Implementation and challenge of China IV Heavy-duty Standard

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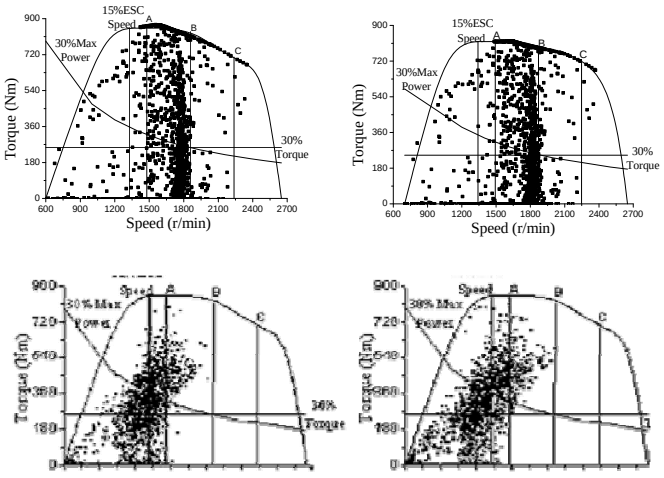
Content

- Differences between road condition and emissions certification condition
- Bus real-world emission characteristics
- Sediments of urea SCR system
- Technology policy
- Technology solution
- Conclusion

Differences



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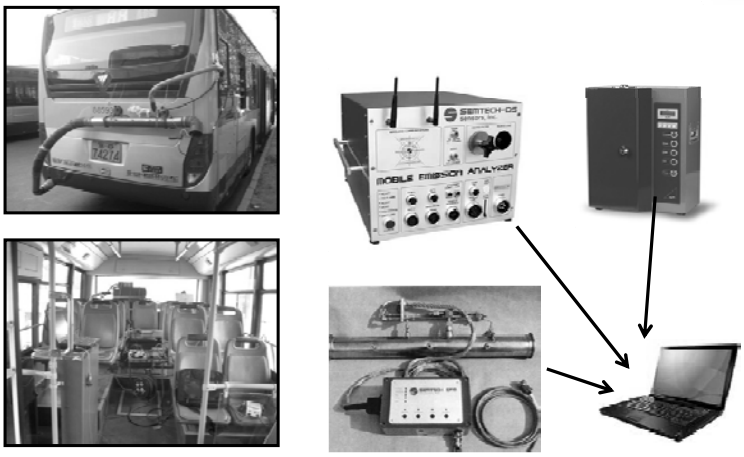
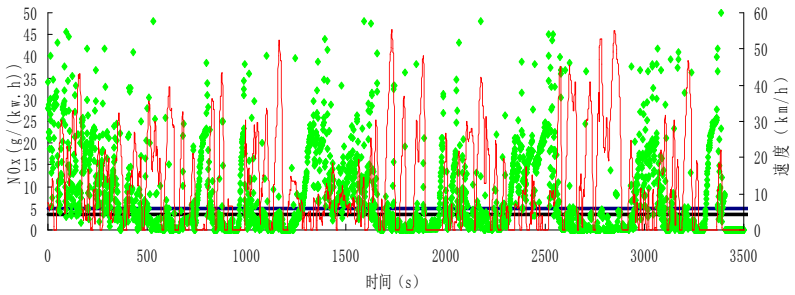
Evaluate SCR effectiveness by PEMS

