Contemporary Agriculture, Vol. 74, No. 1-2 (2025): 98-107
DOI: https://doi.org/10.2478/contagri-2025-0012
UDC: 662.767.2

Review Paper

BIOHEAT: A HEATING FUEL

ISSN 2466-4774
https://www.contagri.info/

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Submitted: 24.01.2025.
Reviewed: 09.04.2025.
Accepted: 10.04.2025.

ABSTRACT

It is widely recognized that modern industrial sectors remain heavily dependent on fossil fuels, with the global demand continuing to rise. In light of this growing demand and the gradual depletion of crude oil reserves, the development of alternative energy sources has become imperative. This paper aims to present the key information on bioheat, a heating fuel that integrates biodiesel into conventional heating oil. Bioheat is the industry-standard term for a blend typically comprising 20% biodiesel and 80% petroleum-based heating oil, intended for use in residential and commercial heating systems. As a renewable fuel, bioheat offers a sustainable alternative for heating applications, delivering notable environmental advantages while contributing to energy security and supporting the local economy. This study outlines the principal benefits of incorporating bioheat into modern heating systems.

Key words: *renewable energy sources, heating fuel, biodiesel*

Citation:
Batić, I. & Babić, M. 2025. Bioheat: a heating fuel. *Contemporary Agriculture*, 74(1-2): 98-107. https://doi.org/10.2478/contagri-2025-0012

INTRODUCTION

Ever since the energy crisis of the 1970s, which exposed the vulnerability of global energy supply chains, there has been an ongoing effort to identify new and reliable energy sources. This crisis prompted political initiatives and financial support for the advancement of biofuel technologies, particularly the production of fuels derived from biomass resources, as noted by Kiss et al. (2023). As global oil reserves continue to decline, developed countries have, over the past two decades, intensified efforts to develop and implement biomass-based biofuel production processes. Today, biodiesel and bioethanol dominate the global liquid biofuels market.

In Europe, rapeseed oil (82.8%) and sunflower oil (12.5%) are the primary feedstocks for biodiesel production, while in the United States, soybean oil is predominantly used, as reported by Petrović and Babić (2013). Biofuel prices and the costs of agricultural feedstocks are strongly influenced by state policies, production costs, and market competitiveness. Increases in raw material prices directly affect biofuel production costs. Serbia, having committed to the international environmental agreements and possessing considerable biomass potential, must implement the appropriate incentive measures to meet the binding targets for biofuel use in the transport sector, as emphasized by Petrović and Babić (2013).

At present, the transport sector remains almost entirely reliant on fossil fuels such as gasoline, diesel, liquefied petroleum gas (LPG), and kerosene, with the demand continually rising. Given the declining availability of crude oil, it is imperative to develop and adopt alternative technologies for producing transportation fuels that can partially or fully replace conventional fuels.

The United Nations Sustainable Development Goals (SDGs), a set of 17 global goals established in 2015, prioritize the transition to renewable energy systems for electricity generation as a central strategy for addressing global challenges such as poverty, inequality, environmental degradation, climate change, and peace and justice (Malla and Bandh, 2023). The SDGs aim to eliminate discrimination and inequality, eradicate poverty, and mitigate climate change by 2030. Biofuels, when responsibly produced and used, can contribute meaningfully to several SDGs, particularly:

1. SDG 2 (Zero Hunger): Certain biofuel production systems can be aligned with food security, using waste or non-food crops to produce energy without competing with food resources. However, it is important to manage land use to avoid food price impacts.
2. SDG 7 (Affordable and Clean Energy): Biofuels can provide renewable alternatives to fossil fuels, contributing to providing affordable, reliable, sustainable and modern energy for all.
3. SDG 8 (Decent Work and Economic Growth): The biofuels industry can create new jobs, especially in rural areas, through the cultivation of biomass and the development of biofuel production technologies.
4. SDG 9 (Industry, Innovation and Infrastructure): Advances in biofuel technologies can drive innovation in industries such as agriculture, energy and manufacturing, and create a sustainable infrastructure for cleaner energy solutions.
5. SDG 12 (Responsible Consumption and Production): Biofuels support circular economy principles by converting waste into energy, thus reducing the overall resource consumption and promoting more sustainable production processes
6. SDG 13 (Climate Change): Biofuels have the potential to significantly reduce greenhouse gas emissions compared to fossil fuels.

