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Actual Issues of using coal mining and processing waste in the mining industry

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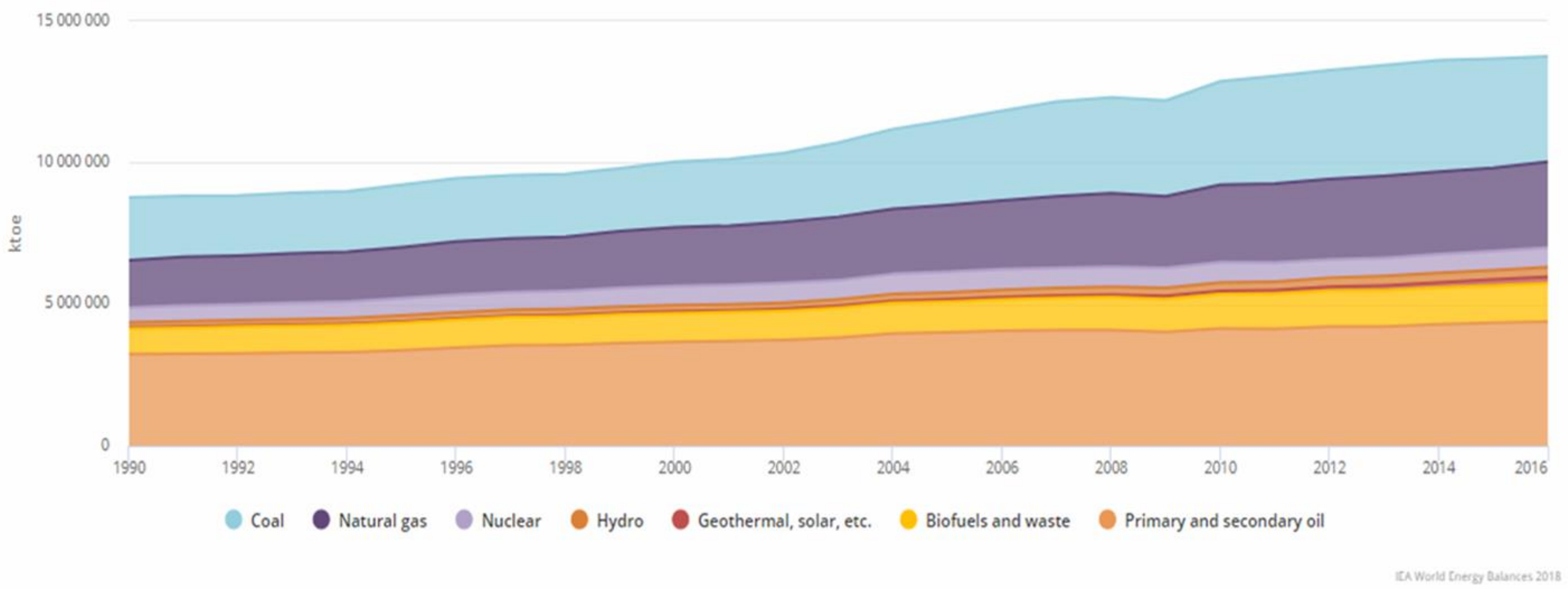
Role of coal in the global production of heat and electricity

Мировое производство тепла и электроэнергии из разных ресурсов (по данным International Energy Agency - IEA)



