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STRUCTURAL DESIGN AND LAYOUT OF A COOKING VEHICLE MODIFIED FROM HEAVY-DUTY TRUCK CHASSIS

ZhongXing Cao
Jiangxi Jiangling Motors Corp. Modified Vehicles Co., Ltd., Nanchang 330200, Jiangxi, China.

Abstract: To meet the needs of centralized meal preparation for multiple personnel in scenarios such as field emergencies, military garrison training, engineering construction, and large-scale events, this paper introduces the structural design of a cooking vehicle modified from a heavy-duty cargo vehicle chassis. Based on a SITRAK heavy-duty cargo vehicle second-type chassis with a maximum total mass of 16 t, the vehicle was modified through alterations to the body structure, interior decoration, water supply and drainage systems, and power supply system to meet the functional requirements of a mobile kitchen. The interior of the vehicle body is divided into three functional zones: water supply and purification area, cooking and processing area, and storage and preservation area. These areas are sequentially equipped with water pump and water purifier systems, water heaters, clean water tanks, rice steamers, meat mincers and vegetable cutters, workbenches, sinks, freezers, storage cabinets, double-burner stoves, spice boxes and cooking oil, and other equipment. External facilities include side pull-out ladders, rear pull-out ladders, wastewater tank, cable reel, support leg controls, gasoline generator, inverter and battery, support legs, city power input, rear single door, roof side lighting, and side roof access ladder. The vehicle adopts a multi-power supply system prioritizing city power with generator backup and inverter-battery supplementation, along with monitoring and alarm functions for water level, fuel level, and wastewater tank overflow. Through reasonable layout and structural design, the vehicle features flexibility, efficient meal preparation, and safety reliability, capable of meeting the daily dining needs of multiple personnel under field conditions.
Keywords: Cooking vehicle; Heavy-duty truck chassis; Structural design; Layout; Mobile kitchen

1 INTRODUCTION

With the development of the national economy and the continuous advancement of emergency support system construction, scenarios such as field construction, military garrison training, disaster relief, and large-scale events have imposed higher requirements on centralized meal preparation capabilities, giving rise to mobile cooking support equipment. As a specialized vehicle integrating water storage and purification, food processing, and cold storage preservation, a cooking vehicle can complete the processing and supply of staple and subsidiary foods under mobile conditions, and is an important component of the logistics support system. In recent years, domestic research has successively carried out the development of intelligent dietary support vehicles and civil emergency cooking vehicles [1-2]; abroad, there has been considerable research and engineering application in the field of field cooking equipment and mobile kitchens [3-4]. Currently, domestic cooking equipment is mostly modified based on box-type trucks or cargo vehicle chassis, and its body structure, functional zoning, and equipment layout directly affect meal preparation efficiency, operational safety, and overall vehicle performance. This paper uses a heavy-duty cargo vehicle second-type chassis as the modification platform, conducting structural design investigation of internal functional zoning, body structure modification, water supply and drainage systems, power supply systems, and external auxiliary equipment, reasonably planning the interior space and equipment layout to improve the mobility and support capability of cooking vehicles, providing reference for the modification design of similar special vehicles.

2 CHASSIS SELECTION AND MODIFICATION

2.1 Chassis Selection

Cooking vehicles belong to special purpose operation vehicles, and their modification design must first determine a suitable base chassis. Chassis selection requires comprehensive consideration of the following requirements: a) Based on the vehicle equipment configuration and personnel usage requirements, the interior space is zoned and reasonably laid out to maximize space utilization; b) The body structure, interior equipment and furniture, interior materials, and modification materials are determined according to design requirements, and the total mass of various equipment equipped in the vehicle is calculated to enable reasonable allocation of front and rear axle loads and left-right load distribution, ensuring driving stability and safety; c) Both the vehicle curb mass and maximum total mass must not exceed the load-bearing requirements specified for the original chassis vehicle. After modification, the mass distribution is reasonable with balanced front-rear axle load distribution. Based on these considerations, the chassis specifications, maximum total mass, wheelbase, and rear overhang parameters are determined, which must comply with the relevant standards including GB 1589-2016 "Limits for Dimensions, Axle Loads and Masses of Motor Vehicles, Trailers and