However, for biofuels to genuinely support the SDGs, their production must be environmentally and socially sustainable. This includes responsible land and water use, social impact considerations such as land rights and food security, and integration with broader strategies to reduce the overall emissions of CO_2 and other harmful substances. Historically, biomass has been a primary energy source since the advent of fire, and it remains essential for nearly half of the global population. While biomass energy previously relied primarily on wood, modern advancements have expanded its use to include agricultural and food industry residues.

Bioheat is the industry term for a renewable heating fuel composed of biodiesel blended with conventional heating oil, typically used in residential and commercial heating systems. Biodiesel is produced through transesterification, a chemical process involving the reaction of vegetable oils or animal fats with methanol (CH_3OH) in the presence of a catalyst, yielding fatty acid methyl esters (FAME) and glycerol ($C_3H_8O_3$) as a by-product. According to Standard EN 14214 (2004), biodiesel is defined as a monoalkyl ester derived from renewable lipid sources. For example, the transesterification of 100 kg of vegetable oil with 10 kg of methanol yields approximately 100 kg of biodiesel and 10 kg of glycerol (Babić and Đurišić, 2008).

The triglycerides in oils and fats, composed of three fatty acid chains bonded to a glycerol backbone, are sequentially converted into diglycerides, monoglycerides, and ultimately glycerol. Each reaction step yields a molecule of methyl ester, contributing to biodiesel production and supporting waste-to-energy strategies. The biodiesel production process involves several stages: raw material storage, crude oil refining, catalyst preparation, transesterification, vacuum evaporation, soap extraction, separation, drying, filtration, and final blending and storage (Babić, 2024).

Biodiesel exhibits physical and chemical properties comparable to those of petroleum diesel, making it suitable for direct substitution or blending. As reported by Ferella et al. (2010), its use significantly reduces emissions of nitrogen oxides (NO_x), carbon dioxide (CO_2), sulfur dioxide (SO_2), and particulate matter. Because biodiesel contains no sulfur, it offers clear environmental benefits and is considered a promising future fuel (Babić, 2013).

Biodiesel is miscible with all grades of diesel fuel, provided the temperature is maintained above its flash point, and is not compatible with gasoline. It is commonly blended with jet fuel, kerosene, No. 1 and No. 2 diesel, military fuels (e.g., JP-5, JP-8), heating oil, and gas turbine fuels. Biodiesel blends are denoted as BXX, where "XX" indicates the percentage of biodiesel (e.g., B20 is 20% biodiesel and 80% diesel).

The methods for blending biodiesel with other fuels are as follows (Babić, 2013):

1. In-tank blending – mixing directly within the storage tank;
2. Splash blending – sequential addition of components, typically during fuel delivery;
3. In-line blending – mixing occurs in the pipeline prior to entering the tank.

Considering that biodiesel has a higher specific gravity than diesel fuel, splash blending, in which biodiesel is sprayed onto the surface of diesel, is typically performed when filling small-volume containers with relatively low levels of agitation, such as vehicle or delivery tanks. In such cases, mixing is aided by the movement of the container or tank, which helps achieve homogeneity. While this method is generally effective, issues can arise if biodiesel is added first into a cooled container, potentially leading to incomplete mixing or phase separation (Babić, 2013; Alleman et al., 2016).

In-tank blending occurs when biodiesel and diesel fuel are introduced simultaneously but separately into a tank or vessel, with sufficient flow rates to enable thorough mixing without the need for mechanical agitation or recirculation. This method is particularly suitable for stationary tanks. Although biodiesel and diesel fuel are generally miscible, the degree of homogeneity still depends on factors such as the blending ratio and tank geometry. If uniform mixing is not achieved, recirculation or additional mixing may be required (Alleman et al., 2016; McCormick and Moriarty, 2023).