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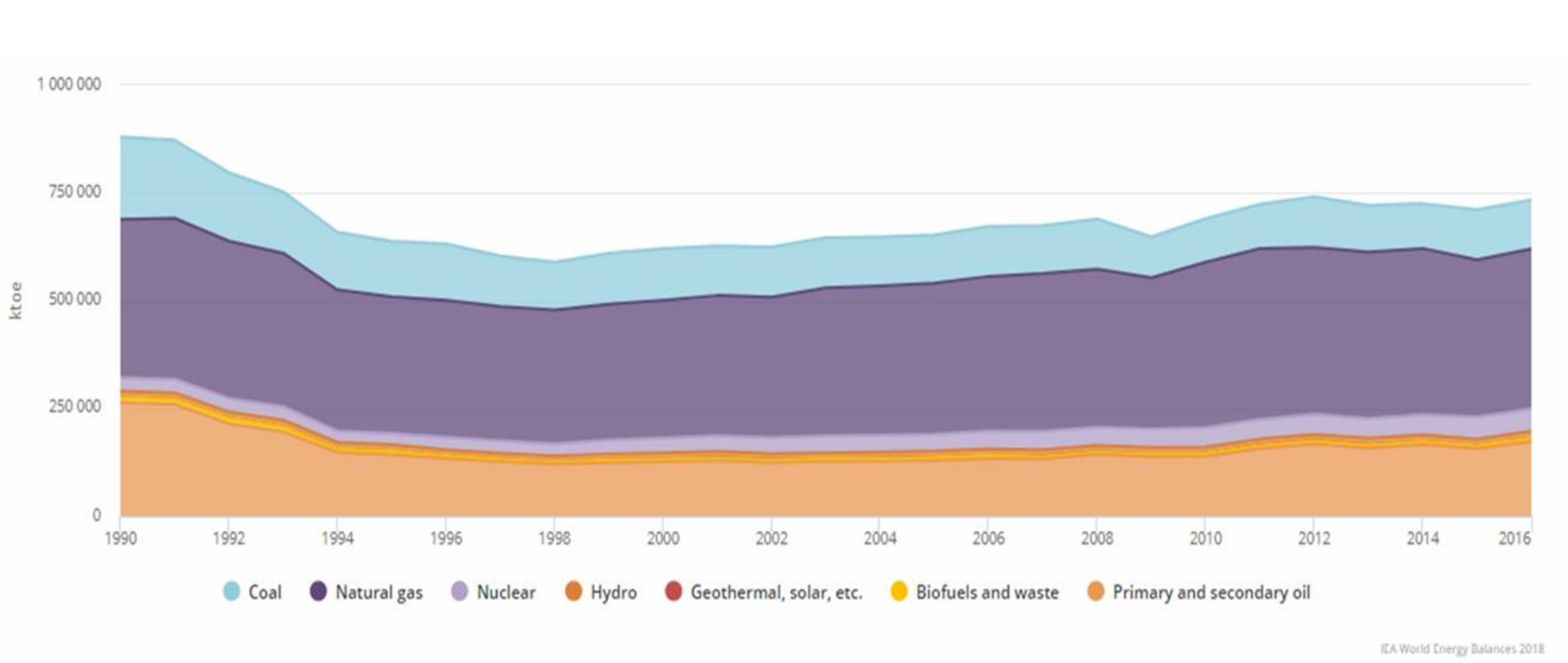
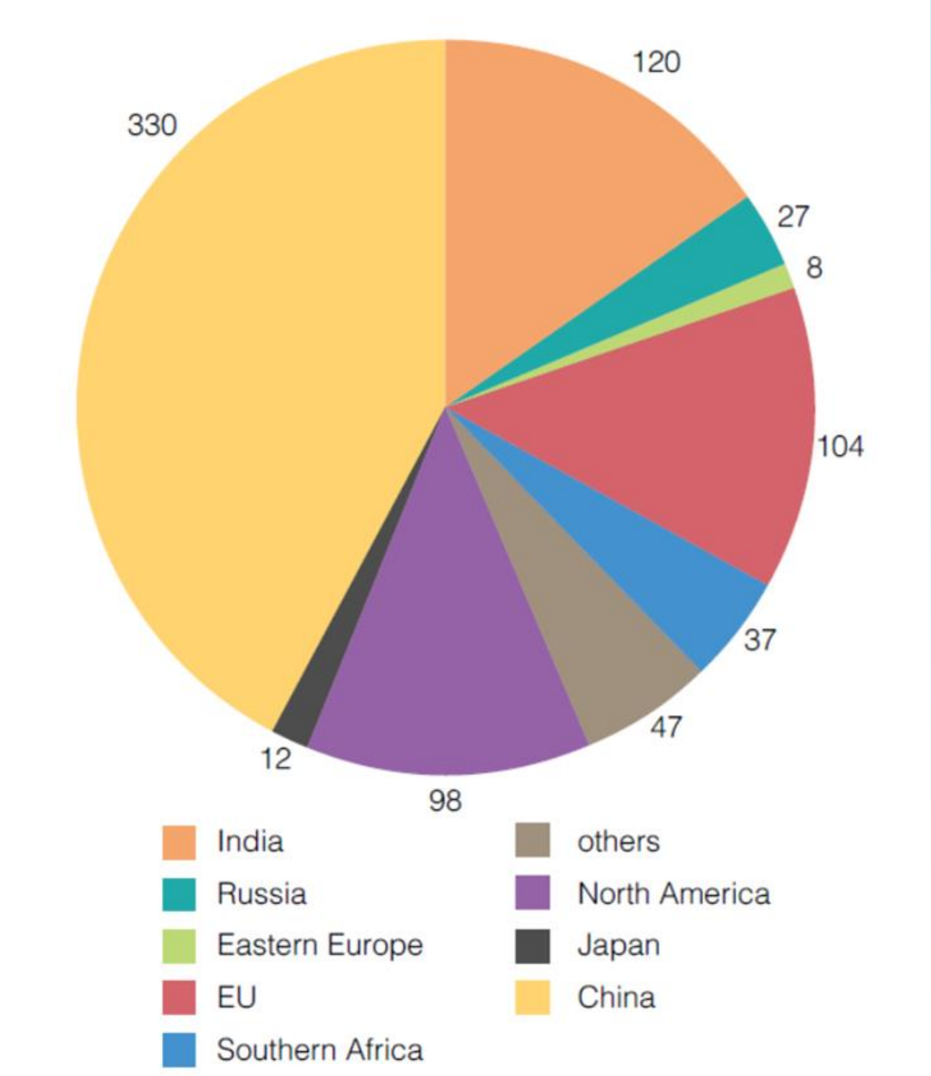
Heat and electricity production in the Russian Federation from various energy sources



The volume of coal combustion waste (Mt annually)



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Volumes of coal combustion waste (CCP) produced and the level of their processing

Table 1 Coal combustion production and utilisation rates for selected countries

	2011		2010		2009		Source
	Production, Mt	Utilisation, %	Production, Mt	Utilisation, %	Production, Mt	Utilisation, %	
Australia	13.1	46	14.1	41	13.7	18	Ash Development Association of Australia (2011)
China	480a	68*	400†	67*	375†	60†	* NDRC (2013), †Yang and others (2010)
Israel	1.09	100	1.07	100	1.13	100	Israeli National Coal Ash Board (2013)
India	131.1	55.8	123.5	62.6	116.7	57.1	Indian Central Electricity Authority (2011)
Japan	9.67	95	10.7	95	10.7	97	Federation of Electric Power Companies of Japan (2012)
Korean R	8.64	67.8	8.41	84.2	8.35	62.8	Wee J (2012)
Poland	20.7	59	19.6	58.3	17.6	60.1	Szczygielski K (2012)
Russia			26.6	18.8	26.1	18.4	Putilov and Putilova (2012)
USA	118.0	43.5	118.1	42.5	114.0	44.3	ACAA (2011)
EU 15¶			48‡	91.4‡	51.8§	90.7§	‡ Caldas-Vieira and Feuerborn (2013), § Ecoba (2013)

¶ The utilisation rate for 2010 includes 39.8% and for 2009 includes 39.2% for the restoration of opencast mines, quarries, and pits

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Volumes of wastes in Russia

In total, during the extraction and enrichment of coal in 2016, **3236.6 million** tons of waste was generated in Russia, mainly represented by “inert” rocks –overburden and host rocks. Of these, **1526.9 million tons (47% of the total mass of waste)** were disposed of in external dumps, the rest of the waste was processed or used to lay the worked-out space of mines and open pits. *

According to 2015 data, Russia has accumulated approximately **1.1 billion tons** of ashes and slag waste (ASW). Each year, this number increases by an average of **22–25 million tons** of waste. For example, in 2015, the production of ASW in Russia amounted to about **30.4 million tons**, while about **4.2 million tons** of ASW were shipped to consumers (less than 10%).