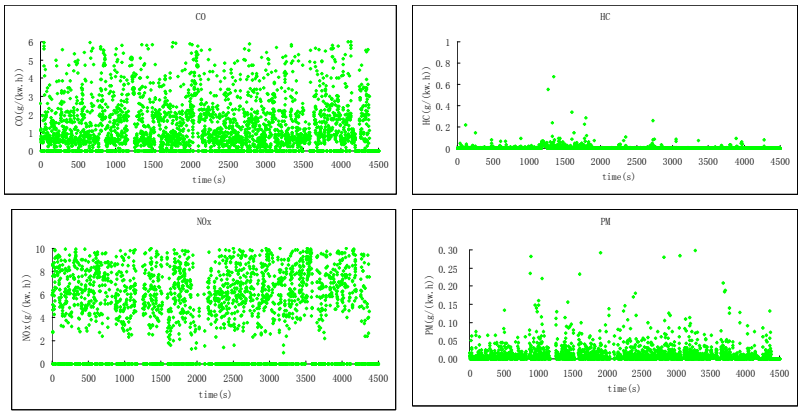


Relationship between NOx emission and speed



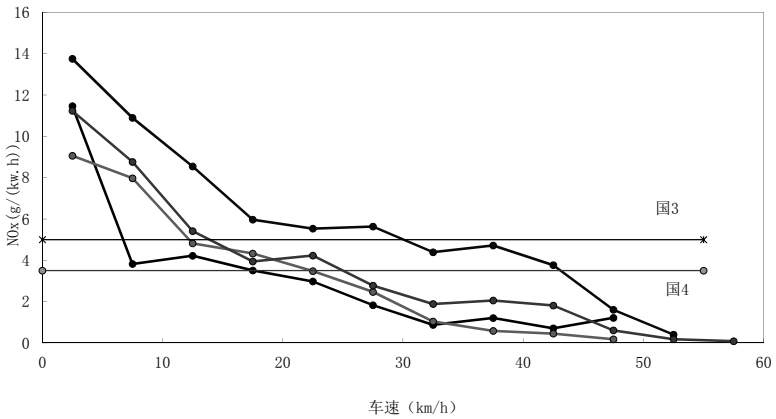
The higher the speed, the lower the NOx emission

Bus real-world emission timeline

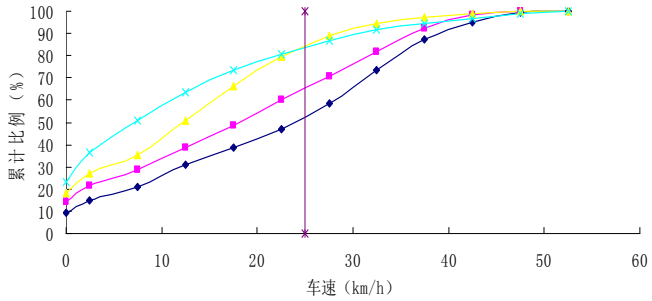


ETC limits for China IV: CO 4.0g/kWh, NMHC 0.55g/kWh, NOx 3.5g/kWh

NOx emission decrease with increase in speed （China IV）

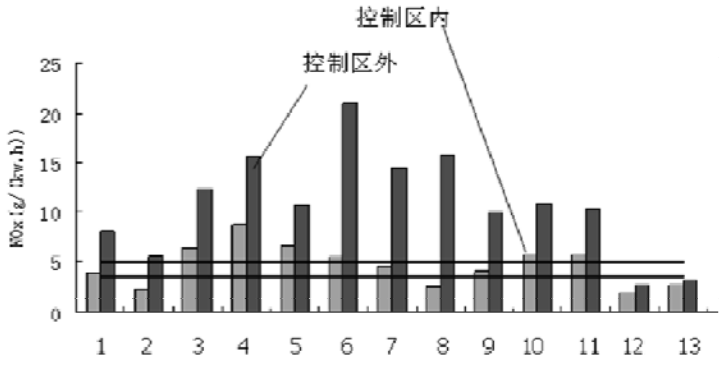


Time percentage of different speed

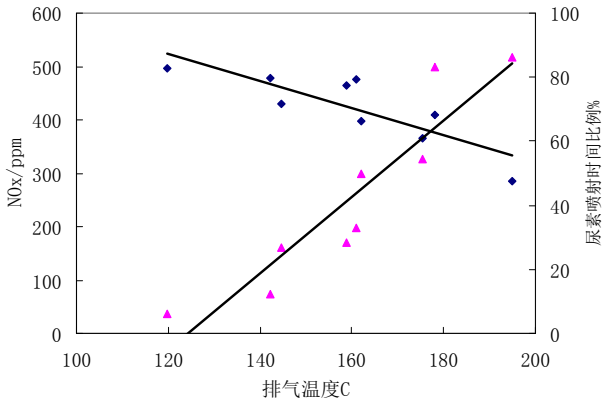


The actual speed more than 25km/h in rural area only occupies 20%-50% of total.