In-line blending or pre-reservoir blending involves injecting biodiesel directly into the diesel stream within a pipeline, where turbulent flow ensures effective mixing. Alternatively, the blend can be prepared in a separate mixing chamber using dynamic mixers before being transferred to the receiving tank. This method allows for continuous blending in a tightly controlled ratio, ensuring consistency and uniformity (Rymsha, 2007).

During the blending process, particular attention must be paid to the temperature of the diesel fuel. If mineral diesel is too cold, it can induce rapid crystallization of the biodiesel component. These crystals are difficult to disperse, require substantially more thermal energy to re-melt, and can only be removed effectively through filtration. To date, no straightforward and effective solution has been found for managing this crystallization issue (Alleman et al., 2016; McCormick and Moriarty, 2023).

THE ADVANTAGES OF BIOHEAT APPLICATION

Bioheat B20 is a blend consisting of 20% biodiesel and 80% mineral diesel No. 2 (D2), as defined by the U.S. Department of Energy (2004).

There are numerous advantages to using bioheat as a heating fuel. The most significant benefits include the following:

a) **Environmental protection.** The use of B20 Bioheat can reduce total CO_2 emissions by up to 30%. During open-flame combustion, other harmful emissions—such as nitrogen oxides (NO_x), sulfur compounds, and particulate matter (soot)—are also significantly reduced. In terms of life-cycle greenhouse gas emissions, studies have shown that bioheat can reduce these emissions by up to 78% compared to conventional fossil fuels, depending on the feedstock used. As a renewable fuel, biodiesel can be continuously produced from agricultural products and waste materials, making it a sustainable energy source aligned with global climate goals and the principles of sustainable development (Beer et al., 2007).

b) **Reduction of energy dependence.** Because biodiesel feedstocks can be domestically produced, bioheat reduces dependence on imported fossil fuels, thus enhancing national energy security. This also supports local economies, as biodiesel can be derived from regionally available materials such as soybeans, canola, and used cooking oil. Biodiesel production provides farmers with additional income streams and fosters rural economic development (Alleman et al., 2016; Heywood, 2023).

c) **Price stability.** Using domestically produced biodiesel can mitigate the impact of global oil price volatility, offering greater fuel price stability (Heywood, 2023).

Despite the advantages of Bioheat B20, broader adoption requires a thorough assessment of fuel characteristics and equipment compatibility, evaluation of fuel supply reliability, price analysis, and environmental impact assessments.

The first large-scale practical application of bioheat in household heating was conducted under the Vermont BioHeat Program (VBHP), part of the Vermont Biodiesel Project (2006). This initiative introduced bioheat as a viable residential heating fuel in Vermont, USA. The research yielded the following key findings:

- A slight reduction in combustion system efficiency (0.5%) was observed when B20 Bioheat was used compared to conventional No. 2 fuel oil. This was accompanied by an increase in exhaust gas temperatures and a decrease in CO_2 emissions. However, this efficiency reduction is considered negligible in practice, as variations below 1% are generally disregarded. The minor efficiency loss may result from the need to adjust the fuel/air mixture ratio for optimal performance with B20 (Vermont Biodiesel Project, 2006).
- A 40.6% increase in the electrical resistance of the flame sensor was recorded when using B20 Bioheat. This could pose issues in certain burner flame control systems due to the lower brightness and altered color spectrum of the bioheat flame compared to standard fuel oil (Vermont Biodiesel Project, 2006).

The VBHP project, which included 26 households with varied individual heating systems, demonstrated that B20 Bioheat is a reliable and stable fuel. Importantly, it can be used seamlessly in the existing oil-based heating systems (still used by over 28 million Americans) without adverse effects on the equipment or system performance (Vermont Biodiesel Project, 2006).

