisis in the environmental situation of Kuzbass for the entire period from 1991 to 2016.

The stage of the crisis is characterized by a significant deterioration in the quality of life indicators and makes it impossible for the region to sustainably develop. The specificity of the crisis state of the environment is that the overcoming of its adverse consequences is impossible with the use of preventive measures alone. This determines the need for large-scale financing of conservation and nature restoration activities. At the same time, the analysis of current and capital expenditures on environmental protection in the Kemerovo region does not show any positive dynamics (Table 1).

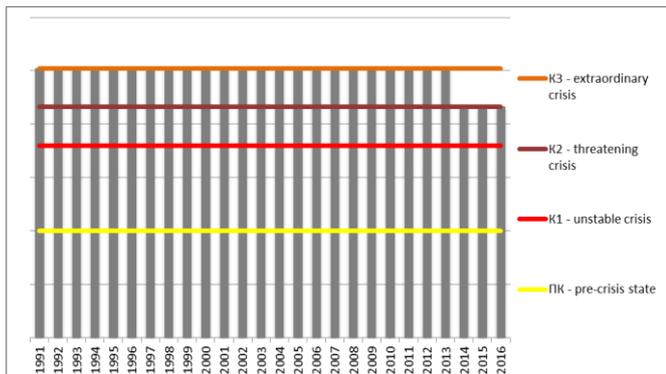


Fig. 2 – The dynamics of states of the environmental component of economic security of Kuzbass in terms of the indicator of specific discharges of polluted effluents for the period of 1991-2016.

TABLE I. CAPITAL AND CURRENT EXPENDITURES ON ENVIRONMENTAL PROTECTION IN THE KEMEROVO REGION (MILLION RUBLES)

Indicators	2012	2013	2014	2015	2016
Fixed capital expenditures, total, including:	1713	1404	3833	2058	1669
on air protection	1459	1143	2026	1107	1256
as % of total amount	85,17	81,41	52,86	53,79	75,25
on protection and rational use of water resources	106	145	68	337	220
as % of total amount	6,19	10,33	1,77	16,38	13,18
Current (operating) expenditures on environmental protection, total, including:	5708	7579	10224	6858	7250
on air	1764	2097	3240	1920	2114

protection and climate change prevention					
as % of total amount	30,90	27,67	31,69	28,00	29,16
on wastewater collection and treatment	2599	4129	5314	3543	4292
as % of total amount	45,53	54,48	51,98	51,66	59,20

The amount of fixed capital expenditures does not have a steady growth tendency, which would be reasonably provided under the prevailing conditions. Its value for the analyzed period was in the range from 1.4 to 3.8 billion rubles; the highest value being in 2014. In different years, from 52.9% to 85.2% of this amount was spent on air protection, much less - on protection and rational use of water resources. Attention is drawn to the insignificance of the allocated financial resources, which is emphasized by the huge profits of the industrial enterprises of the region. For example, in 2016 the enterprises engaged in the extraction of minerals received a profit of about 99 billion rubles (balanced financial result), and the amount of total capital expenditures on environmental protection for the same period did not amount to 2% of this value! No correlation between the dynamics of these indicators was found during the analysis. In addition, there is a clear discrepancy between the change in the amount of capital expenditures on environmental protection and the actual mining output. For example, in 2016, the total amount of fixed capital expenditures related to environmental protection turned out to be lower than in 2012, although the extraction of minerals over the same period increased by 37.7% (Table 2).

TABLE II. MINERAL OUTPUT (MILLION RUBLES)

Indicators	2012	2013	2014	2015	2016
The Siberian Federal District average value	98	100	109	133	150
The Kemerovo region value	478	438	457	553	658
	534	022	400	435	776
Growth rate in relation to the previous year, %	-	91,5	104,4	116,6	119,0
Growth rate for the analyzed period, %	-	-	-	-	137,7

Thus, the analysis of capital investments in environmental protection reveals the following problems and inconsistencies, which in the transition to new industrialization seem particularly significant:

- The absence of pronounced dynamics of growth in the volume of financial resources allocated for capital investments in the environmental sphere in the case of the stable crisis state of the region's environment.
- The insignificance of funds allocated for fixed capital expenditures, which is easily discernible against the backdrop of profits received by enterprises operating in the sphere of mining.
- The lack of the correlation between the indicators of the balanced financial result of companies engaged in

mining operations and the level of fixed capital expenditures related to environmental protection.

- The lack of the correlation between the output of mining of useful resources and the level of fixed capital expenditures on environmental protection.

