Көмірдің өз қажеттіліктері үшін, әсіресе экологиялық көрсеткіштер бойынша табиғи газ және мұнай шығындарынан айтарлықтай төмен екені белгілі. Алайда, Халықаралық энергетика агенттігінің бағалауы бойынша [3], қазіргі тұтыну қарқыны бойынша мұнайдың барланған қорлары 30 жылда, ал газ - алдағы 50 жылда таусылады (бірақ Қазақстанның одан да қолайлы болашағы бар [4]), ал көмірдің қоры ең қарқынды пайдалану кезінде 200 жылға созылады [5]. Қазіргі таңда көмір технологияларын дамыту қажеттілігі ешкімде күмән тудырмайды. Қалған отын ресурстары әлдеқайда қысқа мерзімге жетеді, сонымен бірге олардың құны әлдеқайда жоғары. Дүниежүзілік көмір институтының мәліметтері бойынша, көмір өндіруге жарамды органикалық шыққан барлық минералдардың энергетикалық әлеуетінің шамамен 90% құрайды. Дүниежүзілік энергетикалық сектордың даму перспективалары оның ресурстарының қолжетімділігіне айтарлықтай тәуелді. Бұл тұрғыдан алғанда, көмір өнеркәсібі мұнай-газ өнеркәсібіне қарағанда жақсы жағдайда, демек, ұзақ мерзімді перспективада энергетика саласының перспективалық саласы болып табылады. Бүгінгі Қазақстан үшін негізгі отын ресурсы – көмір. Қазақстанның көмір өнеркәсібі экономиканың ірі салаларының бірі болып табылады [6].

Список использованных источников

1. Дүкенбаев Қ Д. Қазақстанның энергетикасы. 1 том Алматы. Ғылым; 1995 жыл. б. 276.
2. Әлияров БҚ, Алиярова М Б. Энергетикалық қауіпсіздік, энергия тиімділігі және энергетикалық дамудың тұрақтылығы. Алматы. 2010: 277.
3. Әлияров Б.Қ., Алиярова М.Б. Қазақстан көмірінің жылу энергиясында жағуы зауыттар мен ірі қазандықтар. Алматы 2012:304.
4. Оңғар Б, Илиев І, Смағұлова Г, Мергалимова А. Сандық модельдеу ұнтақталған пештерде азот оксидтерінің түзілуі. Инженерлік ЖУРНАЛ Ғылым және технология шолуы 2020:171-175.
5. Алияров Б, Мергалимова А, Жалмагамбетова У. Көмірдің термиялық қолданылуы майсыз өңдеу технологиясы қазандықтардың сақинасы. Latv J Phys Tech Sci 2018;H 2:45-55.
6. Гороховский М.А., Янкоски З, Локвуд ФК, Карпенко Е.И., Мессерле В.Е., Устименко А.Б. Плазмалық технология арқылы көмірдің ұнтақ жануын жақсарту нология. Combust Sci Technol 2007;179(10):2065-90.
7. Чемецкий Ю.М., Дектерев А.А., Бойков Д.В. Кешенді технологияны дамыту терең пури нологиясыfікатион flП-39- қазанының азот оксидтерінен алынған газдар Ақсу ГРЭС 11 млн. Электр станциялары 2012;H◦11:214.

UDC 621.1

THE USE OF ASH AND SLAG WASTE FROM THERMAL POWER PLANTS

Musa Aigerim
musa.aigerim01@mail.ru
Thermal Power Engineering M098-7117-22-01 master student,
L.N.Gumilev Eurasian National University, Astana, Kazakhstan

Keywords: ash and slag waste, building materials, hydroelectric power plants, valuable trace elements, geopolymers, aluminum-silicate microspheres

Introduction

In the modern world, with the undeniable growth of electricity production, the problem of waste management from thermal power plants is becoming more urgent than ever. Among the

various wastes generated as a result of energy generation, ash slags occupy a significant place and pose a significant challenge to ecology and sustainable development.

Ash slags occur during the combustion of hydrocarbon fuels in thermal power plants and are a mixture of mineral and metal compounds. Despite their strength and stability, ash slags have become the object of careful study in order to develop innovative methods for their disposal and reuse.

In this context, the use of ash and slag waste as a secondary resource is becoming a promising research area. This approach not only helps to reduce the amount of waste released into the environment, but also provides unique opportunities for creating sustainable and efficient waste management systems in thermal power plants.

In this study, we focus on the potential use of ash and slag waste in various sectors, from the construction industry to the production of building materials.