NOx emission in/out ETC control area

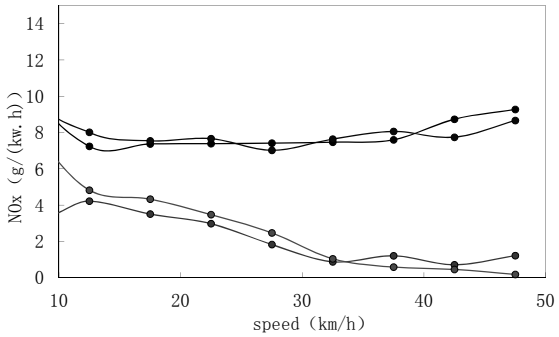


Relationship between NOx concentration/Urea injection ratio and emission temperature



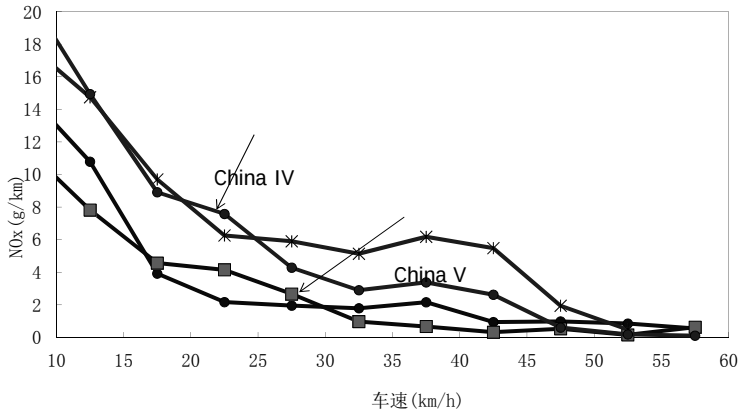
Note: Exhaust temperature measurement point is located in the diesel exhaust exit!

NOx emission comparison (with/without Urea injection)

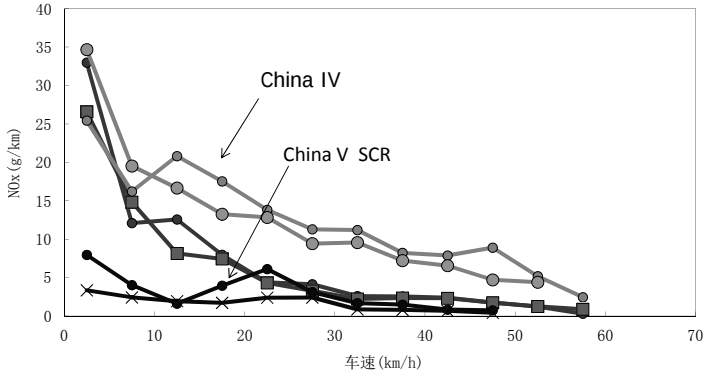


For Heavy-duty diesel with SCR, if SCR system doesn't work properly， NOx emission level will be back to China I. Therefore, strict technical regulation measures should be taken to guarantee the normal work of the system to control NOx emission.