- Source - Reference Document on Best Techniques“Mining and processing of coal”

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Actual tasks of coal mining and processing waste management

1. **Waste classification**
2. **Methods for identifying waste and evaluation of its composition**
3. **Definition of hazard class of waste**
4. **Environmental Impact Assessment for Waste Management**
5. **Development of measures to reduce the negative impact of waste on the environment when used in the mining industry**

Activities of NUST 'MISiS' in the field of classification and methods for identification of coal mining and processing waste

Standardization and Metrology

1. Standard GOST R 57011-2016 **Production and preparation waste of coals. Classification.** The standard applies to solid wastes obtained during mining and benefication of coal, and establishes their classification by origin, basic physical and chemical characteristics in order to determine directions for further use.
2. National GOST standards have been developed that regulate the determination of mercury in coal mining and processing waste (harmonization with ISO and ASTM).
3. In 2019, the first revisions of the standards were developed that govern the determination of chlorine and arsenic in waste and the content and composition of water-soluble substances (leaches).
4. The development of standards for the determination of fluorine in waste, as well as the main macro- and microelements, has been initiated.
5. Technical design specification has been prepared and development has begun for Certified Reference Materials (CRM) of mercury, fluorine and arsenic contents in coal, mining and burinig wastes.

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Activities of NUST 'MISiS' in the field of classification and methods for identification of coal mining and processing waste

Scientific and practical work and educational activities

1. **For coal and energy enterprises of the Russian Federation, activities are underway to determine macro- and microelements in coal, waste from their mining and processing.**

Aim of work: *assessment of the level of emission of potentially hazardous elements during coal processing and storage (or use) of waste.*

2. The use of humic substances within the lignites and peat to improve the environmental safety of the disposal of coal combustion wastes during reclamation.

3**. Development of methods for using coal burning wastes for grouting of degassing wells.**

4. **Training and retraining of specialists in the field of quality and safety management of coal and waste from their mining and processing.**