Similar problems appear in the analysis of current expenditures on environmental protection. Their amount in the analyzed period ranged from 5.7 to 10.2 billion rubles. The maximum value is fixed in 2014. Most of the current expenditures, unlike capital investments, are associated with wastewater collection and treatment; no more than a third of the total amount of allocated financial resources is annually directed on air protection and prevention of climate change. As in the case of fixed capital expenditures on environmental protection, current expenditures do not have a pronounced upward trend, nor do they demonstrate a correlation with the indicators characterizing the intensity of exploitation of natural resources and the economic efficiency of the activities of the enterprises in the sphere of mining.

Together with the analysis of the environmental situation carried out above, these characteristics allow concluding that there is no effective system of environmental standards and norms in the region. The existing approach to financing the environmental protection measures is not effective due to the lack of correlation with the economic indicators characterizing the type of economic activity "mining of mineral resources". Meanwhile, it is this type of activity that makes a decisive contribution to the formation of an extremely unfavorable environmental situation on the territory of the region. In 2016, the share of enterprises engaged in mining was:

- 60,7% of total emissions of harmful substances into the atmosphere;
- 71,4% of total volume of water withdrawn from natural sources;
- 74,3% of total wastewater discharge.

The threat to environmental security is further exacerbated by the development features of the coal industry in the region, which consists in the unrestrained increase in the rate of extraction of natural resources without taking into account internal needs in them and compliance with existing environmental standards. It should be recognized that the current specifics of mineral management in the Kemerovo region currently do not meet the principles of social responsibility, which, first of all, is vested in the owners and leading managers of companies.

The behavior of owners of the coal business is focused on extracting quick financial benefits from the activities of enterprises, and their responsibility is often limited only by financial obligations to the budget system. Needless to say that the profitability of the sold goods of the coal industry enterprises is currently one of the highest in the region, significantly outperforming the profitability indicators of the most popular and promising in the world types of activities, such as the production of machinery, equipment, vehicles.

Not being often even residents of the Russian Federation, such owners have little interest in applying advanced productive forces that meet world environmental standards. They care less about preserving the safe environment and careful use of limited and non-renewable resources, and therefore do not consider it necessary to invest in these purposes. By the way, in the field of mining, despite the relatively high profitability and relatively high investment attractiveness, the level of depreciation of fixed assets over the past years is the highest (52-54%) on average in industry.

Ultimately, the owner will profit, and the rest of the population living in close proximity to such production facilities will have to put up with serious environmental damage that has the most negative impact on human health and life. Rent-oriented behavior of owners of coal mining enterprises is fraught with not only a decrease in the standard of living of the population, but also in an increase in the financial burden associated with covering the costs necessary to reduce the progressive negative impact on the environment, the responsibility for the neutralization of which hardly anyone will undertake, and if he takes it, can he do it in full - remains a question.

One of the most disturbing socially significant consequences of the situation in the sphere of environmental protection is morbidity and mortality for reasons related to the industrial orientation of the region. The largest settlements of the region - the city of Kemerovo and the city of Novokuznetsk - are stably situated in the reports of Russian Meteorological Service among the cities in which cases of high air pollution are recorded. In 2017, in Novokuznetsk, 5 cases of high air-atmosphere air pollution triggered by emissions of a substance called benzopyrene were recorded; the maximum excess of the permissible concentration is 28.4 times. In Kemerovo, 3 cases were recorded with a maximum exceeding the permissible concentration by 13 times. For the full picture it should be mentioned that in this list there are 7 cities, 2 of which are on the territory of Kuzbass.

Benzopyrene is a polycyclic aromatic hydrocarbon belonging to the first class of hazard. Its impact on the environment is extremely dangerous, since it is expressed in the form of irreversible consequences. Benzopyrene has the property of accumulating in soil and water, flowing from there into the organisms of plants and animals and being transmitted further along the food chain. This substance is fairly easily distributed in the environment and without special difficulties is entered even in the territory, significantly removed from the main source of pollution. In terms of human exposure, benzopyrene is carcinogenic, mutagenic, hematotoxic and embryotoxic. It can be accumulated in the body and influence the next offspring generations. At the same time, the degree of hazard to a person does not depend on the way benzopyrene penetrates the body. The systematic exposure of this substance to the human population leads to an increase in diseases (including those associated with neoplasms, respiratory organs, congenital anomalies, malformations, etc.).

