

# The Environmental Impacts Of The Coal Industry

Sergey Burtsev<sup>1\*</sup>, Viktor Efimov<sup>1</sup>, and Tatyana Korchagina<sup>2</sup>

<sup>1</sup> AO HK "SDS-Ugol", 650066, 7/2 Pritomsky ave., Kemerovo, Russia

<sup>2</sup> OOO Mining Engineering Institute of Siberia, 650066, 7/2 Pritomsky ave., Kemerovo, Russia

**Abstract.** The article analyzes the main indicators of the Russian coal industry's impact on the environment: the atmosphere, hydrosphere and lithosphere for the year 2016 compared with 2015. It also identifies actual values of the environmental safety targets of the coal industry and the main investments in the nature protection. For prevention, restriction and minimization the negative impact on the environment, the coal industry has proposed the packages of managerial and technical measures.

## 1 Introduction

Hundreds of thousands tons of polluting substance are emitted into the atmosphere [3, 4], hundreds of millions cubic meters of polluted manufacturing water are discharged into water bodies [5], thousands of hectares of agricultural land are seized [6] by the coal-mining enterprises of Russia every year.

Coal production directly damages the Earth's interior. This damage is closely related with geological exploration, construction, mining and other works that lead to a change in the vegetation cover, hydrogeological regime of the terrain, the formation of anthropogenic relief and other qualitative changes in the land [7, 8].

Thanks to the analysis of literature sources, official reports about the state and protection of the environment, etc. [9-14] the authors could highlight the main environmental problems in the coal industry and formulate measures to reduce its negative environmental impact.

## 2 Materials and methods

### Effects on the Atmosphere

In 2016 the industrial enterprises spewed into the atmosphere 1007.8 thousand tons of pollutants, including 879.5 thousand tons of hydrocarbons (mine methane). Compared to 2015 the emissions increased by 0.3%. With coal production rising by 3.3% in 2016, specific emissions were reduced by 3.3%. Reduction of specific pollutant emissions into the atmosphere was achieved through the implementation of the following environmental measures at the industrial enterprises (Table 1).

---

\* Corresponding author: [s.burtsev@sds-ugol.ru](mailto:s.burtsev@sds-ugol.ru)

### Effects on the Hydrosphere

437.6 million m<sup>3</sup> of sewage were discharged into surface water bodies in 2016, of which 333.2 million m<sup>3</sup> were contaminated (exceeding regulatory requirements). The spillover of polluted wastewater increased by 7.8% compared to 2015, the specific spillover per ton of coal production increased by 3.6%. A significant spillover of polluted manufacturing water is caused by the absence of sewage treatment facilities on part and the ineffective operation of existing mechanical treatment facilities. A positive result is a reduction in the spillover of polluted manufacturing water without preliminary cleaning by 13.2 million m<sup>3</sup> or by 9.6%. The achieved result was obtained thanks to the construction of new and modernization of existing treatment facilities based on the using of modern technologies in the mines to the A.D. Rubana, "Kotinskaya", "Taldinskaya-Zapadnaya-1" (AO "SUEK-Kuzbass"), AO "Ugolnaya kompaniya Yushnaya", AO "Meshdurechye" etc. [1,2].

Effects on the Lithosphere. 5161.4 hectares of land were destroyed by coal industry in 2016, and 964.2 hectares were remediated. Compared to 2015 the area of disturbed land decreased by 1148.6 hectares or by 18.2%. The area of the remediated lands increased by 141.9 hectares or by 17.3%. The increase in the area of reclaimed lands in 2016 compared to 2015 led to an increase in the level of reclamation from 13.0% to 18.7%. Disturbed and discharged lands that can be found in most enterprises and that are unusable now enable to increase the scale of remediation (Table 1).

The coal industry generated 3236.6 million tons of waste in 2016. 1690.1 million tons of it were used and 1526.9 million tons were disposed in external waste dumps for the various production purposes. The amount of generated waste compared to 2015 increased insignificantly - by 1%, the specific indicator of waste generation per ton of coal production decreased by 2.3%. The volume of used waste increased by 191.2 million tons or by 12.8%. The amount of waste disposed in external waste dumps decreased by 452.2 million tons (23%) (Table 1).