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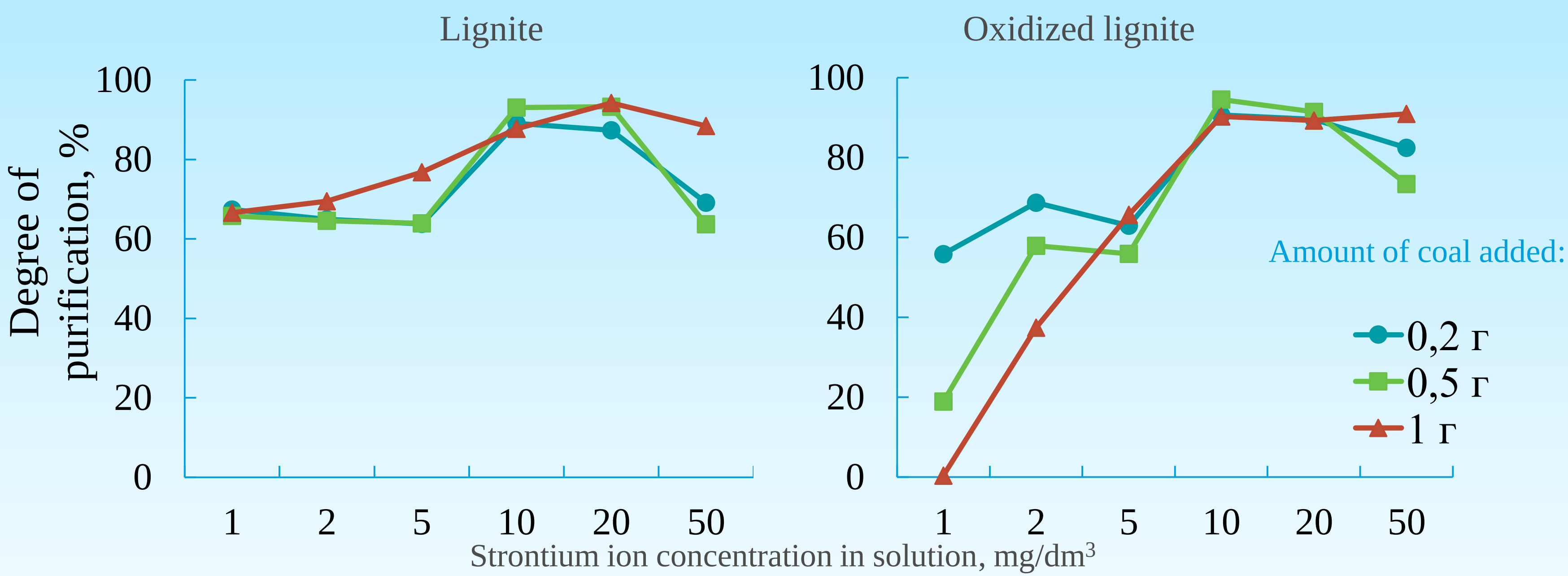
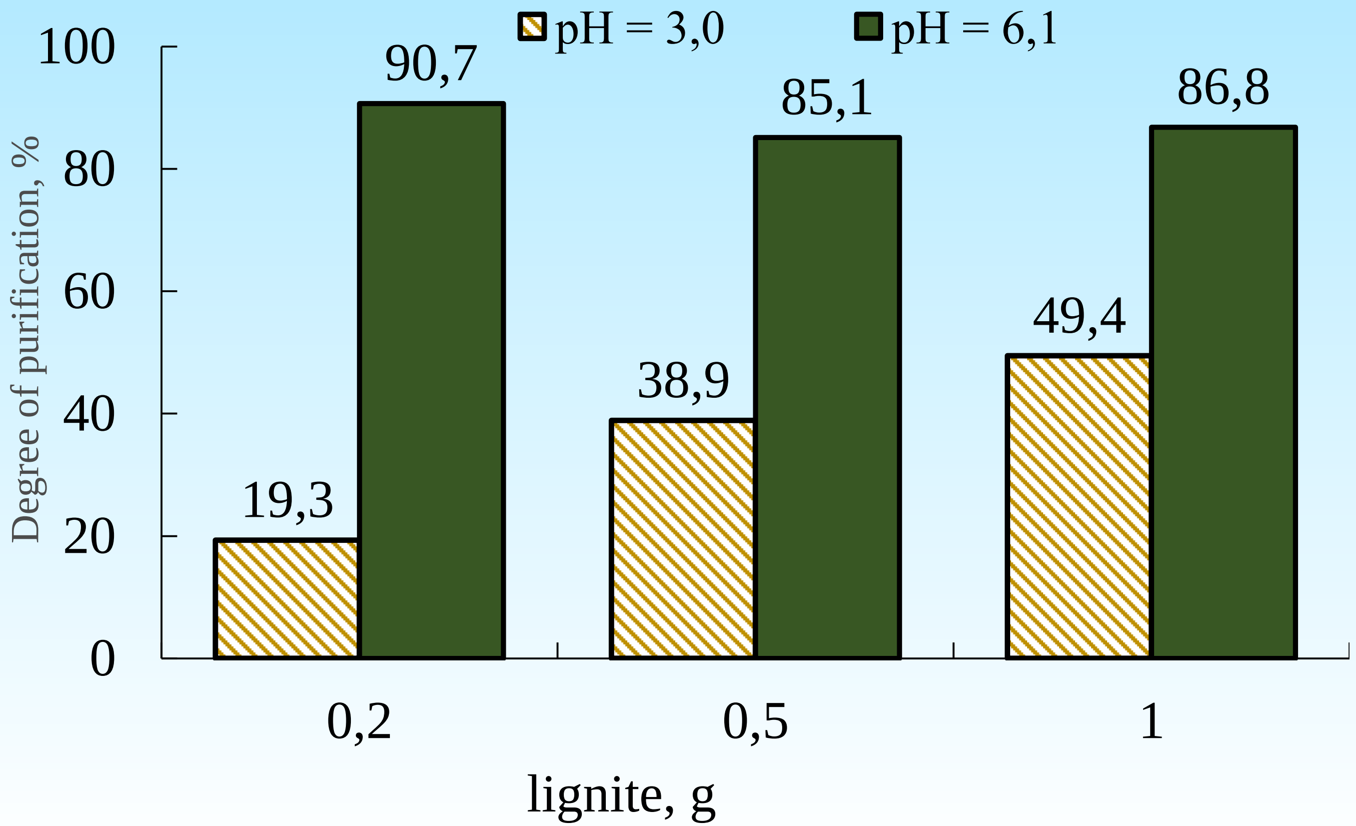
Sorption activity of lignites with respect to strontium ions in water solutions



Degree of purification $= \frac{C_1 - C_2}{C_1} \cdot 100\ \%$, where C_1 – strontium ion concentration in the initial solution, mg/dm^3

C_2 – strontium ion concentration in the solution after interaction with coal, mg/dm^3

Sorption activity of oxidized lignite with respect to strontium (Sr) ions at different pH levels



The use of chemicals to suppress dust during the movement and transshipment of coal and reduce their oxidizability during storage

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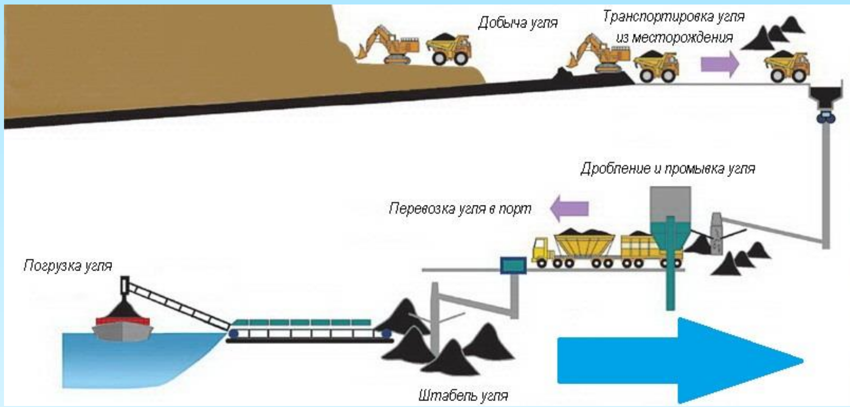
The problem of dust formation during transportation, warehousing and storage of coal



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The main measures of deceleration of coal oxidation and dust suppression

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Dust suppression technology

Estimation of dust content in commercial coal → Determining the effectiveness of dust binding with chemicals → The choice of treatment technology

