Research on Improving Fuel Utilization Rate by Using Vehicle Exhaust Energy

Hu Yong

College of Traffic Engineering, Hubei Three Gorges Polytechnic, Yichang, Hubei 443000, China

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Abstract: In this paper, the existing automobile exhaust gas energy utilization mode is analyzed, and an exhaust gas recycling device that recovers exhaust gas energy through a turbine is designed, and the structure of the device is optimized through modeling and fluid analysis, and the waste heat and kinetic energy can be used to drive the automobile parts to work. It can effectively improve fuel economy and environmental protection and has high theoretical research value.

1. Introduction

This paper mainly uses relevant theoretical knowledge and related equipment to develop a device that uses automobile exhaust energy to improve fuel utilization, thereby reducing fuel consumption and achieving energy saving and emission reduction.

2. Vehicle exhaust energy loss calculation

There are two methods for calculating the damage: the balance method and the entropy balance method. Here, the entropy balance method is used for calculation.

When the ambient temperature is constant, the damage of the isolated system is proportional to the entropy. It can be expressed as:

$$e_{x,exaust} = T_0 \Delta S_{ISO}$$

Using the damage analysis method, the exhaust process is approximated to a constant volume heat dissipation process, which produces an exexaust of 12900 kJ. The low calorific value Hu of the gasoline fuel is 42500 kJ, and the exexaust contained in the gasoline is approximately 0.975 kJHu, which is about 41438 kJ. It can be seen that the damage caused by the exhaust process accounts for 1/3 of the total total value, and the direct discharge is caused. Great energy loss.

3. Automotive exhaust pipe structure design

Generally speaking, under the condition of overall layout permit, the diameter of the engine main pipe should be as large as possible, but this causes the flow rate of the gas in the pipe to be too low, the throttling loss is large, and the exhaust gas energy cannot be fully utilized. Here, the exhaust manifold diameter is determined to be

$$D_P = (0.5 \sim 0.6)\,\mathrm{D}$$

According to the calculation of the performance of the gasoline engine when the throat shrinkage rate is 70 & 7, 75%, 80% respectively, the results show that the throat shrinkage rate of the exhaust system is increased from 80% to 75 under the engine calibration condition and the maximum torque condition. When the % is increased, the scavenging coefficient is increased; when the throat shrinkage is increased from 75% to 70%, the scavenging coefficient remains unchanged. The engine has the least pumping loss. In addition, when the throat shrinkage rate is gradually increased, the pressure fluctuation after the exhaust valve is increased, and even if the throat is further reduced, the scavenging coefficient of the gasoline engine will not be improved, and the pumping loss will increase.

The inlet cross-sectional area and the outlet cross-sectional area of the ejector nozzle are

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respectively expressed by the following formula

$$F_i = 0.15 F_z$$

$$F_0 = 0.10 F_z$$

At present, the exhaust system of the turbocharger system mainly has five forms: constant pressure system, pulse boosting system, pulse conversion supercharging system, MPC supercharging system, MIXPC supercharging system, and the MPC supercharging system is adopted here. In order to maximize the efficiency of exhaust gas utilization, asbestos materials should be installed on the outside of the exhaust pipe for heat preservation to reduce the heat loss caused by the exhaust gas energy during the transfer process. This design is to make the system make better use of exhaust gas energy. Special attention should be paid to the selection of the diameter of the exhaust manifold and the shrinkage of the throat.

The left end of the exhaust pipe is connected to a transition pipe whose cross-sectional area is reduced. The structure of the transition pipe is as shown in FIG1.

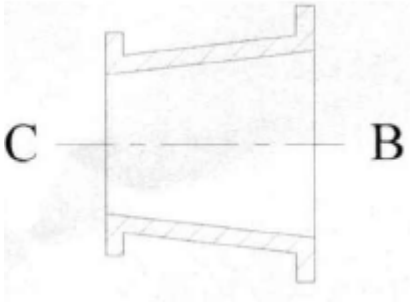

Figure 1 Transition pipeline structure

A sealing member is connected between the B end of the transition line and the A end of the exhaust line, and a sealing device is connected between the C end and the intake port of the turbine casing to form a complete engine exhaust gas energy recovery pipeline.

According to the exhaust system design principles, the following design schemes are initially determined to improve fuel efficiency.

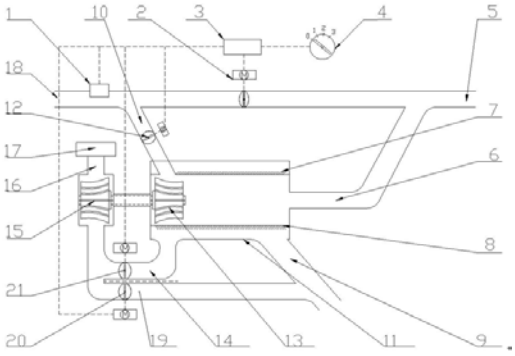

Figure 2 Schematic diagram of the structure of automobile exhaust gas utilization and air conditioning control system

The design is based on the existing exhaust pipe and air conditioning heating system to set up an air conditioning control system, a heat exchanger and an air pump, using the exhaust heat and kinetic energy to replace the work of the blower during air conditioning work, to achieve air conditioning Provide air and warm air, defogging purposes, thereby improving exhaust gas utilization and reducing fuel consumption. The air conditioning control system comprises: an exhaust gas pressure sensor, an exhaust gas pressure limiting valve, an automobile electric control unit, an air conditioning or a defogging switch, a waste air damper, a cold air door, a warm air door; wherein the heat exchanger assembly comprises: a heat exchanger exhaust gas outlet pipe, Heat dissipating vane, heat exchanger inner tube, air outlet pipe, heat exchanger exhaust gas inlet pipe, heat exchanger outer pipe, exhaust gas turbine, warm air guiding pipe; wherein air pump assembly

includes: air pump, air intake pipe, air Filter, cold air duct.