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Motor Vehicle Combinations," GB 7258-2017 "Technical Conditions for Safe Operation of Motor Vehicles," and GB/T 17350-2024 "Classification, Names and Model Coding Methods for Special Purpose Vehicles and Special Purpose Trailers" [5-7]. Additionally, chassis selection must comprehensively evaluate the load-bearing capacity and axle load distribution of the second-type chassis in combination with modification requirements [8].

Based on the above principles, this vehicle selects a SITRAK heavy-duty cargo vehicle second-type chassis as the modification platform. This chassis features strong load-bearing capacity and high reliability, with a maximum total mass of 16 t, providing ample body layout space and load margin to fully meet the load-bearing and layout requirements of various cooking equipment and living facilities. The overall vehicle appearance is shown in Figure 1.



Figure 1 Exterior View of the Cooking Vehicle

2.2 Chassis Modification

a) Since the body portion undergoes overall modification, the cargo area is ordered without original side boards, retaining only the cab and longitudinal frame rails to provide a base for body manufacturing.

b) According to layout and configuration requirements, steel plates are pre-embedded at positions of side panels, floor, and roof fixed components to ensure connection strength, meeting driving safety and operational intensity requirements.

c) According to design requirements, the body floor is reinforced by welding thick-wall square tubes and steel plates for installing heavy equipment such as gasoline generators, inverters, and batteries, preventing floor deformation due to excessive local loads [9-10]. Meanwhile, by reasonably distributing loads on each axle, overall driving stability and safety can be effectively improved [11].

d) According to usage requirements, the original side doors of the cab are retained, and some side windows are retained or blocked according to layout needs.

e) During production and construction, all wiring holes and pipe holes passing through the body roof and side panels are sealed with glue or foaming; when installing equipment on the roof, reverse bolts are installed at corresponding mounting points, with sealant applied first followed by shock-absorbing rubber pads during fixing, and waterproofing is strictly implemented; dust-proof and waterproof treatment is performed at floor openings to eliminate rain and water leakage hazards.

f) According to functional layout requirements, certain areas of the body are sealed with blind windows to ensure the integrity of the interior space and reliability of equipment installation.

3 FUNCTIONAL STRUCTURE DESIGN

3.1 Overall Layout

The overall interior layout is shown in Figure 2. The vehicle space is functionally zoned based on the body structure. Combined with cooking workflow and equipment usage characteristics, the interior of the body is divided into three functional zones: water supply and purification area, cooking and processing area, and storage and preservation area [12]. The water supply and purification area is equipped with clean water tanks, water pumps, water purifiers, sinks, and water supply piping, responsible for water source storage, purification, and supply for the entire vehicle. The cooking and processing area is equipped with workbenches, double-burner stoves, rice steamers, meat mincers and vegetable cutters, water heaters, spice boxes and cooking oil, and other equipment, serving as the core area for completing staple and subsidiary food processing. The storage and preservation area is equipped with freezers and storage cabinets for cold storage preservation and classified storage of ingredients, semi-finished products, and seasonings. Auxiliary equipment cabins with upward-opening doors are arranged at the lower exterior of the body, centrally housing wastewater tanks, cable reels, support leg controls, gasoline generators, inverters, and batteries for convenient maintenance. The functional zones are connected by stainless steel partitions and corridors with smooth operational workflows to avoid cross-contamination [13].