Comparison between China IV/V diesel buses



Comparison between China IV/V LNG buses



Content

Differences between road condition and emissions certification condition

Bus real-world emission characteristics

Sediments of urea SCR system

Technology policy

Technology measure

Conclusion

Sediments of urea SCR system

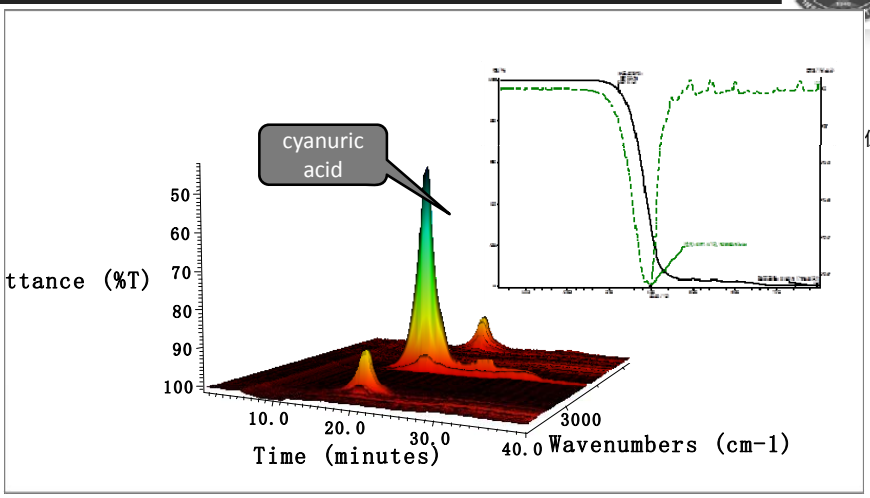
Thermogravimetric-Fourier transform infrared spectroscopy (TG-FTIR)

TG-FTIR

Fourier transform infrared spectrometer NICOLET 6700

TG analyzer TG209F1

Thermogravimetric-Fourier transform infrared spectroscopy （TG-FTIR)



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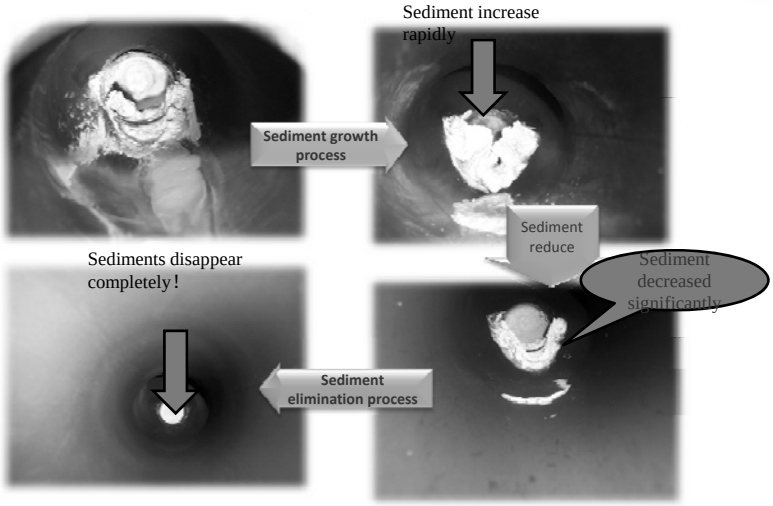
Generation and elimination of sediment



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Technology Policies

1、Introducing WHTC condition as additional condition

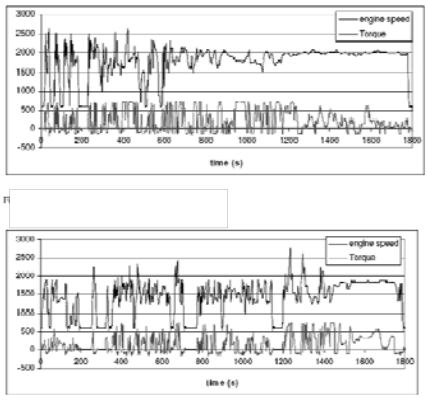
2、Introducing on-board emission measurement standard, using the NTE or "window method" to evaluate

3、Add NOx test for the HDDVs which meet China IV standard in the annual emission inspection

4、 Implementing online NOx monitoring & NOx data real-time transmission for buses