When the car is started, the engine exhaust gas enters the heat exchanger assembly through the engine upstream exhaust pipe, the heat exchanger exhaust gas intake pipe, and the exhaust gas damper, and the exhaust gas turbine starts to rotate under the high-temperature high-speed energy impact of the exhaust gas, and drives the coaxial The impeller of the air pump rotates, the air pump starts to work, a vacuum is generated, the outside atmosphere is sucked into the air filter, filtered through the air filter, and then enters the air pump, and the air is compressed by the air pump. When the air conditioner is required to provide warm air, Between the heat exchanger inner tube and the heat exchanger inner tube that reaches the heat exchanger assembly, absorb the heat of the exhaust gas from the heat exchanger inner tube and the heat dissipating vanes, and circulate from the air outlet tube to the automobile air conditioner The heating system enters the cab to provide warm air and defogging functions. When the air conditioner is required to provide cold air, the cold air duct passes through the air outlet pipe to the air conditioning refrigeration system, passes through the evaporation box, and enters the cab. The role of refrigeration.

The heating air control system includes component exhaust gas pressure sensor, exhaust gas pressure limiting valve, automobile electric control unit, air conditioner warm air or defogging switch, exhaust air damper, cold air door, warm air, mainly used for regulating circulation to heat exchanger assembly. The amount of exhaust gas, when no air conditioning work or defogging is required, the electronic control unit of the vehicle controls the exhaust gas pressure limiting valve to be fully open, the exhaust gas damper is closed, and the engine exhaust gas is directly passed through the engine upstream exhaust pipe, the exhaust gas pressure limiting valve, and the engine downstream exhaust pipe. Discharged into the atmosphere; when defogging or warm air is required, the driver can operate the air conditioner or demisting switch to the corresponding gear position, the electric control unit of the car controls the cold air door to close, the warm air is turned on, and the exhaust gas pressure limiting valve is controlled. The exhaust damper opening adjusts the amount of exhaust gas entering the heat exchanger assembly, so that different air flow rates and temperatures can be obtained, and the wind speed and heat of the vehicle air conditioner heating or defogging can be adjusted; when cooling is required, the driver can pass Operating the air conditioner or defogging switch to the corresponding gear position, the car electronic control unit controls the cold air door to open, the warm air door is closed, and controls the exhaust gas pressure limiting valve and the exhaust gas damper opening Regulate the amount of exhaust gas heat exchanger assembly, which can give different air flow rate and temperature, wind speed and can heat the conditioned air is adjusted car.

The ANSYS software was used to model and analyze the improved exhaust branch pipe, and the pipeline structure was continuously optimized. The flow field velocity distribution map of the improved pipeline model and the total distribution map of the branch flow field pressure were obtained.

Analysis of the improved exhaust pipe structure, it can be clearly seen that the utilization of the internal section of the pipeline becomes more sufficient, and the flow velocity becomes higher, there is no internal consumption of the airflow energy, and the gas pressure at the outlet is also improved, which is favorable for the exhaust gas. The heat exchange with the air also facilitates the rotation of the air pump and acts as a blower for the air.

The design is based on the existing exhaust pipe and air conditioning heating system, an air conditioning control system, a heat exchanger system and a turbine system. The overall design idea is to use the exhaust heat and kinetic energy instead of the air blower. The work to achieve air conditioning and warm air, defogging purposes, thereby improving the utilization of exhaust gas and reducing fuel consumption.

According to the previous design, the overall structure of the exhaust gas energy recovery device is finally obtained.

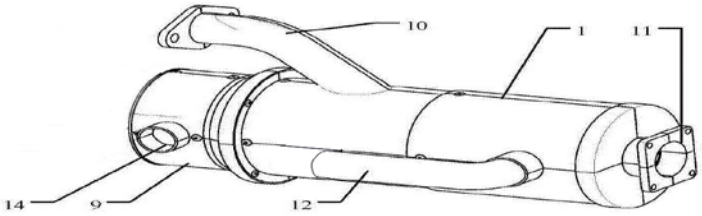

Figure 3.Schematic diagram of the structure of the vehicle exhaust gas reuse device

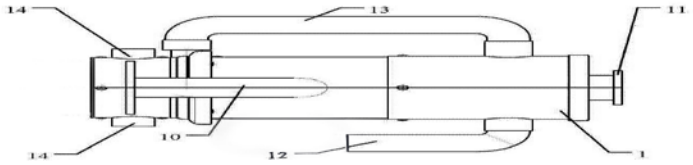

Figure 4. Top view of the vehicle exhaust gas reuse device

1-heat exchanger assembly, 9-air pump assembly, 10-heat exchanger exhaust manifold, 11-engine downstream exhaust, 12-air outlet, 13-air guide, 14-air filtration Device

4. Conclusion and application

Based on the second law of thermodynamics, this paper analyzes the damage of automobile engine exhaust energy, understands the form and cause of vehicle energy loss, and clarifies the limit value of energy utilization. It proposes new automobile exhaust gas reuse based on the existing automobile exhaust pipeline. Design the scheme, and use ANSYS software to model the pipeline of the scheme, carry out fluid analysis, propose improvement schemes, continuously optimize and make the best effect; comprehensively consider the influence of environmental temperature, load, material and other factors to determine the turbine structure. Finally, the overall structure of the exhaust gas energy recovery and reuse device can be used to effectively utilize the exhaust gas energy to improve the fuel utilization rate, reduce the fuel consumption per unit mileage, and achieve the purpose of energy saving and emission reduction.

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