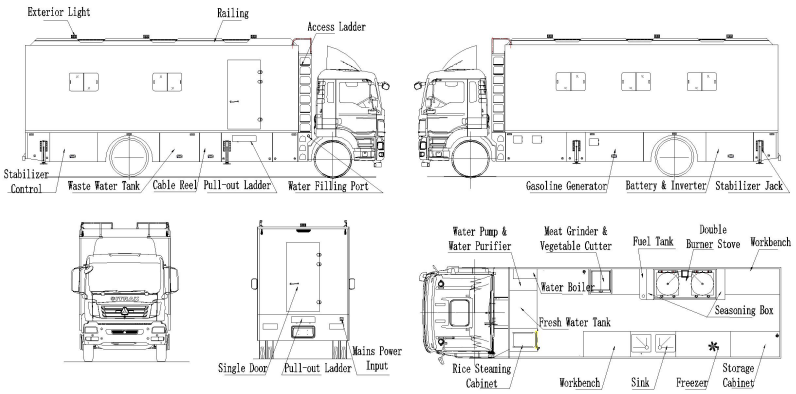


Figure 2 Overall Layout of the Cooking Vehicle

3.2 Interior Decoration Design

After chassis modification is completed, wiring is performed throughout the vehicle according to the layout plan, with pre-embedded conduits for wire threading, and wire passage sleeves installed at harness holes with foaming seal treatment. Subsequently, thermal insulation and heat preservation treatment is applied to the body, with insulation cotton adhered to improve the thermal performance of the body and reduce energy consumption. Interior walls and equipment surfaces all use stainless steel material, which is easy to clean, corrosion-resistant, and meets food hygiene requirements. The floor uses anti-slip patterned aluminum plate, which is wear-resistant, corrosion-resistant, easy to clean, and balances both anti-slip and hygiene properties. The ceiling is equipped with recessed lighting fixtures, air conditioning vents, and ventilation/exhaust metal grilles to ensure adequate lighting and air circulation. The overall interior presents a stainless steel brushed metal texture with neat space and compact equipment layout, creating a clean, hygienic, and professional mobile kitchen environment. The interior layout of the vehicle cabin is shown in Figure 3.



Figure 3 Interior Layout of the Cooking Vehicle Cabin

3.3 Water Supply and Purification System Design

The water supply and purification system is the fundamental support for the normal operation of the cooking vehicle, mainly composed of clean water tanks, water pumps, water purifiers, sinks, and pipeline valves. The clean water tank, installed in the water supply and purification area, serves as the water storage equipment for the entire vehicle for cooking and domestic water supply. The water pump provides supply water power, transporting water from the clean water tank to various water usage points. The water purifier filters and purifies the water source to ensure the hygiene and safety of drinking water. The water purifier body uses stainless steel material, with the cover plate connected to the main body via hinges and equipped with a sealed rubber ring, connected to the water supply pipeline via corrugated flexible pipes, and securely fixed with bolts. The water inlet is arranged on the side of the body for convenient external water source connection to replenish the clean water tank. The sink uses a stainless steel double-basin washbasin with two high-arc faucets for ingredient washing, utensil cleaning, and hand washing. The system is equipped with a clean water tank low-water alarm that prompts water replenishment when the water level is too low, preventing pump damage from dry running. Water supply pipelines are uniformly arranged with reasonable routing, providing water supply to each water usage equipment nearby.

3.4 Cooking and Processing Area Design

The cooking and processing area is the core functional zone of the cooking vehicle, responsible for the processing and cooking of staple and subsidiary foods. The workbench uses a stainless steel countertop with a locked storage cabinet below for placing cooking utensils and ingredients; comprehensive power sockets are configured above the countertop to meet equipment power requirements. The double-burner stove (dual-burner stove) is used for cooking staple foods and dishes, featuring adjustable firepower and high thermal efficiency, capable of operating multiple burners simultaneously to improve meal preparation efficiency. The rice steamer (steaming cabinet) is used for large-batch steaming of rice, noodles, and other staple foods to meet the needs of centralized meal preparation for multiple personnel. The meat mincer and vegetable cutter are built into the workbench for quick meat mincing and vegetable cutting, reducing manual labor intensity. The water heater uses a step-heating energy-saving water heater with temperature display function, equipped with heating, drinking, alarm, and water inlet indicator lights and water outlet buttons, capable of providing sufficient hot water in a short time for personnel drinking and operational use. Spice boxes and cooking oil tanks are arranged near the stove for storing various seasonings and cooking oil with convenient access. Cooking fumes are expelled through the roof ventilation/exhaust grilles and range hood to maintain clean air inside the vehicle. The interior operation area and equipment layout are shown in Figure 4.