Methodology

The analysis of effective methods and technologies of their processing will become a key component, allowing not only to solve the problem of recycling, but also to actively implement the principles of a closed cycle of resource use.

Production of building materials

The production of building materials using ash and slag waste from thermal power plants is an innovative and environmentally sustainable approach aimed at solving the problem of waste disposal and creating products that contribute to sustainable development.

Main part

Cement production.

Several studies have examined the use of ash and slag waste from thermal power plants (TPP) and hydroelectric power plants (HPP) in the manufacture of cement with mineral additives. It was found out that the physical and mechanical properties of these wastes depend on the composition of the materials used, the volume of mineral additives and the specific surface area. The introduction of 15% acidic ash slag from thermal power plants into the composition of cement makes it possible to obtain high-quality materials. The use of mineral additives in the amount of 30%, including waste from the Shulbinskaya HPP (15%) and granulated slag of JSC ArcelorMittal Temirtau Metallurgical Combine, contributes to the creation of cements with high strength characteristics. Also, the ash obtained as a result of entrainment is suitable for the production of gypsum binders. Adding it to the raw material mixture in a volume of up to 20% leads to an increase in the strength and water resistance of the resulting compositions.

Production of concrete.

Waste from the thermal power industry is a potential resource for the production of various types of concrete. Concretes created on the basis of ash cements are not only not inferior to conventional cements in terms of characteristics, but also exceed their water resistance. An example of the possibility of producing heavy and fine-grained concretes is the experience of Ekibastuz HPP-1. Using ash and slag waste in its natural state, it is possible to produce heavy concretes of the B30 brand, and fine–grained concretes of the B25 brand in the ground state. As a promising filler for lightweight ash concrete, non-burnt ash gravel obtained from high-quality fly ash and silicate blocks acts. It has a significant advantage – the thermal conductivity is more than 1.5 times lower compared to expanded clay concrete. However, the use of ash and slag waste in silicate concretes does not always bring the expected results, since it can lead to the formation of a highly porous structure, causing low strength and water resistance of the material. To eliminate this disadvantage, the concretes are treated in a sulfur melt modified with liquid glass, which creates a protective hardening and water-resistant coating. Sulfur concrete containing sand and ash slags instead of water is prepared in the presence of a modifier – phosphorus (III) chloride. This material has high density, strength and low water absorption, making it suitable for use in road structures, tiles and

side stones. It is important to note that the content of fly ash from thermal power plants in concrete by more than 50% of the volume has a negative effect on its quality, manifested in a decrease in strength and frost resistance. To prevent negative consequences, it is necessary to improve the quality of fly ash. For this purpose, various methods are used, including the use of high-voltage electrical separation. This method allows you to separate the organic remains of the ash from its mineral part.

Production of ceramic products.

To effectively reduce the consumption of energy and mineral resources in the production of ceramic materials, a promising solution is the introduction of ash and slag waste (ASH). Numerous researchers are working on this problem, and their work indicates that waste from thermal power plants (TPP) can successfully replace high-quality raw materials in the production of building ceramics. The addition of ash and slag to the composition of the clay charge helps to reduce the fire shrinkage of finished products, and during firing, the formation of wollastonite and hematite is activated. Scientific research at the Yurginsky Institute of Technology is aimed at developing methods for producing ceramic bricks through plastic molding. It has been studied that the addition of ash and slag waste to the clay component should not exceed 15%, and the firing temperature should be at least 1000 degrees Celsius. Studies also demonstrate that the modification of waste by grinding has a positive effect on the physical and mechanical characteristics of the final product. An increase in the content of fine particles of ASH up to 50% in the composition of the charge when using the method of semi-dry pressing with a pressure of 25 MPa improves water absorption and frost resistance of the resulting brick. During the production of ceramic tiles, waste from the fuel and energy complex can also be included in the process. Formulas and technological standards have been developed in the Republic of Belarus for the manufacture of terracotta tiles from man-made products of the energy complex, represented by precipitation from chemical water treatment of dewatering stations and thermal power plants. Research shows that by changing the content of the main components, it is possible to vary the color and technical characteristics of the materials obtained.

Road construction.

