



Experimental Study on Running Loss Emissions of China6-Conventional Gasoline Vehicles and Battery Electric Vehicles

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Abstract. Based on the EPA running loss test procedure, running loss tests were conducted on two China6-conventional gasoline vehicles(ICE) and two battery electric vehicles(BEV). During testing, pollutants was sampled by summa tanks. The test results show that the THC emissions of BEV were about 50% of those of ICE vehicles. There is a significant difference in the composition between ICE vehicle and BEV. The emission of BEV during running is mainly composed of OVOCs and a small amount of alkanes, while ICE vehicles is mainly composed of alkanes, aromatics, and OVOCs. The ratio of OVOCs/alkanes in BEV is between 2.5 and 3.5, and the ratio of OVOCs/alkanes in ICE vehicle is between 2 and 4.

Keywords: Running Loss, BEV, OVOCs.

1 Introduction

1.1 A Subsection Sample

The regional atmospheric composite pollution problem, represented by haze and ozone pollution, is becoming increasingly prominent in China. On the one hand, it is due to the occurrence of severe haze pollution weather, and on the other hand, it is due to meteorological conditions such as calm wind and inversion that are not conducive to the diffusion of pollutants; The sustained high intensity of pollutant emissions and secondary transformation of pollutants are the fundamental reasons for the formation of pollution. VOCs, as important precursors of ozone (O₃) and secondary organic aerosols (SOA), controlling their emissions is crucial for air pollution control [1].

The hydrocarbons emitted by gasoline vehicles mainly come from two pathways: The one is the widely concerned exhaust emissions; The second is evaporative emissions, which refers to the loss of hydrocarbons from the vehicle's fuel system, in addition to exhaust pipe emissions [2]. Running loss refers to the evaporative emissions of oil and gas when the vehicle is in running. China6 [3] of China's light-duty vehicle pollutant emission standards has not yet stipulated it, but as early as the 1990s, researchers

found that the amount of running loss emissions is equivalent to the amount of exhaust emissions. Especially under high temperature (40 °C) conditions, the amount of evaporative emissions from vehicle running increases exponentially compared to 35 °C. Tingting Yue et al.[4] conducted research on the evaporative emissions of gasoline vehicles, pointing out that the characteristics of the VOCs from the hot soak, 24 h diurnal and 48 h diurnalemissions were different due to their different emission mechanisms. Teng Zi[5] et al. studied the composition of components for in use vehicles at different emission control stages, classified according to the proportion of evaporative emission types, and pointed out that among the running loss, hot soak and DBL emissions, alkanes, OVOCs and aromatics were the dominant VOCs groups, OVOCs account for a higher proportion in REC vehicles than in REU vehicles. The major constituents of evaporative emission are small alkanes, alkenes and aromatic hydrocarbons. Aromatics and alkenes contributed the largest portion in OFPs of every emission process[6]. Hata, H.[7][8] et al. estimated the amount of evaporative emissions from vehicular diurnal breathing loss (DBL) by a time-step model, and a detailed inventory was taken of evaporative emissions from parked gasoline vehicles in the Kanto region of Japan. Sun [9] et al. conducted laboratory tests to measure the refueling emissions from ten China 6 vehicles and three China 5 vehicles. Liu[10] et al. tested evaporative VOCs emission of hot soak and DBL from three new China 5, two in-use China 5, and six new China 6 LDGVs, and unravel the deterioration of evaporation control system of in-use ones. Yin Dailin [11] et al. constructed a gasoline vehicle fuel evaporative emission inventory based on the COPERT and MOVES models, and estimated the total amount of different types of evaporative emissions.

At present, there is relatively little research on the different types of evaporative emissions components. This article conducts an analysis of the evaporative emissions components during the running loss process for two gasoline vehicles(ICE) and two electric vehicles(BEV), comparing and analyzing the emission components of ICE vehicles and BEVs, providing data support for the future development of ICE vehicles.

2 Test Scheme

2.1 Test Equipment

The main equipment includes a hydrocarbon analyzer, an running loss enclosure, and dyno. The hydrocarbon analyzer is designed and manufactured by HORIBA company, with model MEXA1170 as shown in Fig. 1 (a). The running loss enclosure is constructed by WEISS company and consists of the enclosure body, air bag layer, fresh air system, fuel tank heating system, temperature control system, etc., as shown in Fig. 1 (b). The dyno is built by the German company Mach, with a maximum speed of 160km/h. The dyno coating is made of low emission materials to minimize the overall background emissions, as shown in Fig. 1 (b). This study used a SUMMA tank (Entech, volume 3.2 L) as the VOCs sampling container, as shown in Fig. 1 (c). The offline analysis and quantitative analysis of VOCs concentration were conducted using the

Hexin AC-GC/MS 2000 atmospheric VOCs adsorption and concentration online monitoring system shown in Fig. 1 (d), which includes 116 VOCs species including alkanes, aromatics, alkynes, OVOCs, and halogenated hydrocarbons.