**Table 1.** Indicators of the negative environmental impact of the coal industry over 2016 compared to 2015

Sequence number	Indicators	Units	Report	
			2015	2016
1	Volume of coal mining	million tons	373.3	385.7
2	Pollutants released, total including:	thousand tons	1004.5	1007.8
	solids	thousand tons	54.9	58.4
	sulfur dioxide	thousand tons	9.3	10.4
	carbon monoxide	thousand tons	35.1	36.0
	nitrogen oxides (in terms of NO <sub>2</sub> )	thousand tons	14.7	18.8
	volatile organic hydrocarbons	thousand tons	2.4	3.7
3	Water reclaimed	million m <sup>3</sup>	887.3	879.5
4	Water used, total	million m <sup>3</sup>	36.2	35.3
	including fresh water	million m <sup>3</sup>	104.5	99.6
5	Water recycling	million m <sup>3</sup>	38.1	40.1
6	Water reuse	million m <sup>3</sup>	329.1	305.0
7	Wastewater discharged, total	million m <sup>3</sup>	10.3	11.5
			425.3	437.6

8	Total volume of wastewater requiring treatment	million m <sup>3</sup>	397.4	410.5
9	Volume of organized discharge of pollutants into surface water bodies	t	177.852.1	129.033.3
10	Polluted wastewater discharged (without treatment)	million m <sup>3</sup>	137.4	124.2
11	Polluted wastewater discharged (insufficiently purified)	million m <sup>3</sup>	171.6	209.0
12	Regulatory clean water discharged (without treatment)	million m <sup>3</sup>	27.9	27.1
13	Regulatory purified water on the purification facilities was discharged:	million m <sup>3</sup>	88.4	77.3
	on biological treatment facilities	million m <sup>3</sup>	0.5	0.8
	on physical and chemical cleaning facilities	million m <sup>3</sup>	26.4	36.1
	on mechanical cleaning facilities	million m <sup>3</sup>	61.5	40.4
14	Capacity of treatment facilities before discharge into surface water bodies	million m <sup>3</sup>	691.6	773.5
15	Waste			
	at the beginning of the year, total	million tons	20.241.8	21.667.8
	at the end of the year, total	million tons	21.667.8	21.029.1
16	Waste generated per year	million tons	3.204.8	3.326.6
17	Waste production disposed in external mine dumps	million tons	1.979.1	1.526.9
18	Waste used, total	million tons	1.498.8	1690.1
19	Waste at the enterprise neutralized, total	t	1.034.9	427.4
20	Waste transferred to third-parties, total including:	thousand tons	35.472.9	365.233.0
	for waste neutralization	t	42.0	58.2
	for use	thousand tons	33.292.0	13.996.6
21	Area of disturbed land:			
	at the beginning of the year	ha	101.800	107.500
	at the end of the year	ha	107.500	111.200
22	The area of disturbed land per year *	ha	6.310.0	5.161.4
	Area of remediated land per year	ha	822.3	964.2
23	Environmental protection capital investments , total including:	thousand rubles	1.095.730.2	902.497.8
	in collection and treatment of wastewater	thousand rubles	780.523.2	511.623.0
	in air protection and prevention climate changes	thousand rubles	2.677.7	10.545.8
	in land protection from production and consumption of wastes	thousand rubles	10.0	37.535.0
	in protection and rehabilitation of land	thousand rubles	3.282.6	18.563.0

24	Current expenditure on environmental protection, total	thousand rubles	1.229.071.9	1.165.003.0
	including:	thousand rubles	462.405.5	535.337.4
	collection and treatment of wastewater	thousand rubles	432.494.2	359.943.0
	air protection and prevention climate changes	thousand rubles	148.576.6	154.164.7
	land protection from production and consumption of wastes protection and rehabilitation of land	thousand rubles	147.076.2	82.775.2

\* The area of disturbed land over a year does not correspond to the difference in the area of disturbed land at the end of the year and at the beginning of the year, due to the inventory of land that occurs during a year at some enterprises or due to the transfer to other enterprises.

The actual values of the environmental safety targets of the coal industry are reflected in table 2.