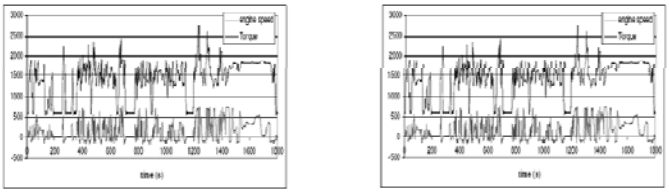
5、Using remote sensing to identify high emission vehicles

1） WHTC&ETC Cycle



ETC mainly covers medium and high load condition under medium engine speed, however, WHTC cycle includes more proportion of low engine speed and low load condition, which is exact typical cycle of operating in urban area. The average engine speed of WHTC cycle is 36% of rated engine speed while the rate of ETC is 57%. The average engine power if WHTC cycle is 17% of rated engine power while the rate of ETC is 31%. In addition, WHTC includes 17% idle condition but ETC includes only 6%. The exhaust temperature under WHTC cycle is lower than that of ETC cycle. As a result, WHTC is more adaptable for the operation situation of Beijing buses.

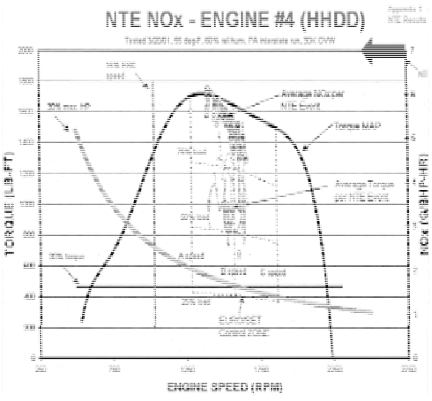
Additional cold start cycle



WHTC with cold start ⟷ Hot Soak period ⟷ WHTC with hot start

Considering the influence of catalyst initiation temperature, we suggest add cold start emission certification test in China IV emission standard, it includes cold start, hot dipping and hot start. final test result indicates the weighted value is cold start 14% + 86% hot start（Beijing）;
MEP WHTC cold start。

2） Vehicle test -NTE

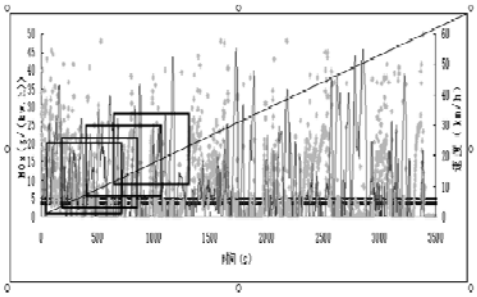


EPA passed the heavy duty vehicle NTE regulations in 2005, and began formally implemented in 2007, NTE regulations are applicable for the finalized diesel after 2007. NTE regulations establish a NTE test area based on the engine external characteristic curve. Pollutant emission cannot exceed the regulated specific ratio in this area. There are no regulations for specific test cycle, but it requires vehicle to operate in real-world condition, that can cover all possible point and easy to carry out.

Vehicle test-window method

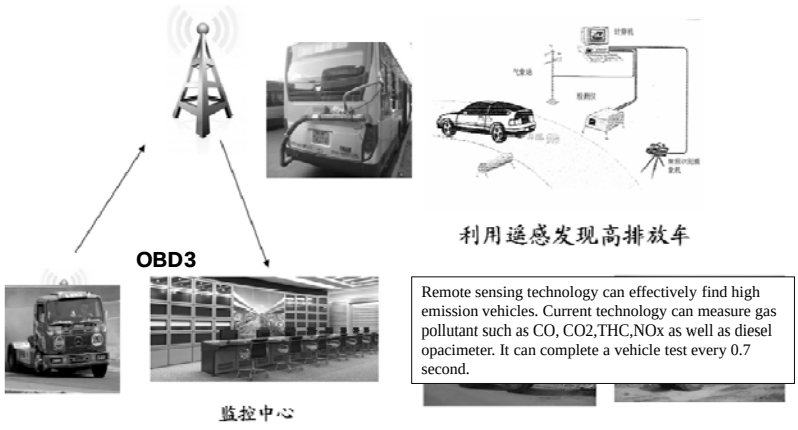
European experts believe that NTE area is not appropriate for city operation condition. Because in many cases, it is difficult to measure and acquire test points in NTE area for 30 seconds. Therefore, they prefer to use window method to evaluate vehicle emission test.

