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PROSPECTS FOR THE DEVELOPMENT OF BIOENERGY IN THE MURMANSK REGION

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Keywords: biomass, peat, torrefaction, steam screw machine, bio-boiler, local energy resources.
Abstract. The article discusses the modernization of the energy supply system in remote villages of the Murmansk region through the use of local energy resources. The possibility of using biomass torrefaction technology to produce fuel with improved fuel characteristics and its use in biofuels is shown, which will reduce the consumption of imported fuel. A scheme for the modernization of existing boiler houses with the installation of steam screw machines for the joint generation of heat and electricity on local fuels is proposed.

ПЕРСПЕКТИВЫ РАЗВИТИЯ БИОЭНЕРГЕТИКИ В МУРМАНСКОЙ ОБЛАСТИ

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Ключевые слова: биомасса, торф, торрефикация, паровая винтовая машина, биокотельная, локальные энергоресурсы.
Аннотация. В статье рассматривается модернизация системы энергоснабжения удалённых посёлков Мурманской области за счет использования локальных энергоресурсов. Показана возможность применения технологии торрефикации биомассы для получения топлива с улучшенными топливными характеристиками и его использования в биокотельных, что позволит снизить потребление привозного топлива. Предложена схема модернизации существующих котельных с установкой паровых винтовых машин для совместной выработки тепла и электроэнергии на локальных видах топлива.

In the Murmansk Region, the introduction of distributed generation is an effective way to solve local energy problems [1]. In the Murmansk region, heating oil or coal-fired boilers predominate, some of them have low efficiency, and some require major repairs. The share of fuel oil in the fuel balance of the region is more than 80%. Reconstruction of boiler houses and the use of local fuel resources: wood waste, coal, peat allows solving problems and abandoning fuel oil.

Heat supply to consumers in hard-to-reach areas of the Murmansk Region is provided by diesel power plants and hybrid power plants, which include diesel generators, wind and solar installations. Heat supply to small consumers in the Murmansk region is carried out from about 80 boiler houses. This is more than half (58.8%) of the total number of boiler houses in the region [2].

The bioenergy resources of the Murmansk Region are relatively small, and the potential of bioresources, including agricultural and livestock waste, is approximately 1 billion kWh per year. There are unused peat deposits in the

Murmansk region. The prospects for peat extraction in the region are determined by the presence of 620 deposits with a total area of 379,575 hectares with estimated reserves of 853.403 million tons of peat. The main part of them is concentrated on 26 deposits, with a total area of 330 thousand hectares and reserves of 788 million tons (humidity 40%) [3].

The advantage of peat boilers in comparison with other types of fuels is environmental friendliness (Table 1) [4]. In the context of rising hydrocarbon prices in the Murmansk region, peat can become a backup fuel for remote villages where there is no energy infrastructure. Its application is especially relevant in the context of the transition to local energy resources.

Tab. 1. Performance indicators of boiler houses using various types of fuel

Indicators	Peat fuel	Coal	Fuel oil	Gas
Caloric, kcal/kg	4100-5000	4000-5800	9600	7600
Emissions SO_2	0,2	11,9	4,69	0
Emissions NO_X	0,45	0,57	0,27	0,38
Emissions CO_2	1,54	2,33	1,3	1,45
Ash	4-8 %	15-50 %	до 0,15 %	-

Energy production from biomass can be divided into two methods, traditional and modern. The traditional use of biomass in energy is direct combustion, while the modern method is the use of biomass torrefaction technology. Torrefaction is a thermal process of converting biomass into a carbon-like material with improved fuel characteristics compared to the feedstock. Heating occurs in the absence of oxygen to a temperature of 200 to 300°C at low heating rates and relatively long stay in the reactor [5]. The general scheme of the torrefaction process is as follows (Fig. 1).

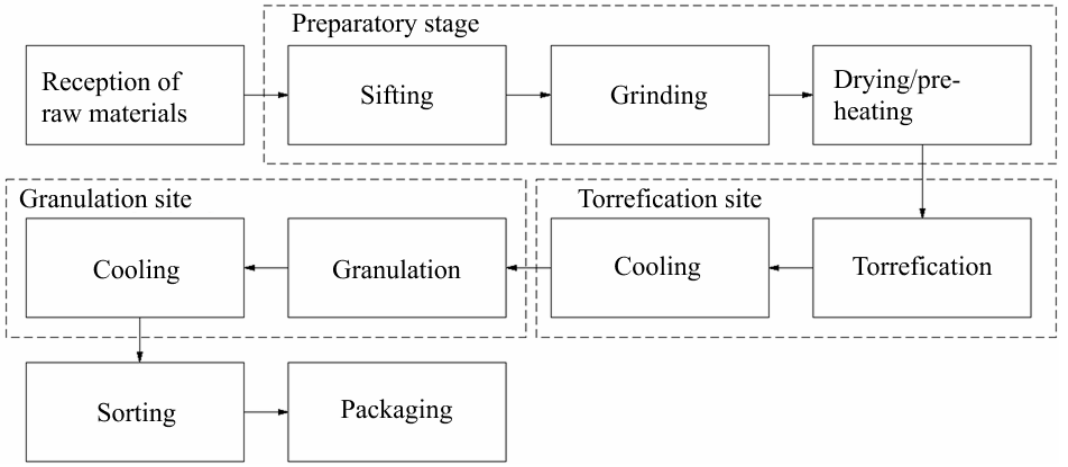

Fig. 1. General scheme of the torrefaction process

There is a possibility of using torrefaction technologies in the Murmansk region. Greater efficiency is achieved by co-burning torrefied pellets with coal or

petroleum products. Construction of new boiler houses has been completed in some localities. In the village Umba uses biofuel boilers based on a local type of fuel (peat). New solid fuel boilers have also been launched in Yenskoye and Severomorsk. There are plans to modernize heating networks in other areas of the Murmansk region. Existing boiler houses have the possibility of using torrefied pellets as fuel.