Monitoring the effectiveness of coal processing with chemicals

Environmental impact assessment

Quality of coal products

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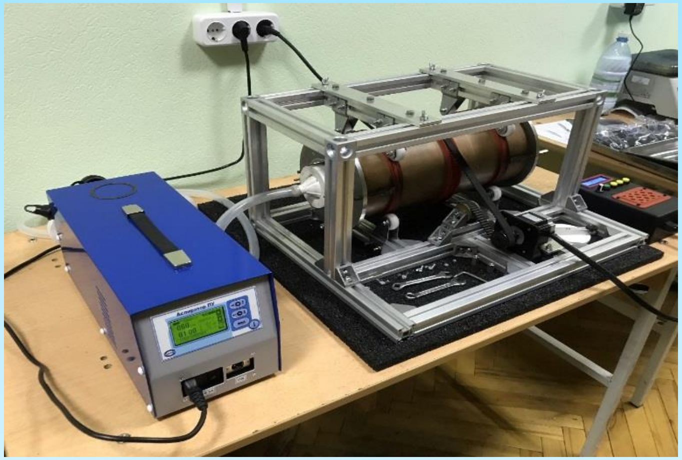
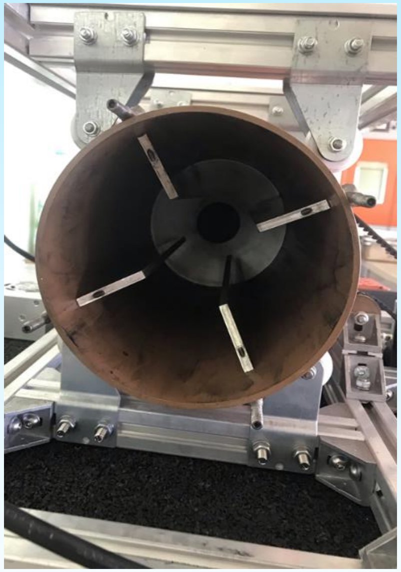
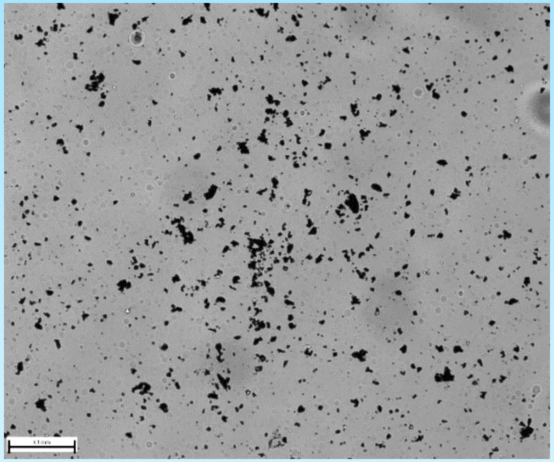
Assessment of dust content in commercial products



General view of the installation



Inside drum



Granulometric composition of the dust residue on the filter

The measured dust content (less than 20 microns) ranges from 0.02 to 0.2% in the 0-3 mm class

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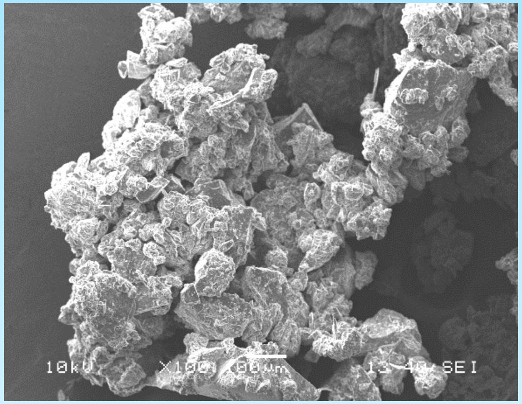
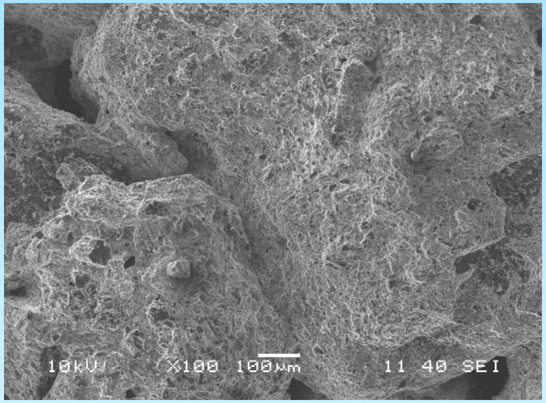
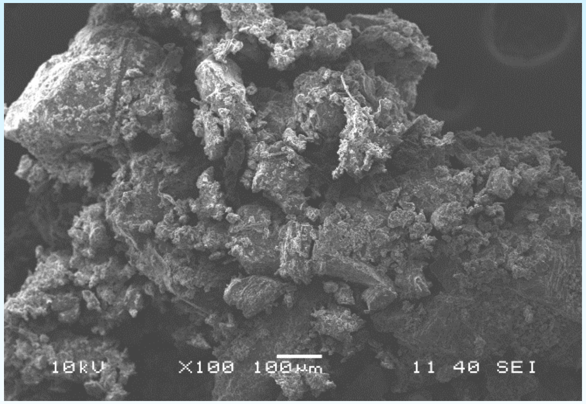
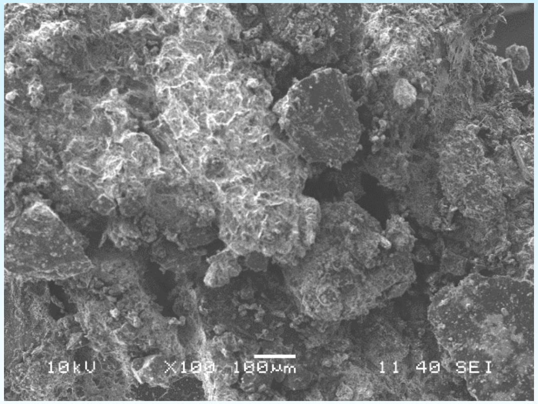
The microstructure of coal after treatment with different chemicals