Figure 4 On-Board Operation Area and Equipment

3.5 Storage and Preservation Area Design

The storage and preservation area is used for cold storage preservation and classified storage of ingredients and seasonings. The freezer uses a chest-type freezer (Model ZB0.3L2JD-F, overall dimensions 1500 mm x 700 mm x 850 mm, rated voltage/power 220 V/0.47 kW, capacity not less than 300 L, temperature range -6 C to -18 C) to meet the frozen storage requirements for meat, poultry, and semi-finished ingredients. The storage cabinet uses stainless steel material with handle-equipped cabinet doors for storing tableware, seasonings, and cooking accessories, enabling standardized management and quick access. The storage and preservation area is arranged adjacent to the cooking and processing area to shorten ingredient access distance and improve operational efficiency.

3.6 External Auxiliary Equipment Cabin Design

Various auxiliary equipment and accessories are arranged on the exterior of the body according to functional needs. An auxiliary equipment cabin with upward-opening doors is arranged at the lower side, centrally housing wastewater tanks, cable reels, support leg controls, gasoline generators, inverters, and batteries for convenient maintenance. The wastewater tank is used for collecting and storing cooking and domestic wastewater, equipped with a wastewater tank overflow alarm to prevent wastewater spillage. The cable reel is used for storing power cables. The support leg control operates the lifting and lowering of support legs. The gasoline generator provides backup power for the entire vehicle. The inverter and battery form an on-board energy storage power supply system. Support legs are installed at the four corners of the body bottom, supporting the vehicle body firmly when parked for operation, reducing the impact of vehicle suspension movement and personnel walking on operations. Side pull-out ladders and rear pull-out ladders are arranged on the side and rear of the body respectively for personnel access and roof inspection. A single door is arranged at the rear for loading/unloading materials and entering/exiting the body; a city power input interface is provided on the side for direct connection to city power; a water inlet is also provided on the side for replenishing clean water. Lighting fixtures are arranged on the roof side for nighttime operation illumination; a roof access ladder is provided on the side, working with the roof railing to ensure safe personnel access to the roof.

3.7 Roof Equipment and Reinforcement Design

The roof is equipped with roof railings, roof side lighting fixtures, and roof access ladders to meet safety, aesthetics, and durability requirements. Roof equipment installation must be stable and secure, waterproof, and easy to maintain, while addressing the impact of equipment installation on body stiffness and strength. Anti-slip patterned aluminum plates are installed on the roof for convenient personnel access to on-board equipment; all roof equipment is mounted on reinforced platforms with strengthened connections to the vehicle body using stainless steel bolts, and roof wiring holes are routed downward through welded U-shaped stainless steel pipes at welding points to completely eliminate water leakage hazards caused by modification. After complete vehicle modification, standard rain testing is performed. All external bolts use stainless steel bolts for anti-corrosion and anti-rust effects. The roof load capacity should meet personnel and equipment inspection requirements, with body reinforcement treatment at the top and left/right side panels to prevent body deformation under equipment mass.

