International Journal of Science and Engineering Applications
Volume 14-Issue 09, 86 – 87, 2025, ISSN:- 2319 - 7560
DOI: 10.7753/IJSEA1409.1010

Research on Lightweight Design of New Energy Light-Duty Trucks

Peng Liang
School of Automotive
Engineering
Zibo Polytechnic University
Shandong Province, China

Abstract: With the rapid development of the new energy vehicle industry and the support of national policies, new energy trucks are increasingly becoming part of our daily lives. New energy light-duty trucks are commonly used for urban cargo transportation and play a significant role in express logistics. Currently, most new energy trucks face challenges such as short driving ranges, and vehicle lightweighting serves as an effective solution to this issue. This paper, based on the overall structure of new energy light-duty trucks and Broussonetia papyrifera, explores lightweighting approaches for the frame, body, drive motor, and power battery by integrating cutting-edge scientific technologies. It proposes innovative ideas and methods for lightweighting new energy light-duty trucks, providing guidance for their lightweight design.
Keywords:New energy light-duty truck; lightweight; hybrid power; frame; body

1. Introduction

With increasingly stringent environmental regulations and the heightened environmental consciousness of enterprises, trucks—the mainstay of urban logistics vehicles—have gradually transitioned from traditional fuel-powered models to new energy models. In 2024, the sales of new energy light trucks reached a total of 99,300 units, marking a cumulative year-on-year growth of 120%. Both traditional truck manufacturers such as Foton, Dongfeng, JAC, and Jiangling, as well as new entrants like Geely and BYD, have launched corresponding new energy light truck models. Examples such as the Geely Farizon E200 and BYD T5DM have gained considerable popularity among consumers. The favorable characteristics of new energy light trucks—such as quiet operation, comfort, and environmental friendliness—have already earned consumer recognition. These vehicles not only reduce the labor intensity for drivers but also contribute to a cleaner and quieter urban environment. Moreover, with the rise of e-commerce, logistics, and community group buying, new energy light trucks are poised to usher in new developments.

Although the number of new energy light trucks in operation continues to grow, their limited driving range remains a concern for consumers. Since revolutionary breakthroughs in automotive power battery technology have yet to be achieved, lightweight design has become a crucial approach to extending the driving range of new energy light trucks and reducing the frequency of charging.

2. Structure of New Energy Light-Duty Trucks

New energy light-duty trucks are improved designs based on traditional fuel-powered light-duty trucks, mainly divided into pure electric light-duty trucks and hybrid power light-duty trucks. In terms of structure, both include a cab, frame, power battery, drive motor, chassis system and cargo box; hybrid power light-duty trucks also include an engine and a generator.

The cab of new energy light-duty trucks is based on that of traditional fuel-powered light-duty trucks, with optimized cab floor to better meet the characteristics of new energy vehicles. The frame of new energy light-duty trucks inherits that of traditional light-duty trucks, which is formed by riveting longitudinal beams and crossbeams. To improve the driving range of pure electric light-duty trucks, the weight of their power batteries usually exceeds 1000kg, and lightweighting of power batteries is also an important way to increase the driving range. Compared with pure electric light-duty trucks, hybrid power light-duty trucks have lighter power batteries, but they add an engine and a generator in structure, so their total mass is not much different from that of pure electric light-duty trucks. At present, most of the drive motors used in new energy light-duty trucks are permanent magnet synchronous motors, and lightweighting of drive motors is also an important development direction. In addition, the chassis system of new energy light-duty trucks is mainly composed of suspension, axle, air compressor and other chassis accessories, and lightweighting of chassis structural parts is also an important way to achieve the lightweighting of the whole vehicle.

The lightweighting of new energy light-duty trucks is not just the lightweighting of a certain system or component, but a comprehensive consideration at the whole vehicle level. It refers to the lightweighting of the whole vehicle on the basis of ensuring vehicle performance.

3. Lightweighting of New Energy Light-Duty Trucks

The lightweighting of new energy light-duty trucks refers to reducing the overall vehicle weight as much as possible while maintaining vehicle performance such as overall stiffness, strength and safety, and without significantly increasing the total vehicle production cost. At present, the lightweighting design of new energy light-duty trucks mainly focuses on components including the cab, frame, drive motor, power battery and chassis accessories.

3.1 Cab Lightweighting

The most direct method for cab lightweighting is material lightweighting. The cab can use lightweight materials such as high-strength steel, aluminum alloy, and magnesium-aluminum alloy.

The density of aluminum alloy is about 1/3 that of steel, making it the preferred material for cab lightweighting. However, since steel has higher strength than aluminum alloy, and the R&D, production and processing costs of aluminum

alloy are higher than those of steel, most parts of the cab still use steel in actual production. For some cab parts with low stress, lightweight design can be achieved by material replacement—for example, the steering wheel and steering column can be made of aluminum alloy or magnesium-aluminum alloy instead of steel without changing their size and thickness. This reduces the overall weight of the cab without significantly increasing production costs.