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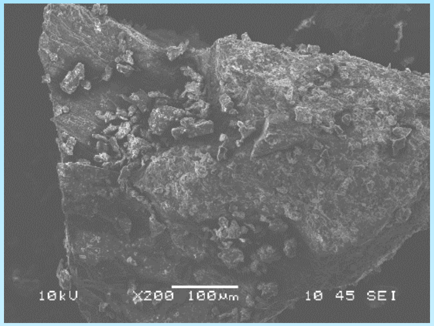
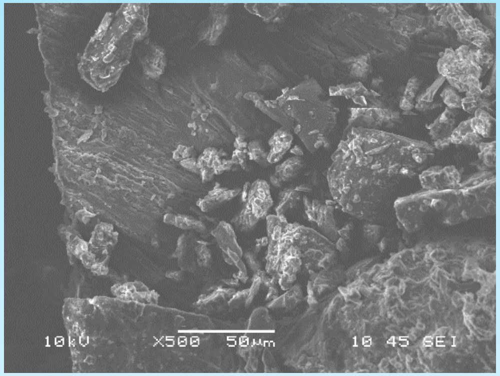
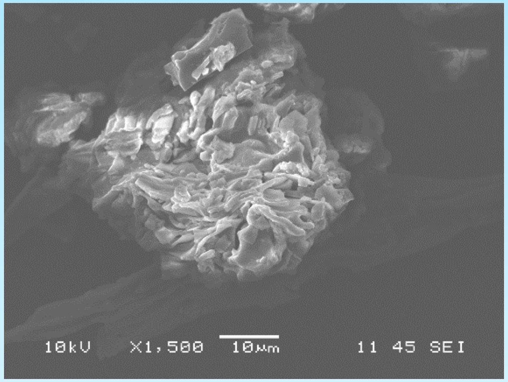
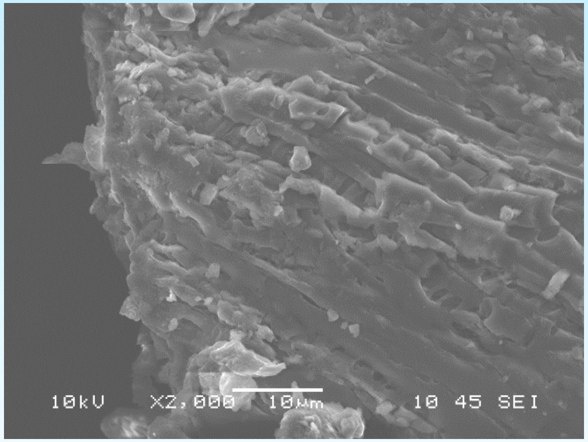
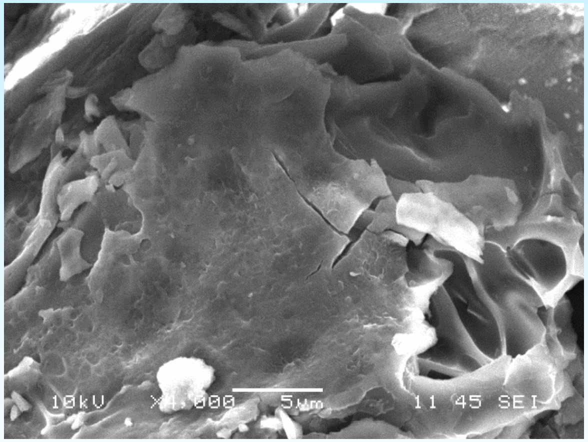
The surface structure of coal after treatment with polymer emulsions

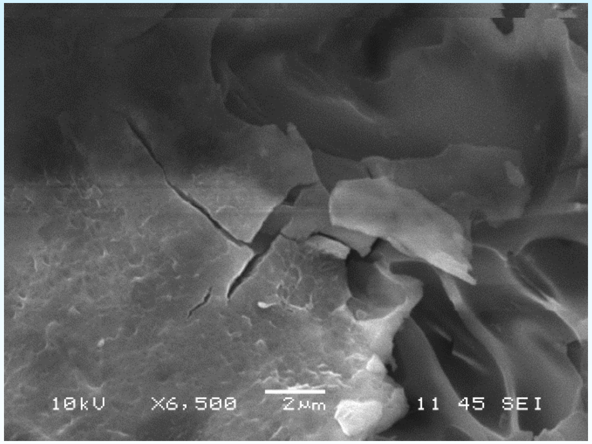












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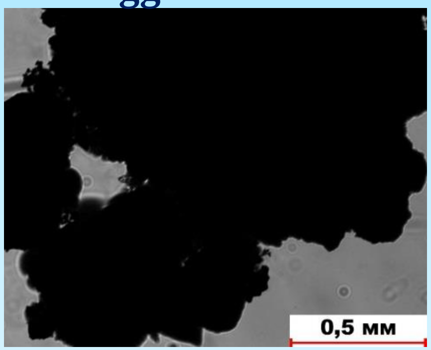
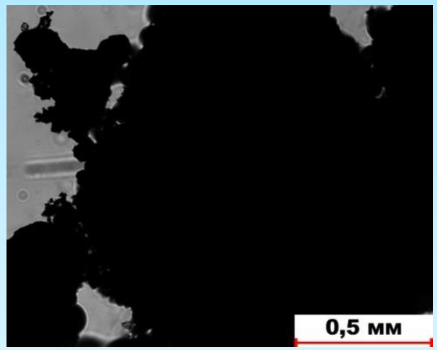
Determination of the stability of dust aggregates when using polymer emulsions