REDUCING CO_2 EMISSIONS

To protect the environment, recent regulations have increasingly required that petroleum fuels contain minimal sulfur content, as sulfur directly affects fuel lubricity. Biodiesel, in contrast, not only meets this requirement but also enhances engine performance by increasing lubricity. Its superior lubricity compared to mineral diesel helps reduce wear on critical engine components. Research has shown that blending biodiesel with conventional diesel significantly lowers harmful emissions, with the optimal lubricity achieved at just 10% biodiesel content (Alptekin and Canakci, 2008).

Despite ongoing advancements in emission reduction technologies, air pollution continues to rise. The following main air pollution issues were identified by Babić and Đurišić (2008):

1. The formation of acidic compounds from sulfur dioxide (SO_2), nitrogen oxides (NO_x), and ammonia (NH_3), which harm vegetation, infrastructure, and aquatic ecosystems.
2. Ground-level ozone formation from photochemical reactions involving NO_x under sunlight, which negatively affects human health, crops, and materials.
3. Deterioration of air quality, particularly in densely populated urban areas.
4. Greenhouse gas emissions contributing to global climate change.

According to Schlamadinger et al. (1997) and Sheehan et al. (1998), using 100% biodiesel (B100) reduces CO_2 emissions by approximately 78% compared to petroleum diesel (No. 2).

Biodiesel B100 is classified as a close carbon cycle (CCC) fuel. The research by Elsayed et al. (2003) demonstrated that when biodiesel and other biofuels are used for electricity generation, heat production, or transportation, they emit significantly less CO_2 per unit of energy compared to fossil fuels.

Transportation is the leading contributor to environmental pollution, accounting for over 50% of total emissions, followed by thermal power plants and conventionally powered industrial facilities. The combustion of fossil fuels in vehicles releases lead, inorganic compounds of chlorine and bromine, hydrocarbons, nitrogen oxides, and sulfur oxides into the atmosphere. In response, the international community continues to tighten standards for liquid petroleum fuel quality and promotes the adoption of plant-based fuels, which substantially reduce harmful emissions (Muralikrishna and Manickam, 2017).

Biodiesel is also non-toxic and biodegradable, particularly when used in its pure form (B100), as commonly practiced in countries like Germany and Austria. For blends of 20% or less, such as B20 used in the United States, the level of non-toxicity and biodegradability is directly proportional to the biodiesel content (Babić and Đurišić, 2008; Gerpen, 2004).

Although the biodiesel use in Serbia remains limited, examples from the United States and Germany demonstrate its environmental benefits. According to Petrović and Babić (2013) and McCormick and Moriarty (2023), emission tests conducted on city transport buses revealed that:

- Using B100 reduced NO_x emissions by 13.35%, and B20 by 2.67%.
- B100 reduced particulate emissions by 32%, CO_2 by 35%, and SO_2 by 8%.
- When observing only tailpipe emissions, B100 resulted in zero SO_2 emissions and reduced hydrocarbon (HC) emissions by 37%.

Moreover, environmental protection organizations in Germany reported test results comparing biodiesel and conventional diesel across 54 different diesel engines, concluding that the use of biodiesel led to the following outcomes:

- CO_2 emissions reduced by 10–12%,
- HC emissions reduced by 10–35%,
- Particulate matter reduced by 24–36%, and
- Soot emissions reduced by 50–52%.

These findings confirm that biodiesel, whether used in its pure form (B100) or as a blend (B20), is considerably more environmentally friendly than conventional diesel.

Biodiesel B100 offers a positive energy balance, meaning that for every unit of fossil energy invested in its production, 3.24 units of energy are obtained. In contrast, mineral diesel has a negative energy balance of 0.83 (McCormick and Moriarty (2023).

Energy balance implies the fulfillment of several key concepts listed below, (McCormick and Moriarty (2023).

1. Life Cycle Systems (LCS) (Table 1)

Table 1. Life Cycle Systems

LCS – diesel	LCS – biodiesel
1. crude oil extraction	1. oilseed production
2. transport to the refinery	2. transport to the oil extraction facility
3. refining into diesel	3. oil pressing
4. distribution to end users	4. transport of crude oil to the biodiesel plant
5. combustion in diesel engines	5. biodiesel production
	6. distribution to end users
	7. combustion in diesel engines

2. Life Cycle Energy Balance

The more energy required to produce a fuel, the less renewable it is considered. The renewable nature of fuel production ranges from completely renewable, which is not the case with fossil fuels, to non-renewable.