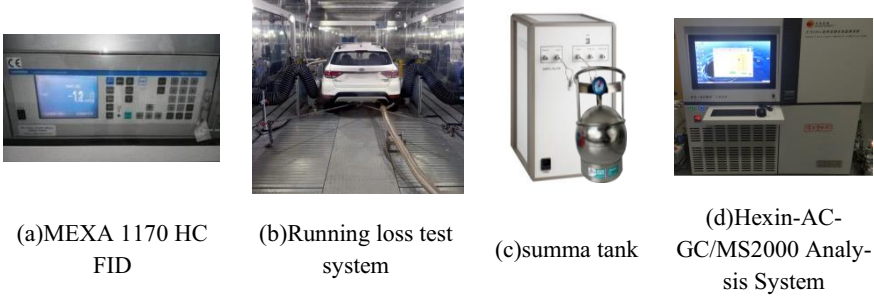


Fig. 1. Test Equipment

2.2 Test Vehicle

Table1 shows that two ICE vehicles that meet the China6 , and two BEVs to conduct EPA running loss testing. During the test, the engine air inlet of the ICE vehicle is connected to the outside of the SHED, and the exhaust pipe is connected to the outside of the SHED to prevent the engine from consuming the air in the SHED and the exhaust gas from polluting the air in the SHED. The schematic diagram of vehicle running loss test is shown in Fig. 1 (b) and Fig. 2.

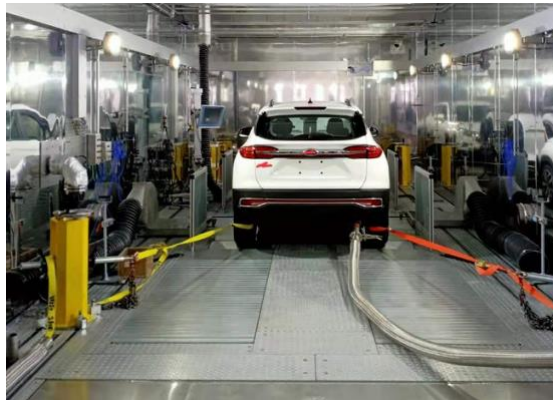


Fig. 2. Schematic diagram of ICE-2 test

Table 1. Test vehicle.

Type	Engine displacement	Emission stage	Mileage (km)	Fuel tank volume
ICE-1	1.2T	China VI	6030	51 L
ICE-2	1.6 L	China VI	4219	46 L
BEV-1	/	/	3300	/
BEV-2	/	/	5600	/

3 Analysis of test results

The test results are shown in Table 2 and Fig. 3. The running loss emission factors of two vehicles, ICE-1 and ICE-2, are 0.0111g/km and 0.0101g/km respectively. ICE-1 was tested according to the EPA running curve, with a driving distance of 27.399km and a hydrocarbon emission of 0.3034g. ICE-2 was tested according to the EPA running curve, with a driving distance of 27.835km and a hydrocarbon emission of 0.2822g, both of which meet the emission requirements of the EPA Tier3 stage. The emission factors for running losses of BEV-1 and BEV-2 are 0.005g/km and 0.0034g/km, respectively. BEV-1 was tested according to the EPA running curve, with a driving distance of 27.575km and a hydrocarbon emission of 0.1377g. BEV-2 was tested according to the EPA running curve, with a driving distance of 27.735km and a hydrocarbon emission of 0.0933g. From the data, it is evidently that the THC emissions of BEVs are about 50% of those of ICE vehicles. The running losses of ICE vehicles mainly come from the escape of the canister air port, the infiltration of the fuel tank, the infiltration of the engine compartment pipeline interface, and non-fuel emissions. The running losses of BEVs mainly come from HC volatilized after heating, such as tire wear and seat clinker, mainly from the emissions of non-fuel hydrocarbons.