In addition to using lightweight materials, cab lightweighting can also be achieved by improving cab processing technology, such as the integrated die-casting process. This process can reduce the body processing steps, lower the cab weight, improve production efficiency, and reduce production costs.

3.2 Frame Lightweighting

The frame of new energy light-duty trucks is generally made of high-strength steel through stamping. As the base of the entire vehicle, the frame is used to fix the position of most vehicle components. During driving, the vehicle body also relies on the frame to maintain its posture and reduce torsional deformation. Therefore, the importance of the frame is self-evident.

The frame design requires no damage throughout the vehicle's service life, so it is difficult to achieve lightweighting by changing materials. Instead, lightweighting of the frame is mainly realized through improved structural design and the use of high-strength steel.

The frames of traditional light-duty trucks mostly use ordinary steel with a yield strength of about 500MPa, while many new energy light-duty trucks adopt high-strength steel with a yield strength of 700MPa or even over 900MPa. This means that under the same thickness, high-strength steel can withstand much greater force, allowing the use of thinner and lighter materials to reduce the frame weight.

3.3 Power Battery Lightweighting

The lightweighting of power batteries can be achieved through lightweight design in two aspects: the power battery itself and the battery case.

For the lightweighting of the power battery, it is mainly realized by increasing the energy density of the battery and reducing the battery volume—this reduces the weight of the power battery without decreasing the vehicle's driving range.

For the lightweighting of the battery case, new materials and new processes are mainly used. For example, the upper cover of the battery pack (which bears less stress) can be made of glass fiber-reinforced composite materials instead of traditional stamped steel plates, achieving a weight reduction of nearly 50%. The lower battery case is a key part of the battery case, responsible for withstanding external impacts and protecting battery modules and cells. It can be manufactured using the aluminum alloy injection molding integrated process, which not only reduces the weight of the case and eliminates the welding process required for traditional steel battery cases, but also enhances the strength of the battery pack.

3.4 Engine Lightweighting

Extended-range light-duty trucks include an engine in their structure, but its main function is different from that of traditional light-duty trucks (which use the engine to provide power for the entire vehicle). Instead, its primary role is to drive the generator to charge the power battery. Therefore, the design of this engine does not need to consider providing high torque at low speeds; it only needs to operate under the working condition with the highest thermal efficiency.

As a result, the engine can adopt an aluminum block instead of the cast iron block used in traditional light-duty trucks, thereby reducing the overall vehicle weight.

4. Conclusion

Based on the structure of new energy light-duty trucks, this paper expounds the ideas and methods for their lightweighting from aspects including the cab, frame, power battery and engine. With the development of China's automobile industry and the innovation of new material technologies, lightweight vehicle manufacturing has become a development trend for new energy trucks, and it is also an inevitable path to promote the sustainable and healthy development of China's new energy truck industry.

5. References

[1] Yu Dong, Zhou Wen, Lan Jun, et al. Lightweight Design and Application of Commercial Vehicle Chassis [J]. Automotive Practical Technology, 2024, 49(17): 33-37.

[2] Lu Yukai, Xiong Shusheng, Zhou Qinyou, et al. Research on Automotive Lightweight Technology Methods[J]. Auto Time, 2023(18): 130-132 .

[3] Wei Ligang. Lightweight-based Structural Optimization Design of Heavy-duty Truck Frames[J]. Special Purpose Vehicles, 2024(04):29-31.

[4] Wu Man. Discussion on the Development and Application of New Automotive Materials Based on the Concept of Lightweight Design[J]. Industrial Innovation Research, 2025(10):75-77.

[5] Li Kuijiang, Guo Yajuan. Research on the Application of High-performance Metal Materials Under the Trend of Automotive Lightweight[J]. Automotive Maintenance Technician, 2025(14):101-102.

[6] Wan Tong. Research on the Application of Lightweight Materials and Body Structure Optimization for New Energy Vehicles[J]. Automotive Maintenance Technician, 2025(14):116-117.

[7] Zhang Qifei. Lightweight Design and Performance Optimization Strategy for Automotive Chassis Components[J]. Science and Technology Innovation, 2025(16):61-64.

[8] Wen Rongrong. Analysis on Lightweight Technology and Its Application for New Energy Vehicles[J]. Internal Combustion Engines and Parts, 2025(07):107-109.

[9] Wang Xiaolong, Feng Shirong. Overview of Lightweight Technology for Commercial Vehicles[J]. Automotive Practical Technology, 2025, 50(01):136-141.

.