3. Total Primary Energy (TPE)

The energy obtained when the basic raw material taken from the natural environment is processed to obtain fuel is called the total basic energy. It is the energy contained in the input raw material for fuel production, i.e. the amount of energy that would be obtained by the complete combustion of the input raw material, whereby the total combustion energy can be measured in two ways:

a) higher heating value (Hg): the amount of energy released when the combustion products, primarily CO_2 and H_2O, are in their condensed (liquid) state,
b) lower heating value (Hd): the amount of energy released when the combustion products, CO_2 and H_2O, remain in the gaseous state; this value is lower than Hg due to the energy loss associated with the vaporization of water.

4. Feedstock Energy

The energy contained in the basic reactants is called the energy of the input raw materials that create the final product. For biodiesel, it is the energy contained in crude oil and methanol, which are converted into methyl ester during a chemical reaction. In like fashion, oil is directly converted into diesel fuel in the refining process, which has a primary or basic energy, whereas oil contains the input energy of the raw material for diesel fuel. The energy of the input raw materials is part of the input energy.

5. Process Energy

Process energy is the second major part of primary energy. It is the energy from coal, natural gas, uranium, and hydropower, directly or indirectly used during the life cycle of the fuel.

6. Fuel Product Energy (FPE)

The energy of the produced fuel is the energy contained in the final product, in this case the fuel, which is available to the engine or burner.

7. Life Cycle Energy Efficiency (LCEE)

$$LCEE = \frac{FPE}{TPE} \quad \text{(Formula 1)}$$

Where:
FPE - Fuel Product Energy,
TPE - Total Primary Energy.

8. Fossil Energy Ratio

$$FER = \frac{FE}{FEI} \quad \text{(Formula 2)}$$

Where:
FE - Fuel Energy,
FEI - Fossil Energy Inputs

The application of the degree of renewability indicator (FER) was introduced in response to climate change, as a high FER value indicates a low level of CO_2 emissions, as demonstrated by Babić (2024).

ENERGY SECURITY AND ENHANCING DOMESTIC AGRICULTURAL PRODUCTION

The use of renewable fuels significantly enhances national energy security by reducing dependency on fossil fuel imports. In Serbia's context, a partial export of domestically produced biodiesel to the nearby EU markets is feasible. For biodiesel to be cost-competitive, its price should be approximately 8% lower than that of fossil diesel, with 5% accounting for its lower energy efficiency and 3% representing the price incentive needed to attract consumers (Kiss et al., 2023).
Biodiesel offers a reliable, high-quality, and often more affordable fuel alternative. In the EU, biodiesel is typically 10 euro cents cheaper per liter than mineral diesel, depending on fluctuations in global oil and vegetable oil markets. Considering the relatively slower price increase in vegetable oils, the competitiveness of biodiesel is expected to improve over time. Moreover, Serbia has the capacity to produce biodiesel using the existing industrial infrastructure, further reducing the import dependence.

CHARACTERISTICS OF BIOHEAT FUEL

Biodiesel possesses several favorable properties compared to mineral diesel: higher cetane number, enhanced lubricity, and greater oxygen content. These characteristics make it particularly suitable for blending with low-sulfur diesel (Babić, 2024).
The cetane number measures the ignition quality of diesel fuel during compression ignition. It indicates how quickly and efficiently diesel fuel will ignite when injected into the engine's combustion chamber. The cetane number is defined as the percentage by volume of cetane (n-hexadecane) in a blend with alpha-methylnaphthalene that has the same ignition delay as the fuel being tested (Canoira et al., 2007; Lin and Wu, 2022). A higher cetane number indicates more efficient combustion. Biodiesel typically has a high cetane number, resulting in efficient combustion and effective thermal output.