Since 2012 in terms of incidence rate per 1000 people the Kemerovo region is significantly ahead of the average

values for the SFO and Russia as a whole. If in 2005 the number of diseases per 1000 people in the Kemerovo region was about 732 people against 782 and 743 in the Siberian Federal District and the Russian Federation, respectively; by 2016 the Kemerovo region has become an obvious leader in the number of diseases per 1000 inhabitants relative to the average values for the Siberian Federal District (850 people) and the Russian Federation (785 people). In particular, in the Kemerovo region, at the present time, the maximum values relative to the average values for the SFO and Russia for diseases such as neoplasms and congenital anomalies (malformations) are recorded (Table 3).

TABLE III. MORBIDITY PER POPULATION OF 1000 PEOPLE BY MAIN CLASSES OF DISEASES

	Years							
	2005	2010	2011	2012	2013	2014	2015	2016
Morbidity, total								
The Russian Federation	743,7	780,0	796,9	793,9	799,4	787,1	778,2	785,3
Siberian Federal District	782,9	818,0	845,3	846,1	869,1	860,9	848,0	850,5
Kemerovo region	732,3	796,4	840,8	818,5	891,8	865,4	870,9	863,8
Including: Neoplasms								
The Russian Federation	9,5	10,8	11,1	11,6	11,4	11,6	11,4	11,4
Siberian Federal District	9,7	11,6	12,8	13,0	13,5	13,9	13,6	13,4
Kemerovo region	8,0	12,3	12,8	12,4	13,2	12,5	12,4	14,3
Respiratory diseases								
The Russian Federation	294,4	324,0	338,8	330,9	338,4	333,4	337,9	351,6
Siberian Federal District	280,3	312,3	324,3	311,9	326,5	323,2	331,8	347,4
Kemerovo region	264,1	284,5	314,8	285,1	314,0	289,1	318,0	310,4
Congenital anomalies (malformations), deformations and chromosomal abnormalities								
The Russian Federation	1,7	2,1	2,1	2,1	2,1	2,1	2,0	2,1

Federation								
Siberian Federal District	1,9	2,2	2,2	2,2	2,3	2,3	2,3	2,2
Kemerovo region	2,1	3,5	3,1	3,6	4,2	3,9	4,2	4,1

Among the main mortality causes of both male and female population of the Kemerovo region are diseases of the circulatory system and neoplasms. It should be noted that against the background of a decrease in the proportion of deaths due to diseases of circulatory system, respiratory system and for external reasons, there is a significant increase in mortality from neoplasms (Table 4).

TABLE IV. POPULATION MORTALITY BY MAIN CLASSES OF DISEASES, AS % OF TOTAL

Cause of death	Years							
	2005	2010	2011	2012	2013	2014	2015	2016
Circulatory diseases	52,0	50,5	47,9	46,3	44,7	42,2	41,3	39,4
Neoplasms	11,6	13,9	14,6	14,9	15,6	15,0	16,7	17,1
External causes	17,6	16,1	14,2	14,0	13,3	12,8	11,3	10,5
Digestive system diseases	4,1	4,8	4,9	4,8	4,7	5,0	5,3	5,2
Respiratory diseases	5,5	4,6	4,8	4,4	4,2	4,6	4,4	4,0

IV. CONCLUSION

The conducted analysis allows drawing a conclusion about the absence of a number of legally established environmental and innovative standards for mining companies which are highly relevant in the context of new industrialization, such as standards for expenditures on environmental innovation, the volume of shipped innovation products in the total volume of the enterprise's products against the background of standards for emissions of harmful substances into the atmosphere, water, soil, as well as penalties for their non-compliance which are fairly forgiving for businesses. Such conditions create opportunities for coal mining enterprises to give preference in favor of making immediate profits in the current period, rather than technical renewal of production and development of human potential.

V. PRACTICAL RELEVANCE, SUGGESTIONS AND RESULTS OF IMPLEMENTATIONS

The problem of increasing the social and environmental responsibility of the coal business in the context of the transition to new industrialization can be solved as follows:

1. Introduction of an additional tax on owners' super profits for the purpose of removing part of the profit received by the owner outside the normal range and then using it to finance environmental and economic activities within the

framework of the regional economic policy implementation. Currently in Russian taxation practice, Mineral Extraction Tax (MET) remains the only rental tax. However, it rather performs a fiscal function and serves the purposes of reproduction of the minerals and raw materials, rather than provides for an inter-branch capital flow. MET is paid from the cost or quantity of mined mineral and is included in the product price, which does not allow it to directly participate in the redistribution of super profits of owners.