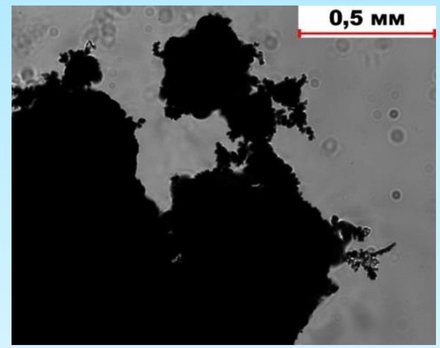
Initial view of agglomerates

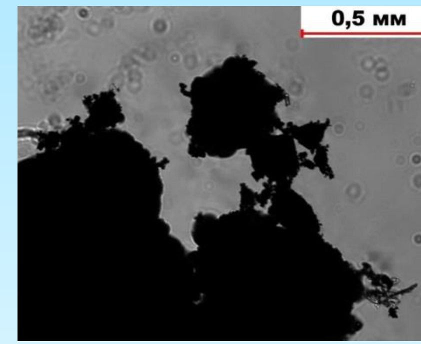
After 5 minutes

After 10 minutes



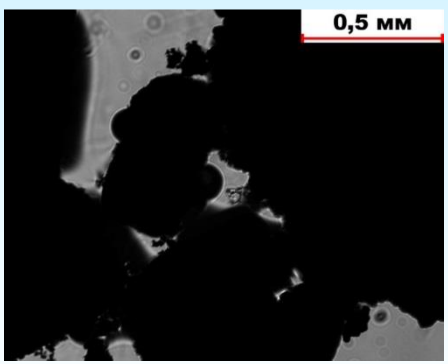


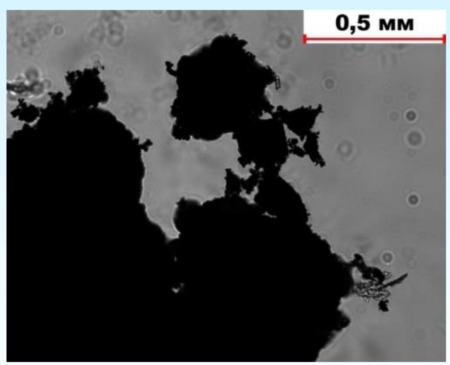


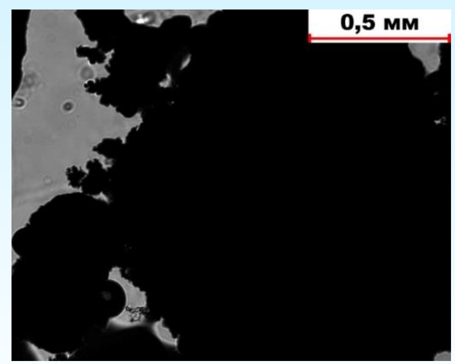


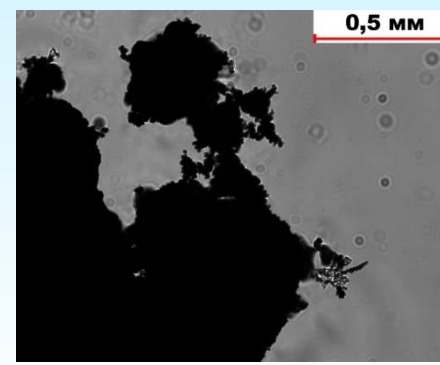
After 20 minutes

After 30 minutes









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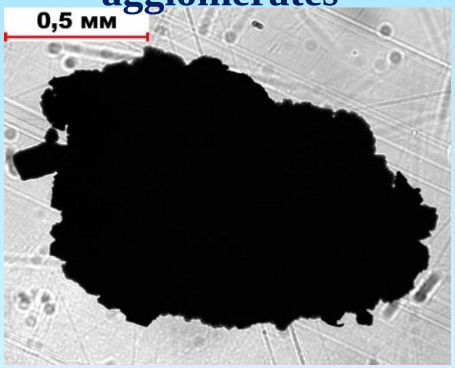
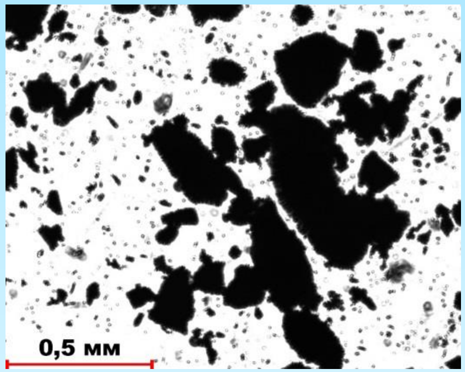
Determination of the stability of dust aggregates when using non-polymer solutions