Ash and slag waste from thermal power plants is a multifunctional material for road construction. They can be used for laying road embankments, forming foundations and all layers of highways, as well as as a component of binders for strengthening soils, mineral powder and additives to cement concrete. Studies have been conducted on the use of ash and slag from thermal power plants in Darkhan (Mongolia) as part of road soils. It was found that due to the high carbon content, acidity and low calcium content, ash slags do not provide good adhesion to the soil, therefore, lime or natural limestone additives must be introduced for the composition of road concretes. While the use of ash and slag from thermal power plants in the Trans-Baikal Territory as part of cement soils makes it possible to obtain an effective material with high strength for road construction. The addition of polymer materials to the composition of cement soils helps to increase their frost resistance and crack resistance. The use of ash and slag makes it possible to create complex binders, including metallurgical slags and Portland cement, which are suitable for strengthening the foundations of highways and contribute to a significant reduction in the cost of laying the roadway. Fly ash is a promising material for use as a mineral powder in asphalt concrete mixtures. Studies conducted with ash waste from Bishkek TPS (Kyrgyzstan) show that fly ash-based asphalt concretes meet state standards in terms of physical and mechanical characteristics and exceed standard samples in terms of strength.

Agricultural industry.

Waste from thermal power plants has a high content of valuable trace elements and oxides, which makes them a valuable resource for use in agriculture and forestry, soil reclamation, land reclamation and other areas. These wastes improve the water-physical and agrochemical properties of soils. In addition, being an effective source of potassium, they contribute to an increase in the

content of exchangeable potassium in the soil by 4-8%. The recommended optimal rate of their use is 60 tons per hectare. The maximum concentration of trace elements is found in the non-magnetic fraction of ash, which makes it suitable for use as micronutrients. To achieve maximum effect, it is recommended to use granular micronutrients enriched with bound nitrogen with prolonged action. The introduction of fly ash into the soil in certain concentrations improves its fertility, stimulates plant growth and the accumulation of macro- and microelements. The yield and composition of nutrients depend on the type of soil, the amount of material introduced and the crops grown. Fly ash has pesticide properties and, introduced into the soil, protects plants from many agricultural pests, reduces the appearance of larvae, strengthens plant resistance to various diseases, and is also used as an insecticide in the processing of garden crops. Ash and slag waste can also be successfully used for the reclamation of disturbed lands, forming a fertile humus layer that supports the growth of various plant species.

Conclusion

The study of scientific articles from Kazakhstani and foreign researchers indicates that ash and slag waste from thermal power plants is a universal material with a wide range of applications in various industries, including construction, metallurgy, agriculture, etc. The extraction of valuable components from these wastes opens up the possibility of obtaining various products. Moreover, the integration of thermal energy waste into the industrial cycle not only reduces their volumes in ash dumps, but also prevents the accumulation of new batches, contributing to the creation of waste-free industries. This, in turn, helps to reduce the environmental impact and relieve the fuel and energy complex.

References

1. Harris, D.; Heidrich, C.; Feuerborn, J. Global Aspects on Coal Combustion Products. Available online: https://www.coaltrans. com/insights/article/global-aspects-on-coal-combustion-products (accessed on 5 July 2020).

2. Nicol, K. Status of Advanced Ultra-Supercritical Pulverised Coal Technology; IEA Clean Coal Centre: London, UK, 2013.

3. Wiatros-Motyka, M. An Overview of HELE Technology Deployment in the Coal Power Plant Fleets of China, EU, Japan and USA; IEA

Clean Coal Centre: London, UK, 2016.

4. Ali, H.; Phoumin, H.; Weller, S.R.; Suryadi, B. Cost–Benefit Analysis of HELE and Subcritical Coal-Fired Electricity Generation

Technologies in Southeast Asia. Sustainability 2021, 13, 1591. [CrossRef]

5. Sloss, L. Emissions from Coal-Fired Utilities in South Africa and Neighbouring Countries and Potential for Reduction; IEA Clean Coal

Centre: London, UK, 2017; Available online: https://stg-wedocs.unep.org/bitstream/handle/20.500.11822/22223/Emissions% 20from%20coalfired%20utilities%20in%20South%20Africa%20and%20neighbouring%20countries%20and%20potential%20 for%20reduction.pdf?sequence=1 (accessed on 7 December 2021).

6. Winkler, H. Renewable Energy Policy in South Africa: Policy Options for Renewable Electricity. Energy Policy 2005, 33, 27–38. [CrossRef]

7. Eskom and Ash Management. Available online: https://www.eskom.co.za/Pages/Landing.aspx (accessed on 7 March 2021).

8. Reynolds-Clausen, K.; Singh, N. South Africa's power producer's revised coal ash strategy and implementation progress.

Coal Combust. Gasif. Prod. 2019, 11, 9–11. [CrossRef]

9. European Coal Combustion Products Association. Production and Utilisation of CCPs in 2016 in Europe (EU 15). Available

online: http://www.ecoba.org/ecobaccputil.html (accessed on 2 January 2022).