- "Window method" was first put forward by West Virginia University, it was adopted by the European Union, window method is suitable for analyzing the actual road emissions in the city



3）NOx test for China Ⅲ+ diesel vehicle

4）Other policy measures



Remote sensing technology can effectively find high emission vehicles. Current technology can measure gas pollutant such as CO, CO2,THC,NOx as well as diesel opacimeter. It can complete a vehicle test every 0.7 second.

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Technology measures-optimal control strategy

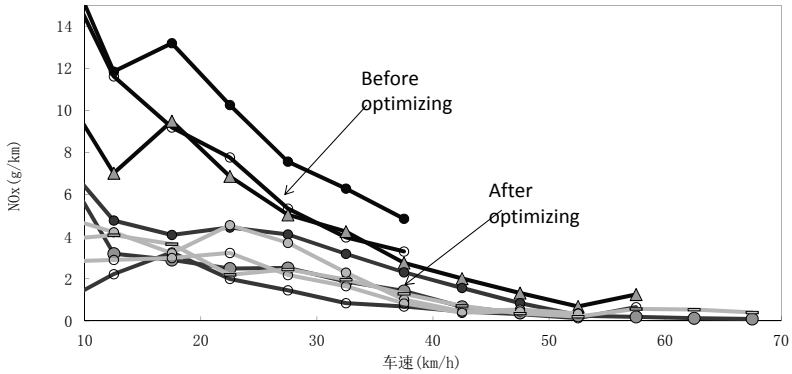
The exhaust system heat preservation;

The application of ammonia storage strategy;

Post-injection;

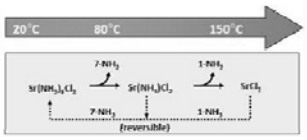
Inlet throttling; ..... .

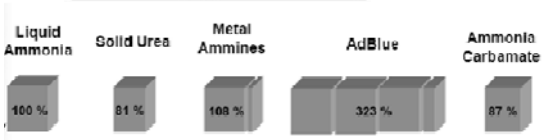
Effect comparison



Solution——Solid SCR

Solid SCR stores NH3 in solid form and stored in an airtight container. When the temperature rise to 80+℃，solid ammonium salt will release NH3. Initiation temperature of molecular sieve based catalysts is about 180℃，initiation temperature of vanadium-based catalyst is around 250℃. The temperature characteristic of solid ammonia is suitable for molecular sieve catalyst, urea SCR temperature characteristic is suitable for the widely used vanadium-based catalyst in China.





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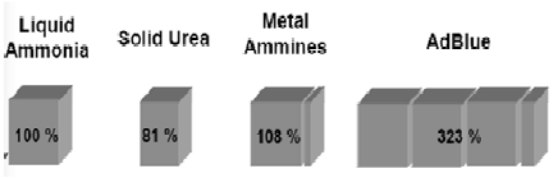
Technical measures −Solid SCR



Advantages:
1.effectively improve the effect of low emission control, initiation temperature can be reduced to about 150 ℃
2. sediments free
3.Longer travel distance with the same storage

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Conclusion

1、The differences between actual operation condition and emission certification lead to the difference of emission effect. Actual NOx emission of China IV bus may not achieve expect effect. We suggest to add additional certification operating condition WHTC and related limit for City bus diesel in China IV/V.

2、Actual NOx emission of China Ⅴ buses is much better than phase

3、On-board emission measurement technology can effectively evaluate road vehicle emission levels, and it should be gradually incorporated into the compliance management of heavy duty in-use diesel engine

4、We suggest to test NOX and soot for that in-use diesel vehicles which use after treatment device in the annual inspection

5、Should enhance the management of heavy duty diesel emission OBD system and carry out online real-time monitoring for the OBD system of municipal vehicles

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