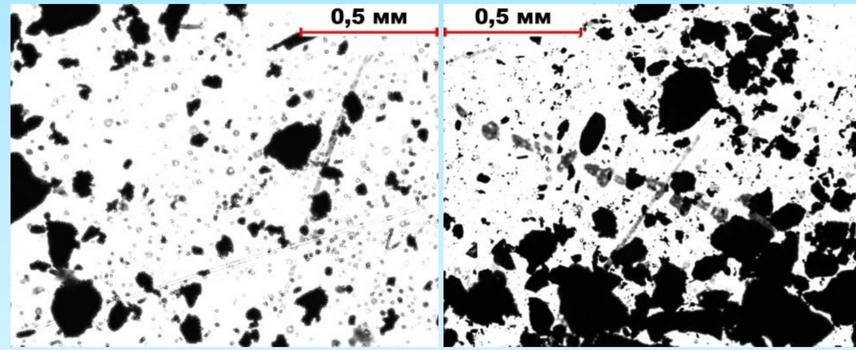
Initial view of agglomerates



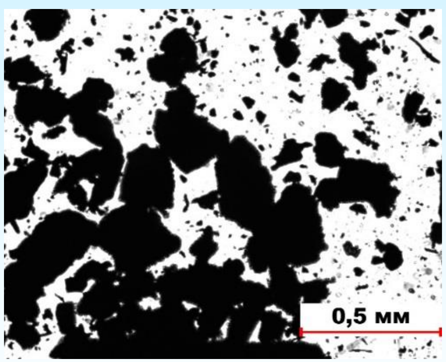
After 1 minute



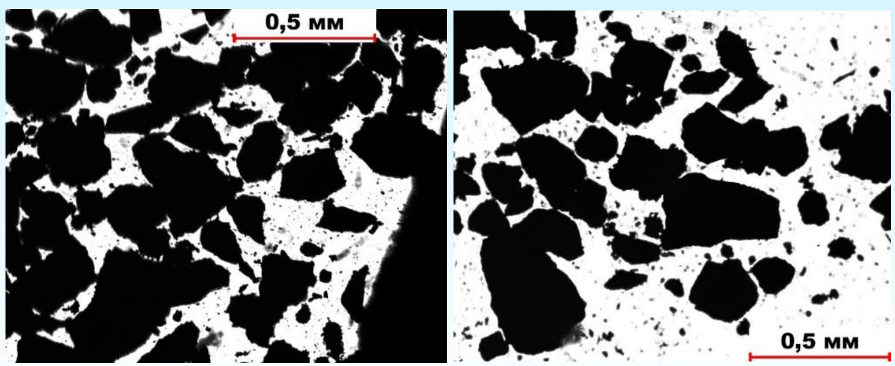
After 5 minutes



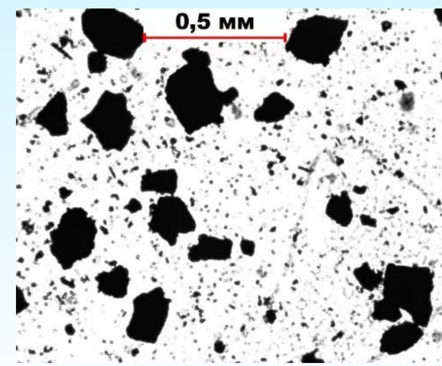
After 10 minutes



After 15 minutes



After 20 minutes



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Carrying out industrial tests on the processing of coal by polymer emulsion

- ✓ **400 tons of coal processed;**
- ✓ **Crushing and grading complex average productivity - 274 t / h;**
- ✓ **Actual consumption of polymer emulsion (10% concentration) - 5 l / t;**
- ✓ **The total coal processing time at crushing and grading complex is 88 minutes;**

Without treatment

With treatment

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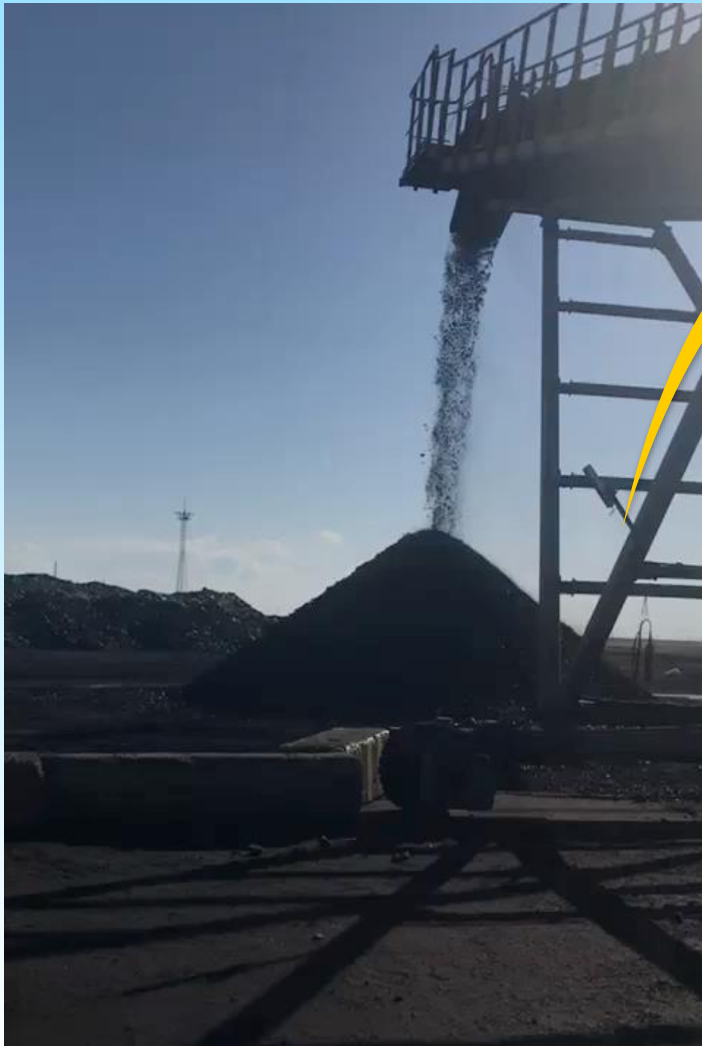

Unloading of treated coal at the railway warehouse

The quality of coal after processing with a polymer emulsion

Coal	W^t, %	W^a, %	A^d, %	V^{daf}, %	$S^d{}_t$, %	$Q_s{}^d$, kcal/kg	$Q_s{}^{daf}$, kcal/kg	$Q_i{}^r$, kcal/kg
Treated	*11,6*	6,6	9,7	44,8	0,56	7029	7785	5930
Untreated	11,2	6,7	8,9	44,4	0,62	7108	7799	6030

View of coal immediately after treatment

View of coal a month after treatment

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