**Table 2.** Actual values of the environmental safety targets of the coal industry

Target	For the program 2015	Fact 2015	For the program 2016-2020	Fact 2016
Specific discharge of polluted sewage into water bodies, m <sup>3</sup> / t of mining	1,1 - 1,2	0,8	0,7-0,8	0,86
The level of polluted sewage discharge to the total discharge volume, %	80 - 85	72,7	70-60	76,1
Coefficient of water cycle	0,73	0,77	0,8-0,85	0,78
Specific emission of pollutants into the atmosphere, kg / t of mining	2,6 - 2,7	2,7	2,4-2,5	2,6
The emission's level of pollutants into the atmosphere in the total volume of educated, %	60 - 65	53,5	45-55	58,5
The level of land remediation compared with annual damage, %	40	13,0	65-70	18,7
Specific volume of waste generation, t / t of mining	5,9 - 6	8,6	5,8-5,9	8,4
Level of waste production disposal in external mine dumps, % of generated	42 - 43	61,8	35-40	47,2
Multipurpose use of coal production's waste, %	10	46,8	13	52,2

Investments for the nature protection. In 2016 27 industrial enterprises invested in the environmental protection from their own resources in the total amount of 902,497.8 thousand rubles, 511 623.0 thousand rubles of which were meant for collection and treatment of wastewater, 37 535.0 thousand rubles for land protection from production and consumption wastes, 18 563.0 thousand rubles for protection and rehabilitation of lands, and 10 545,8 thousand rubles for protection of atmospheric air and prevention of climate change. Compared to 2015, investments fell by 18%.

### 3 Conclusions

In order to prevent, limit and minimize the negative impact on the environment, two main sets of organizational and technical measures are recommended.

A complex of organizational and technical measures to improve the state of the environment and its protection quality:

- introduction of BAT, technological processes and mining and transportation equipment designed to reduce emissions and discharges of pollutants, waste generation volumes and mining capacity of mining operations;
- construction of wastewater treatment facilities and equipping stationary sources of emissions into the atmosphere at new mines, sections and concentrating mills based on new modern technologies;
- equipping sources of emissions and discharges without cleaning facilities, efficient gas treatment facilities and treatment facilities;
- reconstruction of inefficient wastewater treatment plants, gas treatment plants and dust suppression facilities, and other environmental facilities at operating enterprises;
- regular examination of existing environmental facilities and equipment with an assessment of their technical condition, the achievable efficiency, the development and implementation of measures to improve their work;
- implementation of permanent technological control over the technical condition and efficiency of wastewater treatment plants, gas purification plants, waste dumps and other environmental protection facilities, timely taking measures when technological regimes of their operation are violated;
- advanced training of maintenance personnel of environmental facilities, managers and specialists of environmental services of coal companies and enterprises on the basis of scientific centers.

A complex of industrial and technical measures to improve the state of the environment and its protection quality.

For the air protection:

- transition from single-stage and two-stage systems of cleaning off-gas from coal-fired boiler plants and drying plants of concentrating mills to two-stage and three-stage systems respectively;
- replacement of dry cleaning devices for gases (cyclones, battery cyclones) for more efficient wet dust collectors, fabric filters and electrostatic precipitators;
- choosing the ways to reduce the formation and release of dust into the atmosphere during technological processes of mining production, and the parameters of dust suppression equipment operation, taking into account the dust-forming ability of coal;
- use of surfactant's solutions, dusting, dust-binding compounds and foam in the water systems instead of water;
- economic incentives and benefits for enterprises engaged in degassing and utilization of methane (concessional lending, cancellation of MET, etc.);
- development of methods, technologies and technical means for extracting and using methane from vent streams during ventilation of gas mines

For the water conservation:

- adopting effective cleaning methods in the projects of construction and reconstruction of mine and quarry water treatment plants: thin settling, clarification in a layer of suspended sediment and pressure filtration with the use of chemical reagents, electrocoagulation-flotation, filtration, disinfection with ultraviolet radiation, sludge dewatering to tape and chamber filters presses;
- adopting methods of dry enrichment with the use of spiral separators and pneumatic float machines, enrichment technology with thickening of slimes and deep clarification of slime waters using hydrocyclones and radial thickeners, and dehydration of flotation waste by filtering it using filter presses at the undergoing and reconstructed concentrating plants;

- increase in the use of treated mine and quarry water instead of drinking water for production needs of own and related enterprises, including replenishment of recycling water supply systems;
- development of economically acceptable methods and technologies for purification of acidic (pH 2-5) and mineralized (with salt content over 2-3 g / dm<sup>3</sup>) mine waters with utilization of formed precipitation and brines.