Table 2. Vehicle Test Result

	HC Emission(g)	Mileage (km)	Results(g/km)
ICE-1	0.3034	27.399	0.0111
ICE-2	0.2822	27.835	0.0101
BEV-1	0.1377	27.575	0.005
BEV-2	0.0933	27.735	0.0034

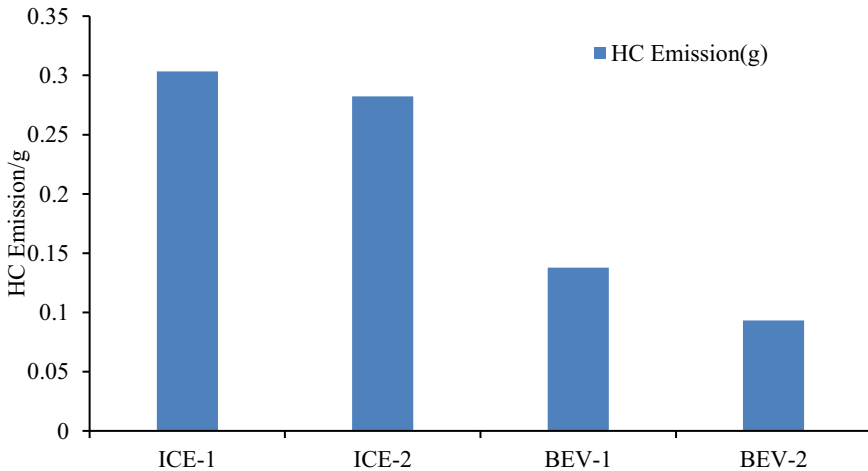


Fig. 3. Comparison of HC emissions from different vehicles

Fig.4. shows the results of different vehicle running loss emission components. Two VOCs samples were collected from each vehicle using the summa tank, and species analysis was conducted using GC-MS. The results showed that there was a significant difference in the composition of the components between BEVs and ICE vehicles. BEV running loss emissions were mainly composed of OVOCs and a small amount of alkanes, while ICE vehicles were mainly composed of alkanes, aromatics, and OVOCs. This is mainly because the VOCs of electric vehicles mainly come from component wear or volatility of interior materials. The VOCs of ICE vehicles mainly come from the volatilization and infiltration of fuel and gas in the fuel system. However, the composition of ICE-1 and BEV-2 in the new model of China6 is relatively close, indicating that the volatilization of fuel and gas from the fuel system is less, indicating that the tightening of China6 emission standards has an excellent control effect on running loss emissions. The OVOCs/alkane ratio of BEV ranges from 2.5 to 3.5, while the OVOCs/alkane ratio of ICE ranges from 2 to 4.

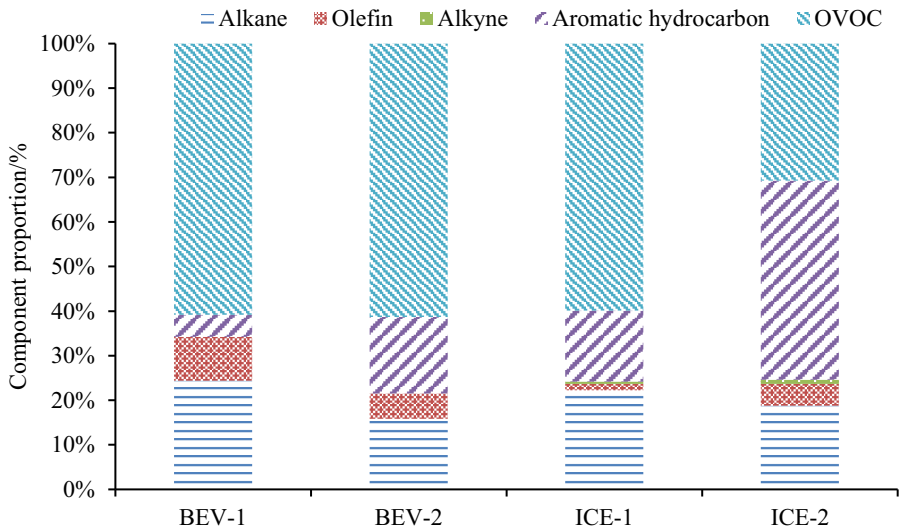


Fig. 4. Emission Component Results of Different Vehicle running Loss

4 Conclusion

Based on the EPA running loss test procedure, running loss test was conducted on two China6 ICE vehicles and two BEVs. Summa tank sampling was conducted on pollutants to analyze the evaporative emission components during the running loss process. A comparative analysis was conducted on the running loss emission components of ICE vehicles and BEVs. The research conclusions are as follows:

(1) The emission factors for running losses of ICE-1 and ICE-2, are 0.0111g/km and 0.0101g/km, respectively, meeting the EPA standard running loss emission limits.

(2)The hydrocarbon emissions of ICE-1 are 0.3034g, ICE-2 is 0.2822g, BEV-1 is 0.1377g, and BEV-2 is 0.0933g. The overall HC emissions of BEVs are about 50% of those of ICE vehicles.

(3)There is a significant difference in the composition between BEVs and ICE vehicles. The emissions of BEV during running are mainly composed of OVOCs and a small amount of alkanes. ICE vehicles are mainly composed of alkanes, aromatics, and OVOCs. The OVOCs/alkanes ratio of BEV is between 2.5 and 3.5, and that of ICE is between 2 and 4.

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