3.8 Power Supply System Design

3.8.1 Power supply system structure and layout

The cooking vehicle has numerous electrical equipment, and the reliability of the power supply system is directly related to the performance of overall vehicle functions. The vehicle power supply follows the principle of city power priority, simultaneously equipped with gasoline generators, inverters, and batteries to form a multi-power supply system with complementary backup. The power supply system structure and layout are shown in Figure 5. The power supply system control panel integrates automatic transfer control of generator, city power, and inverter power sources, equipped with AC/DC voltmeters for real-time voltage monitoring, with PV1 water level and PV2 fuel level digital displays showing real-time clean water tank water level and fuel tank level; three red alarm indicator lights for wastewater tank overflow, clean water tank low water, and fuel tank low fuel are arranged below the control panel, providing timely alarms when abnormalities occur. Power supply circuits are divided by function, including generator circuit, city power circuit, automatic transfer circuit, external power leakage protection, water heater circuit, clean water tank heating, wastewater tank heating, city power outlet, inverter circuit, inverter leakage protection, rice steamer, refrigerator, water pump, dual-burner stove, range hood, master mechanical switch, DC master switch, interior lighting, exterior lighting, front row fan, rear row fan, and sterilization lamp, each circuit with independent switch control.



Figure 5 Power Supply System Control Panel

3.8.2 Power supply system design

a) The power supply system consists of external city power input, gasoline generator, inverter, battery, and power interlock control board. The vehicle body is equipped with a cable reel for storing power cables that can connect to external city power to supply the vehicle; the vehicle carries its own gasoline generator set that can power the entire vehicle when no external power is available, meeting field operation requirements. The vehicle power supply follows the city power priority principle, prioritizing city power when available, while simultaneously charging the battery.

b) To prevent voltage fluctuations from external power sources or generators from interfering with and damaging electrical equipment, the vehicle is equipped with an inverter and battery energy storage system that converts DC power to 220 V AC power, providing stable and clean power for various equipment, and achieving DC 12 V to AC 220 V conversion through dedicated large-capacity maintenance-free batteries and inverters, with integrated AC/DC control, voltage and current indication, low-voltage acoustic-optic alarm, and safety protection functions.

c) A dedicated power distribution control cabinet is configured with Schneider or equivalent brand circuit breakers for each power supply circuit, featuring overcurrent, overload display, alarm, and protection functions; each zone has

independent air switch protection, and leakage protection, overload protection, and other measures are installed on power supply circuits to ensure electrical safety.
d) Power distribution equipment wiring is uniformly grounded, connected to the chassis via copper strips, with grounding rods provided on the vehicle for direct connection to earth when necessary, preventing leakage and lightning damage.
e) Multiple power outlets with switches are installed at appropriate positions inside the vehicle; high-power electrical outlets are directly powered by the generator or city power, each with independent air switch protection.

3.9 Ventilation, Exhaust and Safety Facilities

To ensure a safe and comfortable cooking operation environment, the vehicle is equipped with comprehensive ventilation, exhaust, and safety facilities. Roof ventilation/exhaust metal grilles are arranged to work with the range hood to promptly expel cooking fumes and moisture from the vehicle; front and rear row fans are arranged inside the cabin to promote air convection and maintain fresh air inside. Red dry powder fire extinguishers are equipped inside the vehicle for fighting initial fires, ensuring personnel and equipment safety. Sterilization lamps are installed in the cabin for space disinfection to ensure food hygiene and safety; when the sterilization lamp switch is turned on, personnel must quickly evacuate the cabin to avoid ultraviolet radiation injury. The floor uses anti-slip patterned aluminum plates to prevent personnel from slipping; warning reflective markings and lighting devices are set at the roof, side panels, and rear to improve parking and driving safety.

4 CONCLUSION

Through reasonable layout and structural design of the cooking vehicle modified from a SITRAK heavy-duty cargo vehicle chassis, it possesses basic functions including water supply and purification, staple and subsidiary food processing, cold storage preservation, and safety protection, capable of meeting the centralized meal preparation needs of multiple personnel in scenarios such as field emergencies, military garrison training, engineering construction, and large-scale events, providing comprehensive support for logistics support work. The vehicle adopts a multi-power supply system prioritizing city power with generator backup and inverter-battery supplementation, along with monitoring and alarm functions for water level, fuel level, and wastewater tank overflow, featuring reliable power supply, safe operation, flexibility, efficient meal preparation, and safety reliability. The design concept and layout scheme of this cooking vehicle provide certain reference value for the modification design of similar special vehicles.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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