The energy power of biodiesel B100 is $\approx 133\,000\ \frac{BTU}{gal}$ and is slightly lower than the energy power of mineral diesel No.2 $\approx 140\,000\ \frac{BTU}{gal}$.
The heat output of biodiesel B100 is computed if assumed that $H_g(B100) = 133\,000\ \frac{BTU}{gal}$ and $H_g(No.2) = 140\,000\ \frac{BTU}{gal}$, applying the unit conversion where $1BTU = 1{,}05506kJ = 215{,}997cal$ and $1gal = 3{,}78541dm^3 = 3{,}78541l$, resulting in:

$$\rho_{15°C}(No.2) = 0{,}860\frac{kg}{dm^3}, \quad \rho_{15°C}(B100) = 0{,}8865\frac{kg}{dm^3} \quad \text{(Formula 3)}$$

The obtained heat power per unit mass is $H'_g(B100)$ and $H'_g(No.2)$.

$$H'_g(B100) = 41.815{,}48\frac{kJ}{kg}, \quad H'_g(No.2) = 45.372{,}62\frac{kJ}{kg} \quad \text{(Formula 4)}$$

The obtained ratio of heat power per unit of mass is

$$k_{H_g}(B100) = \frac{H'_g(B100)}{H'_g(No.2)} = 0{,}922$$

The volume content of bioheat is $y_{B100} = 0{,}20$ and $y_{No.2} = 0{,}80$,

whereas the mass content of bioheat is $x_{B100} = 0{,}205$ and $x_{No.2} = 0{,}795$.

Accordingly, the obtained thermal power of Bioheat B20 is

$$H'_g(B20) = x_{B100} \cdot H'_g(B100) + x_{No.2} \cdot H'_g(No.2) \qquad \text{(Formula 5)}$$

That is

$$H'_g(B20) = 44.643{,}41 \left[\frac{kJ}{kg}\right] \qquad \text{(Formula 6)}$$

The ratio of the thermal power of bioheat to the thermal power of mineral heating oil for diesel D2 is

$$k_{H'_g}(B20) = 0{,}984 \qquad \text{(Formula 7)}$$

The volumetric heat capacity is expressed by the following expression:

$$H_g\left[\frac{kJ}{dm^3}\right] = \rho_{15^\circ\mathrm{C}}\left[\frac{kg}{dm^3}\right] H'_g\left[\frac{kJ}{kg}\right] \qquad \text{(Formula 8)}$$

Based on the above equation, the volumetric heating values can be determined as follows:

$$H_g(B100) = \rho_{15^\circ\mathrm{C}}(B100) \cdot H'_g(B100) = 37.069{,}43\left[\frac{kJ}{l}\right] \qquad \text{(Formula 9)}$$

$$H_g(No.2) = \rho_{15^\circ\mathrm{C}}(No.2) \cdot H'_g(No.2) = 39.020{,}45\left[\frac{kJ}{l}\right] \qquad \text{(Formula 10)}$$

$$H_g(B100) = y_{B100} \cdot H_g(B100) + y_{No.2} \cdot H_g(No.2) = 38.630{,}25\left[\frac{kJ}{l}\right] \qquad \text{(Formula 11)}$$

The volume heat power ratios are as follows:

$$k_{H_g}(B100) = \frac{133.000[BTU/gal]}{140.000[BTU/gal]} = \frac{37.069{,}43[kJ/l]}{39.020{,}45[kJ/l]} = 0{,}95 \qquad \text{(Formula 12)}$$

$$k_{H_g}(B20) = 0{,}99 \qquad \text{(Formula 13)}$$

Biodiesel can be completely blended with mineral diesel, and when the mixing is performed correctly, the resulting fuel remains stable and does not undergo stratification despite the notable difference in their densities.

TECHNICAL LIMITATIONS

Certain characteristics of biodiesel limit its suitability for use in high concentrations. Pure (unblended) biodiesel presents challenges at low temperatures, particularly when stored in outdoor tanks in colder climates. It tends to gel when cooled, which can hinder fuel flow. Additionally, due to its solvency, biodiesel can degrade rubber components and dislodge accumulated sludge in fuel tanks, leading to clogged filters. Consequently, blending biodiesel with mineral diesel, as described by Babić (2013), is a standard practice to address these issues.