2. Introduction of strict environmental standards for coal-mining enterprises (to provide for the norms of costs for environmental innovations, to reduce the standards for emissions of harmful substances into atmosphere, water, soil, etc.), with the development of a tariff scale of fines that must be considerable against the background of the usual coal mining profit margins.

3. Increase in the volume of shipped innovative goods falling on the coal industry, while ensuring the growth of the share of special costs associated with environmental innovations (in recent years their share has not risen above 0.5%). Currently used technologies and innovations are mainly used to reduce production costs, which remain quite high in the severe climatic conditions of mining in Kuzbass. Issues such as the mothballing of worked-out mines, the restoration of natural landscapes after overburden work, the use of modern purification equipment are alarming except for local residents.

The reference in this regard may be the leading coal mining company of Russia AO "SUEK", which for several years has been actively implementing a set of measures aimed at reducing the negative impact on the environment. Such measures include the reduction of harmful emissions, the rational use and purification of waste water, the utilization and recycling of waste, and the improvement of energy efficiency. In addition, the company successfully implements large-scale projects for land reclamation, including work of restoring relief, leveling rock dumps, restoring soil layer, planting trees, landscaping; carries out the construction of modern treatment facilities, uses technologies for carbon capture and storage, increases methane utilization, conducts research in the field of coal gasification, and also increases coal concentration volumes annually. To date, AO "SUEK" has been concentrating more than 50% of its coal production, and has also utilized methane 25% more than five years ago.

Annually, AO "SUEK" invests about \$15 million for the human capital development and social projects. Investment in environmental protection for the last 3 years amounted to \$54 million; the target for the next five years was set at \$173 million. That is, the annual amount of funds directed to reduce the negative impact of the company's activities on the environment will be increased by an average of 92%, with an increase in production volume for the same period by 38% and an increase in operating profit by 70%. As a whole, in respect of the complex of measures implemented by AO "SUEK" in relation to environmental protection, as well as the funds allocated for this purpose, the company can be recognized for its activities as the industry leader in terms of environmental and social responsibility.

References

- [1] Shmygleva A.V. (2015) *Bul. Tom. St. Univ.*, Vol. 400, p. 162.
- [2] Jishkariani G., Jandieri G., Sakhvadze D., Tavadze G., Zakharov G., Oniashvili G., Aslamazishvili Z. (2012) *Engin.*, Vol. 4, , pp. 83.
- [3] Mustafina K., Alma T. (2012) Vol. 5, pp. 109.
- [4] Wolak A., Hornik S. (2012) 18th IGWT SYMPOSIUM: Technology and Innovation for a Sustainable Future: a Commodity Science Perspective (at Rome, Italy).
- [5] Pawar D.H., Gaikwad A.T., Res Ind. J. (2013) *Paripex*, Vol. 2, pp. 71.
- [6] Novotna V., Půža B., Hřebíček J. Conference: International Environmental Modelling and Software Society (iEMSs) 8th International Congress on Environmental Modelling and Software Toulouse (France, Sabine Sauvage, José-Miguel Sánchez-Pérez, Andrea Rizzoli (Eds.), 2016.
- [7] Bobylev S.N., Kudryavtseva O.V., Yakovleva Ye.Yu., Reg Ek. (2015) Vol. 2, pp. 148.
- [8] Spash C.L. (2004) *Greenhouse Economics, Value and ethics.* (Taylor & Francis e-Library, London.
- [9] Vishnevsky V., Aleksandrov I., Polovyan A., *Sust Env. De.* (2011) Vol. 13, pp. 65.
- [10] Zonova O.V., Nekhoda E.V. (2016) *Coal 21st Cent.: Min., Proc. Saf.*, pp. 125.
- [11] Bereznev S., Zonova O., Lubkova E. (2017) *E3S Web Conf.*, 04002.
- [12] Chuturkova R., Simeonova A., Bekyarova J., Ruseva N., Yaneva V. (2011) *Assessment of the Environmental Status of Devnya Industrial Region, Bulgaria [J]. Journal of Environmental Protection and Ecology*, Vol. 12, No. 3, pp. 805–813.
- [13] Komatina D., Paunovic Zoric S., Alihodzic Jasarevic E., Kosanovic S., Riabuhina S.A. (2015) *Constr. Un. Build. Struct.*, Vol. 4(31), , pp. 94.
- [14] Nurongguli T., Maimaitiaili A., Zafar A., Maimaiti M., *Pol J.* (2013) *Law*, Vol. 6, pp. 160.
- [15] Kwiatkowski M. (2010) *Arch. Was. Man. Env. Prot.*, Vol. 12, pp. 40.