For the land conservation:

- development of remediation projects based on complete initial data on mineralogical, granulometric, chemical, microbiological composition, agrophysical and agrochemical properties of regenerated soils and rocks, taking into account the landscape approach and natural and climatic conditions;
- taking measures to prevent spontaneous combustion of rock dumps prone to spontaneous ignition during remediation projects;
- development on commercial scale of new methods and technologies for the restoration of biological productivity of disturbed, degraded and polluted lands, in particular the microbiological method of accelerated remediation and the method of biological remediation of rock dumps by the Institute of Agrarian Problems of Khakassia;
- proceeding with the development and industrial testing of new methods and technologies for technical and biological remediation, special machines and equipment for removal and deposition of PSP and PPP, hydroseeding on slope surfaces, mechanized planting of trees and shrubs.

For the waste management:

- a detailed study of the current production waste and the rock mass accumulated in the dumps, with the definition of composition and properties, the content of associated minerals and valuable elements, the determination of their reserves and state registration;
- increase in the use of coal mining and preparation waste in construction, in building materials production, for the extraction of coal and valuable elements, in the production of fuel briquettes;
- improvement of existing and development of new efficient methods and technologies for processing waste products into commodity products with obtaining energy fuel and ash residue;
- reducing the volume of waste generation by improving mining technology, including rational cutting of mine fields and the sequence of their mining, optimizing the technological parameters of overburden and mining operations, maximum placement of overburden and enclosing rocks in the worked out area of cuts and mines;
- application of fire-safe technologies for their formation on existing and planned waste rock dumps;
- monitoring of the thermal state of rock dumps in order to identify hotbeds of self-heating and spontaneous combustion and the adoption of operational measures to eliminate them;
- extinguishing burning rock dumps by transforming conical dumps into flat dumps, carrying out preventive measures and subsequent remediation.

## References

1. *Official report "About the state and protection of the environment of the Russian Federation in 2015"*, 639 (Ministry of Natural Resources of Russia, NIA-Priroda, M, 2016)

2. N.M. Kachurin, L.L. Rybak, V.I. Efimov, S.A. Vorobiev, *Industrial safety*, **2**, 24 (2015)
3. N.M. Kachurin, L.L. Rybak, V.I. Efimov, S.A. Vorob'ev, *Industrial safety*, **3**, 36 (2015)
4. V.I. Efimov, R.R. Minibaev, T.B. Korchagin, S.A. Svinarenko, *Coal*, **6**, 62 (2017)
5. V.I. Efimov, L.V. Fisherman, *Industry and the environment* 336 (MGGU, M, 2012)
6. V.G. Gridin, V.I. Efimov, *40 environmental questions*, 168 (MGGU, Moscow, 2007)
7. V.G. Gridin, V.I. Efimov, *Industry and the environment: lectures: " Industry and the environment"*, (MGGU, Moscow, 2007)
8. V.I. Efimov, *The Fundamentals of Nature Management: tutorial*, (MGGU, Moscow 2004)
9. V.I. Efimov, R.R. Minibaev, T.B. Korchagin, Ya.A. Novikova, *Coal*, **1**, 66 (2017)
10. V.I. Efimov, R.R. Minibaev, T.B. Korchagin, Ya.A. Novikova, *Mining information-analytical bulletin*, **1**, 85 (2017)
11. V.I. Efimov, S.M. Popov, P.M. Fedyaev, N.V. Efimova, *Methodological bases of the ecological and economic evaluation of ways of involving coal waste into economic activities of the regions*, 121 (Tula State University, Tula, 2016)
12. V.I. Efimov, R.V. Sidorov, T.V. Korchagin, *Coal*, **12**, 90 (2014)
13. V.I. Efimov, T.V. Korchagin, *Ecological and economic analysis of the impact of coal enterprises on the environment*, 173 (MGGU, Moscow, 2006)