Biodiesel exhibits slightly higher density and cloud point compared to traditional mineral heating oil. Cold weather is the principal challenge in its use, as biodiesel may gel and become unpumpable at low temperatures. To counteract this, it is common to add flow-improving additives or blend biodiesel with petroleum-based heating oil. These approaches ensure operability in winter conditions. The cold flow characteristics of biodiesel are generally similar to those of diesel fuel No. 2.

According to Babić (2024), the cold flow properties are defined as follows:

- Cloud point: The temperature at which small solid crystals begin to form. The fuel remains usable with standard filtration.
- Cold filter plugging point (CFPP): The temperature at which crystal formation is sufficient to block fuel filters.
- Pour point: The lowest temperature at which fuel remains fluid. Below this temperature, the fuel solidifies and ceases to flow.

Bioheat B20 (containing 20% biodiesel) exhibits a cold flow temperature increase of approximately 2 to 5 °F (1.1 to 2.8 °C) compared to mineral diesel. This increase can be mitigated by adopting standard industry solutions, such as blending with kerosene to lower the pour point or using storage tanks equipped with heating elements. The cold flow temperature of Bioheat B20 can be approximated by:

$$t_{B20} = t_{No.2} + (2 \div 5)[°F] = t_{No.2} + (1{,}1 \div 2{,}8)[°C] \cong t_{No.2} + 2{,}5°C \quad \text{(Formula 14)}$$

Where:
t (No.2) is cold flow temperature of mineral diesel D2.

Bioheat B20 (with ≤20% biodiesel by volume) is fully compatible with existing fuel oil tanks, heating systems, gaskets, and rubber components. Most residential and commercial heating systems can operate on bioheat blends without requiring significant modifications, facilitating a straightforward transition from conventional fuels to renewable alternatives.

CONCLUSION

The depletion of crude oil reserves, rising global consumption, increasing costs, and environmental impacts (particularly those contributing to climate change) are driving the shift toward biofuels.
Bioheat is a blend consisting of 20% biodiesel and 80% mineral diesel (No. 2). Biodiesel is a renewable, biodegradable, and non-toxic fuel. Although partial substitution of mineral fuels with biodiesel does not fully resolve the challenges associated with non-renewable energy sources, it offers a meaningful step toward mitigation.
The availability of biodiesel varies by region. Areas with developed production infrastructure benefit from better accessibility, whereas regions without such facilities may face supply challenges. Serbia has extensive arable land with favorable agrotechnical conditions for cultivating rapeseed, a key feedstock for biodiesel production and thus for bioheat.
Biodiesel primarily replaces mineral diesel and offers environmental advantages by significantly reducing emissions of NO_x, CO_2, SO_2, and particulate matter, as it is sulfur-free. While CO_2 emissions per engine kilowatt are similar to those of fossil diesel, the carbon released during combustion originates from atmospheric CO_2 fixed by the plants used to produce biodiesel, thus forming a closed carbon cycle.
Technically, biodiesel offers advantages such as a high cetane number, better lubricity, a higher flash point, and improved combustion characteristics. However, its market price is influenced by feedstock costs, production methods, and demand. In some cases, biodiesel may be more expensive than mineral diesel, though incentives and subsidies can offset the cost differential. Maintaining fuel quality is critical, as low-quality biodiesel may cause equipment malfunctions and reduce efficiency.
Bioheat represents a sustainable and practical alternative to conventional heating fuels, delivering environmental benefits while enhancing energy security and supporting local agriculture. Notably, bioheat can be used in all standard heating systems without adverse effects on the equipment. As technology progresses and awareness increases, the adoption of bioheat is expected to grow, playing a key role in the transition to renewable energy sources.

Authors' Contribution: Conceptualization: I.B., Formal Analysis: I.B. and M.B., Investigation: I.B. and M.B., Resources: M.B., Writing – Original Draft Preparation: I.B., Writing – Review & Editing: I.B. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest: The authors declare that they have no conflict of interest.

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