10. American Coal Ash Association. Coal Combustion Products Production & Use Reports 2016. Available online: https://acaa-usa.org/wp-content/uploads/coal-combustion-products-use/2016-Survey-Results.pdf (accessed on 2 January 2022).

УДК 621.1

АКТУАЛЬНЫЕ МЕТОДЫ МОДЕРНИЗАЦИИ ТЕПЛОСНАБЖЕНИЯ И ПОВЫШЕНИЯ ЭНЕРГОЭФФЕКТИВНОСТИ ЖИЛЫХ ДОМОВ

Нуржанов Диас Жанболатович
hola.weiss53@gmail.com
Магистрант ОП «7М07117 – Теплоэнергетика»
ЕНУ им. Л.Н.Гумилева, Астана, Казахстан

Решение проблемы энергоэффективности в наше время может стать краеугольным камнем в полной реконструкции энергосистемы Казахстана. Прямо сейчас по стране наблюдается дефицит электрической энергии, и сравнивая тенденции роста потребления к производству, уровень дефицита лишь продолжит расти, ставя под угрозу энергобезопасность страны.

“Обеспечение энергетической безопасности – одна из главных задач. Темпы энергопотребления в Казахстане растут из года в год. Но новые источники энергии, которые запускаются, не соответствуют темпам роста. По сути, развитие страны напрямую зависит от стабильности энергетической отрасли” – Касым-Жомарт Токаев [1].

В 2022 году дефицит электроэнергии по всей стране длился восемь месяцев, тогда как статистика только южного региона говорит о более длительном периоде. В 2023 году потребление электрической энергии по стране достигло объёма в размере 115 млрд кВт*ч, тогда производство составляет всего 112,8 млрд [2]

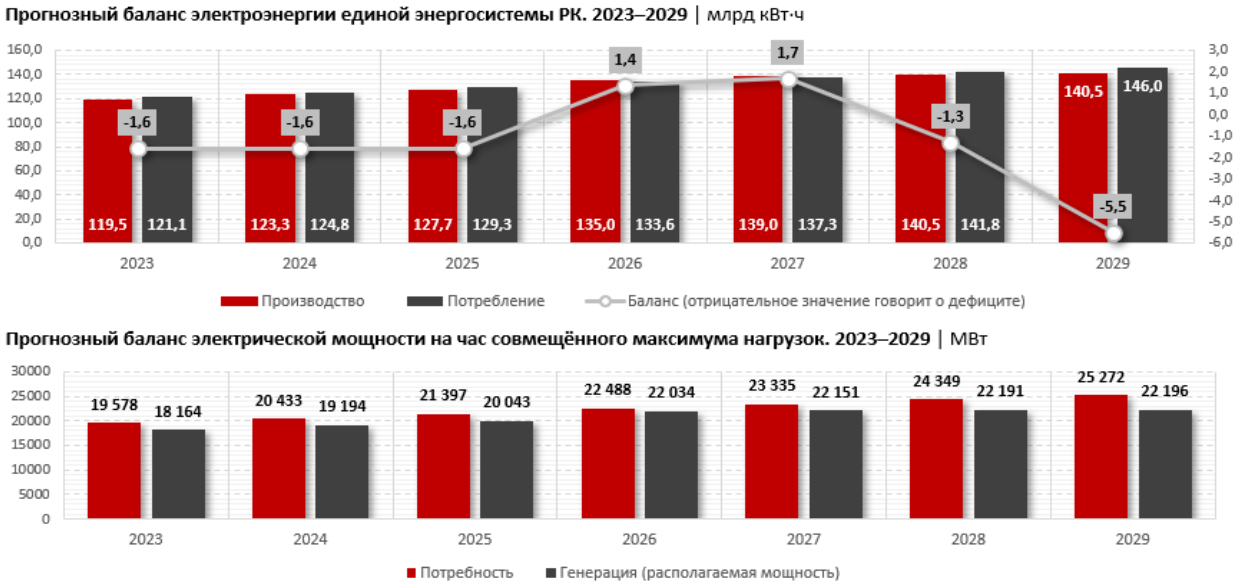

Рис. 1 - Прогнозный баланс электроэнергии Казахстана на 2023-2029 года [2]

Полагаясь на исследование актуальности применения источников альтернативной энергетики Калимбетова Г.П. [3], потенциал применения альтернативных источников в Казахстане довольно высок, и несмотря на больший срок окупаемости, нежели у традиционных источников энергии, экологически чистая энергия – не только способ восполнить недостающую мощность прямо сейчас, но и без сомнений правильный вклад в