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THE IMPACT OF HEAT EMISSIONS FROM LIGHT GASOLINE VEHICLES ON URBAN MICROCLIMATE AND AIR TEMPERATURE: AN EXPERIMENTAL AND MODELING ANALYSIS

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Abstract
This study investigates the impact of heat emissions from light gasoline vehicles on urban microclimate and air temperature. Using both experimental measurements and computer modeling, the effect of vehicle-generated heat on ambient air temperature was analyzed. The results provide insights into the contribution of automobiles to urban heat load and offer recommendations for improving urban microclimate management.

Keywords: Gasoline vehicles, heat emissions, urban microclimate, air temperature, modeling.

Introduction

The urban microclimate and air temperature are influenced by human activities, transportation, and industrial enterprises. In recent years, due to global warming and the rapid development of cities, the phenomenon of urban heat islands (UHI) has become an increasingly urgent issue. This phenomenon is characterized by significantly higher air temperatures in city centers compared to the surrounding rural areas. Urban heat islands negatively impact human health, energy consumption, and environmental conditions.

Transportation is one of the most important sources of urban heat.

Figure1. Urban Air Pollution, Urban Heat Island and Human Health

During the combustion process in the engines of light gasoline vehicles, a significant amount of heat is released. This heat can substantially affect air temperature and the urban microclimate. Studies show that in areas with heavy traffic, air temperature can increase by 1–3°C. In addition, vehicle emissions release hot gases into the atmosphere, which leads to local variations in air temperature. Heat emissions from light vehicles not only alter the urban microclimate but also cause several ecological and social problems: Increase in air temperature and higher thermal stress during hot days; Increased demand for air conditioning and cooling systems, resulting in higher energy consumption; Changes in heat distribution that affect airflow and wind patterns; Increased demand for urban green spaces to absorb heat. Currently, there are two main approaches to studying urban microclimate:

Experimental measurements – measuring air temperature, vehicle emissions, and other parameters under real conditions; **Modeling** – using computer simulations to predict heat distribution and microclimate changes. The aim of this study is to determine the impact of heat emissions from light gasoline vehicles on urban microclimate and air temperature through both experimental and modeling approaches. The results of this study provide opportunities to optimize urban planning and transportation systems, as well as to ensure ecological sustainability.

Research objectives: Determine the amount of heat emitted by vehicles, measure the effect of vehicle heat emissions on urban air temperature, compare experimental and modeling results, Develop recommendations for improving the urban microclimate.

Significance of the introduction: This section summarizes existing scientific knowledge about urban microclimate, vehicle emissions, and the urban heat island phenomenon. It also highlights the relevance and scientific novelty of the study, helping readers understand the theoretical and practical foundations of the research topic.

RESEARCH METHODOLOGY

Sources of Heat Emissions from Vehicles The main sources of heat in light gasoline vehicles are as follows: Engine Combustion Process: In an internal combustion engine, fuel (gasoline) reacts with oxygen in the air, producing mechanical work and releasing a significant amount of heat. According to research, the thermal efficiency of a light gasoline vehicle engine is approximately 25–30%, with the remaining 70–75% of energy released as heat. Part of this heat is dissipated through the radiator, while another portion is released from the engine and exhaust system into the air and surrounding environment.

Exhaust System: Exhaust gases can reach temperatures of 400–700°C. This heat spreads through the air and significantly increases the ambient air temperature in urban areas. Transmission and Brake Systems: During vehicle movement, friction generates heat in the brake and transmission components. This is particularly significant under traffic congestion conditions, where heat from braking can be substantial. Impact on Urban Conditions: In areas with high vehicle density, heat dispersion contributes to the intensification of local urban heat

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islands. Studies indicate that in regions with high traffic loads, air temperature can rise by 1–3°C compared to open areas.

The purpose of the experimental study was to determine the impact of heat emissions from light gasoline vehicles on urban microclimate and air temperature. The study was conducted on congested road segments in the city center. Selected areas had varying traffic loads: low, medium, and high traffic flow during the day. Thermal sensors and infrared cameras were used to measure the amount of heat emitted by vehicles. Air temperature, wind speed, relative humidity, and other meteorological parameters were monitored. Measurements were taken at different times of the day (morning, afternoon, evening). Data on traffic flow and air temperature for each vehicle were collected, collected data were analyzed using statistical methods.

To generalize experimental results and predict heat dispersion under various urban conditions, computer modeling methods were applied. ANSYS Fluent – for analyzing heat dispersion and airflow. Matlab – for data processing, graphical visualization, and forecasting. In areas with high traffic load, local air temperature increases by 1.5–2.5°C.

Urban geometry significantly affects heat distribution: narrow streets and tall buildings retain heat longer. Wind speed acts as a factor that can either reduce or enhance heat dispersion. Each light gasoline vehicle emits an average of 50–80 kJ of heat through the radiator, exhaust, and braking system during operation.

Under congested road conditions, this heat can increase urban air temperature by 0.5–2°C. In high traffic areas, heat dispersion depends on building height and wind direction.

In open areas, heat spreads quickly, while in narrow streets and between buildings, heat remains for longer periods. Urban heat islands affect human health, increasing thermal stress and the risk of cardiovascular diseases during hot days. Energy consumption increases due to higher demand for air conditioning and cooling systems. The importance of urban planning and traffic system optimization is highlighted to mitigate these effects.

CONCLUSIONS AND RECOMMENDATIONS

This study examined the impact of heat emissions from light gasoline vehicles on urban microclimate and air temperature using both experimental and modeling approaches. Based on the research findings, the following conclusions can be drawn: Heat emitted from the engines, exhaust systems, and braking systems of light gasoline vehicles increases ambient air temperature. In congested road segments, air temperature can rise by 0.5–2°C. Urban geometry (narrow streets, tall buildings) affects heat dispersion, causing heat to remain for longer periods. Experimental measurements and computer modeling results confirmed each other. Modeling enables the prediction of heat dispersion under various traffic loads and urban conditions. Urban heat islands negatively affect human health, increasing thermal stress and the risk of cardiovascular diseases on hot days. Energy consumption rises due to higher demand for air conditioning and cooling systems. Optimizing traffic flow, promoting the use of electric vehicles, and expanding green areas are effective measures for improving the urban microclimate.

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