There is also a potential for the introduction of steam screw machines (PVMs) in the Murmansk Region. PVM is a promising basis for the creation of mini-CHP plants in the Far North. Small-scale cogeneration should use local bioenergy fuel resources: wood waste, coal, peat, and torrefied pellets. Two cogeneration plants based on steam screw machines were installed at the boiler house in the city of Olenegorsk. This innovative power plant is the only one in the Murmansk region. The choice of the thermal scheme and the composition of the equipment for creating a mini-CHP depends on the scheme and mode of heat consumption of the boiler house and its technical and economic indicators (Table 2).

Tab. 2. Operating modes of the steam screw machine

PVM loading, %	Steam consumption, t/h	Inlet pressure to the PVM, bar	Back pressure, bar	Generated power, kW
20	7,5	5	1	220
30	9,5	6,3	1	300
50	14,5	9,5	1	500
70	16	10,8	1	700
100	20	14	1	1000

The installation of a steam screw machine is possible both in new boiler houses and in existing ones. The technology of introducing a steam screw machine is to use steam energy to generate electricity. As a result, part of their own needs will be covered and electricity consumption from the grid will be reduced, which allows them to switch to a combined energy production technology. The main purpose is to generate electrical and thermal energy from various types of fuels.

The problem of reliable energy supply to remote villages in the Murmansk region can be solved by increasing the efficiency of using local fuel and energy resources, introducing torrefied pellets and steam screw machines as part of a mini-CHP. When using torrefied pellets in boilers, PVM provides simultaneous generation of heat and "green" electricity, which increases the share of renewable sources in the energy balance of remote villages.

References

1. Lazarev N.I., Kuznetsov N.M. Solar energy for power supply of remote consumers in Murmansk Region // Journal of Advanced Research in Technical Science. 2024, iss. 40, pp. 55-58. doi.org/10.26160/2474-5901-2024-40-55-58.
2. Minin V.A. Characteristics of heat supply in small settlements of the Murmansk region // Proceedings of the Kola Scientific Center of the Russian Academy of Sciences. 2014, no. 7(26), pp. 98-107.

3. Evzerov V.Ya. Untapped raw materials of the Murmansk region // Bulletin of the Kola Scientific Center of the Russian Academy of Sciences. 2018, vol. 10, no. 2, pp. 38-52. doi.org/10.25702/KSC.2307-5228.2018.10.2.38-52.
4. Abdulyekeen Kabir, Umar Ahmad Abulfathi, Abdul Patah, Muhamad Fazly, Daud Wan. Torrefaction of biomass: Production of enhanced solid biofuel from municipal solid waste and other types of biomass // Renewable and Sustainable Energy Reviews. 2021, vol. 150, pp. 111436. doi.org/10.1016/j.rser.2021.111436.
5. Tian C., Dorakhan R., Wicks J., Chen Z., Choi K.-S., Singh N., Schaidle J.A., Holewinski A., Vojvodic A., Vlachos D.G., Broadbelt L.J., Sargent E.H. Progress and Roadmap for Electro-privileged Transformations of Bio-derived Molecules // Nature Catalysis. 2024, vol. 7, pp. 350-360. doi.org/10.1038/s41929-024-01131-6.

Список литературы

1. Lazarev N.I., Kuznetsov N.M. Solar energy for power supply of remote consumers in Murmansk Region // Journal of Advanced Research in Technical Science. – 2024. – №40. – С. 55-58. – doi.org/10.26160/2474-5901-2024-40-55-58.
2. Минин В.А. Характеристика теплоснабжения небольших населенных пунктов Мурманской области // Труды Кольского научного центра РАН. – 2014. – №7(26). – С. 98-107.
3. Евзеров В.Я. Неиспользованные сырьевые ресурсы Мурманской области // Вестник Кольского научного центра РАН. – 2018. – Т. 10, №2. – С. 38-52. – doi.org/10.25702/KSC.2307-5228.2018.10.2.38-52.
4. Abdulyekeen Kabir, Umar Ahmad Abulfathi, Abdul Patah, Muhamad Fazly, Daud Wan. Torrefaction of biomass: Production of enhanced solid biofuel from municipal solid waste and other types of biomass // Renewable and Sustainable Energy Reviews. 2021, vol. 150, pp. 111436. doi.org/10.1016/j.rser.2021.111436.
5. Tian C., Dorakhan R., Wicks J., Chen Z., Choi K.-S., Singh N., Schaidle J.A., Holewinski A., Vojvodic A., Vlachos D.G., Broadbelt L.J., Sargent E.H. Progress and Roadmap for Electro-privileged Transformations of Bio-derived Molecules // Nature Catalysis. 2024, vol. 7, pp. 350-360. doi.org/10.1038/s41929-024-01131-6.

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